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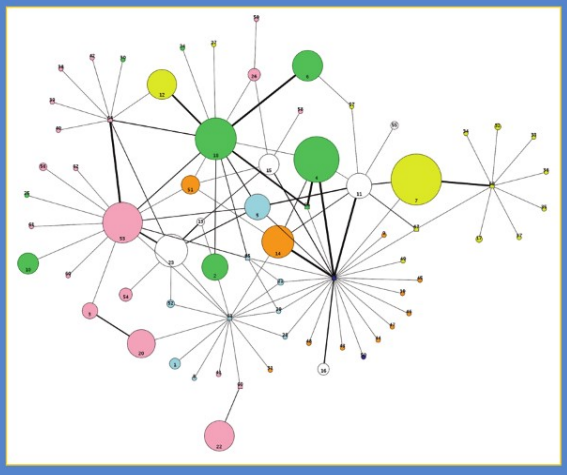
Pompeu Casanovas Ugo Pagallo
Giovanni Sartor Gianmaria Ajani (Eds.)

AI Approaches to the Complexity of Legal Systems

Complex Systems, the Semantic Web, Ontologies, Argumentation, and Dialogue

**International Workshops AICOL-I/IVR-XXIV
Beijing, China, September 2009 and AICOL-II/JURIX 2009
Rotterdam, The Netherlands, December 2009
Revised Selected Papers**



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Pompeu Casanovas Ugo Pagallo
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Foreword: What AICOL Workshops Intend to Be

This volume assembles the selected papers stemming from two workshops, organized at the XXIV World Congress of Philosophy of Law and Social Philosophy (IVR, Beijing, China, September 15–20, 2009), and at JURIX 2009(December 16–19, 2009, Rotterdam) (see: `http://idt.uab.es/IVRXXIV-aicol09`). AICOL stands for "Artificial Intelligence Approaches to the Complexity of Legal Systems."

Complexity and complex systems, then, summarize the perspective chosen to describe recent developments in AI and law, legal theory, argumentation, the semantic web, and multi-agent systems. In this sense, AICOL Workshops, the two former as well as the forthcoming ones, are conceived as a meeting point for diverse researchers (legal theorists, political scientists, linguists, logicians, and computational and cognitive scientists) eager to discuss and share their findings and proposals. We want to contribute to overcome through theoretical and mutually informed dialogue the multiple gaps and misunderstandings existing between formal and empirical approaches to the law, and between theoretical inquiries and the practices of lawyering, rule-making and sentencing. Some years ago, the distinguished American scholar John Henry Merryman referred elegantly to this communication problem by choosing as a general title for his selected works *"The Loneliness of the Comparative Lawyer"* (1999). We think that, in a way, researchers in the complexity of legal systems have experienced this isolation too, partly due to the same expertise which is required to properly carry out their work.

The inspiring idea of AICOL 2009 was indeed to develop models of legal knowledge, concerning its organization, structure and content, in order to promote mutual understanding and communication between different legal systems and cultures. By achieving more precise models of legal concepts—from multilingual dictionaries to taxonomies and legal ontologies, namely, formal models of legal conceptualization—we enhance our comprehension of legal cultures, of their commonalities and differences. Moreover, in this way we can profit increasingly from computer support in managing legal knowledge, drawing on convergences and bridging differences for deeper understanding.

Legal ontologies, in particular, support the creation of multi-agent systems for the law—where the different agents can understand one-another by sharing the same concepts, or through the awareness of their different conceptual structures—which can be useful, for instance, in electronic commerce and the building of web services. Legal ontologies can profit from social network analysis, which could indicate what terms are fundamental for comparison. The study of how legal information is produced and distributed in complex social systems makes it possible to follow the semantic evolution of the network through its own

topology, since the set of nodes with highest degree represents the main core of the taxonomy with the shortest average distance-concepts. The domain of multi-system and multi-lingual ontologies offers the opportunity to integrate artificial intelligence not only with legal theory, but also with further, more empirical and comparative, legal studies.

The relation of legal ontologies, multi-agent systems, and distributed networks, is only one, albeit important, among many other examples of research in AI and law. The aim of the AICOL workshops is thus to offer effective support for the exchange of knowledge and methodological approaches between scholars from different scientific fields, by highlighting their similarities and differences. The comparison of multiple formal approaches to the law—such as logical models, cognitive theories, argumentation frameworks, graph theory, game theory, as well as opposite perspectives like the internal and the external viewpoints—should stress possible convergences, as for instance in the realms of conceptual structures, argumentation schemes, emergent behaviors, learning evolution, adaptation, and simulation.

We would like to thank the AICOL reviewers and the Organizing Committees of the JURIX 2009 and IVR 2009 conferences. We would also like to thank Alfred Hofmann for being so sensitive to the main AICOL idea. The following projects allowed the conception and organization of the research workshops, and the edition of this first volume: CSO-2008-05536-SOCI, TSI-020110-2009-39, TSI-020110-2009-374, TSI-020501-2008-131, TSI-020100-2008-134, and JLS-28002-CFP-CJ-08.

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Table of Contents

III Argumentation and Logics

IV Dialogue and Legal Multimedia

Introduction: Complex Systems and Six Challenges for the Development of Law and the Semantic Web

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Abstract. AICOL workshops aim to bridge the multiple ways of understanding legal systems and legal reasoning in the field of AI and Law. Moreover, they pay special attention to the complexity of both legal systems and legal studies, on one hand, and the expanding power of the internet and engineering applications, on the other. Along with a fruitful interaction and exchange of methodologies and knowledge between some of the most relevant contributions to AI work on contemporary legal systems, the goal is to integrate such a discussion with legal theory, political philosophy, and empirical legal approaches. More particularly, we focus on four subjects, namely, (i) language and complex systems in law; (ii) ontologies and the representation of legal knowledge; (iii) argumentation and logics; (iv) dialogue and legal multimedia.

Keywords: AI & Law, legal theory, complex systems, Semantic Web, legal ontologies, legal semantic web services, argumentation.

1 Introduction

Work on Artificial Intelligence and Law has been particularly fruitful in the last decade. Besides providing advanced computer applications for the legal domain such as knowledge based systems and intelligent information retrieval, research in AI and Law has developed innovative interdisciplinary models for understanding legal systems and legal reasoning, which are highly significant for philosophy of law and legal theory. Among such models, we can mention, for instance, logical frameworks for feasible legal reasoning and dialectical argumentation, logics of normative positions, theories of case-based reasoning, and computable models of legal concepts.

Today there is a strong need not only to integrate research in AI and Law within legal theory, but also to encompass the different branches of research in this area. When different branches are developing quickly, the risk is in fact missing the opportunities to exchange knowledge and methodologies. This is particularly so in the case of the multiagent systems-approach and social network analysis, that share concepts and objects of study, but often present merely superficial convergences in practice as

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well as in theory. Multilingual ontologies provide an important opportunity for complementing different trends of research in AI and Law as those mentioned above: logical models of norms and concepts, multiagent systems, and distributed networks.

Recently, research on models of legal systems and legal reasoning has merged with research on multiagent systems (MAS), in order to animate such models: normative structures may provide guidance to, and result from, the interaction of digital agents, that is autonomous entities able to act and communicate, in the pursuit of their purposes, possibly accepting the constraints of violable rules. By developing computable models including not only legal norms and concepts but also legal agents (with the associated roles and procedures) we can go beyond the statics of a legal system, i.e., its representation as a set of norms and concepts, and capture the social, interactive and dialectical dynamics of the law (using also ideas from game theory). An even more recent line of research in AI and Law uses social network analysis to model the evolution of the law. This means identifying the patterns of emergent behavior of complex social networks and the ways to anticipate and control such dynamics.

Thus, the AICOL Workshops aim at addressing legal subject matters, by facing the methodological, epistemic and ontological problems of knowledge and information processing in complex systems. In what follows, we will examine these theoretical and practical dimensions of complexity in the law, legal systems and legal web services.

2 Complexity and Legal Systems

Complexity is a complex notion on its own: Along with dozens scientific definitions of the concept [1], it has been argued that complexity is "too general a subject to have much content" so that only "particularly classes of complex systems possessing strong properties that provide a fulcrum for theorizing and generalizing can serve as the foci of attention" [2].

Unsurprisingly, we find several and often contradictory definitions of complexity in the realm of law as well. For example, Luhmann claims in *Social Systems* that complexity "means being forced to select; being forced to select means contingency; and contingency means risk" [3]. Moreover, in Hayek's *Law, Legislation and Liberty*, the idea of complexity is introduced to illustrate the very difference between *taxis* and *kosmos*, that is, between deliberate human arrangements and the emergence of spontaneous orders, thereby representing the key word of Hayek's critique of any kind of social constructivism: "One of our main contentions will be that very complex orders, comprising more particular facts that any brain could ascertain or manipulate, can be brought only through forces inducing the formation of spontaneous orders" [4].

Furthermore, the expression 'complexity of law' is not rarely used as opposed to simplification. Along with scholarly work [5], specially in France [6, 7, 8], public organizations and institutions often refer to the effects of globalization in terms of anxiety and panic, insofar as "la complexité croissante de notre droit est devenue une source majeure de fragilité pour notre société et notre économie" [9].

This panoply of different meanings and approaches, however, should not worry us. Let aside prescriptive or value-laden assumptions on the topic, the key is to preliminarily grasp the mechanisms of complexity by developing analytic tools for describing it. Following the abovementioned work of Simon [2], the aim is to briefly recall

the 'three eruptions' or burst of interest which have characterized scholarly research throughout the twentieth Century, so as to cast light on different aspects of the phenomenon.

First, after World War I, the key term was the neologism 'holism', together with 'Gestalt' and 'creative evolution.'

Then, after World War II, research on complexity was associated to the notions of 'information', 'feedback', 'cybernetics' and 'general systems.'

Finally, current work on the topic mainly focuses on the ideas of 'chaos', 'adaptive systems', 'genetic algorithms' and 'cellular automata.'

As well-known, Simon proposes a sort of compromise between reductionism and holism. By suggesting that hierarchy, *i.e.*, a system made of inter-related subsystems, offers the clue for grasping the architecture of complexity, it does not follow that both the description of the properties of those subsystems and the laws of their interaction would allow us to infer how the whole mechanism actually works: In the same way in which determinism does not mean predictability, very simple laws often end up in really complex phenomena.

Besides, Simon's ideas on hierarchy provide another conciliation between the top-down approaches and bottom-up perspectives on complexity mentioned above, *e.g.*, Luhmann's theses on the structure and functioning of social systems, on one hand, and Hayek's views on the evolution of spontaneous orders on the other. Simon's notion of "nearly decomposable systems" reconciles such outlooks because "the clusters of dense interaction in the chart" of social interaction "will identify a rather well-defined hierarchic structure" [2]. Nevertheless, according to the "empty world hypothesis," the term of near decomposability denotes that "most things are only weakly connected with most other things; for a tolerable description of reality only a tiny fraction of all possible interactions needs to be taken into account" [2].

Quite interestingly, this aspect of Simon's work has been deepened by today's research on network applications to (complex) legal systems. Their representation in terms of nodes, arcs or links, diameter of the network and its clustering coefficients, has delivered fruitful modeling for the comprehension of poorly understood systems and even modeling as a source of new knowledge [10, 11]. For instance, in the light of the differentiation of regular networks, random networks, and small worlds, we know that Simon's "empty world hypothesis" can be grasped with the notion of hubs, *i.e.*, a small fraction of nodes in the network with a much higher degree of connectivity than the average. These hubs not only offer the common connections mediating the short path lengths between nodes of the network, but also explain the clusters of dense interaction in the chart of social exchange. This occurs when small, tightly interlinked clusters of nodes are connected into larger, less cohesive groups, through the hubs [12, 13].

Along with specific work on jurisprudence [14, 15, 16], codes [17], and even legal theory [18], there have been attempts to measure the complexity of legal systems in order to compare their structure and content in terms of interpretability, density of norms, institutionalization, and so forth [19]. This would be possible by determining the "structure-based" measure of the network, which involves the organization of the legal text and the quotations in a given corpus, as well as the "content-based" measure, namely, the diversity of legal outputs produced by any legal system [20].

Despite such theoretical efforts, there are still open problems concerning, say, the heuristic capability of the models in explaining real world-phenomena [21, 22], and the mechanisms according to which the distribution of information arises in social systems, that is, via combinations of exponentials, inverses of quantities, random walks, the "Yule process," phase transitions and critical phenomena, self-organized criticality, etc. [23]. Whereas it is essential to ascertain on what "level of abstraction" network analyses are carried on [24], we can single out some convergences with other fields of research, so as to determine what is going on in the realm of legal theory and complexity. Let us point out three main areas.

First, today's complexity of the law stands for the crisis of legal positivism and the dogma of sovereignty: Even when adopting a top-down approach, there are no simple vertexes like in the traditional Kelsenian model of the legal pyramid. As it has been stressed by seminal work in transnational law [25], we observe the fragmentation of such old vertexes [26, 27, 28], which should be properly understood in the wider context of Simon's clusters of dense interaction mediated by institutional hubs [29].

Secondly, today's complexity of the law recalls the bottom-up approach of Hayek's ideas on evolution and constructivism, spontaneous orders and human (political) planning, for the informational complexity of the *kosmos* cannot be reduced to any *taxis* and, furthermore, orders spontaneously evolve from such informational complexity. It is noteworthy that, in conformity with Simon's theses, this evolution is framed in novel hierarchical forms [30]. Along with research in 'evolutionary algorithms' or 'adaptive social systems' [31, 32], the topic has also been addressed in terms of "normative emergence" from a multi-agent systems-perspective [33].

Finally, we have to mention the impact of technology on current legal systems [34], and how multiple fields of AI and Law are practically dealing with complexity in terms of, say, legal ontologies, Web services, computer engineering, etc. Because of their relevance in the exchange of knowledge and methodologies put forward by the AICOL workshops over the last year, let this new frontier in contemporary legal systems guide us through the detailed analysis in the next paragraph.

3 Legal Semantic Web Services: Six New Challenges

It is generally accepted that computational complexity theory deals with the practical boundaries on what computers can and cannot do. In his Turing Award Lecture in 1982, Stephen A. Cook distinguished parallel computation models from probabilistic computation, computational information models and upper and lower bounds in the measurement of the complexity of a mathematical problem [35]. As we have said, these different approaches have been considered in the legal information field only recently. Computable models of the law are usually proposed within the regular strong Church-Turing paradigm [36]. Alternative approaches —such as quantum interaction [37] and interactive models [38]— are being developed first on other non-legal domains. Besides, engineering in law poses a set of different problems dealing with the practical behavior of users within multiple scenarios. This means that, as H.A. Simon pointed out, computer and human behavior interface matters [2]. Complexity lies in context, within the inner/outer ambience dynamics which is commonly referred as the 'extension mind hypothesis' (or 'active externalism') rather that in a

closed human mind. In contrast with the conventional view of the computer/brain metaphor, body and world can sometimes form part of the machinery by which mind and cognition are physically realized [39, 40].

Let's consider complexity from this practical side, too. There are three challenges to be considered related to the development of the Semantic Web: (i) the relationship between the Social Web (Web 2.0) and the Web of Data (Web 3.0); (ii) evolving legal ontologies (and their relationship to folksonomies), (iii) and the construction of Semantic Legal Web Services (SLWS).

Bridging the gap between the Social and the Semantic Web is perhaps one of the main concerns [41, 42] The Web is no longer considered only a web of linked websites, but a *web of linked data*: publication of capabilities is as important as vertical applications. Flickr, YouTube, Delicious, mySpace, eBay… are examples of user generated content which can be harnessed by semantics and participative architectures [43].

In this way, collected intelligence outputs may become the path for collective intelligence processes as well. *Mashups* (combining data or functionality from two or many more external sources to create a new service) and *Web-based crowdsourcing* (*e.g.* collaborative tagging) are related to this basic idea. As Tom Gruber [44] put it, collective knowledge systems are based in the synergy of the ecosystem of participation and the ecosystem of aggregated data. In the former, value is created by the aggregation of many individual users; in the SW, value is created by the integration of structured data from many sources. 'We will know we are crossing into the new learning paradigm when we see a qualitative change in the way people think of interacting on the web. Today, that interaction pattern treats the web as an information source: we learn by browsing, searching, and monitoring the web. Tomorrow, the web will be understood as an active human-computer system, and we will learn by telling it what we are interested in, asking it what we collectively know, and using it to apply our collective knowledge to address our collective needs'.

The way of facing ontology conception and construction is changing too. Contextual ontologies constitute a classical problem [45], especially in multimedia [46] and ontology visualization [47]. However, in the second SW generation, ontologies are conceived in a lighter way, to be combined with data mining, NLP techniques and folksonomies [48]. Tagging-systems (i.e. *folksonomies*) seem especially apt to be combined with a more structured semantic approach, even if they present phenomena as tag synonymy, tag polysemy, and basic level variation [49, 50].

Semantic Web Services (SWS) constitute a third challenge. Combination of semantic and social dimensions produce Web 3.0, and by combining semantic technology and web services we create the possibility of offering service communities [43, 51]. Fig. 1 shows the vision of SWS, as recently plotted by SW developers (J. Davies, J. Domingue, D. Fensel et al.). This would imply the transformation of service-oriented architectures (SOA) into an architecture comprised of billion of services, grounded into the worldwide sharing of content: (i) properly incorporating principles that made the web scale to a worldwide communication infrastructure (contracting, reusability, autonomy, discoverability, composability…); (ii) achieving significant automation of service lifecycle activities (location, negotiation, adaptation, composition, invocation and monitoring as well as service interaction requiring data, protocol and process mediation); and (iii) reaching a balanced integration of services provided by humans and machines [43].

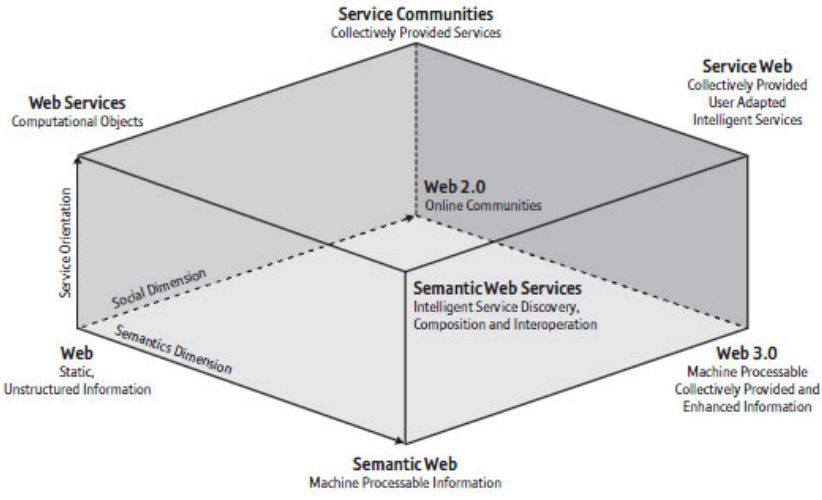

Fig. 1. SWS technological pillars. Source: [43] (reproduced with permission).

This seems to be a reasonable next step for the development of the web. However, what does it happen in the legal field?

Law in the web constitutes an ever expanding field. Since the nineties, World Legal Information Institutes provide free access to thousands of legal databases [52, 53]. Contrary to an extended belief, legal professions (mostly, law firms, judiciaries and governmental agencies) have shown a growing interest in taking advantage from the web communicative and expressive capabilities, and this is still the case with the emergence of *blawgs* and the provision of legal services in the Web 2.0 [54]. Moreover, partly due to the special risk-aversion of the field, privacy, trust and security have been an issue since the beginning. Protecting sensitive data, and setting up secure content and interfaces for users are the main concerns [55, 56].

Therefore, there are at least three more challenges to be faced by law and the spreading of Semantic Web services: (iv) bridging the gap between IT law and IT for lawyers; (v) grasping the changing and evolving nature of regulations through the convergence between Web 2.0 and Web 3.0; (vi) adding reasoning and applying dialectic systems to facilitate users' exchanges and legal operations (contracting, sentencing or drafting).

The fourth challenge means overcoming the traditional divide between IT law (intellectual property, patent law, privacy…) and IT for lawyers (legal programming, computer and AI tools) [54, 57]. With the web focused on linked content, it does not make much sense maintaining the two fields separated: computer scientists and ontologists have to model content regulations into programs, and lawyers should be able to understand and even actively participate in protocol design.

The last two challenges are directly connected to the developments of legal theory, argumentation, and multi-agent systems (MAS). Regulation is not just rules and norms. Besides technical protocols and web languages, there is in the web a consistent growing trend towards user-centered patterns and collective behavior. Sharing content means capturing emergent patterns which lie on the complexity of interactions. People

are only partially aware that sometimes they are following paths that can be described and explained by means of complex systems [58]. Self-regulation and personalization may wide up this dimension of an emergent collective order through the layers of semantic languages.

Critical thinking, informal logic, deontic logic, non-monotonic logic, argumentation theory, multi-agent systems, can be incorporated to set up the legal reasoning frame in which LSWS may flourish. In this way, users could add content into an automated environment able to facilitate the performance of legal acts through successive (interactive) moves. Dialectic systems are crucial to reach this late objective. Legal theory is crucial to structure its content.

4 On the Content of This Volume

AICOL Workshops are planned to foster discussion on these topics among the different perspectives and branches of AI & Law, legal theory, political philosophy, and empirical legal approaches. We have organized the papers included in this volume in four sections: (i) language and complex systems in law; (ii) ontologies and the representation of legal knowledge; (iii) argumentation and logics; (iv) dialogue and legal multimedia.

Complex systems are the subject matter of the first section. Ugo Pagallo illustrates the informational nature of complex social systems via a theory of spontaneous orders and an evolutionary theory of complex social networks. He reflects on the main distinction between *taxis* and *cosmos* set up by Hayek. Gianmaria Ajani and PierCarlo Rossi propose some insights on how the relationship of Law and AI concerns the issue of knowledge discovery. They focus on social network analysis and the application of ontologies in multicultural contexts. Romain Boulet, Pierre Mazzega and Danièle Bourcier search for hidden structures within the network of citations of the French Environmental Code. The graph associated to it has a small-world structure. Monica Palmirani uses NLP techniques to isolate relevant parts of linguistic speech in the content of norms. She presents a methodology to classify a special kind of norms called “modificatory provisions”.

Ontologies and legal knowledge representation constitute loosely the next section. Alexander Boer, Tom van Engers, and Radboud Winkels write on traceability and change. They introduce the Agile Project, in which a mediating layer of representation functions as link bases for traces to sources of law and other resources (business processes, service specifications, etc.). Tommaso Agnoloni, Meritxell Fernández-Barrera, Maria Teresa Sagri, Daniela Tiscornia and Giulia Venturi compare a FrameNet-style (NLP-based analysis) and an ontological characterization of the fundamental legal concept of ‘obligation’. They contend that lexicons can be mapped into ontological characterizations, bridging the traditional gap between linguistic (NLP) and semantic approaches. Jeroslaw Bak and Czeslaw Jedrzejek present a crime ontology-based model of fraudulent disbursement. They set up a ‘conceptual minimal model’ consisting of eight layers of concepts to use available data on facts and to map crime actions and roles. Gioele Barabucci, Luca Cervone, Monica Palmirani, Silvio Peroni, and Fabio Vitali introduce Akoma Ntoso, a project with African Parliaments to organize and classify their legal texts as XML documents. Akoma Ntoso maintains separated

many conceptual layers, and provides ontologies on top which allow simple legal reasoning as well.

The third section focuses on argumentation and logics. Guillaume Aucher, Guido Boella and Leon van der Torre make the distinction between prescriptive and descriptive obligations within dynamic epistemic deontic logic. In a second paper pointing to the same direction, Antonino Rotolo, Guido Boella, Guido Governatori and Leon van der Torre reflect on applicability conditions of norms. They outline a logical framework to capture the norm change power and, at the same time, the limitations of the judicial system in revising the set of constitutive rules defining the concepts on which the applicability of such a rule is based.

Finally, the fourth section addresses the issue of relational justice and dialogue. Relational justice models are based on cooperative behavior, negotiation, and agreement. Pompeu Casanovas reelaborates the content of ancient rhetoric terms such as *stasis*, *ekphrasis* and *inventio* to monitor the construction of new relational justice tools, such as Legal Electronic Institutions (LEI) and the Ontomedia platform for Online Dispute Resolution (ODR). Marta Poblet, Pompeu Casanovas, José Manuel López Cobo, Alvaro Cabrerizo and Juan Antonio Prieto describe its design as a semantically-driven web service that allows end-users to negotiate and mediate in different domains (family, commerce, consumer disputes…). Antoni Abad-Ninet deepens into the notion of relational justice and introduces Bruce Ackerman's theory of 'neutral legal dialogue'. Finally, the volume ends up with a paper on the new field of legal multimedia. Jorge González-Conejero introduces legal multimedia management through some parts of the JPEG2000 framework to deal with content. This kind of developments on the treatment of images, sound and videos are most required to develop multimedia functionalities on LSWS in the web.

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As Law Goes By: Topology, Ontology, Evolution

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Abstract. The paper deals with Hayek's classical distinction between cosmos and taxis, i.e., evolution vs. constructivism, spontaneous orders vs. human (political) planning. Recent empirical evidence confirms that the informational complexity of the law is not reducible to taxis alone and, furthermore, orders spontaneously emerge from the complexity of the environment through specific laws of evolution. Whereas, most of the time, today's research on AI & Law focuses on the taxis-side of the law, my aim is to illustrate the informational nature of complex social systems via a theory of spontaneous orders and an evolutionary theory of complex social networks. By distinguishing three levels of analysis, namely information as reality, for reality, and on reality, a topological approach shows how information is produced and distributed in current legal systems, how it is possible to harness these properties and obtain useful applications in the legal domain, while shedding further light on some aspects of current AI research.

Keywords: Complexity, Evolution, Information, Legal Systems, Ontology, Topology.

1 Introduction

As stressed by the organizers of both the AICOL workshop in Beijing and its follow-up in Rotterdam (respectively in September and December 2009), "today there is a strong need to integrate research in AI & Law within legal theory" as well as "to encompass the different branches in AI & Law." While different fields like legal ontologies, network analyses, multi-agent systems, and so forth, are developing quickly, there is a risk of "missing the opportunities to exchange knowledge and methodologies."

Hence, by following up the AICOL proposal, there are two reasons why I think Friedrich Hayek's work on philosophy of law is particularly relevant when promoting the integration between AI & Law and legal theory, and between different branches of AI & Law.

On the one hand, it is of course a matter of information: In the preface of the third volume of *Law, Legislation and Liberty* from 1979, *i.e.*, *The Political Order of a Free People*, the Nobel laureate updated his own lexis with the informational perspective and network approach suggested by cybernetics and contemporary system theory [1]. Although Hayek did not mention Norbert Wiener, but Ilya Prigogine's work on complexity, Karl Popper and "another friend of mine from Wien," Ludwig von Bertalanffy,

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the point can be summarised with a quote of Wiener from *Control and Communication in the Animal and the Machine*: "Information is information, not matter or energy. No materialism which does not admit this can survive at the present day" [2].

On the other hand, there is the distinction between *cosmos* and *taxis*, evolution and constructivism, spontaneous orders and human (political) planning. The idea is that the informational complexity of the *cosmos* cannot be reduced to any *taxis* and that orders spontaneously evolve from this informational complexity. While scholars often discuss the first facet of Hayek's work, *e.g.*, an informational theory of complex social systems as a theory of spontaneous orders, my aim has been to develop another aspect: The *evolutionary* theory of complex social networks [3]. More specifically, such an approach suggests some interesting modes of interaction with other areas of AI & Law.

In order to illustrate such a double Hayek's legacy, this paper is presented in four sections.

First, I summarise twelve years of research on the 'small world'-paradigm and, hence, some work on the topology of complex legal systems. An expert of spontaneous orders like Friedrich Hayek would have been very pleased to discover the way we have deepened these topics over the last years.

Secondly, I mention some applications of the paradigm to extremely hot issues of today's legal debate like privacy and copyright: A concrete example is given by a new kind of recommender system on the internet and how it deals with some constitutional rights.

Thirdly, I focus on possible applications of the paradigm to areas of AI & Law and, in particular, to the field of 'legal ontologies.' We will look at how we can annotate legislation with concepts and evaluate the performance of the informational system facing massive amounts of data.

Finally, I differentiate two meanings of 'evolution,' namely, between Hayek's idea of *cosmos* and his thesis on evolutionary psychology [1]. This allows me to sum up the multiple outputs of the new paradigm while singling out three ways of conceiving the connection between information and reality, that is, information *as* reality (section 2), *for* reality (section 3), and *on* reality (sections 3 and 4). This very differentiation sets the proper ground to prevent some misunderstandings of today's debate and the risk of missing the opportunities to exchange knowledge and methodologies between different branches of AI & Law and legal theory.

Let us start with Hayek's ideas on information *as* reality, that is law, *cosmos* and *taxis* as matters of information.

2 Network Thinking

Some of the most relevant problems in AI & Law concern two major questions entwined with the complexity of Hayek's *cosmos*, namely, the amount of work we need to gloss relevant legal information and the issue of evaluating the performance of a given tool with increasing amounts of data [4]. Over the last years, I have been showing how Hayek's ideas on legal *cosmos*, spontaneous orders, and the evolution of complex social networks may be illustrated topologically, that is, analysing how information is distributed among the nodes of the network.

The general idea is offered by Gregory Chaitin's algorithmic theory of information [5]: We should start thinking of information in terms of complexity, and vice versa. The phenomenon will become all the more complex as the quantity of information grows and its theoretical compression decreases. While some scholars as Murray Gell-Mann [6] or Mark C. Taylor [7] have been applying these ideas to adaptive complex systems and to social networks, I developed this outlook as an evolutionary theory of social institutions and, more particularly, of complex legal systems [3, 8].

In a nutshell, Chaitin has algorithmically updated Gödel's theorem of incompleteness by proving that truth should be considered as a subset of complexity. In social terms, this means that complex networks are constituted by a quantity of information irreducible to complete formalization and algorithmic compression. As in the case of Gell-Mann's adaptive systems [6], or Taylor's complex networks [7], the evolution of contemporary social systems goes along with the emergence of spontaneous orders. Although we can predict this evolution only in very partial terms due to the intrinsic *randomness* of the system, there is a way to *quantify* these spontaneous orders as a sort of informational network. We can determine, in other words, the complexity of the social system.

To simply grasp the point, consider three key parameters of every network, namely (i) its nodes, (ii) the average distance between nodes or diameter of the network, and (iii) its clustering coefficients. This allows us to single out three models.

The first one is represented by a regular network in which all of the nodes have the same number of links: This network has high clustering coefficients but a long diameter since the degree of separation between nodes is high.

The second model is a random network with opposite characteristics: It presents low clustering coefficients but a very short diameter. The explanation is that random links exponentially reduce the degree of separation between nodes in the network.

The third model is a small world-network: Its peculiarity depends on the apparent deviation from the properties of both random and regular networks. Like random networks, small world-networks present a short characteristic path length, but they also share with regular networks high clustering coefficients.

Since the pioneering work of Stanley Milgram [9] and, later, of Mark Granovetter [10], the idea of small world-networks became in few years one of the key words of contemporary scientific research by fostering a large set of empirical studies on the topology of complex systems. Significant effort has been made in order to structure analytical models able to capture the nature of small world-networks. Here it suffices to mention only two of these.

The first small world-model was proposed by Duncan Watts and Steven Strogatz [11]: They suggested to randomly rewire a small fraction of the edges belonging to a low-dimensional regular lattice so as to prove that the degrees of separation in the network would exponentially decrease. Yet, contrarily to random networks, the shortening of the diameter proceeded along with high clustering coefficients as in regular networks. These small world-features explain the results of Milgram's and Granovetter's research because short diameters of the network and high clustering coefficients quantify both the low degrees of separation between two citizens picked up randomly in such a complex network like the American society studied by Milgram in the mid 1960s [9], and the "strength of weak ties" stressed by Granovetter in the early 1970s [10].

The second analytical model we need to mention was defined by Albert-Lászlo Barabási [12]: He noted that most real world networks grow by continuous addition of new nodes whereas the likelihood of connecting to a node would depend upon its degree of connectivity. This sort of special attachment in a growing system explains what Watts and Strogatz apparently missed, namely, the power-law distribution of the network in a topological scale-free perspective: Small world-networks in the real world are indeed characterized by few nodes with very high values and by most nodes with low connectivity. The presence of hubs or of a small fraction of nodes with a much higher degree than the average offers the key to comprehend why small world-networks can be both highly clustered and scale-free. This occurs when small, tightly interlinked clusters of nodes are connected into larger, less cohesive groups.

More recently, Melanie Mitchell [13] and Sebastian Schnettler [14] have offered a comprehensive picture of this work with its many applications to real world-networks like the brain, genetic regulatory networks as in the case of metabolic networks, of epidemiology, ecologies and food webs. Apart from economics, art, and sociology, however, both Mitchell and Schnettler missed some relevant applications of the new paradigm to the realm of law. Here it suffices to recall two studies from 2005.

The first work is by Seth Chandler [15], who built an electronic map of 26000 decisions issued by the U.S. Supreme Court from early 19th Century onwards. He assumed each case as a node of the network and each citation as a link, while links between nodes are intended as directional arrows rather than simple lines. The result is a network with very low density that, nevertheless, has a main core. In fact, only 258047 out of 365 million possible citations have been made in actual law. We also find decisions among the large group of weakly connected cases that are both well cited and interdependent. These decisions are the hubs of the network and, unsurprisingly, Chandler claims that this main core substantially concerns "rights of free speech and association under the American constitution" [15]. More particularly, there are 122 nodes each with 28 or more links to the other cases of the main core, so that the density is more than 500 times greater than the density of the network as a whole. By grasping these cases as hubs of a small world-network, it is then easy to understand why any First Amendment decision would reverberate more readily through the U.S. law than a decision made in any other field. In a nutshell, hubs offer the common connections mediating the short path lengths between other nodes in the network.

These results were (partially) confirmed in June 2005 by Thomas Fowler and Sangick Jeon [16], who presented the network of 30288 U.S. Supreme Court majority opinions from 1754 to 2002 (actually, they also accounted for the decisions of the Supreme Court of Pennsylvania contained in the first volume of the U.S. Supreme Court Reporter). Again, each case is considered as a vertex or a node of the network and each citation as an arc or a link. The total number of links to and from the node represents its degree (in and out). The overall result is a list of all of the cases that are connected together by 220500 citations according to the power-law distribution of a small world-network. From this viewpoint, it is not only possible to highlight the "good hubs" (well cited) as well as the "good authorities" (most interdependent nodes) of the network. We are also able to follow the rise and fall of a precedent's importance in a continuously evolving legal system such as the U.S. constitutional law. While the most authoritative cases before the American civil war involved freedom of contract,

namely the contract clause, after the war and until the end of the 1930s with the New Deal the main core became balance of power in order to regulate commercial issues in a federal system. Whereas this perspective confirms Chandler's conclusions – in that the contemporary main core of the U.S. Supreme Court jurisprudence is given by rights of free speech as Justices shifted their focus towards civil liberties – Fowler and Jeon also back up our network perspective: "In particular, the power-law tail in the degree distribution of inward and outward citations in the precedent network suggests that there is something systematic about the evolution of law that mimics the evolution of other network phenomena" [16].

The laws of this complex evolution has been found in other legal fields [17, 18], and have suggested to ask whether the "web of the law" is really a "seamless web" [19], that is, an interconnected network where "the categorization of legal doctrine into discrete fields (torts, property, contracts, and so forth) does not accurately capture the nature of the law" [20].

Whether or not this is the case, our network perspective has achieved three important results.

First, all legal networks we have been considering *optimize* the distribution of information in the system by shortening its diameter via hubs. This is how, finally, Milgram's *The Small World Problem* was resolved after forty years: Even though, compared to regular networks, randomness increases in small world-networks, small world-networks are *more efficient* than regular networks by shortening the average distance between the nodes of the system.

Secondly, these legal networks are *complex* in that optimization of distribution of legal information goes along with high (local) clustering coefficients. Although this latter property is also a feature of regular networks, randomness explains why you need *more information* in order to understand the features of small world-networks: They are actually less compressible in theoretical terms, *i.e.*, harder to understand.

Finally, randomness reappears when examining the taking over of the hubs in the network (both at institutional and semantic levels). In fact, it is impossible to predict the evolution of the network due to its own complexity: Whether or not you agree that today's spontaneous orders present some specific properties as short diameters, high clustering coefficients, etc., there is no algorithm or computation in order to determine the evolution of the hubs.

Notwithstanding these theoretical limits (information *as* reality), there are interesting applications of the new paradigm by exploiting the topological properties of small world-networks (information *for* reality). In order to stress this theoretical difference and set the framework of the following section, it is useful the example of a new generation of recommender systems on the internet and their impact on some crucial fields of today's legal systems as copyright and privacy. After all, no *cosmos* can do without *taxis* in a complex world.

3 Overloading Information

A striking example of today's spontaneous orders is given by peer-to-peer (P2P) networks and the way these file sharing applications-systems have been evolving over

the last years on the internet. In particular, after Barabási's work [12], several scientific papers have shown the existence of small world-patterns and power laws-distribution of information that characterize any P2P system at different levels. There is significant evidence of spontaneous clustering of users by content distribution in, say, both P2P systems like Gnutella and Kazaa as demonstrated by Iamnitchi *et al.* [21], and Ruffo *et al.* [22]. If different models can be used in order to detect this phenomenon, like "data-sharing graphs" or "affinity networks," what is remarkable is the fact that the topology remains the same in such complex networks as the Web studied by Barabási and the U.S. Supreme Court jurisprudence which I mentioned in the previous section. Regardless of the nature of the system or of its peculiar constituents, the probability that a vertex in a complex network is connected to other vertices decays according to a power law.

It is thus possible to exploit the topological properties of the network (information *as* reality), so as to obtain some interesting applications in the legal field (information *for* reality). I clarify the point with the difference between recommender systems which harness the topological properties of the network (*i.e.*, information *as* reality), and the goals we can achieve through these recommender systems (*i.e.*, information *for* reality, namely sets of rules or instructions for the determination of other informational objects). Let me start with the first point: What is a recommender system?

In a nutshell, recommender systems are techniques for coping with the problem of overloading information on the internet. Most of the time the semantic of the approach has been to find a simple match between a query string and the content of documents, without considering user's preferences. Centralized approaches appear to be content-based as in the recommender systems of *News Weeder* and *Syskill & Webert*, or collaborative filtering as *Tapestry*, or using a demographic strategy. With Giancarlo Ruffo and his team at the University of Turin, however, I have been developing the idea that it is not necessary to get user profiles, and users are not required to give feedback to a data collector entity, in order to obtain useful information. First presented in [22], then deepened by Ruffo and myself [17, 18], this topological model can be illustrated with a P2P file sharing applications-system as the software of Gnutella. It is important to grasp its basic structure to explain how this decentralized recommendation scheme, based on "spontaneous affinities," works.

First of all, Gnutella consists in a two-tier overlay where a set of interconnected ultrapeers forms the top-level overlay to which a large group of 'leaves' are connected. Leaves never forward messages as they send queries to the ultrapeers and simply wait for a set of Query-Hits matching the searching criteria. Even if an ultrapeer acts as a proxy to the Gnutella network for the leaves connected to it, ultrapeers are nonetheless connected to each other and to regular Gnutella hosts, so that Query-Hits messages return back to the querying user by reverse path forwarding. This ensures that only those servents, *i.e.*, both servers and clients that routed the Query message, will get the returning Query-Hit message. Hence, an ultrapeer receives all Query-Hit messages addressed to its leaves. Since Query-Hit messages contain information about files which match searching criteria stored in answering peers, they are a precious source in order to identify who shares what. Besides, the two-tier architecture allows one to collect Query-Hits by means of a passive monitoring of Gnutella traffic that transits through an ultrapeer node. In fact, it receives both Query-Hit replies from

leaves peers which it is connected to and (part of) the traffic that the top-level ultrapeers forward each other. (Although the information extracted from Query-Hit messages is only a small fraction of the overall resources shared by a peer, however, this does not seem to change the picture as a whole.)

Another important technical detail is that instead of implementing a Gnutella crawler from scratch, it is possible to modify the open-source client Phex with the multi-source download feature in order to realize an effective passive searching and snooping for files. This adapted client is forced to enter the network in ultrapeer mode by collecting and storing all of the Query-Hit messages it forwards. Since the goal is to identify unambiguously both users and files in a Gnutella network, a technical device such as the SHA1 hash codes permits binding identifiers to the content rather than to the name of a resource. Another problem consists in the possibility that the same IP address can correspond to different users and, vice versa, the same user can obtain different IP addresses in different sessions. Therefore, it is necessary to filter out all IP addresses that belong to the private network class specification.

After running for a week, the data collected by the Gnutella ultrapeer crawler is composed by more than 3 million search replies generated by a community of 283000 different clients that advertise more than 900000 different files. Let me sum up these results with the following table:

Table 1. Data collected by the Gnutella ultrapeer crawler

CHARACTERISTICS OF TRACES COLLECTED

Time Interval	7 days
WHOLE DATASET	
# IP (unique)	283.431
# GUID (unique)	470.333
# Files (distinct SHA1 hashes)	944.758
# *(IP,SHA1)* pairs	3.092.794
WITHOUT PRIVATE CLASS ADDRESSES	
# IP (unique)	278.281
# GUID (unique)	422.726
# Files (distinct SHA1 hashes)	714.640
# *(IP,SHA1)* pairs	2.261.396

As in other small world-networks seen above, the result is the phenomenon known as 'rich gets richer.' Few very popular files along with a very large set of resources are shared by only one or two people (see below fig. 1). In other words, the network presents a power-law distribution characterized by an exponent $\gamma = 3.17$ and an error $\alpha = \pm 0.04$ (fig. 2). What does this mean? Once again, as in other small world-networks, this is the proof of the existence of hubs, namely users that share a large amount of items playing a significant role in providing connectivity, along with short paths between couples of peers and high clustering factor. On the one hand, let us see this particular distribution:

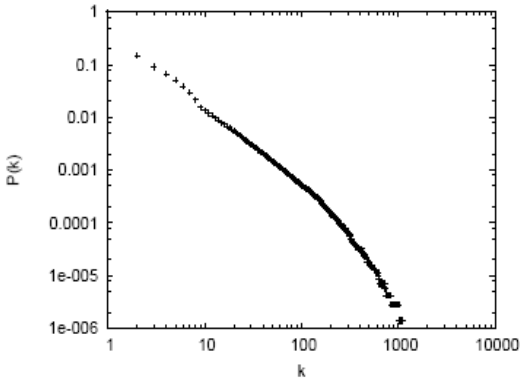

Fig. 1. Cumulative distribution of the files popularity plotted in a log-log scale following a zipf's law

On the other hand, let us observe its peculiar power-law:

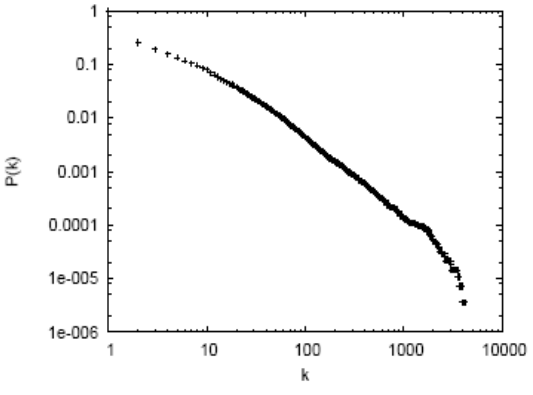

Fig. 2. Cumulative distribution of the node degree, i.e. the number of distinct files shared by a peer, plotted in a log-log scale

As you can notice, we get the characteristic long tail determined by few nodes with very high values and by most nodes with small degree. The existence of hub peers, *i.e.*, users who share a large amount of items playing a main role in providing connectivity, proceeds with high clustering factor and typical short path length. Therefore, the topology is the same of such complex networks as, say, the U.S. Supreme Court jurisprudence analyzed by Chandler [15] or by Fowler and Jeon [16], or the Web by Barabási [12]: By computing the average shortest path of the network and its clustering coefficients it is possible to prove that even in the case of P2P file sharing applications as Gnutella, hubs link small worlds of strongly interconnected clusters. Besides, what is striking about this network is that this property seems to depend neither on the overall number of connected cases nor on the thematic sphere analyzed, *e.g.*, video or audio files. On the contrary, small world-properties of the network appear to be scale-free as well as free from thematic constraint [22]. Hence, by exploiting these topological

properties of the network (information *as* reality), we obtain some interesting applications on recommender systems, digital privacy, and even copyright (information *for* reality), because we do not need to structure our digital object in terms of author names, genre, movie, song titles, and the like. What is recommended here is based on partnership degree and users' relationships by harnessing small world-properties. Leaving aside some further details of the experiment, it is enough to present its final outcome:

Table 2. Average accuracies of the recommendation by exploiting the topological properties of the network

Folds	Normal Recommendation		Strong Recommendation	
	Accuracy	σ	Accuracy	σ
0	0,8145	0,145113	0,6682	0,189547
1	0,8115	0,152825	0,6549	0,194969
2	0,8174	0,149422	0,6657	0,189540
3	0,8215	0,137835	0,6766	0,186365
4	0,8261	0,143064	0,6629	0,192164
5	0,8022	0,148108	0,6453	0,199965
6	0,8097	0,148670	0,6517	0,191519
7	0,8066	0,150512	0,6595	0,194688
8	0,8035	0,166106	0,6560	0,199304
9	0,8029	0,154615	0,6574	0,204398
Tot	0,8116	0,149630	0,6598	0,194250

As it is easy to see, these good results are also good news for our privacy because you do not need to disseminate personal information on the Web in order to obtain information which is not personal at all. By harnessing partnership degree and users relationships it is not necessary to get user profiles and users are not required to give feedbacks to a data collector entity. In other words, we do not need to trade off personal data for digital personalization on the Web, for there is a way to update Amitai Etzioni's dichotomy between "liberalizing technologies" and public protective ones [23].

Yet, this sort of new 'invisibility' has its own risks because this topological approach could also permit, say, music companies to concentrate their attention upon one of the key features I mentioned above, *e.g.*, the hubs of the network. Let aside today's debate on the "three strikes"-doctrine and, in France, on the so called HADOPI 2 law (passed by the Parliament on October 22nd, 2009), legal troubles of P2P systems with both copyright and privacy interests clearly illustrate how political decisions influence or attempt to determine possible developments of technology. While, on the Web 1.0, the main target of surveillance were not individuals but web sites (*Napster case*, 2000) and P2P software developers (*Grokster case* before the U.S. Supreme Court in 2005), on the Web 2.0 the target has become P2P users chosen by private investigators (as shown by both the Torrent Spy and Peppermint cases which I fully examined in [24, 25, 26]).

This legal trend brings us back to the role of Hayek's *taxis*: Although human planning does not exhaust the complexity of legal information, this does not mean that *taxis* cannot shape the evolution of *cosmos*. On the contrary, we have to pay attention to this interaction between *taxis* and *cosmos*, which impacts on the very nature of the

law and the ways in which we represent legal knowledge. It is all about the difference between philosophical inquiries on being *qua* being, or traditional ontology, and research semantically committed to knowledge and concepts, as in the case of current legal ontologies. After looking at information *for* reality, we shall focus on the difference between information *as* reality and *on* reality [27].

4 Ontology of Law

There are many meanings of the word 'complexity' [28], and this polysemy affects the idea of 'information' as well [27]. Hence, it is not surprising to find that 'ontology' represents a complex informational topic of its own.

The word 'ontology' was coined by Jacob Lorhard in his *Ogdoas Scholastica* (1606), and perhaps independently by Rudolf Göckel in his *Lexicon philosophicum* (1613). Defined by Nathaniel Bailey's *Universal Etymological Dictionary* (1721) as "an Account of being in the Abstract," the word became particularly popular thanks to a Leibniz's pupil, Christian Wolff, and his book *Ontology* from 1729. As a "general metaphysics," ontology would deal with information *as* reality, namely, the examination of being *qua* being or its essence. This approach is closely related to Hayek's ideas on *cosmos* and his critique of any form of legal constructivism and positivism as, say, in the case of Kelsen [1]. We will come back to this primitive meaning of ontology at the end of this section.

Yet, ontology can be understood as information *on* reality, namely as a matter of knowledge and concepts that frames the representation and function of a shared legal terminology, thereby representing "the missing link between legal theory and AI & Law" [29]. The aim being to represent knowledge, legal ontologies model concepts traditionally employed by lawyers such as norms, rights, or duties, in fields like criminal law, administrative law, etc., so that a machine can comprehend and process this very information *on* reality. Whereas, according to the type, role, character, construction and application, there are at least 24 different projects of legal ontologies nowadays [30], we should further distinguish different kinds of information *on* reality, *i.e.*, formal semantic accounts, specifications of a conceptualization, representations of a conceptual system through logical theory, and so forth [31].

All this work, however, incur in a significant problem when reducing the informational complexity of a legal system which is subject to evolution in its concepts and relations. In order to illustrate the point, let us consider the example of formal descriptions of knowledge, *e.g.*, 'structured dictionaries' and research efforts on formal ontologies.

An interesting project has been presented by Gianmaria Ajani and his research group: Over the last years, they have been developing an ontology designed both to recover legal information and to build conceptual dictionaries. Avoiding as much as possible the polysemy of legal terms as well as terminological and conceptual *faux-amis*, an experiment has been conducted on a taxonomy, where "terms are supported by a clearly identified concept inserted in a knowledge structure of a text and related to the other concepts that belong to such a structure" [32]. From a technical outlook, it is crucial to stress the "bottom up fashion" that starts from legal terms defined by scholars. In fact, a traditional "top-down approach works well for the topmost level,

where the basic conceptual primitives are precisely defined (concept, relation, role, qualia, processes, etc.), and the representation instruments are put at the disposal of those who build the ontology" [33].

Still, a lot of issues arise when the core ontology level is taken into account: Simply put, the amount of information involved in the project of a structured dictionary with its headwords is hardly compressible. In particular, "two main problems arise in our approach: the first one is theoretical, and it concerns the issue of evaluating the performance of the system with more massive data. (…) Secondly, the amount of work needed to annotate the EU directives with concepts, terms and their transpositions, is huge" [4].

All in all, legal concepts evolve and their relations change both diachronically (remember the U.S. Supreme Court network seen above), and synchronically (as it occurs with the different legal systems defined by national sovereign states or by the EU legal system with its 23 official languages). What is more, the overwhelming number of concepts and relations obliges us to prioritize which ones should be considered first. It is enough to mention William Prosser's efforts to systematize privacy rights in the U.S. law torts-field [34].

A useful approach to such complex networks is suggested by the cumulative distribution of the information in the Gnutella network seen in the previous section (check above fig. 1-2). The power-laws of distribution highlight some properties of language (*i.e.*, information *as* reality), which are useful when computing huge amounts of data so as to build conceptual dictionaries (*i.e.*, information *on* reality).

Quite interestingly, since the early 1930s, by paying attention to the statistical distribution of quantities and how information 'flows' in any large text, George Zipf noted a curious power law in such distributions, in that the frequency of a word would be approximately proportional to the inverse of its rank [35]. Some years later, both Benoit Mandelbrot [36] and Herbert Simon [37] shed further light on this law. While the former considered 'words' as messages sent by a source who wants to maximise the amount of information and minimise the cost of sending it, the latter thought about the probability of using a word in making a text. In both cases, the outcome was the same: On one hand, Mandelbrot proved that, if the information content and transmission costs are optimized at the same time, the outcome is Zipf's law. On the other hand, Simon envisioned a typical feature of small world-networks, *i.e.*, the mechanism of preferential attachment or the probability that the choice of a word is proportional to that word's recurrence in a text. Whereas words not yet appeared have nonzero probability of being added, the result of this process is again Zipf's law.

Therefore, when computing huge amounts of data so as to produce, say, 'structured dictionaries,' a network perspective would suggest to single out the *possible* hubs of the system. Dealing with linguistic issues, it is likely to find determinate clustering coefficients that go along with a diameter shorter than that of regular networks. The set of nodes with highest degree would represent the main core of the taxonomy because our empirical research would conduct us, with fair probability, to the shortest average distance-concepts with their specific grades of 'betweenness.'

Moreover, by further considering the topological features which I mentioned in section 2, this outlook offers a good way to face our own 'trials and errors' while structuring a legal dictionary. Hubs, in fact, will probably indicate the nodes mostly tested by scholars in order to check the quality of the taxonomy. While a topological

approach allows us to understand which concepts and relations of the (specific field of a given) legal system are more relevant, such an empirical evidence helps us to define the complexity of these systems in two ways.

First, we can check support knowledge-acquisition for legal domain ontologies as well as general language for expressing legal knowledge. Due to the *cosmos* side of the law, legal theory does not always reflect legal experience because law is far more complex than its own language. Network theory allows us to shed light on this gap.

Secondly, this approach focuses on the most interdependent nodes of the network and its hubs: It is likely that only a few of many millions of *possible* connections in the network *really* exist.

Let aside further considerations on information *as* reality and massive work in statistical natural language processing [38], what about the specific contribution of network analysis to the representation of a shared legal terminology via knowledge and concepts, that is, information *on* reality, which is semantically committed?

As shown by work in the "semantic seismographers" and "conceptual hubs" of the US Supreme Court network [15, 16], along with its "semantic subsets" [19], or the "hidden communities" of the French environmental code examined in this volume by Boulet *et al.*, it is beyond doubt that network analyses deal not only with the statistical distribution of quantities that determine how information is distributed in any large text such as a 'structured dictionary.' Indeed, most recent network-studies on legal systems are semantically committed to the analyses of concepts and legal knowledge: They involve jurisprudence and case-studies [8, 15, 16], codes [19, 39], general theory [40], and so forth. It is enough to stress two points of this shift in network theory, from traditional researching information *as* reality to today's researching information *on* reality [41].

First, the semantic commitment concerns knowledge acquired and organized by legal experts in both the development and evaluation-phases established by most ontology building methodologies nowadays. This implies that we can test the expertise of legal scholars, and further grasp their concepts, through a network approach. For example, the semantic commitment is clear in the case of network analysis on U.S. constitutional law, freedom of speech, and the First Amendment discussed by Chandler [15]; in the difference established between "good hubs" (well cited) and "good authorities" (most interdependent nodes) of the network put forward by Fowler and Jeon [16]. Moreover, there is also the example of today's debate on whether the web of law is "seamless," *i.e.*, whether the categorization of legal doctrine into discrete fields like torts, contracts, etc., captures the nature of the law [19, 20, 40].

On the other hand, the representation of a shared legal terminology via a network theory involves knowledge that may be tuned to reality in terms of evolution, but should not be confounded with the ontological inquiries of philosophers on being *qua* being [42, 43]. Integration between network theory and legal ontologies does not hinge only on information *as* reality as, say, Pinker's evolutionary psychology suggests [44], so that basic human concepts would be wired in our brains thus grounding cultural evolution. Although this very possibility also attracted Hayek [1], it should accurately be distinguished from the idea that even *cosmos* and spontaneous orders are necessarily entwined with semantics and matters of knowledge and concepts. In the first case, we are still dealing with the traditional area of being *qua* being; in the second case, what is at stake with evolution concerns the representation of a shared

(legal) terminology. When discussing the opportunities to exchange knowledge and methodologies between different branches of AI & Law and legal theory, this difference should always be taken into account.

5 Conclusions

This paper focused on legal dynamics, ontology and the topology of complex social systems, according to a threefold informational perspective [3, 27].

First, we referred to information *as* reality, which deals with the analysis of being *qua* being, as information opposed to knowledge and concepts. As seen in section 2, this outlook characterizes the current network approach to the distribution of information in complex systems as a matter of statistical properties of quantities (like nodes, edges and diameters of the network).

Secondly, we have information *for* reality, *e.g.*, sets of rules or instructions for the determination of other informational objects. As stressed in section 3, network analyses are fruitful for tackling the problem of informational overload.

Finally, there is information *on* reality as a matter of knowledge and concepts that frames the representation and function of a shared legal terminology. As shown in section 4, most recent research in network analyses and the law is increasingly focusing on the semantic features of this representation.

The conclusion is that today's debate on the opportunities to exchange knowledge and methodologies between different branches of AI & Law and legal theory, should take this difference into account so as to preliminarily define whether the exchange of knowledge and methodologies concerns information *as* reality, *for* reality, or *on* reality.

After all, this is what emerges through the analysis of the topology, ontology and evolution of the law. Leaving aside specific projects on information *for* reality, which are neither true nor false, topology, ontology and evolution are grounding current research on legal information *as* reality. Namely, topology is conceived as the study of the statistical properties of quantities (section 2), ontology as the study of being *qua* being (section 4), and evolution as concepts making us adapt to the complexity of the environment (as remarked in sections 2 and 4).

Yet, there is the other side of the coin. Along with sets of rules or instructions for determining other informational objects (section 3), I mentioned topological research in concepts and legal knowledge that goes hand in hand with the semantic commitment of current efforts in legal ontologies. Even though *cosmos* cannot be reduced to any form of human planning (information *as* reality), spontaneous orders are necessarily entwined with the evolution of *taxis* (information *on* reality). This latter level of analysis frames the representation of a shared legal terminology as law goes by.

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Sailing the Semantic Seas by Structural Vessels: Problems and Perspectives for the Identification of Implicit Knowledge in the Legal Domain

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Abstract. In this paper we propose some preliminary insights on how the relationship of Law and AI affects the identification of implicit knowledge in the legal domain. From a theoretical point of view, the notion of knowledge, as conceived in AI, is problematical for law, because it cannot be solved making recourse to a dominant theory on truth. As it is known, the current state of legal research is fragmented, not only on the issue of identifying truth, but more generally on the issue of evaluating the relationships between formalism and informalism in law. in diverse theories of truth. From an operational point of view, new advances in terms of social network analysis could be fruitful to knowledge discovery in the legal domain, especially for application of legal ontologies in multicultural contexts.

Keywords: legal ontologies, legal culture, social network analysis, epistemological completeness.

1 Legal Ontologies at the Helm: Questions about Theory of Knowledge

Artificial intelligence for law has been in existence for several decades as a multidisciplinary field of research. To achieve the purposes of AI and Law, it is essential to bring together researchers from different research communities. These include AI and computer science, as well as legal philosophy.

AI and Law is directed toward different research lines, such as the development of legal knowledge systems, knowledge management, models of legal argumentation, and legal ontologies, where cross-fertilisations are possible.

Therefore, the demand for information retrieval has determined an increasing attention towards the development of legal ontologies for knowledge engineering [50]. Since legal ontologies are useful for sharing knowledge, they play a significant role in areas dealing with vast amounts of distributed and heterogeneous computer based information, such as legal information available on internet and specialised database for legal purposes.

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Legal ontologies may also be implied in modelling the legal reasoning[1] in order to define the prior knowledge of the legal domains, which is helpful for formalizing case abstractions, selecting procedural rules, refining input data, and representing the output in a comprehensible way. Legal ontologies can enhance information extraction from semi-structured and non-structured data, adding a new dimension to legal research [20], [25], [43]. One of the most complicated issues is, however, the definition of "prior knowledge" either from the process or the domain. Ontology building is a time consuming activity that requires a lot of effort for knowledge domain acquisition[2]. Several methods have been developed to overcome these problems, including tools that automatically or semi-automatically allow to generate ontologies [34], [1], [43], [14]. Within the legal domain, semi-automatically ontology building employs text-mining, machine-learning, and NLP algorithms [18].

The interaction between the prior knowledge as encoded in ontologies and the derived knowledge as the result of a process, such as a knowledge-based system application or a data mining analysis [41], has not been fully explored.

Knowledge[3] in AI theory may reproduce the traditional concept of truth as adequacy between object and cognition at different levels of world description [29]. In short, research within the field of Artificial Intelligence is directed to perform tasks that would otherwise require human intelligence. The simulation of human intelligence may be designed following different frames. A choice has to be made among the several options, to acquire and process the knowledge. An architecture based on the correspondence theory of truth[4] should modify its beliefs, to maximise the accuracy of its predictions about the external world, while one founded on the coherence theory[5] should maximise internal consistency.

Furthermore, the different theories about the nature of the law may inspire different methodologies in the building of a legal ontology: even if we consider law as a social phenomenon, the outcomes in ontology building can be assorted. Knowledge, consequently, may be obtained by corpora of statutory texts according to a conventionalist and positivist view of law [36], while the perception of law as an institutional reality [48] may pay more attention to case-law and regulations.

As it is known, the major effort in developing legal ontologies is related to the world knowledge.

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[1] Reasoning systems can be divided into systems of case-based, rule-based, or statistical approaches. The first aims at drawing analogies to find previous cases that are similar to the current one. The second is constituted by a knowledge base in which the domain knowledge is represented by rules, an inference mechanism which makes it possible to reason with the rules. The third encompasses several machine learning methods, such as neural networks, to learn new concepts from sets of input features [47], [2].

[2] With regard to the several ways of using knowledge, the acquisition process can be guided by different principles and methods to increase the efficiency of the acquisition process [39].

[3] In this paper we refer to knowledge discovery in a broader sense than the notion of partially automated process of extracting patterns from databases [1], [49]. Essentially we think about the process of showing concepts and connections, locating implicit knowledge within the legal domain [43].

[4] By assuming that statements or propositions are true because they match with reality, state of affairs or facts [51], [12], [16].

[5] By assuming that statements are true because they fit together with other statements, even though there are different conceptions about epistemic or constitutive coherence [32], [52].

Law, in fact, seems to lack its own ontological foundation. When legal philosophers discuss the ontological assumptions in law and legal reasoning, their discourse is invariably about normative knowledge. This is different from other knowledge-based fields of practice like medicine or engineering, which ground their ontological foundations in notions established within the realm of physics, mathematics, and so forth. Jurisprudence and legal philosophy are primarily concerned with the justification of law and legal systems, rather than with the explanation of the role of law and its relation to social and natural reality. It is, therefore, clear that ontology in jurisprudence and legal philosophy implies different issues than ontology in computing. Building knowledge systems involves indeed the creation of models that are necessarily an abstraction of the domain being modelled. However, as noted in [44] "assessing the epistemological completeness of an ontology is problematic because in order to determine whether an ontology facilitates the modelling of some piece of legal knowledge we need to identify this piece of knowledge first". And this statement calls for a "some commonly accepted theory about legal knowledge that tells us what pieces of knowledge exist in the legal domain". But no theory in the current state of legal research may answer this question.

Seen from an instrumental point of view, AI models are a representation of information in a specific structure, and claims for the model's effectiveness point out the interface between models and the world, asking for instruments to assess the represented knowledge.

Since AI models can only be improved through their use by particular agents in specific situations, the question of effectiveness in the representation is often reduced to its efficacy to some environments or uses.

As to law, different ontologies have been developed according to specific domains, such as diverse jurisdictions or typologies of documents. Consequently, core ontologies are required for enabling the re-use of legal knowledge bases written in different representation formats and formalisms. These examples, however, are only a few, and they encompass a straight division between ontological explanations and epistemological justifications so that they may be defective in dealing with epistemological completeness, as considered in the literature on knowledge engineering [26], [50].

2 Ontology Mapping: Knowledge in the Legal Domain

Interoperability is one of the main issues about semantic knowledge management; its role is to prevent the construction of copious contents not properly communicating with each other. A knowledge base represented in a specific language or format should be interoperable with other knowledge bases. As to legal ontologies, there is, here, an additional issue: numerous natural languages express legal contents, and different communities at the international, national and regional levels employ such languages.

The ongoing globalisation compels those communities to redefine the role of languages in the international lawmaking where contents from a language to another have to be exchanged, while preserving for each one precise communication and linguistic diversity. Moreover, there is a prospective shift to multilingual law in institutional contexts such as the European Union, where the rules are considered to be expressed with the same meaning in the different national languages.

The ontology building in the legal domain cannot resolve the interoperability issue by working only on the final step represented by the integration of the diverse knowledge bases[6].

There is another level of knowledge representation that is not always documented at the normative surface. As noted, "documents have a physical perspective (the support), a representational one (the language), and a cognitive one (the intended content): legal practice refers to those perspectives in each application case" [3].

Several legal contents are present in the various jurisdictions and different legal systems support the production, interpretation and implementation of such contents. Although there are variations in the ontological commitment on what the law is, it may be a positivistic illusion to understand the functioning of the legal systems by studying the corpus of laws in force in the diverse jurisdictions. Despite the fact that legal rules are ultimately based on formal sources, meaningful understanding of a legal system requires also the ascertaining of the socio-cultural contexts in which legal rules operate. The tension and the reciprocal adaptation between legal rules and cultural norms is considered in different ways depending on the perspectives of the local epistemic communities. Culture is usually constituted by a common language, a common history, a collective memory and a shared territory, while the enforcement of legal rules may be influenced by customs and cultural habits. Classical examples are the open-ended principles in which the judicial interpretation recalls these elements, such as good faith or the duty of care principle. Moreover, other socio-cultural experiences may affect the same territory, such as those of minority groups and immigrant peoples. We find legal conceptions within different social, ethnic and religious groups. Those groups, as an effect of globalization, do move from one territory to another, and contribute to an increased multiculturalism that irritates local (legal) cultures.

Legal ontologies cannot ignore cultural features relevant for law. In particular, the so-called legal culture - that is the attitudes towards the law in a given jurisdiction – has to be taken into account [18], [25].

Legal culture is a more and more cited expression in scholarly literature, giving raise to different policy options in the current projects of law harmonisation, like the ones developed in the European Union. Given the different attitudes towards the law in the national jurisdictions, it may seem that legal systems cannot "understand" each other because of irreconcilable differences in "mentalities" [30], [31]. On the other hand, since legal cultures are the development of historical outcomes, it may be observed that the singularity of national jurisdictions can be reconciled by the recourse to legal (historical) traditions [37], [53], [54]. Under these opposite views, the debate is still open to understand how legal cultures constitute legal systems. In fact, legal culture is not univocally defined by its advocates; the various definitions can be arranged on two main lines: a "narrow" identification of it as a set of shared perceptions

[6] The integration of ontologies is especially important to enable sharing of data between heterogeneous knowledge bases and to allow applications to reuse data from different knowledge bases. There are different ways to achieve such a goal: the ontology mapping that is related to the representation of correspondences between ontologies in way that ontological axioms and intended interpretations may be respected in the diverse knowledge bases; the ontology alignment that is related the discovery of these correspondences; and the ontology merging that is related to the building of new ontologies, based on the correspondences between the merged ontologies.

on what is formally normative, and a "broad" recognition of it as a blend of (formal and informal) practices and beliefs on what is normative.

Legal culture may refer to common concepts and values shared only by the legal elites of a given legal system. As already mentioned, then, it is important to recognize that, as a result of globalization, a legal culture is no longer necessarily national. The globalising process has not only accelerated increased the communication among national elites and consequently the circulation of legal models and legal reasoning which can be adopted as patterns for legal adjudication or for statutory reforms.

Legal culture may refer also to external influences on the legal elites, such as client groups representing economic or political forces that lawyers assist or, ultimately, such as the community of laymen constituted by the people living in a given territory.

The relevance of cultural features of law for knowledge discovery is demonstrated by the conundrum in which existing multilingual legal applications find themselves. There is a high dependency between the language of the people and their culture. Thus, within a community of people speaking the same language, we can find different usages of terms, even within the same context. Seemingly, the ideal solution for such a problem is to provide a set of rules for the usage of each term, considering all the cultural issues, both of lawyers and of laymen. Although it may be possible to report all such issues, the subsequent large quantity of multicultural contents, when imported in a multilingual environment, will not support a scalable approach for the information management.

Cultural features of law are relevant also at a deeper conceptual level. Researches on knowledge discovery by data mining have reported the existence of discretionary domains where decision-makers, mainly judges, act combining the dictates of their judgements with the formal process of adjudication recognised by the rule of law [49]. Undoubtedly, the logical or mathematical description of patterns and regularities in a set of data could be improved whether legal ontologies would enhance information extraction by the resort to cultural features of law.

Legal ontologies may constitute, indeed, a valid solution, but only after assessing the trade off between domain re-usability and epistemological completeness.

Ontologies are supposed to capture knowledge at the domain level independently from task requirements [21], [8]. Reuse is commonly agreed to reduce the cost of the ontology building. However, a main concern in ontology mapping is the difficulty of isolating the re-usable components. Since the relationship between primitives may vary within diverse knowledge structures, aiming at the epistemological completeness in the knowledge representation may affect the reusability [7].

3 Ontology Modelling: Considering Legal Culture

Core ontologies are intended to capture knowledge by the identification of basic concepts and categories of a domain. The knowledge represented by legal culture, however, is hardly formalised and therefore it is underestimated in ontology modelling. A legal culture is framed by individuals who have their own perception about the law; as a collective phenomenon, however, it is also distributed among the members who share the same historical path. Local variations of norms are originated in the intersections and gaps between the formal aspect of legal rules and the expectations that become relevant in the various social contexts in which they arise.

Thus, different authors may produce substantially different conceptualisations of the legal domain although their purposes are rather similar. It is, therefore, clear that legal ontologies cannot support a new legal dogmatism. Conversely, the final aim of a core ontology should be to ascertain the main primitives of legal knowledge and the different kinds of their relations. The wide range of primitives and relations allows conceptualizations defined by group of axioms or rules, but there is nothing preventing that different conceptualizations, linked to the same arrays of primitives and relations, will sort out.

A discussed topic in the literature on knowledge engineering is that the large part of the intended meaning of the ontological concepts may remain implicit among ontology developers [22]. The issue is particularly relevant in the realm of law, where some rules remain implicit, because jurists rely on legal culture as an informal background for justification. Legal systems are normative systems and what jurists typically do can be described as striving to construct the most normatively attractive account of their system that they can offer [14]. However, local legal culture participates in structuring the law in several ways: through the legal perception, common to the citizens, through patterns of legally relevant behaviour transmitted by legal education, through the action of institutional setting as the outcome of historical accidents, through the classification and arrangement of rules (such as a codification) and through legal doctrines, inspiring the process of adjudication [10].

Several patterns of legal culture may also coexist within a legal system, where legal scholars can confront their different views and receive diverse influences from political, economic, and social forces [44]. These dynamics together with historical accidents in the course of time, may change legal cultures that cannot be considered immutable.

The ontology modelling can be characterised as either a top-down approach or a bottom-up approach, the conceptual and the lexical one. Both approaches require to better consider the legal culture claims. The top down approach adopts categorizations of legal notions developed from legal theory. Analytic frameworks on legal categorization, however, vary greatly; the main reason is that lawyers compete in producing explanations of the interaction among legal rules and values. These categorizations can stipulate new coherent orders in a legal system, but they may fail to describe the real, yet rather inconsistent, conceptualizations implied in the legal practice. Behind ephemeral products of legal problem-solving there are, in fact, mentally structured representations typical of a given legal culture. In particular, the patterns of legally relevant behaviours are to be considered. They comprise the psychology of legal elites, the styles of legal reasoning, and the hermeneutical practices. Some patterns referring to what the law is and to the ascertaining of facts can question the modalities of incorporation in the upper level ontologies. Other patterns may drive different conceptualizations of the same subject-matter, like, for example, property law, according to the different legal cultures.

The lack of communication between the categorizations implied in the top down approach and the multiple conceptualisations - mainly context dependent - implied in the legal practice may hinder an acceptable degree of epistemological completeness in the legal domain.

Conversely, the bottom up approach adopts an ontology extraction from the lexical level performed on the basis of relevance criterions and adapting techniques taken

from, for example, NLP, computational linguistics, machine learning and text mining. However, the concept formation, and especially the labelling, is differently intended by ontology developers who often treat terms as concepts and directly add them to the ontology.

To properly represent a domain, the real challenge is to match the localised extracted knowledge with a generalised background knowledge. Many approaches tried to use different kinds of background knowledge in addition to the input text corpus, such as using the WordNet dictionary or other resources. Linguistic resources (such as lexicons, dictionaries and glossaries) can be used as consensus references to root ontology concept. Within the legal domain, this background knowledge cannot be constituted only by semantic criterions, because the way in which the "legal texts" become "legal norms" does not lie only in the legal provisions of such texts.

The background knowledge can be constituted by a macro-textual ontology of legal provisions emerging from the corpus of legal texts, collected for their reference to a specific domain[7]. This background knowledge is not complete, because of the role played by case law in the legal system, according to the different authority attributed to judicial decisions in the several jurisdictions as well as in the diverse branches of law, like for example constitutional law.

Also a macro-textual ontology of normative texts enriched by legal decisions relevant for a specific domain is, however, limited to its teleological function, thus influencing in a recursive way the relevance criterions and the techniques adopted for ontology extraction.

To improve ontology extraction, background knowledge needs to be integrated with conceptualisations from legal culture. A classic instance of this is the case of general rules governing the interpretation as well as the enforcement of specific domains. The problem is that such rules are not always documented by normative references, but are normally applied by scholars and practitioners, in the process of adjudication.

4 Hooking: Semantic Nodes and Social Nodes

The ascertainment of the conceptualizations grounded on legal culture is hindered by the difficulties in knowledge representation of the outcomes (judicial decisions, statutes, doctrinal comments) produced by the different players (judges, legislators, scholars). The picture of law as a socio-cultural phenomenon can be sketched out as a network of discourses and practices, where the correspondence between meanings produced by discourses and outcomes produced by practices may change according to the different contexts.

The challenge is, then, how to evaluate such conceptualizations in terms of their diachronical stability and of their effective impact on legal practice.

As it is known, the metaphor of the network has contributed to import in legal research methodologies aiming at measuring the network effect for different usages.

[7] Such as environmental protection, consumer protection or others.

Leaving aside the foundational quest of the network paradigm[8], legal scholars have already shown the potentialities of social network analysis in detecting regularities in precedents, such as the US Supreme Court majority opinions or case citation.

The question is whether social network analysis may contribute to integrate currently used legal ontologies. According to the hypothesis proposed by Ugo Pagallo, network analysis should be applied to ontology building in terms of what he calls "topological ontologies" [42].

Network analysis may indeed hold up the ontology mapping, and reinforce the effectiveness of knowledge discovery in the legal domain. As mentioned, the conceptualizations produced within a given legal culture are, usually lacking a normative reference. The risk is to devise several conceptualisations within the same domain, grounded on the different scholarly discourses focused on the meaning of the rules. To avoid subjectivism in ontology building, the conceptualisations proposed by legal experts should therefore be evaluated in terms of stability and effective impact on legal practice.

Some difficulties, however, remain when the topological relations are applied to legal ontologies, because these kind of relations are made of connections among entities situated in a physical space and considered in their social interaction[9]. Whilst several ontologies can be used to represent social networks [38], the contrary may not be as well true. Capturing the semantics of legal concepts [45] in a controlled terminology requires to represent the collection of semantic nodes and the links that exist among them. The nodes represent concepts and the links represent relations between nodes. Conversely, social networks are representations of social interactions. The nodes represent the social actors (i.e. individuals or organizations) which are tied by one or more specific types of interdependency.

An attempt to bring together concepts and the relations among social actors who share such concepts has been made in case of contents distributed on the internet where web users may add user-driven metadata, in the form of tags to contents. In this way, ontology modelling may consider to represent tagging choices in order to discover lightweight conceptual structures called folksonomies[10]. Once they are structured in an ontology representation, the relations among the tags and between the tags and the users allow to analyse contents by the means of social ties and social networks through the typology of data produced by social actors[11].

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[8] Despite its first usage in the mid-1930s in social and behavioural sciences, interest in network analysis has increasingly grown in the last years. Thanks to physics and biological studies handling with metabolic systems, network analysis has been popularised by the problem of "small world", even if some authors are absolutely unconscious of the previous works. In particular such a problem which comprises one particular feature from the several methodologies and tools in network analysis has become a paradigm as an intersectoral regulatory framework for studying world wide web as well as electric grid reliability [6], [9].

[9] The topological properties may change according to several ontological classifications, such as for example in the case of physical objects, or internal relations in ontological models [4], [15].

[10] Folksonomies are conceptualizations shared by given communities. Unlike ontologies, they are not formalized, but rather implicit [33], [26].

[11] See for instance [28].

Even if a large part of legal contents would be distributed on internet, the conceptualizations from legal culture might not be elicited in the same way as folksonomies.

One reason is obvious: lawyers and laymen contribute to conceptualizations from legal culture, but legal elites show lower inclination to explain the underpinnings of their behaviour to a large public outside the legal process, especially when in form of social networking.

Another reason concerns the proper design of the social network analysis for legal ontologies.

Social networks can not correspond to a representation of the whole social reality in which a top level ontology may be grounded. Social network analysis may be viewed as a broadening or a generalization of data analytic techniques which usually focus on selected observational units. Deciding on the sets of objects that lie within a network is a difficult problem for whole-network studies[12], since network boundaries are often permeable or ambiguous[13]. As to the network sampling[14], the explicit assumptions about how vertex, edge, and arc variable are related devise different research outcomes. Also, the degree of granularity may vary, depending on the quantity of parameters; it is pretty evident that only through recourse to a few parameters, discrete models and clustering of dyad distribution may arrive to a conditional independence of links[15].

In other words, the research focus of social network analysis is too tailored on localised objectives, while conceptualisations from legal culture require a wider research focus according to the multi-layered issues of the legal domains at the international, national and regional levels.

A different approach could combine semantic nodes and social network analysis, mainly small world functions[5]. Legal theorists are well aware that legal concepts are open textured because different instances may be read against a notion of relevance which is dependent from the legal context [24]. Some social network techniques may give some insights on the clustering coefficients among legal concepts.

Instead of considering the nodes as agents in a real environment, small world functions can be applied to legal documents in order to detect the hub centrality of some terms or their degree of betweenness. The linkage to the social dimension may derive from the ranking in the use of such terms by legal elites and laymen, when these data are reported, as in statutes, case law or legal literature.

Finally, two considerations can be made with respect to this approach. Small world applications mainly focus on structural information (e.g. centrality, closeness, betweenness, etc.) of nodes whit a weak meaning. This implies that the analysis mainly considers the existence of a relation among subjects, and not the typology of the relations, which may be inferred by a following step. This argument is strictly related to the rigid nature of a node-based network. Nodes are a sort of abstraction in the network and they have finite boundaries that distinguish them from their surroundings.

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[12] As sets of interrelated objects or actors that are regarded for analytical purposes as bounded social collectives [17].

[13] Such as, for example, the selection about some judicial activities or some lines of binding authorities.

[14] Designed as a multivariate complete multigraph.

[15] For further reading [11].

Meaning nuances may fail to be detected when social network analysis is applied directly to semantics.

To come back to the epistemological completeness of legal ontologies, social network analysis may address the question of validating different legal culture conceptualisations.

As noted above, background knowledge needs to be integrated with conceptualisations from legal culture in order to enlarge ontology extraction in the case of rules which are not documented by normative references, but normally applied by jurists.

Therefore, the solution to present alternative and different types of extensional semantics requires to combine them with a group of common axioms at a core ontology level.

This method is reductionist in the axiom formalisation and static in its implementation. Nevertheless, empirical analysis by social network could be applied orthogonally to defined tasks, linguistic occurrences or instances with the purpose of bridging the different extensional semantics relating to a specific period of time and a specific social context[16].

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Network Analysis of the French Environmental Code

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Abstract. We perform a detailed analysis of the network constituted by the citations in a legal code, we search for hidden structures and properties. The graph associated to the Environmental code has a small-world structure and it is partitioned in several hidden communities of articles that only partially coincide with the organization of the code as given by its table of content. Several articles are also connected with a low number of articles but are intermediate between large communities. The structure of the Environmental Code is contrasting with the reference network of all the French Legal Codes that presents a rich-club of ten codes very central to the whole French legal system, but no small-world property. This comparison shows that the structural properties of the reference network associated to a legal system strongly depends on the scale and granularity of the analysis, as is the case for many complex systems.

Keywords: Legal complexity, graph theory, network analysis, Environmental Code, citation network.

1 Introduction

In recent years, the debates about the legal complexity by spontaneous orders and the possibility to control it have recovered strength and interest from many different scientific and politic communities. In particular, when it is seen as a part of liberalization, the simplification of law is expected by different governmental bodies in Europe to reduce some administrative burdens, to induce net positive economical returns or, for example, to increase the trade volumes between State members, or even worldwide. However, what is the legal complexity, how to control it, and what might be the impacts of the simplification of the Law, are questions without any element of answer. This article does not attempt to define or redefine legal complexity (exposed for instance by Hayek's works) but is aimed to better understand an aspect of this legal complexity induced by the numerous citation links between articles. In a seminal paper [1], we proposed to open a field of research aiming at building rigorous definitions of legal complexity that could be operational and exploited over large legal data bases.

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Instead of directly confronting ourselves with the semantic complexity of the Law, we decided to analyze some structure associated with the legal systems. The positive fact in choosing this less ambitious objective is that we start building and using definitions of some aspects of legal complexity that, exploited with legal corpuses, provide new insight on the structural properties of some legal systems. These insights in turn open new perspectives on the Law. In particular the granularity of the legal texts we are considering is fundamental in the analysis because, as we shall see, the properties of the legal structure differ with the scale of the analysis (as is the case for many complex systems). Indeed in a previous study, we considered as the smallest object legal codes themselves and proceed to the analysis of the network formed by their cross-citations [2]. Using mathematical tools developed for the analysis of social networks, we found that several hidden stable structures are underlying the network of the French legal codes: a "rich club" is gathering the ten most cited and most citing codes that are very strongly connected to each others. Several other code communities also exist, in particular one of 12 codes related to "social matters" and "social activities", and another one of 11 codes regulating various matters linked to "territories and natural resources".

Changing the scale and granularity of the analysis, new structural properties are likely to appear. Here we choose to consider a single code and to analyze the network of citations within it. In a previous study, we have increased our resolution till the distinction of subdivisions within the articles. A statistical analysis of the distribution of the levels of organization of the Environmental Code and of the corresponding number of objects brought interesting clues about a kind of self-organization even within a code [3]. In the present study we go beyond the statistical analysis by considering with scrutiny the associated network structure.

2 A Network Approach to Legal Complexity

2.1 Networks Dealing with Legal Complexity

Studying legal networks brings a new point of view on the issues of the complexity of Law. Approaching the complexity of the law through network analysis is a novel area of study and few analyses have been made so far.

Previous work mainly focused on the analysis of the citation network of the Supreme Court jurisprudence [4], [5], [6]. In [6], some structural elements are highlighted: the network possesses a main core of 122 vertices, the most cited cases and the most central cases are enumerated and, despite a low density, the network is locally dense. James Fowler also used the different notions of centrality to study the citation network of the Supreme Court precedents [4]. The United States Code is also considered as a network in [7], the vertices of the network are the different sections of the US Code and the links are citations links. A common aspect of these papers is the examination of the degree[1] distribution in order to bring out a scale-free effect. The network structure of the Uniform Commercial Code is analyzed in [8]; in this paper citations links and hierarchical links are considered and several tools are exposed in order to understand the shape of the network. These tools are computing indices of the

[1] The degree of a vertex is the number of vertices linked to this vertex.

graph (like small world indices or centralities) or performing a good visualization of the graph in order to detect communities.

In the next subsection we shall introduce the legal network we study throughout this paper and then in Section 3 we shall not only compute the degree distribution and central vertices but also exhibit a small-world structure and cluster the network into communities. The analyses we perform, with an emphasis on legal interpretations of our results, will give us a better understanding of the shape of this network .

2.2 Associating a Network to the Environmental Code

Several networks – sets of vertices (or node) possibly linked by edges - can be associated to any legal corpus. We consider the cross-citations between various objects. Such an object can be, among others, an international Treatise or Convention, a law, a whole code, any subdivision of a code (book, title, chapter, etc.), an article, a key word, *etc.* There are numerous citations between these objects. Then it is straightforward to associate a network of citations (hereafter also called *reference network*) where the objects of the considered corpus are vertices and the citations constitute edges (or links) between them. For a network of several tens to thousands of vertices and edges, only appropriate mathematical tools allow to recover the main underlying properties and hidden structures.

In this study our corpus is the French Environmental Code (but our approach would apply as well to any other code). The nodes are the articles belonging to the code and also the various objects of the hierarchy of the code, say books, titles, chapters, sections, etc. Then we define two kinds of edges [1], [3]: influence-type edges and selection-type edges. Influence-type links are closely related to the hierarchy structure of the Code as they link objects *A* and *B* if *B* is a subdivision or a part of *A*. Being a "part of" surely indicates a non-arbitrary relationship, a dependence based on the organization of the legal substance of the corresponding texts or hierarchical levels within the code. This yields the tree structure of the Code (as can be retrieved from its table of contents).

A selection-type edge links two articles *C* and *D* if there is an explicit reference to *D* in *C*. For instance, the following extract of Article L211-3 produces a link between articles L211-3 and L211-2 and a link between articles L211-3 and L211-1: "*Article L211-3 (extract): In addition to the general regulations mentioned in Article L. 211-2, national or particular provisions with regard to certain parts of the territory are established by a Conseil d'Etat decree in order to ensure the protection of the principles set out in Article 211-1.*". This kind of link is also called *citation link* or *reference link*. Moreover any other object of the hierarchy of the code (not only articles) can be cited as for example in the Article L222-4 which explicitly cites the Article L222-1 and the Chapter III of Title III of Book I, thus creating the corresponding two selection-type links in the associated network. Note that the links to objects that do not belong to our corpus (here the Environmental Code) are discarded in the analysis.

2.3 The French Environmental Code

In France, an important step in the intelligibility and the accessibility of the Law was made in 1989 when the Government decided to accelerate and reinvigorate the codification process with the creation of the *Commission Supérieure de Codification*.

The codification process contributes to the clarification and ordering of the Law for citizens by collecting norms and regulations on a specific field in a single book called a *Code*. The present study is realized with the version of the Environmental Code as available on the Légifrance site [9] at the reference date of March, 27th 2009. Though the code is regularly updated and transformed, we believe that the results presented here are robust and representative for a period covering a decade or so (this period will depend on the rate of change of the texts in the corpus, this rate being itself most dependent on the regulated matter).

The French environmental Code is divided into a legislative part and a regulatory part. The legislative part has been voted by the parliament in 2003. The regulatory part should theoretically mirror the structure of the legislative part, and its content develops more specifically the corresponding regulations to be implemented. Here we only consider the legislative part and we construct the network of references as described in the previous sub-section. The legislative part of the Environmental Code is divided into the following seven books [9]: (I) Common provisions (Art. L121-1 to L110-2); (II) Physical environments (Art. L211-1 to L220-2); (III) Natural spaces (Art. L310-1 to L300-3); (IV) Flora and fauna (Art. L411-1 to L430-1); (V) Prevention of pollution, risks and nuisances (Art. L511-1 to L582-1); (VI) Provisions applicable in New Caledonia, French Polynesia, the Wallis and Futuna Islands, French Southern and Antarctic Territories and Mayotte (Art. L611-1 to L656-1); (VII) Protection of the environment in the Antarctic (Art. L711-1 to L713-9).

Added to these 7 books, we find 1775 other vertices (the smallest objects that we consider being articles) distributed into 31 titles, 122 chapters, 201 sections, 107 subsections, 26 paragraphs and 1288 articles. Among this total of 1782 vertices, 513 vertices do not share any link with another vertex. They are "isolated vertices". This is particularly the case of objects of the hierarchy which are never explicitly cited like for example the Chapter IV of Title II of Book II *"National technical measures for the prevention of atmospheric pollution and the rational use of energy"*. There are 93 such vertices that are not texts but headings of group of articles. It is also the case for articles which are never cited and do not cite any other part of the code like for example the Article L429-2 (*"The right to hunt on lands or water-covered areas is administered by the municipality for and on behalf of the owners"*).

We hereafter focus on the greatest connected component which contains 980 vertices, that is more than 80% of vertices sharing at least one link. The second greatest connected component has 40 vertices, the third one has 26 vertices and the remaining components have fewer than 5 vertices.

3 Analyzing the Network Structure of the Environmental Code

In the following the graph G denotes the greatest connected component of the reference network of the French Environmental Code. In order to visualize the hierarchical organization of the code on this reference network, we give a color to each vertex according to the book they belong to. A first representation of this network is done by using a spring-like force algorithm, often used to represent networks in a readable way and such as there are as few crossing edges as possible (Figure 1). However, owing to the high number of vertices, further analyses are necessary to better understand the network.

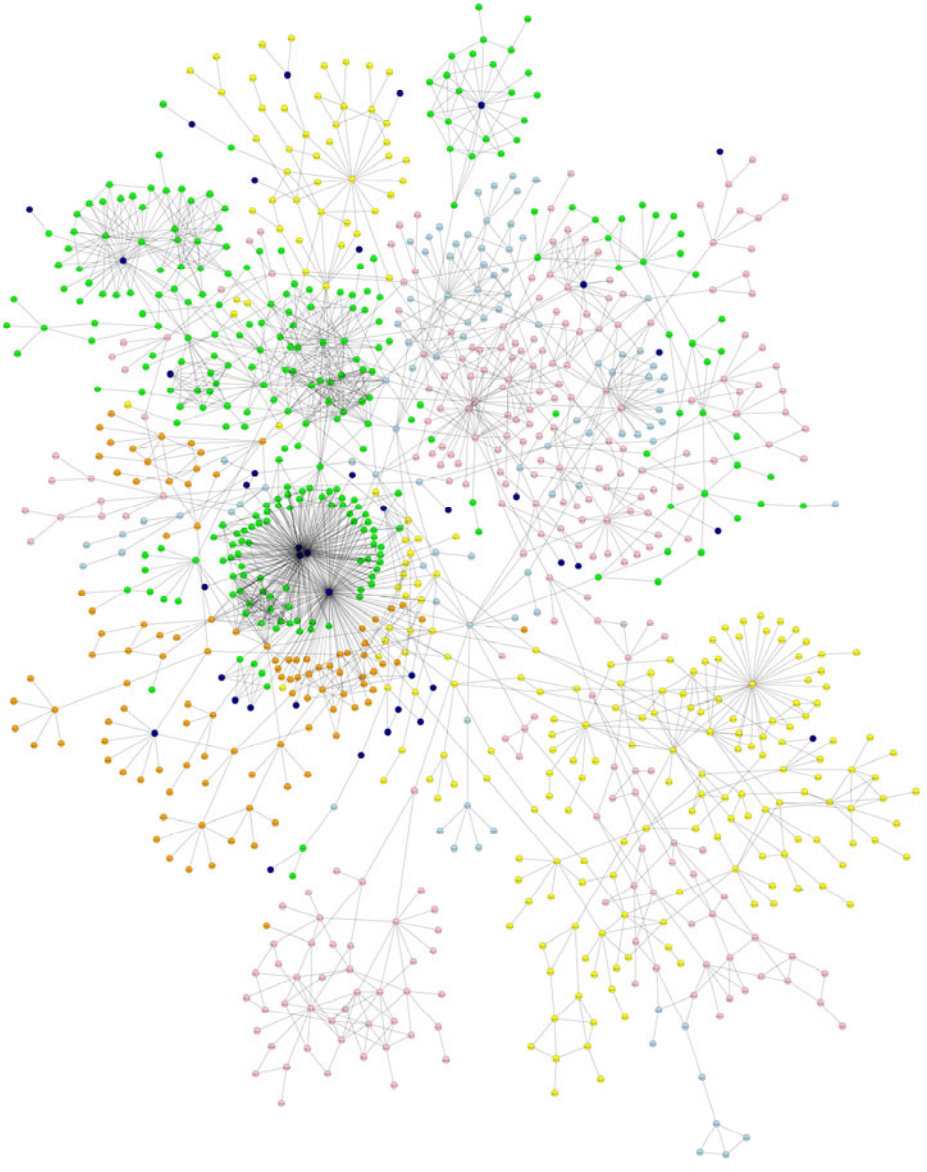

Fig. 1. The graph G associated to the main connected component (980 vertices, 2186 edges) of the Environmental Code (legislative part only). The colors given to the vertices indicate the Book they are belonging to (hereafter only short names are given): (blue) Common provisions; (green) Physical environments; (orange) Natural space; (yellow) Flora and fauna; (pink) Prevention of pollutions, Risks nuisances; (dark blue) Provisions applicable in New Caledonia etc.; (grey) Environmental protection in Antarctica.

3.1 A Small-World Network

The small-world structure has been found in many social or social-like networks [10], [11], [12], [13]. The definition of a small world structure is based on two main properties:

- Only few steps are needed to link two any vertices;
- The probability that two vertices are linked by an edge is much higher if these vertices already have a common neighbor.

The first point can be measured by the *characteristic path length* [13], [12] which is the median of the average shortest path starting at a vertex. The second point can be measured by a *clustering coefficient* which is the mean of densities of neighborhood of vertices. The global density of the graph is the ratio between the number of edges in the graph and the maximal number of edges the graph could have if all the vertices were pair wise linked. The clustering coefficient measures the local density that is the density around a vertex. In a small-world network this local density is much higher than the global density.

In order to estimate how high or low are these indices (the characteristic path length and the clustering coefficient), we compare them to those of other real networks sharing the small-world property. We also compare these indices to those calculated on an Erdos-Renyi random graph: the global connectivity (here measured by the characteristic path length) must be almost the same and the clustering coefficient must be much higher in a small-world type network.

Table 1. Small-world indices of G (graph of the greatest connected component of the Environmental Code), of the associated random graph, of a medieval social network [14] and of a network between German companies in 1993-1997 [15] (two companies are linked if they have a common owner). The number of vertices is denoted by n, the number of edges by m and the density by d, (with d=2m/[n(n-1)]). The small-world properties are related to the characteristic path length (L) and the first clustering coefficient (C).

Graph	n	m	d	L	C
G	980	2186	0.0046	6.78	0.49
Random graph	980	2186	0.0046	4.61	0.0046
Medieval	615	4193	0,0222	3.71	0.78
Companies	291	1036	0.02		0.84

As we can see in Table 1, the reference network of the French environmental code is a small-world. Indeed, the global connectivity measured by the characteristic path length is close to the one obtained for a random graph and the clustering coefficient is much higher than the global density of the graph.

3.2 Degree Distribution

Another strong characteristic of real networks (or social-like networks) are scale-free networks or networks having a power-law degree distribution. That means that the

empirical probability[2] for a node to have a degree k, that is to be linked to k other nodes, is proportional to a power of k. As the network considered in this paper is undirected we only examine the degree distribution for this graph. This distribution is represented on Figure 2a and is clearly a long tail distribution: there are a lot of vertices with a low degree and few vertices with a high degree revealing the presence of hubs. Figure 2b represents the same distribution but drawn on a log-log scale in order to check if this distribution is a power-law[3]. We recall that a power-law distribution can be obtained by a preferential attachment model [16]: when a new vertex enters the network, it links to other vertices with a probability proportional to their degree. In other words this new node will preferentially link to a high degree node (this can be seen as the *winner-takes-all* effect or *rich get richer*).

Here, we observe that the decreasing of the distribution is stronger for high degrees, this is a common phenomena which occurs for instance in the distribution of inward and outward citations of the judicial precedent network [4]. This deviation from power-law can be explained by the fact that the network elements have a finite capacity to add links, which limits their maximum degree [17].

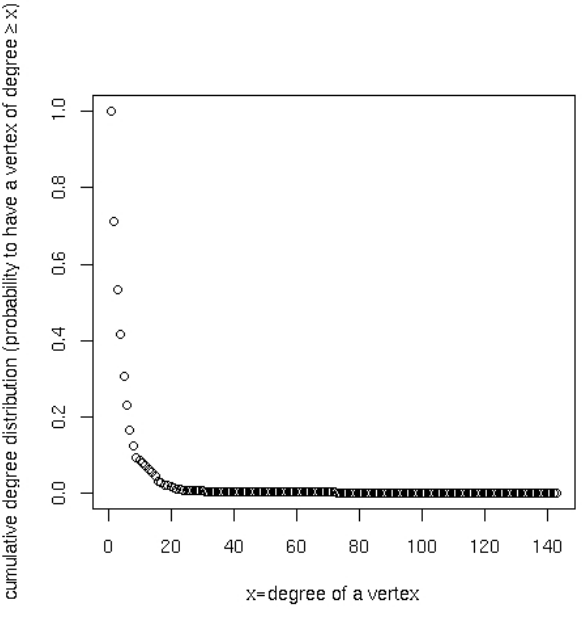

Fig. 2a. Cumulative degree distribution of the citation network of the French environmental code. The y-axis represents the probability to have a vertex of degree greater than or equal to x.

[2] For practical reasons we consider the cumulative distribution, that is the probability for a node to have a degree greater than or equal to k. This allows a smoothing of the distribution. Note that a distribution is power-law if and only if its cumulative distribution is power-law.

[3] A power-law drawn in a log-log scale is represented by a straight line.

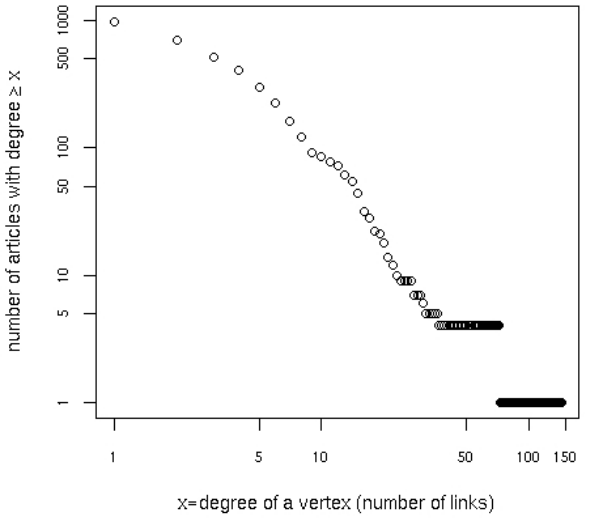

Fig. 2b. Cumulative degree distribution of the citation network of the French environmental code plotted on a log-log scale. The y-axis represents the probability to have a vertex of degree greater than or equal to x.

3.3 Central Articles

We then examine whether G possesses a "rich-club" that is a central and influent community consisting of vertices (e.g. articles) with highest degrees and highly interconnected. A rich-club provides a network structure mainly organized around this influential group. The degrees of the nine articles with highest degrees are listed in Table 2. It appears that this distribution is quite heterogeneous with a strong decrease and a gap between the largest degree and the second largest degree. In the network of citations of the French Environmental Code, it appears that there is no edge between the eight vertices with highest degree. Therefore they cannot constitute a highly interconnected group. Oppositely to the network of French Legal Codes [2] the network of citations in the French Environmental Code does not have a rich-club of articles (or of any other objects in the code). From a legal point of view, it means that every code is written in an autonomous way following an internal logic but that the global project of codification follows an emergent and successive organization.

Table 2. The nine vertices with highest degrees

Rank	Article	Degree	Rank	Article	Degree	Rank	Article	Degree
1	L640-1	143	4	L632-1	72	7	L216-5	30
2	L612-1	72	5	L429-1	36	8	L213-11	27
3	L622-1	72	6	L216-3	31	9	L652-1	27

Another important centrality notion is betweenness [18] which measures how important a vertex is for the network connectivity by counting the number of shortest paths going through this vertex. Figure 3a distinguishes some articles with a particularly high betweenness measure and Figure 3b shows some vertices with a low degree but a high betweenness centrality. We select the eight vertices with highest betweenness indices, the corresponding articles are listed in Table 3.

Among other things, Article L640-1 enumerates the references of a large list of articles of the Books I, II, III and IV of the Environmental Code that apply to the French Southern and Antarctic Territories. This content explains why it has both the highest degree and the highest betweenness (see Table 2 and 3, and Fig.2a). The Title I of Book V has a relatively high degree that results from being often cited. All together the Articles L511-1 to L517-2 form a whole description of the "*Classified facilities for the protection of the environment*" under this heading that is cited in preference to the individual articles. But these facilities for the protection of the environment are of concern for many other parts of the Environmental Code that otherwise would not be related. This is the reason for the relatively high betweenness centrality of this heading (Title I of Book V).

Table 3. The eight articles with the highest indices of betweenness centrality

Rank	Article	Betweenness	Degree	Rank	Article	Betweenness	Degree
1	L640-1	$2.57\ 10^5$	143	5	L218-44	$5.80\ 10^4$	14
2	L141-1	$1.28\ 10^5$	15	6	L142-2	$5.49\ 10^4$	7
3	L424-3	$7.31\ 10^4$	14	7	Book V, Title I	$4.50\ 10^4$	23
4	L413-4	$7.22\ 10^4$	4	8	L581-32	$4.38\ 10^4$	3

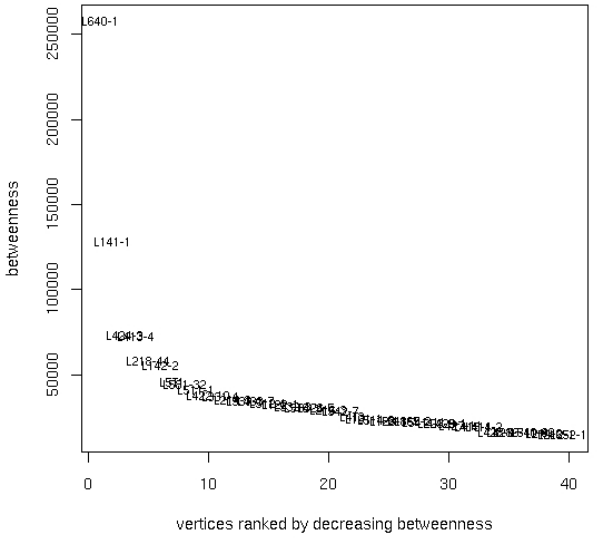

Fig. 3a. Betweenness centrality for the 40 vertices with highest betweenness measure

Article L142-2 is a good example of a central vertex with a low degree ($d=7$). Indeed it cites only three other articles and is cited by four other articles but these articles belong to four different books. As a result Article L142-2 is linking different communities of articles. As is seen in Fig.2b, many other articles in the Environmental Code have a low degree and a relatively high betweenness. By linking different communities they strongly structure the overall architecture of the code. But how do we reveal these communities? Do they exactly coincide with books, titles, or chapters of the Environmental Code or are they forming hidden structures within the Code?

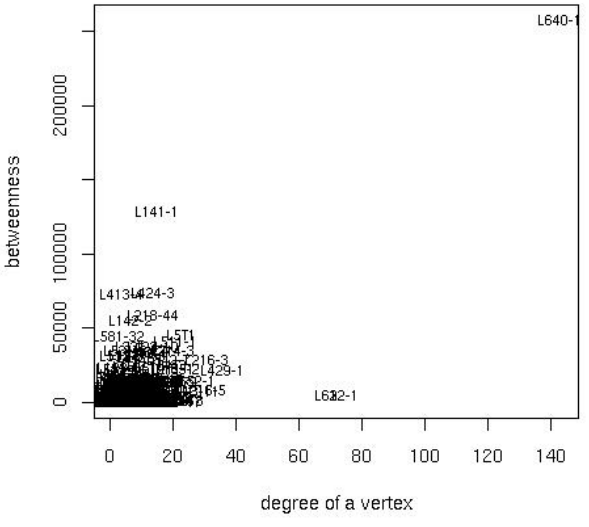

Fig. 3b. Betweenness centrality of a vertex (y-axis) as a function of its degree (x-axis)

3.4 Gathering Articles into Communities

Like social networks, the vertices of many real networks can be gathered into groups densely wired internally and with few connections between these groups. By analogy with social networks, such groups are called communities. In graph theory, the process of graph partitioning aims at dividing the graph into parts such that the number of links between the parts is as small as possible, and as large as possible within each part.

A preliminary step in the partitioning process is to remove the eight central vertices found in Section 3.3. Excluding these vertices will afford a clearer representation: let us assume that a central vertex links two communities A and B. If we do not remove the central vertex, there is a risk for A and B to be aggregated together in a single community at the end of the partitioning algorithm though they are distinct. Moreover this approach will allow us to emphasize the role played by these central vertices (e.g. articles).

Without entering into technical details (see the mathematical references if required), we use a spectral partitioning algorithm based on the eigenvectors of the normalized graph Laplacian [19], [20]. We obtain a set of communities of articles. Some of them are directly linked by edges between articles belonging to these communities. By adding the central vertices we previously deleted we can visualize how these different groups of vertices are connected. Figure 4 gives a visualization of this structure.

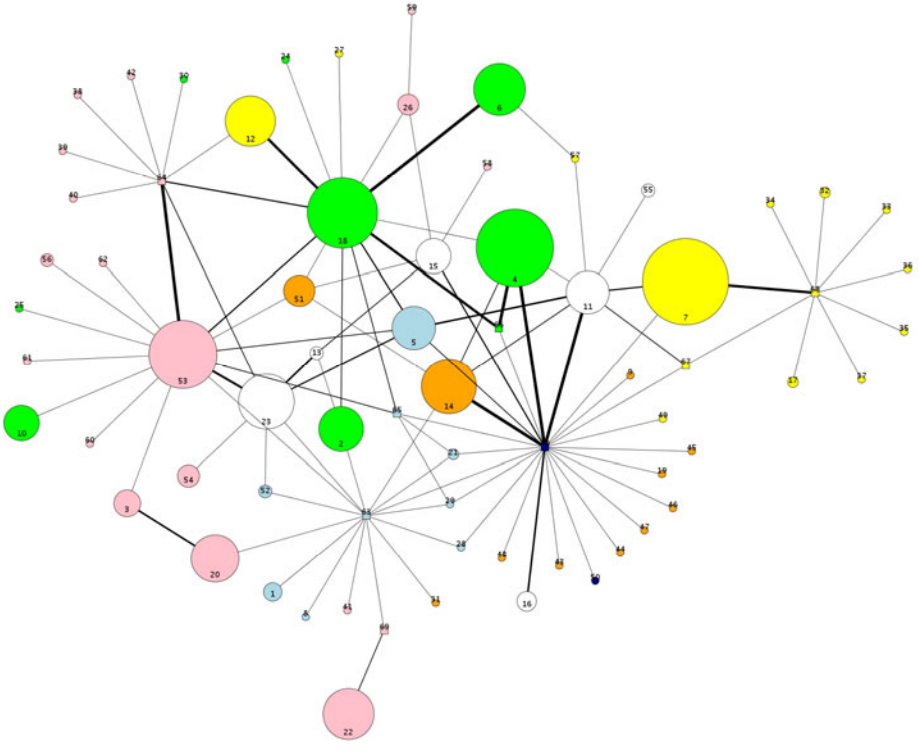

Fig. 4. Communities found in the largest connected part of the French Environmental Code and obtained by a spectral partitioning. A disk represents a community of vertices. Its area is proportional to the number of vertices therein. A community is colored if more than 75% of the vertices belong to the same Book; otherwise the community is white. The colors are the same than in Fig 1. The thickness of a link is related to the number of citations between the communities.

Three kinds of communities arise:

- Communities consisting of articles from the same section, chapter or book (note that for instance belonging to a same chapter is stronger than belonging to a same book). For example, the community with number 1 is composed of articles from the Chapter I of Title III of Book I *"Institutions acting in the domain of environmental protection"*;

- Communities mostly composed of articles from a same part of the Code. For instance vertices of community number 6 belong to the Chapter III of Title I of Book II excepted the articles L652-1and L652-8;
- More heterogeneous communities. Among the 22 vertices of community 15, 10 of them belong to Chapter II of Title II of Book I and 9 belong to Chapter I of Title VII of Book V.

In Table 4 we give the list of the main communities found in the graph G. The biggest one counts 135 articles, almost all belonging to the Book IV (*Flora and fauna*) of the Environmental Code. This group of articles has been gathered together in the code, and functions like a closed, "autonomous" community where most of references is pointing towards an article of the same group (and book). This community appears as the largest yellow disk on the right side of Fig.3.

Table 3. Size of the communities with the percentage of vertices belonging to the Book the most represented in that community (that Book and its associated color in Figure 4 are given in brackets). We do not mention the 34 communities of size 1.

Size	% of art. Book, color	Size	% of art. Book, color	Size	% of art. Book, color	Size	% of art. Book, color
135	99.3 (IV, yellow)	47	97.9 (V, pink)	22	50 (I, white)	3	66.7 (I, white)
109	77.1 (II, green)	46	87.0 (IV)	18	100 (III, orange)	3	66.7 (II, white)
90	85.6 (II, green)	41	80.5 (V, pink)	13	92.3 (V, pink)	3	100 (I, blue)
84	91.7 (V, pink)	36	94.4 (II, green)	9	88.9 (V, pink)	3	100 (V, pink)
56	64.3 (V, white)	34	94.1 (II, green)	8	100 (V, pink)	2	100 (I, blue)
55	96.4 (III, orange)	33	63.6 (IV, white)	7	57.1 (II, white)	2	100 (IV, yellow)
48	95.9 (II, green)	23	95.7 (II, green)	6	100 (I, blue)	2	100 (IV, yellow)

About 77% of the articles of the second largest community (109 articles) are belonging to Book II. The nearly 23% of the remaining articles are from one or several other books of the Environmental Code. An interesting exercise would be to analyze the content of these articles and see if they could be explicitly gathered under a common heading. It could be also extended to the other communities that we find and that present a non negligible number of articles external to the principal book of membership. We also notice that five important communities mainly issued from Book V appear in Fig.3 (green disks; see also Tab.4), though this Book counts only two titles, entitled "*Water and aquatic environments*" and "*Air and the atmosphere*" respectively. This features shows that the communities retrieved in the reference network are not simply reproducing the organization of the content of the code, but constitute hidden structures underlying it.

We also find several communities of size 1. Indeed, when we remove the central vertices, the resulting graph contains some isolated vertices, that is vertices sharing no links; these vertices cannot be gathered into a larger community and therefore constitute a community of size one.

Most of the revealed largest communities are mainly constituted of articles from the book treating of the physical environments (green disks in Fig.3), from the book on the prevention of pollutions, risks nuisances (pink) and from the book on the flora and fauna (yellow). The matters treated in these communities are presented in several articles with a relatively important number of cross-citations, like in a local sub-network. In these quite complex matters (see for example the way the water and aquatic environments are regulated in the Environmental Code) there is now easy or desirable way to organize the articles in a tree-like hierarchy. The contents of the articles are intrinsically interdependent. On the opposite we found no community gathering a majority of articles related to the provisions applicable in New Caledonia etc. (Book VI; dark blue vertices in Fig.1) or to the environmental protection in Antarctica (Book VII; grey vertices in Fig.1).

In Fig.3 we also see several small communities (sometimes in fact a single article) that are the center for a star-like shape (see e.g. the right most part of Fig.3), but the articles linked to this central node are not citing each others. Then they do not form a community.

4 Discussion

We can point out the particular position in the network of Book VI. A quick examination of figure 1 reveals that this book (the articles of which are colored in deep blue) is very disconnected and its articles are scattered and spread out in the network and they are linked to articles belonging to the five first books. As mentioned in the previous section, Figure 4 substantiates this fact as there is no community colored in deep blue. This observation confirms a remark made by the *Commission Supérieure de Codification* in paragraph of [21] devoted to French overseas territories "*The Commission met in a very classic way, questions relating to the codification of provisions relating to overseas territories. The complexity of the law of the overseas presents for each code some issues*."

The low density, the small world structure and the absence of a rich-club in the citation network of the French Environmental Code clearly contrast with the architecture found in the analysis of the reference network at the scale of codes [2]. Changing the granularity of the analysis modifies the nature of network structure and its associated properties. The density variation is not unexpected because while increasing the granularity (that is grouping vertices), the number of vertices decreases and the probability of existence of a citation between the two any bigger vertex increases. If this structure modification may be evident for the density (and therefore the small world effect), the disappearance of the rich-club is remarkable. This observed relationship between change of structure and granularity could be further investigated by considering other codes and other legal systems.

The mathematical analysis of the graph associated to the Environmental Code allows to identify hidden communities of articles interrelated by cross-citations.

An analysis of the content of the articles so grouped should bring new understanding on the way the matter is regulated. This question can be approached by lawyers or by the members of the *Commission Supérieure de Codification* (but is not the subject of this study), probably giving new insights on the way the legal substance is conceived and organized. Such analysis should be performed considering the largest communities with the higher percentage of "external" articles (articles in the community but belonging to different books or titles) as identified in Table 3.

5 Conclusion

This study provides a detailed analysis of the network of citations of a legal code. As a result we made a step forward in understanding the aspect of law complexity induced by intra-references of the norms in the Environmental Code. We focus our analysis on the largest connected graph found in this code that counts 980 vertices and 2186 edges (citations). This network is characterized by a small-world structure with several central vertices connecting communities. The structure into books of the Code is globally consistent with the exception of Book VI (*Provisions applicable in New Caledonia, French Polynesia, the Wallis and Futuna Islands, French Southern and Antarctic Territories and Mayotte*) which is not well and densely connected and the articles of which are linked to very different parts of the Environmental Code.

The structure of the Environmental Code is contrasting with the network formed by the citations between the French legal Codes (each code being a vertex). In this dense network we found a central group of ten most cited and most citing codes, strongly interlinked, and forming a rich-club, but no small-world structure. This comparison reinforces the idea that the underlying structures and properties of legal networks are dependent on the scale and granularity of the performed analysis.

The present study is a necessary stage to future applications. One of them is to compare different environmental codes for example the National Environmental Code and the two recent Provincial Environmental Codes of New Caledonia (the environmental matter belongs to the territories), or to compare this environmental code with other codes related to other legal fields (like the rural Code). These comparisons would allow us to state new hypotheses about the specificity of the organization of laws related to environmental matters or, if the occasion arises, to make assumptions concerning the constant shape of citations networks of legal codes. Another application would be to perform such analysis at different dates; this would give a way to measure the dynamical evolution of Law by measuring the evolution of small world indices, degree distributions and by examining the behavior of communities (which communities becomes denser or which communities are created).

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Model Regularity of Legal Language in Active Modifications*

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Abstract. One of the main emerging challenges in legal documentation is to capture the meaning and the semantics of normative content using NLP techniques, and to isolate the relevant part of the linguistic speech. The last five years have seen an explosion in XML schemas and DTDs whose focus in modelling legal resources their focus was on structure. Now that the basic elements of textual descriptiveness are well formalized, we can use this knowledge to proceed with content. This paper presents a detailed methodology for classifying modificatory provisions in depth and providing all the necessary information for semi-automatically managing the consolidation process. The methodology is based on an empirical legal analysis of about 29,000 Italian acts[1], where we bring out regularities in the language associated with some modifications, and where we define patterns of proprieties for each type of modificatory provision. The list of verbs and the frames inferred through this empirical legal analysis have been used by the NLP group at the University of Turin to refine a syntactical NLP parser for isolating and representing the sentences as syntactic trees, and the pattern will be used by the light semantic interpreter module to indentify the parameters of modificatory provisions.[2]

Keywords: Legal XML, Legal Ontology, NLP.

1 Semantic Layers in Legal Text

Certainly, one of the most important challenges now facing legal informatics is to achieve an ability to effectively capture the legal knowledge embedded in legal documents and to represent such knowledge in an appropriate formal format able to

* This paper was carried out with the following authors' contributions: M. Palmirani paragraphs 1, 2, 6, 7, appendix; R. Brighi paragraphs 3, 4, 5.

[1] Our research was conducted in Italian on Italian act, to be sure, but our methodology is language-independent, and we have solid evidence that it works as well on European directives. For this reason, and in order to make for a clearer exposition, we will use here several examples from the Eur-Lex database.

[2] For more detail on the NLP techniques used in this research work see also the paper "NLP-based Extraction of Modificatory Provisions Semantics", ICAIL2009, [15].

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express descriptiveness, meaning, semantic, all the while enabling machine-computable functions with which to address numerous specific problems.

In Europe, as well as outside Europe, many national and supranational initiatives have established XML standards for describing legal sources and schemas with which to represent legal documents[3] and uniquely identify the legal resources on the Web (URI). These initiatives have since grown into projects for the development of a new, Europe-wide representation format making integration and interoperability possible across all legal domains.[4]

A legal resource is a complex multilayered information architecture that includes several angles or layers of analysis:

TEXT. The part of the document officially approved by an authority with legal power.

STRUCTURE OF THE TEXT. The part of the document that states a text's organisation.

METADATA. Any information that was not issued by an authority in its deliberative act. Metadata can involve document description metadata (e.g., keyword), work-flow (e.g., procedural steps in the bill), document's lifecycle (e.g., document's history), and document identification metadata (e.g., URL, URI, URN, and annexes).

ONTOLOGY. Any information about the setting in which the document plays a role, for example, information specifying a concept pertaining to the legal system or any concept which is invoked in the text and which needs modelling.

LEGAL KNOWLEDGE MODELLING. The interpretation and modelling of the text's legal meaning, especially as concerns the representation of norms and rules that are not already included in the more abstract ontology layer.

The figure 1 shows how each layer needs a separate description and representation mechanism within the document, so as to enable multi-annotation on the same level and to manipulate data on any level without affecting the higher level. The layers are in this sense *strata* of information applied on the original document, as happened with the ancient palimpsests.

1.1 Text and Structure Layer

A feature common to all schemes is that they model the text and the structure of a normative text: text containers, by way of meaningful elements (preamble, title,

[3] Among these initiatives we have, in Europe [14], the Eur-Lex portal based on FORMEX data model, the Dutch projects MetaLex and SDU BWB, along with LexDania in Denmark, eLaw in Austria, CHLexML in Switzerland, the Crown XML Schema for Legislation in United Kingdom and NormeinRete in Italy, forming the main basis for this contribution. Outside Europe we have the AKOMA NTOSO project, coordinated by the United Nations Department of Economic and Social Affairs (UNDESA) and launched by the Pan-African Parliaments Organization; EnAct, with the governments of Tasmania, Canada, New Zealand; LexMLBrazil promoted by the Senate of the Brazil Republic and based on NormeInRete and Akoma Ntoso experiences, a number of states in the US as well as the United States House of Representatives [12]. Others national government initiatives [7] design legal XML DTD or schema that are not available for comparative studies, but are largely used in the on-line publications in official legislative portal like Legifrance in France, eBundesanzeiger in Germany, Finlex in Finland.

[4] See ESTRELLA - European project for Standardised Transparent Representations in order to Extend Legal Accessibility (IST-2004-027655) and CEN MetaLex Workshop.

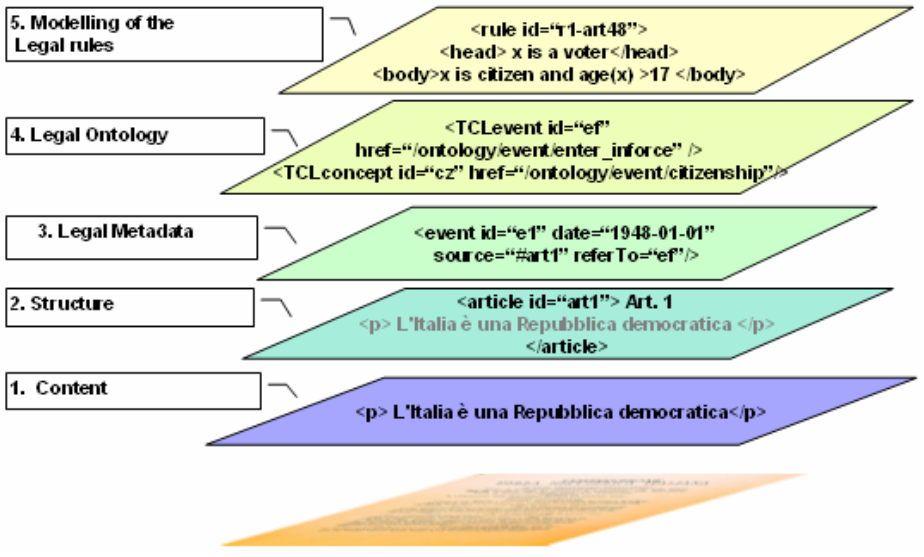

Fig. 1. Layers of representation in Legal Document Modelling

article/sections/clauses, quoted text, etc.) or by way of general textual elements. The structure markup capture the text and how the document was organized by the author empowered to endorse the document.

1.2 Legal Metadata Layer

A normative text is described not only through its structural elements but also through metadata, consisting in additional contributions provided by some agent (editor, publisher, etc.) to make sure the content more closely represents the legal knowledge embedded in the text and that the text is suitable for interpretation and use.

The metadata can be divided into *objective* and *subjective* metadata. The objective metadata don't need any strong subjective interpretation but do need to be detected within the text and linked to the proper ontology class: belonging to this category are data for identifying and managing the act (publication, location or legislative workflow, etc.).

We have also *subjective* metadata: belonging to this class are lifecycle attributes (helpful in versioning a document as it changes over time or in tracking events linked to the document), keywords, functional metadata (for modificatory and functional provisions, as well as for permissions, obligations, rights, etc.), and normative references made using Uniform Resource Identifiers (URIs).

Metadata should be always clearly distinguished from content, independently of the syntactical approach used, because they are an enrichment added to the text, usually by a different agent other than its author (as by an editor, publisher, etc.), and in case the author also provides the metadata, these will still need further annotation: we can place metadata on a separate layer sitting on top of the structural content (as in CEN Metalex or in Akoma Ntoso) or inline close to the content itself (as in

NormeInRete), or instead in an external document (as in Legal RDF, UKMF, LMAS, JMAS) [13].

1.3 Semantic Layer

On top of the metadata it is possible to define a domain ontology with which to enrich the metadata definition with abstract definitions, properties, axioms, and relationships between classes like LKIF-core [4].

While the ontology layer defines the abstract legal concepts (*Tbox*), in each legal text there are assertions that constitute the instances of the ontology classes (*Abox*): assertions, resources, and literals have to be associated with the proper legal concept (e.g. "Smith is Supreme Court justice" is modeled as Smith is an instance of the class *Supreme Court justice*). In the Semantic Layer, we find also the logic layer that fosters the ontology definitions and axioms. The logic layer models the norms' content, or legal knowledge (e.g., "Any person who wilfully infringes a copyright shall be punished as provided under section 2319 of title 18" is modelled using a logic formalism such as $\forall$ x (infringes (Person(x), copyright)$\Rightarrow$ Punished(x; #title18.section2319); another example is Art. 48 of the Italian Constitution, "Any citizen, male or female, who has attained majority, is entitled to vote," formalized in Fig. 1, where the status of *citizen* is linked to the ontology class of *citizenship*).

1.4 Fill the Gap

Important advancements are being made in the effort to model and represent the structure and content of legal texts and so as to model their meaning, but legal knowledge will not really be useful unless tools are available with which to automatically extract structural and semantic data from legal texts in order to generate formalized serialization of assertions [25] (XML, RDF, RDF/A, OWL, LKIF-rules.).

Still, one of the main problems in the state of the art is to fill the gap between these multiple layers, so that the information embedded in each level can be fostered and used by the others. Partly owing to a new legal-drafting policy in Italy,[5] as well as in Europe,[6] Africa,[7] and in internationally, legal provisions now have a regular structure making it possible to use a text editor to mark up in an automated or semi-guided fashion a normative text's structural partition [5] and normative references [6]. We do have several tools such as XML-Leges, MetaVox, and Norma-Editor [17] that are provided to a parser capable of capturing a legal text's format and automatically marking up the text to give it a structure equal to that of the corresponding legal document; so, too, these tools add identificatory data to this text in such a way as to build for it a URN[8] and to recognize the normative references made in it.

But there still remains the problem of filling the gap between the text's structure and its concepts. Our problem in particular, where consolidation is concerned, is to

[5] Circolare 2 maggio 2001, n. 1/1.1.26/10888/9.92. Guida alla redazione dei testi normativi.

[6] Joint Practical Guide of the European Parliament, the Council and the Commission for persons involved in the drafting of legislation within the Community institutions. http://eur-lex.europa.eu/en/techleg/index.htm

[7] Legislative Drafting Guidelines for Africa - www.akomantoso.org

[8] See also [6].

detect and formalize a provision's content and functional properties. Specifically, our objective is to develop a tool with which to automatically classify a modificatory provision (meaning a provision that modifies other provisions) by pointing out its attributes and the action it expresses, both of which are elements that serve a useful purpose in helping us apply a text so modelled. Several other researches have the same goal [9], [10], but their scope is limited mostly to detecting textual modifications. Our research aims to also discover and model temporal modifications and modifications of content that may be hidden within a textual modification.

2 Methodology and Semantic Annotation Architecture

This research was developed as part of the National Italian Research Project PRIN 2005, and is being developed under the ICT4Law project, Converging Technologies Project financed by Piedmont Region.

The previously stated objective makes it necessary to define a methodology developed on the basis of seven steps as follows:

1. Using Norma-Editor for XML markup of a legal text's structure and references.
2. Legal experts manually annotating modificatory provisions.
3. Using a taxonomy of modificatory provisions to extract from the text verbs frequently used in connection with each modificatory action.
4. Inferring a pattern of parameters in the language for each type of modificatory provision.
5. Running a deep syntactical parser using NLP tools and semantic interpreter on the basis of the taxonomy and the extracted verbs.
6. Applying the pattern of the parameters linked to each type of modification, so as to isolate the meaning of each text fragment connected to the modification.
7. Comparison and evaluation. In this paper we present the steps from 1 to 4, which form the basis for applying the NLP techniques under steps 5 to 7.[9]

We also present the architecture of the application serving to provide the service of semantically annotating legal texts via Web services (see Fig. 2).

The application is based on the SOAP Web-service architecture; therefore, any editor can use a standard API to communicate with the Web application. The use-case scenario is composed of seven steps as follows:

(a) The application or the end user directly calls the Web application and submits an NIR-compliant XML file.
(b) The file is converted from the original XML NIR version into the v2.2 mark-up.
(c) Two parsers are used to refine the mark-up in case the file was not completely and correctly marked up in those parts (such as structure, references, quoted text, and nested quoted text) that are fundamental for semantic detection and extraction. (These parsers are developed by CIRSFID and are already present in Norma-Editor.)

[9] See also [15].

(d) The XML file is processed by the NLP module (developed by Computer Science Department in Turin) to detect the modification qualification on the modificatory provisions.
(e) Output is converted into XML-compliant NIR v2.2 because the previous step does not harmonize all the metadata found in the document header or locally in the provision.
(f) We also produce an intermediate format, CEN Metalex, to preserve over time the pattern-oriented knowledge acquired during the process and not well stored in the NIR XML.
(g) The Web services display output for any further purposes.

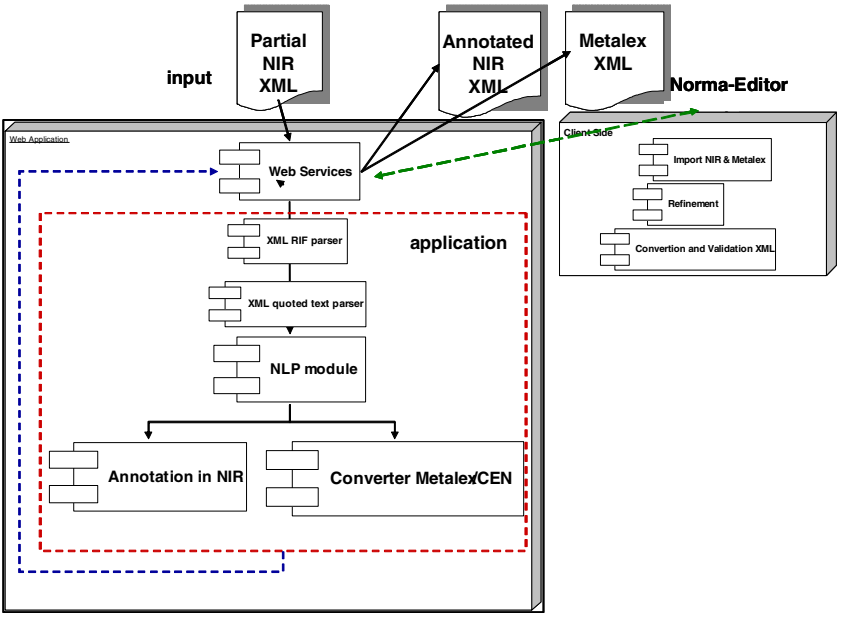

Fig. 2. Architecture of the semantic-annotation service on legal texts

Finally, we have designed and developed two important tools for testing and refining the methodology:

(a) A repository base on an XML-native database (*eXist*) storing the 29,000 XML Italian acts marked up using the NIR standard;

(b) A query module with which to flexibly extract the fragments of the modificatory provisions and their corresponding statistical data.

3 Modificatory Provision Definition

A normative system, for its part, will be understood as a body of provisions that change over time, in a process where existing provisions are amended or ejected as new ones

are introduced, or where a provision simply changes its normative content.[10] The provisions making up a normative system are therefore interconnected not only by their structure (textual part of the provision) but also through the meaning of a text amended within an entire norm. Thus, it will often happen that one provision should change other provision's text, purview, or term of enforceability through an amending clause embedded in the provision itself (e.g. "in Article 125(1) and (2), the words 'until 31 December 2007' shall be replaced by 'until 31 December 2010'").[11] For this reason we strongly believe that the modificatory provisions should no longer be limited to textual amendments but should ontologically also extend to the modifications of a norm's time parameters (time of entry into force or of efficacy), to its role (as when a national legal corpus comes to include an international treaty or implements a EU directive), to a legislative document's hierarchy within the normative system (delegation or delegification act), and surely to the scope of the application of the norms.

Therefore, modificatory provisions also require special attention because they affect the entire normative system at different times: they can act instantaneously, retroactively, or in the future (e.g. "in Article 28, paragraph 2, 'Directive 79/1072/EEC shall be repealed effecting 1 January 2010'").[12] Therefore, it is important not only to detect the action explicitly or implicitly stated in the text, but also to detect when the modificatory provision should act on the normative system. It should be underscored, in this regard, that a lavish use normative modifications tends to undermine the certainty of the law, all the more so that the changes so introduced are sometimes fragmentary and incoherent, making it that much more difficult to arrive at a clear understanding of what the law is, or which of several versions of a provision counts as law.

If we can automate the process by which to semantically analyze modificatory provisions, including all the connected attributes, we will have made great progress toward simplifying the legal system and consolidating texts of law,[13] because we will immediately be able to appreciate all the interconnections among provisions as well as the way in which one provision acts on the preexisting body of norms. This second ability in particular opens the possibility of simulating the effect of legislation during the lawmaking process, so as to build quality into our legislation right from the start.

4 Modificatory Provision under the *NormeInRete* Standard

This research is based on the NormeInRete XML standard (or NIR), for Italian legal texts; still, we can also apply the same methodology to Akoma Ntoso and CEN

[10] In See [11] for a theory of diachronic normative system in the time useful for designing a information system.

[11] Council Directive 2007/75/EC of 20 December 2007 amending Directive 2006/112/EC with regard to certain temporary provisions concerning rates of value added tax.

[12] Council Directive 2008/9/EC of 12 February 2008 laying down detailed rules for the refund of value added tax, provided for in Directive 2006/112/EC, to taxable persons not established in the Member State of refund but established in another Member State.

[13] By consolidated text is meant the updated version of a normative text—the version embodying and showing any and all changes overlaid onto the initial norm by norms subsequent to it. See [1].

Metalex, whose pattern designs are in certain respects similar, especially as concerns the modificatory modelling part (e.g., Akoma Ntoso as a metadata block dedicated to modificatory analysis similar to NIR and LKIF-core include a fragment of the modification ontology presented in § 5).

The NIR standard defines some structural elements serving to mark up the main partitions of a text of law, as well as its atomic parts (articles, paragraphs, subparagraphs, and lettered and numbered items) and any nonstructured text fragment.

A provision can be qualified through a specially defined space called <meta> in which a URN connects the element expressing a qualification with the textual element referred to (whether this is an atomic element or a string in the run of text).

Provisions can be classified on the basis of the taxonomically described functions they serve in a legal text [3]: constitutive provisions (e.g., definitions), regulative provisions (deontic concepts), and modificatory provisions (active or passive), and it is the provisions in this last class that make up the subject of our investigation.

A modificatory clause can be modelled through the following formalism.

ACTIVENORM (URN) — a provision stating a modification.

PASSIVENORM (URN, internal/external, complete/incomplete, negative/positive, single/multiple) — a provision affected by the modification. The *PassiveNorm* can be multiple when the affected provisions are many, and it is often a problem to automatically identify all the subparts of a complex string of provisions referred to (e.g., "Articles 3, 4, 6, paragraph 2 and 8," where it is unclear whether the 8 identifies *paragraph* 8 or *article* 8). It is incomplete where the text does not include unambiguous or unique parameters for indentifying the provision referred to. Sometimes the passive norm is expressed through a negative sentence (e.g., "Repeal all chapters except the first one"), making it necessary to express this through a negative proposition: *Repeal* (¬ (Chapter I)).

ACTION (TYPE, DURATION, DATE_APPLICATION, IMPLICIT/EXPLICIT) — an action the active provision entails for the passive one. Actions are organised into a taxonomy, and each action can have a date of application different from the date of entry into force of the law where the provision is found. So it is possible to find that the modificatory action is retro-activated or postponed, and the provision's application date fixes the time of the action. In most of cases, this action starts on the date of entry into force of the document hosting the modificatory provision. Still, it is not so difficult to find different points in time when the action is to be activated. This date is a fundamental element for determining the correct and valid chronological sequence of legal events in the diachronic representation of the normative system.

TIMES (INFORCE(START,END), EFFICACY(START,END)) — *Times* refers to two intervals, one indicating the time during which a modificatory provision is in force and the other the time during which it is efficacious. The modificatory provision is ultimately fixed by a triple date: the date of the provision's entry into force, the date on which it becomes efficacious, and the date when the modification is applied. A complex algorithm chooses the appropriate date in the triplet and it determines the timeline for the events of the process by which change is managed in the versioning chain.

CONTENT (OLD TEXT, NEW TEXT, POSITIONS) — This represents the part of the text that models the old text to be replaced or repealed in the modified provision. Any new text is inserted in the receiving norm, and the provision may indicate where the new text is to be inserted (e.g., "Insert the following paragraph before the paragraph beginning with 'If 2557'").[14]

PURVIEW — This part of the modificatory provision is sometimes used to indirectly describe a change in the range of application, or to point out an exception in this range, or to specify the way the range is to be interpreted.

SPACE — A parameter used to specify a geographical area across which the modification applies (e.g., "Estonia shall be granted a temporary derogation from the application of Article 21(1)(b) and (c) until 31 December 2012").[15]

CONDITIONS — (event, space, domain). Sometimes a norm's efficacy is conditional on an event, geographic space, or class (or domain) of application. When a modificatory provision is conditioned by an undefined event, this freezes the action until the conditional is resolved. This part of the language is very complex to detect, but the idea is to use a logic formalism to transform these cases into rules, so as to logically validate the time at which the conditions are satisfied. That will determine the time when the modificatory provision will take effect.

REFLEXIVITY — When an *ActiveNorm* and a *PassiveNorm* collapse into each other in the document, we have a *reflexive modificatory provision*, one that acts recursively on the same text with an introversion modification. This kind of modification is usually aimed at postponing a norm's application (e.g., "7. The percentage referred to in paragraph 1(d) and paragraph 3 shall from 1 January 2011 be 25 %)"[16] or at implementing an exception, condition, or space restriction restricting or expanding a norm's scope or jurisdiction. This particular propriety of the modificatory provision is a challenge to detect, for it is difficult to distinguish the *acting* text string from the string acted upon.

The NormeInRete standard includes in its Document Type Definitions (DTDs) a part dedicated to modifications that make it possible to implement this model into XML. Below is an example of how a nonqualified provision can be enriched with semantic metadata (bold type) by marking it up in XML through NormeInRete.

Original text of the Article 2 of the Directive 2005/1/EC:

```
Article 2
Directive 94/19/EC
In the third subparagraph of Article 3(1) of Directive
94/19/EC, the words "Banking Advisory Committee" shall
be replaced by the words "European Banking Committee".
```

marked up in XML NormeInRete standard:

```
<articolo>
  <num>Article 2</num>
  <rubrica>Directive 94/19/EC</rubrica>
  <comma id="art2-com1">
   <corpo>In the third subparagraph of
    <mod id="mod18">
```

[14] Commission Directive 96/86/EC.
[15] Directive 2008/3/EC.
[16] Council Directive 2003/48/EC.

```
      <rif id="rif53" xlink:href="urn:nir:unione.europea
;consiglio:direttiva:1994-05-30;1994-19-ce#art3-com1">
    Article 3(1) of Directive 94/19/EC</rif>, the words
      <virgolette tipo="parola" id="mod18-vir1">"Banking
Advisory Committee"</virgolette>
    shall be replaced by the words
      <virgolette tipo="parola" id="mod18-
vir2">"European Banking Committee"</virgolette>
    </mod>.
   </corpo>
  </comma>
</articolo>
```

and its enrichment with metadata qualification:

```
<dsp:sostituzione>
   <dsp:pos xlink:href="#art2-com1"/>
   <dsp:norma
xlink:href="urn:nir:unione.europea;consiglio:direttiva:
1994-05-30;1994-19-ce">
    <dsp:pos xlink:href="#rif53"/>
    <dsp:sub xlink:href="urn:nir:unione.europea;
consiglio:direttiva:1994-05-30;1994-19-ce#art3-com1"/>
    <dsp:incompleta/>
   </dsp:norma>
   <dsp:novella>
    <dsp:pos xlink:href="#mod18-vir2"/>
   </dsp:novella>
   <dsp:novellando>
    <dsp:pos xlink:href="#mod18-vir1"/>
   </dsp:novellando>
</dsp:sostituzione>
```

Before any semantic annotations are added, the text is marked up with structural data as well as with normative references and "quotation mark" elements, meaning text matter referring to a passive norm (such as any additional or replacement text, along with a string indicating where this text belongs in the passive norm). Semantic annotation enriches a text with the <mod> element, which acts to delimit a modificatory clause and the metadata.

There are several classes that NIR uses to qualify the action of modificatory provisions: these classes are identified by the namespace *dsp:*, which will be illustrated as we go along.

Every class of modificatory provisions is modelled as well by a number of sub-elements that further specify it. The DTD also makes it possible to write in your own sub-arguments, appropriately identified by a namespace, in case you need an even more detailed description of the modificatory action.

5 How Modifications Are Classified

A normative modification is a change made to one or more clauses within a text (to its articles, paragraphs, etc.), or to the entire text along with its annexes (repeal of an

entire law), or to the relations that hold among the constituent provisions of a legal system (as when a decree-law is made into law). Each such change will correspond to an *event* represented as a point in time when the change takes place.

We can proceed on this basis to break down normative modifications into five main classes as follows:

TYPE 1. A change made to a norm's text or form (an integration, substitution, deletion, relocation) or to a norm's meaning (an interpretation or variation of meaning or a modification of clauses);

TYPE 2. A change made to a norm's range (an expansion of its subject matter or range of application or a provision stating an exception to such a range);

TYPE 3. A change made to a norm's temporal parameters (the time of its entry into force and the time when it becomes operative);

TYPE 4. A change made to a norm's status within the legal system (a decree-law made into law, an international treaty transposed into domestic law);

TYPE 5. A change made to the powers conferred under a norm within the legal system (examples being a *legge delega*, by which the parliament entrusts the government with issuing a legislative decree under which certain public laws may be passed; or a legislative decree entrusting a ministry to deregulate a certain subject matter within its competence; or again a EU directive transposed into domestic law).

The Fig. 3 shows the complete taxonomy for modificatory provisions. This classification was arrived at by working together the modificatory forms described in legal theory[17] and legal informatics [21], on the one hand, and the schemas functional to the consolidation of normative texts, on the other. When the objective is to have a consolidated text, the legal-theoretical forms need to be specified into further forms expressing the actions the passive or target norm is made to receive, but this specification must be effected in such a way that the resulting text does not lose its legal use or relevance.

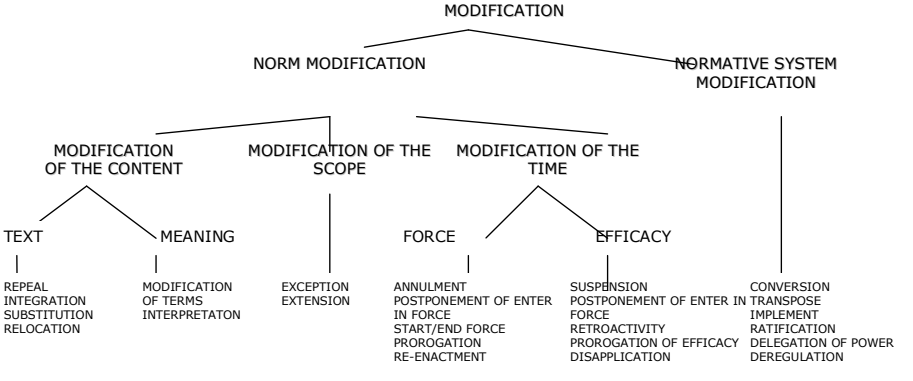

Fig. 3. Modification taxonomy

[17] See, among others, [11], [16], [24], [26].

The taxonomy is developed into an ontology within the LKIF-core to support the NLP tools with their axioms and properties. In particular, the ontology definitions define frames for the NLP semantic analysis. An intermediate class was created, called *Semantic Annotation,* to distinguish the temporal-modification and textual-modification classes from the other typologies.

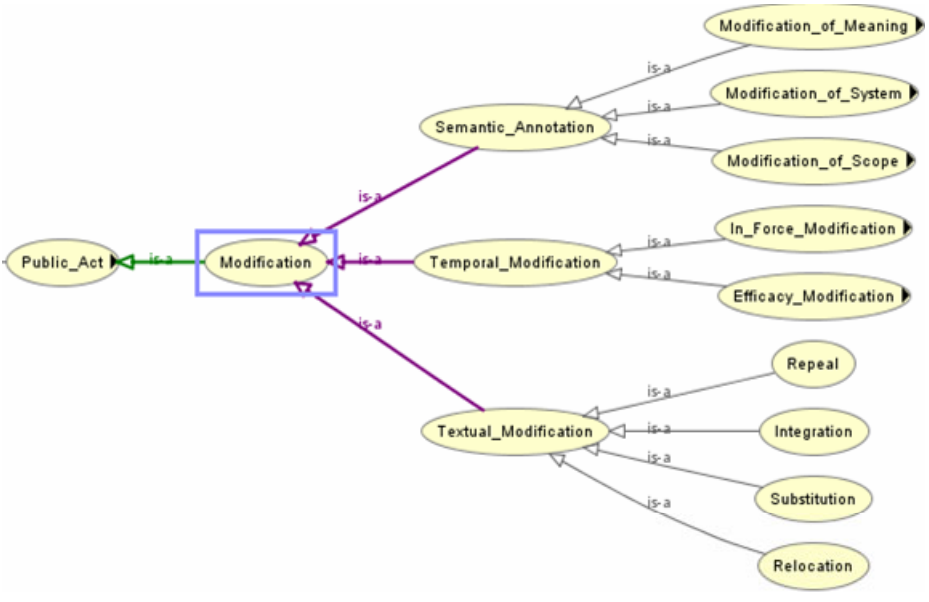

Fig. 4. Architecture of the semantic annotation service on a legal text

6 Regularity of Legal Language in Active Modifications

In addition to carrying out a legal-theoretical analysis of the changes a norm may receive and to developing models by which to represent these changes, we have also gone back—by way of testing the system at work—and surveyed a large body of norms that legal practitioners have semantically annotated with Norma-Editor on the basis of the NIR format. Our specific purpose was to asses the relative impact that each type of modification would have on the normative corpus that had been consolidated. We took a heterogeneous collection of documents (about 29,000 dating from 2005 to 2009), all of them published in the *Official National Gazette*, issued by the High Court of Cassation, and selected on the basis of a project that over the last five years CIRSFID worked on turning these documents into an XML format. On this body of documents we did a linguistic analysis to isolate patterns for each type of modificatory provision.

The articles processed are 46,483, and the total modifications are 19,203, representing 41% of the articles. The modificatory documents are 6,026, representing 21% of the all the documents processed.

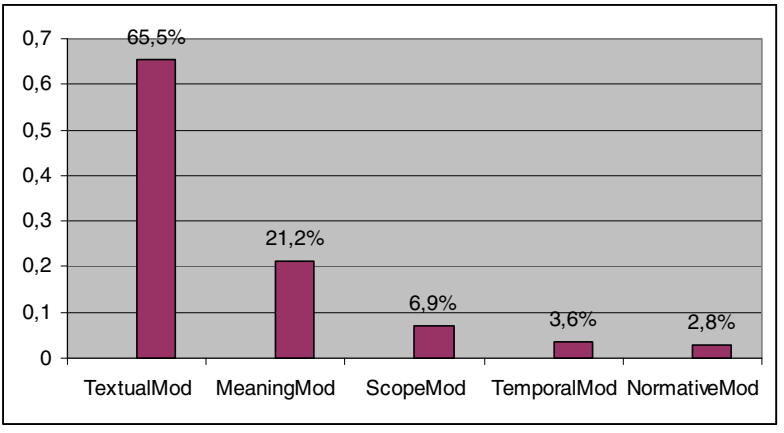

Fig. 5. Relative impact that each modification type had on the sample of norms considered

This figure shows that the biggest impact was owed to textual modifications (about 65.5%). Other types of changes seem either very rare or merely procedural (and so do not explicitly show up in the text); still, some indicators show that there is a hidden qualification in the statistical analysis. For one thing, 7% refers to exceptions and extensions, and this means the applicable norms are widely modified. And, for another thing, we see that temporal modifications are the third typology to impact our body of law. Significant is the 21% of modifications done without textual alterations but simply by paraphrasing (e.g., "The tax is increased by 2%"), so they elude machine-detection, and sophisticated NLP tools need to be developed to capture them.

Finally, we discovered that textual modifications contain several hidden temporal and exception/extension modificatory provisions and, vice versa, that some exception/extension undermined some textual modifications. In the following example (see Table 1) we can see a substitution producing a side effect on the target norm's temporal parameters.

For this reason we also proceeded, for each modificatory class, to extract meaningful elements and analyze the legal language in which they are expressed and the compositional rules or forms used in this language.

In doing so, we observed a degree of regularity in the language and the forms of expression used in writing active modificatory provisions: this holds not only for textual modifications but also for exceptions, extensions, and temporal modifications.

The recurrence of certain terms may suggest that in some cases we can determine how this modification should really be classified.

In certain cases we cannot determine the specific legal class. For example, the expression "shall apply from" + <data> suggests a temporal modification, but we cannot distinguish between a change made to a norm's entry into force from a change made to its efficacy; moreover, the expression can be confused with a procedural description.

Table 1. Example of substitution that produces a temporal modification as to efficacy

2000/185/EC: Council Decision of 28 February 2000	**2002/954/EC - Amendment**
Article 3	***Article 1***
This Decision shall take effect on the day of its publication in the Official Journal of the European Communities.	Decision 2000/185/EC is hereby amended as follows:
It shall apply from 1 January 2000 to 31 December 2002.	1. in the first subparagraph of Article 1 "three years running from 1 January 2000 to 31 December 2002" **shall be replaced** by "four years running from 1 January 2000 to 31 December 2003";
	2. in the second subparagraph of Article 3, "31 December 2002" **shall be replaced** by "31 December 2003".
[**ORIGINAL**]	**[M1]**

Thus, for example, the recurrent use of certain terms or expressions may suggest a temporal modification, but we cannot proceed on the basis of these wordings alone in determining how this modification should really be classified (change affecting entry into force or change affecting efficacy). To this end we need additional information about the provision, and sometimes it proves necessary to do a legal interpretation on the text in order to properly qualify it as being of one legal type or another.

The common language locutions that recur in the different modificatory provisions have thus been sorted into different classes of modificatory language, classes designed to be neutral with respect to the legal effect they can produce. For each such class we associated one or more legal class or subclass (from the list of five that was earlier introduced in Section 4). The idea is that the semantic parser should make a neutral classification only once the language has been syntactically analyzed and semantically interpreted using the NLP technique. The semantic interpreter uses the pattern built by the above-mentioned classification and analysis, and provides a classification based on the forms of expression alone (on the locutions). And then, in a second run, a set of compositional rules—operating in combination with a specialist's interpretation of the text—will make it possible to translate the language-based markup of the text into a markup based on a more appropriate set of legal classes, types, or forms.

In analyzing selected textual portions prior to markup, we also found that the standard locutions are often accompanied by other recurrent elements specifying the relevant modificatory action.

If we sort out these accompanying elements and make them work with the support of formal rules, we can in certain cases automatically map out the relevant legal type, and in *every* such case we can exhaustively mark up a modificatory norm's action on a passive or target norm.

Table 2. An excerpt from the classificatory analysis we carried out ranking modificatory linguistic classes by their impact on the normative system

Linguistic Category	Linguistic terminology	Legal Category
Insert	insert, add, Integrate	integration (temporal, exception, etc.)
Delete	repeal, soppress cassate, remove, delate	repeal
Update	substitution, change modify, replace	substitution
Relocation	renumber, relocate replace	relocation

Table 3. List of linguistic elements

Legal Category	Subject	Object(s)	Date	Old Text	New Text	Position(s)	Conditional
Insert	Fragment of provision	Provision Text Schedule Normative Reference	X		X	After, Before, Between, At the end, At the beginning, From .... to, Following	Since Until When If
Repeal	Fragment of provision	Provision Text Schedule Normative Reference	X	X		After, Before, Between, At the end, At the beginning, From .... to, Following	Since Until When If
Substitution	Fragment of provision	Provision Text Schedule Normative Reference	X	X	X	After, Before, Between, At the end, At the beginning, From .... to, Following	Since Until When If
Renumbering	Fragment of provision	Provision Text Schedule Normative Reference	X	X		After, Before, Between, At the end, At the beginning, From .... to, Following	Since Until When If

Here is a list of the elements accompanying the standard locutions:

- *Date*. A date can express the moment a modification is applied (effective immediately or at some time in the future), or it can modify a term or signal the beginning or end of a temporal modification.

- *Quoted text* (quotation marks). Text enclosed within quotation marks can be used to define a concept, but aside from this case, it can be used in a modificatory clause as text to be inserted into the passive or target document to be modified (the intervening string is called a *novella*), or it can specify text to be replaced in the target document or deleted from it (in which case the string will be called a *novellando*), or again it can quote something from the target text so as to locate the place where a modification is to be made in the same document.

- *Position*. This is expressed by function words such as *before*, *after*, *between*, *from*, and *to*, followed by a quoted string or atomic document partition (paragraph,

line, index, title), and it locates the exact point where a modification is to be made in the passive or target text.

- *Condition*. This is a useful element stating the constraints subject to which a modification is to be made. Conditions are generally tied to an event (whether certain to happen or otherwise), or to a legal form of some type, or to a place, and the locutions used are *since*, *until*, *if*, and *when*.

On the basis of these parameters we can design some frames to feed to the NLP tools. Here are some frames relating to substitution:

Table 4. Example of frames for representing the modificatory provision of substitution

FRAME1: PassiveRif – quoteTextOld:(optional) – passive verb – quotedTextNew << at the point 4.1 the words "*not less of the 80%*" **are substituted** by the words "*of the 100%*"; >>
FRAME2: PassiveRif – quotedPosition:(optional) -quotedOld:(optional) – passive verb - quotedNew <<In the article 169, first comma, of the decree 16 March 1942, n. 267, after the word "*council*", the word: "*article*" **is substituted** by the following: "*article 45,*">>
FRAME3: PassiveRif – passive verb - ResourceRif <<The annex B of the Ministerial dDecree 24 March 2005 **is substituted** by the annex B of this decree.>>
FRAME4: ResouceRif – verb - PassiveRif <<The annex B of this decree **substitutes** the annex B of the Ministerial Decree 24 March 2005.>>
FRAME5: quoteTextNew– verb – PassiveRif <<The following text "Art. 5. New version 1. new content" **substitutes** the art.5 of the Ministerial Decree 24 March 2005.>>

The previous example brings out another important issue in linguistic detection: the active and passive verb form defines the role of the subject and object. Thus the expression *is substituted by* implies a preexisting *PassiveRif* (a passive or target norm), as well as it implies a new text in some part of the linguistic tree. Some parts of the tree are fundamental and mandatory:

Table 5. Example of mandatory elements in the substitution frame

Passive	PassiveRif[destination] – quotedTextOld [old text] –verb– quotedTextNew[new text] PassiveRif[destination] – verb – ResourceRif
Active	PassiveRif[destination] – quotedTextNew [new text]– verb – quotedTextOld[old text] ResourceRif – verb – PassiveRif[destination]

The treebank results (see Appendix) are compared with the amendment frames, and we can detect all the parameters and arguments of the action of modification and their meaning for passing to the appropriate translation in XML NIR compliant metadata. The NLP indeed detects the arguments of the modification but it is not able to assign the adequate meaning into the context of the legal text without the support of the modification ontology.

7 Conclusion

The regularity of the modificatory provisions and the frequency of the textual ones encourage research in the direction we have indicated. Moreover, the results from NLP application bears out our methodology: a more detailed vocabulary of verbs can be extracted from this large database (29,000 normative documents), and that would make it possible to reinforce the linguistic categories in conjunction with the taxonomy of modificatory provisions. On the other hand, we can also focus more on modelling the textual modifications that include temporal information (postponement or retroactivity of the modification) or conditionals (events or facts that block a modificatory action). Another important goal is to detect the overlaps that nontextual modificatory provisions may come to have as a result of textual amending that can hide a modification's real semantic meaning. Even so, some indirect language covers some direct modifications. So we intend to work further on the textual modification patterns, improving them with temporal parameters and conditional attributes. In the meantime, we will also be looking to widen our investigation to other neighbouring information—such as title, nearest paragraph, and marginal notes—that can help us understand a text's normative meaning. The new version of the NIR, DTD2.2, can help in working toward this goal. This approach also opens the prospect of taking into account other types of modificatory provisions, like exception and extension, that more closely connect with the task of interpreting a norm's semantic content, which is the final ambition of this research.

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Appendix: Treebank of Some Modificatory Frames

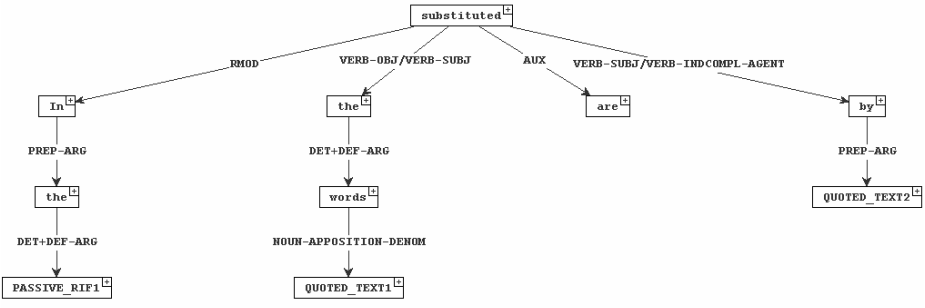

Fig. 6. Example of passive sentence tree processed by TULE and TUT[18]

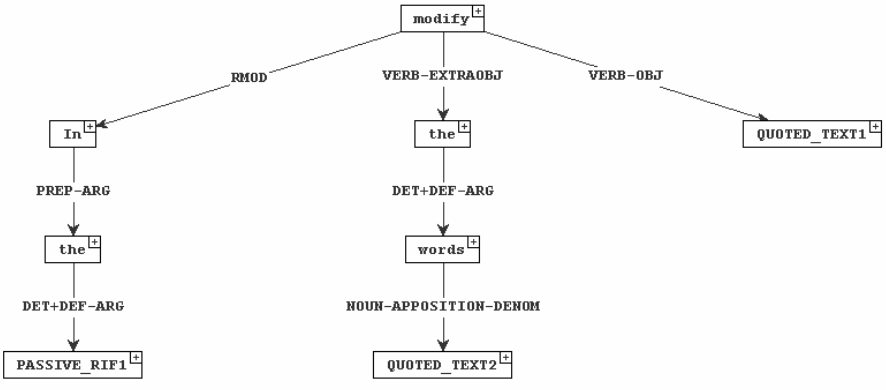

Fig. 7. Example of active sentence tree processed by TULE and TUT

[18] TULE - Turin University Linguistic Environment, TUT - Turin University Treebank.

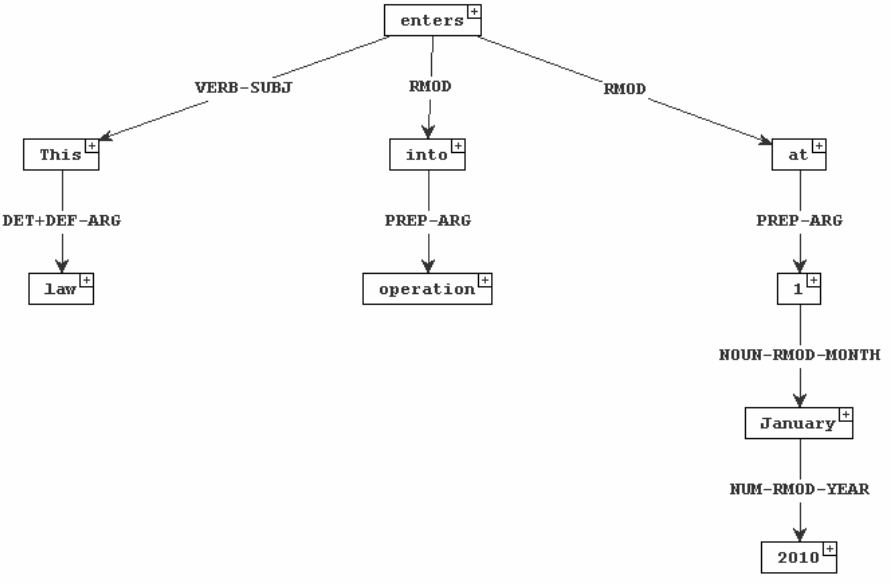

Fig. 8. Example of temporal modification tree processed by TULE and TUT

Traceability and Change in Legal Requirements Engineering

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Abstract. While *isomorphism* of knowledge representation has been recognized as important, particularly to maintenance in legal knowledge representation, the requirements of the maintenance process in general get less attention. Traceability from knowledge resources used in the organization to the sources of law used in their production is a central maintenance issue in administrative organizations. This paper explores a mediating knowledge representation for reconstruction of traces to sources of law and to implementation knowledge resources, that should be helpful for analysis of the impact of changing sources of law.

1 Introduction

While *isomorphism* has been recognized as important to maintenance in legal knowledge representation [1,2], the maintenance process itself gets little attention. Traceability from knowledge resources used in the organization to the sources of law used in their production is a central maintenance issue in administrative organizations. This paper explores a knowledge representation in the form of rules for reconstruction of traces to sources of law and to implementation knowledge resources, that should be helpful for analysis of the impact of changing sources of law.

In the context of the Agile project, introduced in section 2, we are working on the the robustness of traceability of knowledge resources of the organuization to sources of law, and on dealing with the risks involved in agile network arrangements with other organizations.

The increasing interest in public administration for traceability to sources of law and modeling network arrangements is driven by:

1. increasing commercial traffic between jurisdictions, which leads to increasing interest in the complications of *legal pluralism*[1] in its broader sense,
2. the increasing dependence of service provision on negotiated network arrangements between organizations, also within the same jurisdiction,
3. the increased formalization of interactions through ICT [3] (XML standards, the service paradigm, etc), and generally
4. the perception that the pace of change in society increases.

[1] The EU and its free traffic of goods, services, and persons should for instance come to mind here.

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Network arrangements are for instance service contracts, resource sharing, automated and standardized data exchange, etc, between independent agents that only enter into such arrangements if and as long as these are beneficial to the participants. No larger organizational framework creates and enforces the network arrangement. Loose network arrangements make it harder to organize compliance to the law: meeting obligations no longer necessarily translates to control objectives, to allocation of responsibilities to roles in fixed business processes, and to specific groups of employees in departments. The organization that depends on service delivery of others becomes increasingly responsible for (intelligently monitoring and reacting to) what happens outside its organization.

An administrative organization may for instance use an electronic service of the tax administration to perform an income check on behalf a client, yielding a simple yes/no answer, instead of asking the client to claim an income and provide evidence. This saves work, increases the reliability of data, and – if used properly – protects the client's privacy. It however also creates dependency on the tax administration, thus a need to understand the requirements and constraints – including but not restricted to the legal ones – that motivate and constrain service delivery, and a need to monitor for changes to these requirements and constraints. Network arrangements create opportunities for increasing efficiency and quality, but they also increase exposure to risk.

Traceability is the solution to the legal provenance issue involved in legally justifying the structures and knowledge resources of the organization. Following implementation traces back to sources of law is helpful for diagnosis when undesired or unintended results are produced, and is the starting point of impact analysis when the law changes. Lastly, it is also a requirement for justifying individual case handling decisions.

In section 3 we position the requirements model as a knowledge resource produced and used in two feedback loops, from individual case handling processes, and to the legislator.

Our approach to traceability, explained in section 5, and demonstrated in section 6, is to distinguish between three different universes of discourse, layered on top of eachother. The entities in each layer are explicitly linked to corresponding entities in adjacent layers by a logical theory – a set of Agile rules – in order to be able to trace the impact of changes in sources of law all the way to implementation in an organization, and back from experiences on the work floor to the legislator's actions and intentions. The logical theory will account for in what sense the sources of law and implementation knowledge resources are related. Provenance information about the sources of law, based on MetaLex (section 4), and applicability rules (subsection 5.4) also play an important role.

We expect that the interjection of an abstract legal institutional layer between law and implementation in the legal requirements model leads to more accurate documentation of the impact of changes, and better reflects the degrees of freedom the organization has in implementation. The *Agile* project, and the pilot implementation projects that are part of it, will test this hypothesis.

In the concluding section (section 7) we discuss two additional issues raised by the design choices for the Agile rules, being the design rationale for the three proposed

layers in an analysis of the impact of changes, and the commonly held opinion that (legal) rules should be modeled in a defeasible logic, which we do not do.

2 Background: The Agile Project

The work reported in this paper was performed in the context of the Agile project (acronym for Advanced Governance of Information services through Legal Engineering). Agile aims to develop concepts helping administrative organizations to reduce the time from a request for changes based on a change in the relevant law to implementation in the organization. The project develops models that are intended to help administrative organization in developing alternative implementations, estimating required effort and time, identifying risks and opportunities, providing useful and accurate feedback to the legislator, and generally to change from a project-centered approach to a maintenance-centered approach to dealing with change of the law.

The Agile project is specifically concerned with public administration. Implementation of changes in the law is in public administration not an occasional isolated interruption of peaceful stasis, but a core activity of the organization. Moreover, the organizations in this category usually have a close working relationship with the legislator, at least some direct influence on the formation of positive law, and their interpretation of codified law is of direct relevance to many others. There is a feedback cycle between legislator, these organizations that implement the law, and the courts that judge those implementations, which drives theory construction in many areas of law.

Involved in the Agile project are the Dutch Immigration and Naturalisation Service (IND) and the Dutch Tax and Customs Administration (DTCA). In both organizations, timely and efficient adaptation to changing legislation, case law, and patterns of behaviour accommodating or evading law in the relevant environment, is seen as an important organizational objective, and one whose realization is a constant cause of problems. Immigrants and taxpayers are notoriously capricious customers to have. The IND and DTCA have to reinvent themselves continually, and sometimes move to have the law changed, in response to problems and opportunities arising from their environment.

2.1 Objectives of the Agile Project

In the Agile project we aim at developing a design method, distributed service architecture simulation environment, and supporting tools for legal requirements engineering. The project aims to take the resilience of existing systems, dependencies on the environment, and the unpredictability of change processes explicitly into account [4,5].

The Agile project started in the second half of 2008 and will last for four years, producing two PhD theses. The project uses knowledge representation technology developed within the semantic web community, OWL2, and some of the ontologies and technologies partially developed within our institute, like LKIF [6], MetaLex [7,6], and the LKIF Core ontology and its predecessor [8], as a starting point.

Note that real world deployment of OWL2-based web services is not intended: actual technical implementation has to take into account the existing technical infrastructure of an organization, and the modernization of infrastructure or selection of delivery platforms is not the focus of the project. The primary purpose of modeling implementation

of legislation in OWL is to account for that implementation, to validate it, to do impact analysis if something changes, to simulate candidate new service arrangements, and to provide feedback to the legislator.

The project does include a modest agent simulation activity for simulation of candidate realizations of legal services and of the reaction of network partners and clients [5]. This activity is not the focus of our work, and not of this paper, although it is sometimes alluded to in the explanation of design choices.

Lastly, we also intend to demonstrate the effectiveness of the use of methodological guidelines empirically in a later stage of the project.

3 Sources of Law in Process and Product Development

The issue of traceability and impact analysis is of relevance not mainly for the primary business processes, i.e. individual case handling, but for internal product and process development activities within public administration. Product and process development translates the legal requirements into implementation knowledge resources, which guide primary business processes, but it also takes input from the work floor and gives feedback to the legislator. As such the activities can be conceived of as taking place within two feedback cycles – one with the primary individual case handling processes as the subject of implementation and monitoring activity, and one in which product and process development activity is being monitored by the legislator.

See Fig. 1 and Fig. 2 for a visualization of these cycles, using the decomposition of problem solving activities proposed in [9]. The legislative feedback loop is about the production and use of sources of law. The individual case handling feedback loop is about the production and use of implementation knowledge resources. Implementation directly influences the law, and vice versa.

The purpose of the legal requirements model mediating between sources of law and implementation knowledge resources presented in the next sections should be seen in the context of these two cycles.

The idea of a mediating legal requirements model is in itself not original even outside of academia: one of the project partners has one, focused on legal concepts, and their links to the text of the law and implementation knowledge resources. It is considered hardly helpful for any other purpose than as a resource for acquisition of domain knowledge for new employees of the IT department and external consultants. It doesn't help significantly for impact analysis, because it links too many things to too many things without qualification.

Our objective is to develop a knowledge representation methodology for a requirements model, presented in this paper, that is explicit enough about the relation between implementation and law to be useful, that is cost-effective to implement, that is compatible with existing business process and business rule modeling practices, and that is conceptually simple enough to be understandable to people with the skill set typically found in administrative product and process development activities.

The representation explored in this paper is focused on representing the meaningful uses the sources of law afford (in the sense advocated by for instance [10]), i.e. the things the organization can or should do, and the things that can happen to it, because

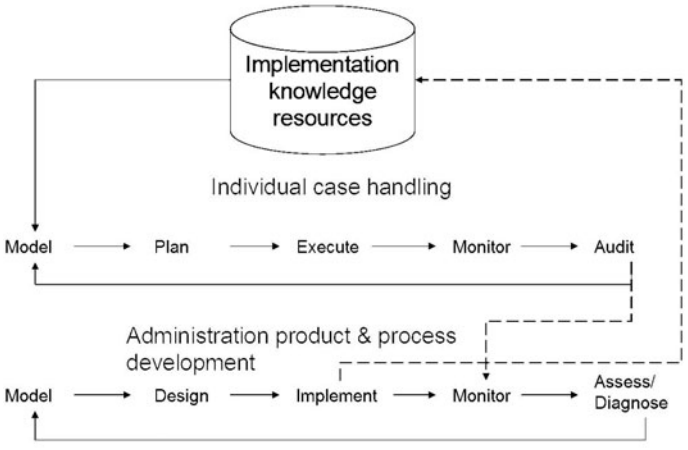

Fig. 1. The product and process development feedback cycle

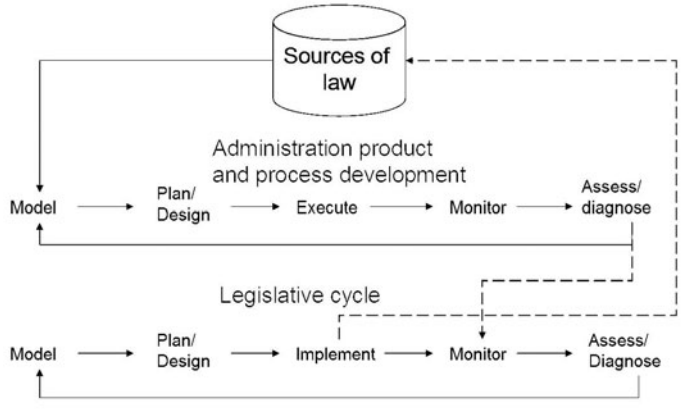

Fig. 2. The legislative feedback cycle

the sources of law exist, or are changed. Legal rules afford avoidance of violations, the assumption of certain social roles and execution of predictable interaction protocols, the intentional improvement of one's legal position, the monitoring of the behaviour of others, misrepresentation of our intentions to others to our own advantage, etc.

This contextual meaning of legal rules leads us to reject the notion that a knowledge base for a decision support system, or an ontology used to validate case data in a database, can be considered as the primary ("executable") specification of the meaning of legal rules. The issue is rather which distinct uses the rule affords, and what design patterns the organization's knowledge engineers should consider when interpreting them.

A simple example: The legal protocol that guides buying and selling, and the formal evidence produced in this protocol in the form of orders, invoices, and receipts, provides the material for various fraudulent disbursement, money laundering, and tax evasion schemes. Besides the primary use of legislation about sales transactions for the execution of sales transactions, a tax administration may for instance use the same rules to organize information about tax evasion. A fraudulent disbursement is for instance transaction that follows the sales pattern, but without an actual duality of stock flows, and a sale far below market price between family members is for instance not an arm's length transaction and is therefore classified as a gift, etc. The tax administration *uses* the legal rules in a monitoring and assessment activity, and changes of these rules are relevant to it. The role these rules play in the activity is however not at all apparent from studying the content of the rules.

This kind of monitoring activity is quite common and constitutes a reusable design pattern for administrative organizations; An immigration administration for instance takes an interest in marriages of convenience, and specifically develops interpretation rules for those. While it is very well possible to give a more general account of the intentions and assumptions behind this design pattern, such an account has only limited added value for a requirements modeling methodology. We are therefore more interested in the design pattern than in its reduction to generalized legal reasoning.

Improvements to the legal requirements model are in part to be found in a better account of the relation between the model and the sources the law, discussed in section 4. In section 5 we present a modeling approach based on a general ontological stratification of our problem domain into three largely separable knowledge domains – abstract legal institutional reality, the sources of law and their provenance, and implementation in the organization – and the conception of Agile rules that describe the ways in which these domains potentially influence eachother.

4 Bibliographic Identity of Sources of Law

To implement traceability from knowledge representation to sources of law, the Agile project builds on the results of our work on MetaLex XML (cf. for instance [6,7,11]), an XML metastandard for legal and legislative resources. MetaLex is a common document format, processing model, and metadata set for software development, standardized by a CEN/ISSS[2] committee specification in 2006 and 2010.

MetaLex requires adherence to a URI[3] based, open, persistent, globally unique, memorizable, meaningful, and "guessable" naming convention for legislative resources based on provenance information. This provenance information can be extracted in RDF form and used in OWL2 [12].

MetaLex is especially useful for our purposes because it standardizes legal bibliographic identity. The determination of bibliographic identity of sources of law is essential for deciding on the applicability in time of legal rules presented in those sources of law.

[2] `http://www.cen.eu`

[3] Uniform resource identifier.

MetaLex and the MetaLex naming convention strictly distinguish the source of law as a published work from its set of expressions over time, and the expression from its various manifestations, and the various locatable items that exemplify these manifestations, as recommended by the Functional Requirements for Bibliographic Records (FRBR; cf. [13]).

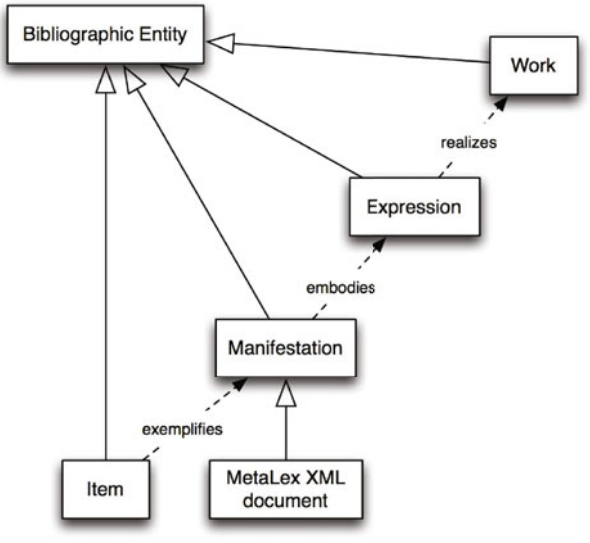

Fig. 3. Taxonomy of bibliographic entities in MetaLex, and their relata, based on FRBR

MetaLex extends the FRBR with a detailed but jurisdiction-independent model of the lifecycle of sources of law, that models the source of law as a succession of consolidated versions, and optionally *ex tunc* consolidations to capture the possibility of retroactive correction (errata corrige) or annulment after the fact of modifications to a legislative text by a constitutional court. In these cases the version timeline is changed retroactively: the conceptual time travel involved is an excellent example of the weird applications of constitutiveness. See for instance [14] for an explanation of the practical ramifications of annulment, and more generally an overview of the complexities involved in change of the law. Note that while MetaLex permits the identification of versions in different tiimelines, the involved reasoning requires defeasibility.

The use of MetaLex identification and referencing solves one aspect of the traceability problem. In current organizational practice links are more often than not made to locatable items, often without formal agreements about the permanence of the used item identifiers *even* between different departments of the same organization. Correct traceability to the right bibliographic abstraction (generally work or expression depending on the purpose of the reference) is – particularly at the levels below *formal* law – a notable weak point in organizational practice, and *ex tunc* change scenarios are not explicitly modeled, or even recognized. MetaLex makes this aspect of the traceability problem at least explicit, and provides some tools to address it.

In the MetaLex metadata set, specified in an OWL ontology, the `realizes` property between expressions and works represents the connection between the two ontological levels at which documents exist that are of relevance to their real world use (see Fig. 3). The source of law on the expression level for instance *cites* other rules on the work level, while the legal rules we represent knowledge about are necessarily identified by their representation in a discrete number of expressions [11].

A citation *(text fragment)* w *applies to (concept)* C should for instance be read as *each legal rule that is represented by an expression-level text fragment that* `realizes` *work fragment* w *applies to* C. This representation technique plays an important role in the Agile project, and is observed to significantly cut down on rather pointless maintenance operations redirecting reference pointers.

The idea of the MetaLex standard is of course that provenance metadata will be supplied by the publisher of the used XML manifestation, and is extracted from it in OWL form by organizations that use it.

4.1 Actions Performed on Documents

In MetaLex provenance information is organized around actions performed on documents.

Provenance metadata more often than not exists of simple predicate-object statements about electronic documents, even though permitting different perspectives on the same action, because its identity was not made explicit, may yield incompatible metadata descriptions. This results in unnecessary duplication of metadata, and separate occasions in which to make mistakes. It therefore creates unnecessary maintenance, and, lastly, the loss of relevant references between documents [15].

An action generally plays the mediating role between relevant entities and the resource the metadata description is about. The natural coherence between for instance *author*, *publication date*, and *publication channel* information (e.g. state gazette bibliographic information) is apparent to all: all are participants in the publication (promulgation) event. There is also a natural coherence between an old consolidation, the new consolidation, the modifying legislation, the modifying authority, and the modification date: the modification event links them together.

Because actions also play a central role on the other layers, we choose for a uniform representation of action inspired by MetaLex. Generally, we try to build on analogies between the legislative domain and the implementation domain, choosing the same representation solutions for both.

5 Agile Rules

Conceptually, Agile knowledge representation is based on a distinction between three universes of discourse (see Fig. 4):

1. sources of law,
2. legal institutional reality, and
3. implementation in brute reality.

Between these three systems we find simple and uniform interfaces, existing of a *representation*[4] relation, which interfaces written law and legal institutional reality, and a constitutiveness or *counts as* relation, which interfaces legal constitutional reality and implementation in brute reality.

The Agile knowledge representation consists of logical rules describing these three systems individually, and the interfaces between them. Logical rules functioning as interfaces between these systems may be presumed to be defeasible in practical use. Logical rules that describe the structure of one layer are not: we assume that the organization commits to using a transparent interpretation of the ontological structure of the sources of law, legal institutional reality, and the working floor at any point in time, and that the legislator usually has no intention of creating confusion.

The first domain addresses the relevant provenance and efficacy information about the sources of law. The sources of law include not only legislation and case law, as already pointed out, but also policy statements and guidelines of lower level rule makers used in the organization. This is in essence the metadata of the sources of law that is relevant in positioning them.

Fig. 4. Law, legal institutional reality, and implementation in brute reality

In the next domain we find abstract legal institutions, whose presence is produced by the sources of law [16,17,11]. We take the source of law to be a writing that may be used to back an argument concerning the presence of a certain institutional entity, a legal rule, created by the legislator in a certain legal institution [7]: The source of law is the result of a legislative act performed with the intent of creating that institutional entity, and functions as evidence of the legislative act.

Finally, in the third domain, there is the implementation of the legal institutions in brute reality. The institutional reality as represented in the sources of law only comes to life through the brute reality that constitutes (or counts as) it. The raising of a hand for instance counts as a bid in an auction. The issuing of a document invented by some administrative agency tasked with issuing residence permits similarly counts as an official residence permit.

The *legal rules* presented by the sources of law constrain the structure of institutional reality and the superposition of institutional reality on brute reality. Any *logical* rule in the Agile model mapping brute reality (the raising of the hand) to institutional reality (the bid) may either be backed by the applicability of a legal rule presented by the sources of law or simply by knowledge of the domain, as for instance represented by business process and service specification resources. Both legal rules and the various rules one may find in software (production rules, integrity constraints) are from the perspective

[4] Or presentation if one prefers to take that ontological stance.

of the mediating model identifiable resources, in the domain being represented by the rules of the legal requirements model.

5.1 Implementation Knowledge Resources

In the context of Agile, brute reality means business processes, and services. Related to these are *resources*, the implementation knowledge resources, such as documents and forms, fielded software, business process specifications, manuals, etc, but also the declarative, logical rules in fielded knowledge bases.

An affordance of a legal rule may for instance be implemented by:

1. a computer-registered event or an accountancy event that counts as the performance of a legal act performed by a person;
2. an executable declarative rule used by a decision support application;
3. an integrity constraint in a database that triggers an event if the constraint is violated;
4. an explanation of the legal rule in a document; and
5. a non-executable business rule in a business process or software specification.

Concepts in the model may be used by:

1. a class in a business process or software specification;
2. a database schema or application data structure;
3. a field in a form;
4. an explanation of the concept in a document.

Part of the implementation knowledge resources we are dealing with are information artifacts arising from interaction protocols and reasoning strategies. In particular we need to address two categories of such artifacts that take a prominent place in computer science & law: *defeasible rules*, and representations of *argument*, particularly adversarial argument with its attack relations (e.g. [22]).

We however consider these second-hand knowledge resources. The use of a legal rule, and even the choice for the interpretation of its meaning in the organization, is tightly linked to workflow and resource allocation considerations. Workflow considerations are modeled through event-condition-action (ECA) orchestration mechanisms [5]. This view of the use of legal rules makes a singular approach to the defeasibility issue in reasoning with legal rules a less pressing concern, although we of course acknowledge that a generic defeasible reasoning ability to validate arbitrary sets of claims and rules would be a very valuable addition to requirements analysis tools.

The agent definition in the project, which is based on ECA orchestration [5], has little in common with the (more ambitious) normative agent system approach outlined in for instance [18].

5.2 OWL2, Validation, and Defeasibility

The entities named in Agile rules, including knowledge resources, are all URI-identifiable and may serve as anchors for reference from other knowledge resources.

The ability to make some sort of URI-based hyperlinks from other knowledge resources is increasingly common, and doesn't impose a high implementation burden.

Agile knowledge representation is based on OWL2 axioms, augmented with the MetaLex OWL2 schema and a rule formalism [19] that allows for additional constraints on RDF graphs not expressible in OWL2. The example in section 6 will be based on OWL2 expressiveness only.

Agile rules are OWL2 axioms reified using the RDF reification mechanism. An assertion of a reification of an RDF triple does not implicitly assert the RDF triple itself: this means that there are no entailment relationships which hold between a triple and a reification of it, although semantic extensions *may* include such interpretations. Any other information is also expressed in the form of reified RDF triples.

Because Agile rules are reified, they may carry provenance information, and can be easily version managed on work and expression level, to reflect improved understanding of the law over time. Provenance information on reified OWL2 rules create the possibility for a belief base revision approach to defeasibility [20,11], and is also the preferred approach to extending the operational semantics of Agile Rules in other directions.

The intention in Agile is not to commit to a defeasible logic, but rather to come to an account of which argument schemes are – in the proper context – recognized as a defensible basis for decision making in the organization. In section 7.1 we return to the discussion of defeasibility in Agile models.

5.3 Constitutiveness and Representation

Institutional events are constituted by events in brute reality. The main function of the constitutive rule is to define the interface through which the state of the institution can be changed through necessary and indicative conditions. Constitutive rules may be defeasible. Institutional rules map out a logical space of possible models of the institution: they form the institution's ontology, and can be interpreted as terminological axioms [16,11]. They are not to be considered defeasible as a matter of convention, because permitting ambiguity about the institutional ontology makes no sense from the administrative organization's perspective.

Constitutiveness is modeled through the *constitutes* (inverse *constitutedBy*) property in OWL2 [11]. This property applies to *legal things*, and not legal propositions: we do not follow the custom of talking about *legal facts* arising from brute facts in representation. Newly created legal things *must* be constituted by another thing, which means in essence that one of the constitutive rules that can create a legal fact *must* be applicable [11]: a legal thing is constitutedBy some thing, and a legal rule is applicable to it.

Constitutiveness is often accompanied by (re)presentation, modeled through the *represents* (inverse *representedBy*) property. A formal act is an act of representation of a legal proposition, with the intent of being constitutive of that proposition. This pattern is typical for legislation itself, and is also often found in administrative transactions.

The use of formal acts creates confusion between proposition and the use of formal representations of a proposition as evidence. For immigration, the proposition that someone is married may for instance be legally relevant; In the implementation of this criterion this for instance becomes the proposition that someone has supplied a marriage certificate, but even if the marriage certificate must be renewed every year, a certificate

may in fact be still valid at the moment of decision making while the marriage is not at that point in time in existence. Moreover, some issuers of certificates in foreign countries may be notoriously unreliable, etc.

Behind a single proposition in the law are often complete forms, procedures, checks, constraints, etc, and many subtle differences in meaning in all those places where the proposition exists. The formal act of marriage remains of course a single, unique event, but not the only one to which the applicable rule is relevant.

5.4 Applicability

Applicability plays a central role for knowledge engineers as soon as the identity of the legal rule and the interpretation of its logical meaning are distinguished. The logical rule must assert explicitly that the legal rule is being applied. The law also frequently identifies rules: a special class of legal rules, *applicability rules* (e.g. [21,22,11], constrains the applicability of other rules, or make the application of one legal rule conditional on the application of another legal rule.

Applicability is modeled through the *applicable* (inverse *appliesTo*) property [11]. This property applies to the *legal* thing the rule is about, regardless of its left hand or right hand side position in the axiom. Together *constitutedBy* and *applicable* explain how a legal thing arose.

Applicability is wherever possible attached to legal actions as a methodological choice. Since we do not determine confluence of applicability rules from subsumption between propositions, or sets of them, we have to be sure that rules about the same subject apply to the same thing. Actions are the focal objects.

One of the great challenges in understanding applicability is the distinction between its dispositional and categorical meaning (i.e. if the rule *were* applied to something, the result would have some quality that it wouldn't have if it were inapplicable, vs. the rule has been as a matter of fact applied). In its epistemological applications (of which [22] is an example) in defeasible reasoning, and in implementation resources, it is generally taken to be dispositional. Why make explicit the application of a rule at all, unless it is defeasible?

While the effect of switching "switching the OWL2 axioms on and off" may be realized by an extra condition to the OWL2 axiom styled as a form of dispositional applicability statement about the legal rule, this is an unnecessary epistemological commitment not explicitly warranted by the legal corpus itself. Such dispositional use of concepts in essence tries to capture *it is consistent to assume that*, which refers to reasoning strategy rather than to the meaning of the legal rule per se. Section 6 gives an example of the categorical use of applicability we prefer for Agile rules.

We also do not attempt to account directly for metalegal principles like lex superior (higher rules defeat lower rules), lex specialis (more specific rules defeat general rules), and lex posterior (newer rules defeat older rules). Following [11] we are of the opinion that lex specialis and lex posterior are based on generic principles of practical communication and cognitive function that give rise to temporal and logical nonmonotonicity, and do not as such have to be specifically accounted for in legal knowledge representation.

Lex superior is on the other hand clearly a design feature: sources of law are explicitly stratified in order to make it possible to instruct the reader to not apply intuitions about temporal and logical nonmonotonicity. The legislator sometimes immediately regulates reasoning, explanation, and communication strategy. The legislator however does so in his own words, and the representation of these constraints on reasoning activity can be left to the organization representing their interpretation of those words. Generally the application of lex superior depends on provenance information about the sources of law (e.g. acts promulgated by government and parliament defeat acts promulgated by the crown).

Applications of these three principles that have entered the legal corpus, or are deeemed prudent by the organization, enter the Agile model as applicability rules that make the applicability of a legal rule dependent on the applicability of another legal rules.

6 Rules Example

The example source of law for this paper consists of two sentences presenting two simplistic rules:

t_1 The publication of a text presenting a rule counts as the creation of that rule.
t_2 Rule t_1 applies to text published by a rule maker.

The legislative example is *qua* design pattern representative of formal legal acts in bureaucratic environments (see subsection 6.1).

Agile knowledge representation consists of making rigorous distinctions between entities in different domains.

Firstly, we distinguish the text, which is a MetaLex expression object, from the legal rules: t_1 represents legal rule r_1, and t_2 represents legal rule r_2. This distinction makes alternative interpretations of the same text, and the maintenance of provenance information about these different interpretations, possible. We moreover also distinguish the legal rules from the (logical) OWL2 rules a_1 and a_2 describing their meaning.

Rule r_1 is clearly constitutive. Rule r_1 (represented as an OWL axiom written in a compact Manchester syntax-like notation for purposes of readability) demonstrates an interesting pattern relating the *constitutes* and *represents* relations:

```
if :Publication that
 (:resultsIn some (:Text that
  (agile:represents some :Rule)))
 then
  (agile:constitutes some (:Creation that
   (:resultsIn some :Rule) and
   (agile:applicable value :r1)))
```

This pattern is typical of implementation of legal acts as *formal* acts, and occurs often in public administration. Here we also see the major expressive limitations of OWL: it describes treelike patterns, and here we would like to add the constraint that the rule

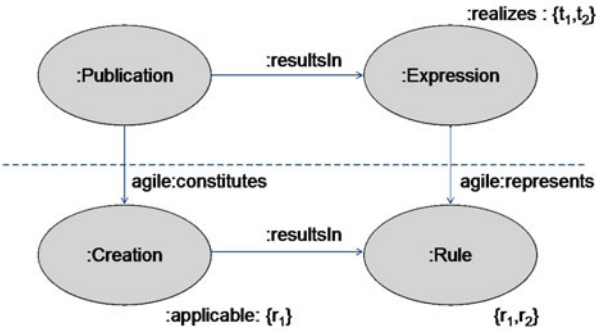

Fig. 5. The structure of interest in rule 1 of section 6

represented by the text is the rule being created (as in Fig. 5). Some workarounds are possible in OWL2, but these sacrifice readability. We use the extension to description graphs in [19].

The second rule r_2 limits the applicability of r_1, but also of any other rules derived from any *future or alternative* version of t_1, as follows, showcasing the subtle bibliographic identity distinctions made by MetaLex:

```
if (agile:representedBy some
 (metalex:realizes value :t1))
 then
  (agile:appliesTo all ((:actor some :RuleMaker) and
   (agile:applicable value :r2)))
```

Because of the distinction allowed by MetaLex, we can *refer* to the work, and *represent* the expression in Agile rules.

In the universe created by this small set of rules, the entities r_1, r_2, any instance of *Rule*, *Creation*, and *RuleMaker* are institutional (and this is enforceable through domain and range restrictions), and the rest are implementation entities. Texts t_1, t_2 represent information, while rules r_1, r_2 are institutional entities.

Note that, although these two rules are consistent, the applicability assertions may turn out to be in logical conflict with respect to some common types of cases. We intentionally do not resolve this defeasibility between t_2 and t_1 in the rules, because there are alternative, equally reasonable ways to resolve it depending on the knowledge representation language semantics used, and on the disposition one has towards these rules. The problem is to enumerate prototypical roles rules play in the organization and its environment.

We believe that this method of representing applicability results in better and more durable isomorphism between sources of law and implementation resources [1] over time. More gains will come from the distinction between resource (here for instance t_1) and the thing it presents (r_1).

6.1 Rationale of the Example

The example shows that the conceptual frameworks that relate the three knowledge domains are not actually different: In both the constitutiveness and representation concepts play key roles. They are only different from the implementing organization's point of view, to the extent that it sees itself as addressee of formal legislation only, and perceives a disjointness between legislative and implementation domains that is non-existent ontologically in our interpretation of institutions.

We tend to focus on the representation issue when talking about the sources of law simply because this, and not the legislator's abstract legal act, is our point of access to the law as knowledge engineers. We focus on constitutiveness when talking about implementation, because implementation is to a large extent a matter of designing ways to perform legal acts. The centrality of constitutiveness is itself only a relatively recent realization in academic knowledge engineering and requirements engineeering, which hasn't been fully absorbed by the business community yet.

In implementation in administrative processes, representation however also plays a central role. It is the marriage certificate that represents the legally relevant marriage, the receipt that represents the financial transaction, the written administrative decision that represents the change of legal position, and an ODBC update in some database that represents the fact that the administrative organization officially recognized a legally relevant new fact in some procedure.

The example patterns can be trivially reused for marriage certificates, etc.

7 Conclusions and Discussion

In this paper we focused on ontological stratification as a modeling device, and on applicability reasoning using features of MetaLex. We believe these are areas were quick gains are to be made in large organizations, as opposed to for instance the normative reasoning aspect of legal knowledge representation which is often perceived as very academic on the work floor.

In our approach, a deviation from mainstream legal knowledge representation is found in the rigorous ontological stratification (cf. [23,24]) of legal entities and implementation entities (as opposed to propositions) we have chosen for Agile. Legal knowledge representation literature does propose "counts-as" or constitutive rules (cf. for instance [25]), although it often considers them just one type of rule, among other (notably normative) ones [26]. On the other hand, in [27,11] we do for instance find useful reconstructions of obligation and violation in terms of constitutiveness. We aim to add a similar reconstruction of norms.

We expect increased precision in traceability as a result. Good traceability tools are however not the only important aspect of impact analysis. Importantly, the organization also faces an increasing need to model its behaviour and the behaviour of agents it interacts with. To explain the services it provides, it needs to have an understanding of the effects its actions have on the agents that request those services, and the reasons why those services are requested. It, in other words, needs to engage in agent modeling to understand its own services and its performance of those services, and the impact of changes.

Network arrangements increase the stakes in agent modeling. When the organization itself plays the role of client requesting service of other organizations, it needs to understand why those services are provided and how those services are implemented. It needs to keep an eye on the legislation governing the performance of those services, and to resist the temptation to merely defend those arrangements against change.

The Agile project includes an agent simulation activity for simulation of candidate realizations of legal services and of the reaction of network partners and clients [5]. This activity is not the focus of our work, and not of this paper. For the business process compliance aspect (cf. e.g. [28]) of this project, we could refer to existing work in legal knowledge representation, for instance [29]. The business process compliance perspective does not, however, cover all relevant perspective on the use of legal rules, as indicated in section 3. Moreover, if we do take this wider perspective, we come to the conclusion that so much relevant knowledge must be added that the generic normative agent is hardly a realistic point of departure for the Agile project.

Tax evasion behaviours, tactics to postpone realization of taxable assets, and the tendency of immigrants to try out every conceivable loophole or delay tactic in immigration legislation of developed countries, are to some extent predictable. Therefore they are suitable subjects of agent simulation. But clients are likely to game the system, and their behaviour is not simply a correlative function of their obligations, abilities, rights, etc. On the other side of the system boundary the bureaucracy also uses the possibilities it has to improve enforceability and efficiency. A change in the law may create an advantage to be exploited by redesign, instead of just a reason to perform a compliance check. Moreover, the organization is in a position to *ask* for changes that are in its interest.

In the translation from law to *requirements*, and to a question of *compliance*, the opportunity aspect of law is of course easily lost. Moreover this aspect will, in our view, resist attempts at recovering it through an extension to automated normative reasoning as for instance performed in [29]. The problem is in our view a knowledge acquisition problem rather than a reasoning problem. Our methodological approach to this problem is to focus on providing a framework for modeling prototypical agent patterns, and to ask the organization to explicitly reassess the applicability of patterns in the impact analysis process.

In the following two subsections we conclude with an explanation for our decision not to include defeasible reasoning in the Agile project definition, and for our claim that the ontological stratification into three domains helps with impact analysis.

7.1 Defeasibility

The requirements model aims at an ontological account of the interpretation(s) of legal reality accepted by the organization, without however aiming at global consistency of its definition. It is important to keep in mind that although Agile rules have a definite semantics in OWL2, and are as such subject to OWL2 consistency checking, they are RDF reifications of OWL2 axioms and therefore not by default *asserted* in any specific OWL graph with which they must be consistent. The act of asserting them in a certain graph, for purposes of validation or simulation of reasoning, is a design decision.

In OWL-based applications, OWL statements may amongst others be found in knowledge bases, in queries, and in query premises [30]. For instance, a knowledge base may contain "somebody raised his hand to greet someone", and a query may be "if raising a hand constitutes a bid and the applicability of legal rule r to that bid, has a bid been made?". Since the knowledge base may also contain "if a bid is made then $r2$ is applicable to it and it is not constituted by raising a hand to greet someone", the consistency of the query premises with the background knowledge base being queried has to be checked explicitly.

From OWL aware knowledge bases we generally expect functionality to merge two graphs, to determine consistency of a graph, to query a graph, based on the OWL2 definition of entailment of OWL2 graphs by OWL2 graphs, and ideally – for purposes of implementing defeasible reasoning and for explanation – to determine the prime implicants of an entailed graph in a graph (i.e. the minimal subgraphs that still entail some graph).

Merging, consistency and entailment are common features of all OWL reasoner APIs. The Pellet reasoner and the Protégé editor for instance supports prime implicant-based explanation [20,31], and Pellet has been used for an implementation of default rules [20], while OWL-QL for instance advocated the use of query premises [30]. This provides the necessary ingredients for modeling some forms of defeasible reasoning, and emulating some kinds of stratified production rules-based decision support.

We have defined simple knowledge base generation and validation tools based on these functionalities, that will be developed in a later stage of the project. We do not intend to commit to a generic defeasible reasoning mechanism that could be applied to the whole of the Agile model, amongst others because making the most of the resilience of existing systems (including existing production rules systems) is an explicit goal of the project. The expectation is that the Agile model is not introduced in a *green field*, and that the organization's preferences for the description of reasoning strategy depend on specific technology choices.

7.2 Design Rationale for the Three Domains of Discourse

We believe that changes can often be isolated to one of the domains of Fig. 4, and the interfaces between them. If the requirement for a valid passport is for instance dropped from immigration law and replaced by the more general requirement that an immigrant should be identified, the implementing organization may still opt to retain the requirement for a valid passport in a fast track service implementation, and delegate the handling of cases where no valid passport can be shown to the fully manual appeal procedure. The business process remains the same, while its legal justification changes.

Generally, we distinguish between:

1. changes of the law that change institutional reality, and necessitate change of implementation,
2. changes of the law that change institutional reality, but do not necessitate change of implementation,
3. changes of the law that do not change institutional reality (for instance codification of case law or practices already developed within the organization),

4. changes of institutional reality due to a new interpretation (not coerced by the law) that necessitate change of implementation,
5. changes of institutional reality due to a new interpretation (not coerced by the law) that do not necessitate change of implementation, and
6. change of implementation for it's own sake, for instance due to work floor feedback.

Any change can be classified without much trouble in this framework.

We maintain that many of the common organizational problems in tracing resources and actions back to the sources of law are based on not understanding the distinction between abstract legal entities and their implementation. Organizations that are unique in their institutional status, and have no others to compare themselves to or learn lessons from, are bound to suffer from this problem most.

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When a FrameNet-Style Knowledge Description Meets an Ontological Characterization of Fundamental Legal Concepts

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Abstract. The need for bridging the gap between linguistically-oriented knowledge resources (i.e. lexicons) and domain-oriented ones (i.e. ontologies) is acknowledged within both the NLP and the AI&Law community. In this paper we propose to face this need by comparing a FrameNet-style and an ontological characterization of the 'obligation' Fundamental Legal Concept. In particular, we carried out a case-study aimed at investigating whether and to which extent different views on this Fundamental Legal Concept offered by the FrameNet resource can be mapped to an ontological characterization of the complex concept of 'public function', stemmed from the basic normative position 'obligation'.

Keywords: Legal Ontologies, Semantic Lexicons, Fundamental Legal Concepts, FrameNet.

1 Introduction

The increasing improvements in Natural Language Processing techniques result nowadays in a fast growing of Ontology Learning strategies based on bottom-up approaches. At the same time, within the Ontology Engineering field big efforts are devoted at developing networking tools which link accurate and specialized Domain Ontologies, rather than at building time-consuming and complex Core or Foundational Ontologies.

Consequently, two parallel directions of research are followed: the first one is aimed at making local ontologies more inter-operational through the definition of standards and mapping procedures; the second one is aimed at improving NLP techniques with a view to higher-level semantic potentialities.

According to these premises, bridging the gap between linguistically-oriented knowledge resources (i.e. lexicons) and domain-oriented ones (i.e. ontologies) is more and more a strategic phase. Namely, it is aimed, on one hand, at lexicalizing the ontology and, on the other hand, at structuring the literal meaning in accordance with many domain perspectives.

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Currently, the gap between the lexicon and knowledge cannot be considered completely filled by automatic procedures, nor it is realistic to think that it will be in a short time; but aside from the technical aspects, there is a lively debate within the sector about theoretical assumptions, meta-models and formal architectures that are able to express the links between lexical meaning and conceptual/ontological meaning.

The goal of this paper is to contribute to the aforementioned discussion by describing the results of an experiment carried out in the law field. The representation of legal concepts in an ontological framework has become very popular within several applications to the legal domain, as legal ontologies provide a shared vocabulary, able to support the inferential process, case-based reasoning and argumentation. Even if ontological models are often built on the conceptualization provided by domain experts, it is widely agreed that a flexible and re-usable methodology would require a middle-out approach, able to respect both the reference to written sources and the generalization of coherent shared models.

The represented study is aimed, on one hand, at testing a methodology for enriching, through the lexicalization, the models formulated by legal doctrine and implemented in core and domain legal ontologies and, on the other hand, at assessing the potentialities of a semantic lexicon such as FrameNet[1], developed in the NLP community, in providing a description of legal knowledge based on linguistic principles. As a consequence, we expect to consolidate the design of the meta-model reported in Dalos [1], which expresses links between conceptual models and terminology extracted from normative statements; in order to capture the multi-layered structure of legal discourse the framework should be extended to include 'local' meanings as defined within national systems, or the extensional meanings inducted from case-law or common sense interpretations, while keeping distinct different levels of localization.

In particular, we have carried out a case-study meant to explore evidence for mapping ontological models that describe Fundamental Legal Concepts [2], expressed by the deontic operators of *obligation*, *permission*, etc. with suitable linguistic structures (i.e. FrameNet Semantic Frames which describe 'deontic' situations). We have chosen this case-study for several reasons: they concern the availability of formal reformulations of the Fundamental Legal Concepts [3], [4], [5], the availability of their ontological description in the Core ontologies as LKIF-Core and CLO [6], the availability of semantic models of the legislative provisions [7], [8] and of their formal specification [9]. Moreover, the deontic operators are domain independent and they are expressed by a relatively limited number of linguistic structures. This feature allows the portability of our approach to several different legal sub-domains.

By stemming our analysis from the Fundamental Legal Concepts, we have the opportunity to model complex legal concepts from the basic ones. In fact, the Hofheldian concepts formalised in classes of normative positions (duty, liability, claim, power, etc..) as reifications of deontically qualified situations, are the building blocks on which it is possible to express complex concepts like, for example, *delegation*, *entitlement*, *authorization*, etc. Accordingly, in our case-study, we model on the normative positions the concept of 'public function', a key concept in the ontology of the services proposed in [10].

[1] http://framenet.icsi.berkeley.edu

In what follows, we will provide an overview of the existing projects aimed at bridging the gap between linguistically-oriented (lexicons) and domain-oriented (ontologies) knowledge resources, which have been developed both for the open-domain and for the legal domain (Section 2). Section 3 reports teorethical approaches to the formal specification of fundamental legal concepts and the state of the art on the existing Core Legal Ontologies, where they are represented. In Section 4, we show the potentialities of the FrameNet lexical model we have chosen. The case-study we carried out is reported in Section 5. Section 6 reports some reflections on the obtained results.

2 State of the Art and Related Projects

Interoperability is a crucial issue, as large scale applications mainly depend on the possibility to map and to connect different models and structures. One point under discussion is the definition of consistent models for interfacing resources and ontologies, as argued in [11] «There is an implicit mapping assumption between lexical and conceptual knowledge, which underlies "ontology lexicalization", namely that (intensional) senses from a lexical model are mapped to (extensional) interpretations on ontology elements (individuals, classes, restrictions, properties). The lexical semantic content of the lexicalizations, originating from linguistic/terminological resources such as term banks, thesauri and dictionaries, is considered to be lightweight, and in need of formalization. Classes, properties or individuals of the ontological meta-model can be provided with lexicalizations from the separate linguistic model in the form of lexemes, i.e., units of form and meaning. This model contains a set of data categories that captures all the relevant linguistic/terminological information associated with concepts such as lexicalizations, lexicalization types and multilinguality.»

The Linguistic Meta-model LMM [12] is based on a semiotic perspective, that takes into account the social-cognitive aspects on which the DOLCE foundational ontology is inspired, in order to offer a new linguistic layer to the foundational conceptualization and an adequate linguistic interpretation of terms and predicates expressed in a language with a formal semantics. The LMM framework allows several notions of concept (as a synset, a frame, a thesaurus descriptor, etc.) to be connected and both intensional (through class relations and restrictions) and extensional (among instances, e.g., Synsets) meaning to be expressed.

Lexical semantic databases can be combined by means of a meta-model as LMM or by aligning semantic structures, as in [13]. Here a FrameNet and a WordNet-like database are mapped and lexical units (LUs and synsets) are merged in a unified lexical ontology where sense distinctions and semantic structures are preserved. In Kyoto[2] a collaborative and multi-perspective definition of meaning will be allowed by the creation of platforms "different organization principles will enable semantic resources expressing multiple points of view and different layers of linguistic and conceptual information to be interconnected, while keeping distinct different conceptualization models".

[2] http://www.kyoto-project.eu/

In the legal domain, projects aimed at providing multi-layered frameworks where lexical and conceptual meaning are combined, have been proposed in [14], [15]. Methodological issues are discussed in [16]. Even if the work on ontology and the linkage between terminology and ontology have been carried out manually, nevertheless the project outcomes are promising, both from the perspective of dealing with the language/law interdependencies and at the level of improving semantic annotation.

3 Ontologies on Fundamental Legal Concepts

The initial trend in legal ontology engineering was to heavily draw on legal theory and built relatively highly axiomatised ontologies of the legal domain. One of the consequences of this trend was the development of several *core ontologies* early in the history of legal ontology engineering. Core ontologies are formal ontologies which contain the general basic concepts of a specific domain, for instance, the legal domain. They can be called generic domain ontologies as well, in the sense that they make commitments to a certain domain but in a very generic way that enables reuse in other subdomains [17]. Despite their nature being mainly theoretical, core legal ontologies have not been contextualised yet in the history of legal thought. This section provides some initial insights in this direction (3.1), as well as a brief overview of the core legal ontologies so far developed and their main characteristics (3.2).

3.1 A Short History of *Informal Ontologies* on Fundamental Legal Concepts

It has been acknowledged that legal theories contain ontological assumptions about the sources of legal knowledge and that their primitive concepts could be translated into an ontology [18]. In this line, similarly, if we take a broad notion of ontology as meaning the result of the effort to provide a clear conceptualisation of a domain (therefore excluding the requirement of formalisation), it is possible to talk about a history of core legal ontologies. By this concept we refer to the identification and clear definition of the basic conceptual units of the legal language. The most significant efforts in this direction took place during the XIXth century. Indeed, partly influenced by the positivist paradigm, partly driven by the desire to give law a scientific methodology, decades of legal research were committed to this endeavour. Apart from the philosophical underpinnings of the effort, practicalities were as well at issue, for the development of a common terminology for legal reasoning was deemed essential for achieving clarity and correctness in legal thought. In the common law sphere several scholars referred indeed to the need of establishing a clear usage of legal terms that would set free legal discourse from obscurity (for instance Bentham, Austin or Wigmore). This is the stream of thought corresponding mainly to analytical jurisprudence, with roots in Bentham's thought and that starting from Austin's *The Province of Jurisprudence determined* (1832) [19], leaded the quest for the main conceptual components of the law. In continental legal thought a similar line of thought was manifested in the works of the German pandectists. Represented by main legal scholars such as Savigny, Ihering, Puchta and Windscheid, and with origins in Hugo, it developed in the context of a strong debate on the suitability of codification which

would eventually culminate in the German Civil Code, which has been considered more similar to a doctrinal treatise than to a legislative piece of work[3].

Core conceptualisations of the law include different types of basic legal concepts. Firstly, they contain general concepts about the entities that populate the domain, such as `legal person`, `norm`, `responsibility`, and so on. Secondly, they refer to deontic concepts that are in charge of expressing the normativity of legal discourse. The latter are the result of the detailed and *logical*[4] analysis of rights and duties aimed at providing a formal account of legal discourse and reasoning. The one to provide a complete and detailed framework for such notions and to go down in history for such an achievement was Hohfeld [21], [22], who built up the following system of correlatives: `right/duty`; `privilege/no-right`; `power/liability`; `immunity/disability`[5].

Even if focus has shifted in legal thought during some periods from analytical conceptualism to more pragmatic approaches, modern computable models of the law have revived the need of giving a formal account of core legal concepts such is the case of core legal ontologies and not infrequently have drawn inspiration from some of these informal historical models, specially Hohfeld's.

3.2 Core Legal Ontologies

Early attempts to conceptualise the legal domain for computational purposes can be found in representational formalisms proposed as languages containing the lowest common denominators of legal discourse for expressing legal knowledge. In this line, a pioneer in the application of formal methods to the law was L.E. Allen, who built on the Hofheldian conceptualisation of legal relations as a model for representing the deontic structure of norms [25]. Similarly, McCarty proposed a representational formalism for the law which despite not being an ontology embodies a general conceptual model of the legal domain, based on a compositional syntax and well-defined semantics and inference mechanism [26], [27].

Later on a variety of core conceptualisations of the law have been proposed explicitly as ontologies. Among them we can at least mention the following seven: FOLaw [28]; Frame Based Ontology [17]; Ontology of causality [29], [30]; Applied Legal Epistemology [31]; LRI-Core [32], [33]; Core Legal Ontology [6]; LKIF-Core [34].

Some of them take a more epistemological approach by representing the categories of legal knowledge (for instance, FOLaw and Applied Legal Epistemology); some others represent just a fragment of the basic conceptual blocks of the law (such as the Ontology of causality); some others put an emphasis on building an actual ontological representation of the law distinguished from its epistemological component (LRI-Core); and still some others try to ground a core legal conceptualisation on a sound

[3] The BGB (German Civil Code) has actually been criticised for embodying an abstract system of private law, in accordance to the conceptual apparatus built by the pandectists rather than a system adapted to actual conditions of life in society [20].

[4] In late XIXth century legal discourse the adjective 'logic' was used to characterise something analytical, clear, ordered, not contradictory, but by no means included a precise reference to the properties of modern symbolic logic.

[5] Some other legal scholars had already lingered on the clarification of the concepts of rights and duties for a while (see for instance [19], [23], [24]).

philosophical scheme (such is the case of CLO, an extension of the DOLCE foundational ontology which draws inspiration from cognitive science studies and from traditional philosophical categories, such as *endurants* and *perdurants*). Nevertheless, even if core legal models are already there, a current issue is still how to connect those language-independent models with actual textual manifestations, so that beyond philosophical accuracy those abstract conceptual models support concrete applications. Following this line, this paper explores the issue of the missing bridge between conceptual core legal notions and their linguistic expressions as presented in legal texts.

4 A FrameNet Resource for the Legal Domain

Amongst the various existing kinds of lexical resources, we have chosen the FrameNet project model [35] (hereafter referred to as FN) to ground our study. We believe that the organization principles underlying the FN lexicon can adequately represent events and situations typically expressed in legal documents.

As a matter of fact, in the legal knowledge modelling community, it is pointed out the need for *capturing and handling all possible stereotypical situations distinguished by law* [36]. Thus, the importance of taking into account the **context** where legal entities move is acknowledged. Accordingly, legal experts state that, despite their utility, WordNet-like resources are not completely satisfactory in order to represent the inner structure of complex situations in terms of their participants, e.g. "under which *Circumstances*, which *State of affairs* is sanctioned by which *Principle*". In fact, in the WordNet (hereafter referred to as WN) model [37], words are organized in *synsets* (i.e. sets of synonyms) in turn linked by hierarchical or taxonomical relations such as hyponymy and hyperonymy. Under this view, the meaning of a word is intended as a distinct, atomic semantic object, fully identified by its position in the general semantic network.

4.1 The FrameNet Project

The FN resource considered here is a lexical resource for English, based on Fillmore's *Frame Semantics* theory [38] and supported by corpus-evidence. The goal of the FN project is to document the range of semantic and syntactic combinatory possibilities of each word in each of its senses. Typically, each sense of a word belongs to different Semantic Frame, conceived in «a script-like conceptual structure that describes a particular type of situation, object or event along with its participants and properties». For example, the APPLY_HEAT frame describes a common situation involving participants such as "Cook" and "Food", etc., called Frame Elements (FEs), and is evoked by Lexical Units (LUs) such *bake, blanch, boil, broil, brown, simmer*, etc. As shown by the following example, the frame-evoking LU can be a verb (bolded in the example) and its syntactic dependents (those written in subscript) are its FEs: [Matilde $_{\text{COOK}}$] **fried** [the catfish $_{\text{FOOD}}$] [in a heavy iron skillet $_{\text{HEATHING\_INSTRUMENT}}$]. FN currently contains more than 800 Frames, covering roughly 10,000 Lexical Units; these are supported by more than 135,000 FN-annotated example sentences.

The type of representation produced by FN is a network of "situation-types" (frames) organized across inheritance relations between Frames (frame-to-frame relations), as opposed to a network of meaning nodes, as in the case of WN. In FN, Frame Elements can be also specified with Semantic Types (i.e. ontological categories) employed to indicate the basic typing of fillers that are expected in the Frame Element. Most of these semantic types correspond directly to synset nodes of WN, and can be mapped onto already existing ontologies. The latter is the case of [39], who developed a semi-automatic approach for linking FN Frame Elements to the Suggested Upper Merged Ontology (SUMO)[6] [40] classes.

4.2 Towards a FN-Like Resource for the Legal Domain: The General Approach

It should be noted that the case-study presented in Section 5 is part of a broader project which we are currently carrying out. It is aimed at developing a FN-like resource specialized for the legal domain, by extending and refining the general purpose FN resource.

To our knowledge, the most notable example of legal-domain specialization of an open-domain lexical resource is represented by the JurWordNet ontology-driven semantic lexicon [41], developed for the Italian language, together with its multilingual extension LOIS [42]. Note that both JurWordNet and LOIS have been developed following the organization principles underlying WordNet model. However, legal experts claim that, despite its utility, the taxonomical organization of legal concepts is not the only possible one. This is the reason why we faced the need for building a lexical resource initiated from the organization principles underlying the FN model. A detailed description of a number of design issues encountered so far is provided in [43].

5 A Case Study

In the first phase the modelling activities were directed to achieve two distinct and independent tasks, namely:

a) testing the expressiveness of the Framenet model in capturing the deontic modalities in legal statements.

b) testing the possibility of building complex legal concepts from the Basic Hofheldian positions.

The second step was devoted to the main goal, i.e. is to combine the two conceptualizations in order to evaluate how far the lexical manifestations of normative position are from the abstractions of legal theory. This goal, as explained above, is of interest not only from a purely methodological point of view, but also in the light of building tools and framework for interfacing lexical and formal models in order to support practical applications.

Following this idea, we have built on the conceptualisation of the legal notion of public function, a fragment of an 'ontology of public services' (which can be viewed as the 'operative' expression of the notion of public function) and we have evaluated how

[6] http://www.ontologyportal.org/

mapping frame elements to ontological class could at the same time enrich the ontological representation and support the process of linguistic knowledge acquisition.

In order to investigate how domain-specific knowledge is differently represented from a linguistically-oriented and from a domain-oriented point of view, we carried out a case-study by comparing a FN-style and an ontological characterization of the 'obligation' Fundamental Legal Concept. As domain for the case-study we have chosen the European norms on consumer protection and the Italian regulations on car tax payment. The two corpora have been analysed in order to annotate suitable examples for testing how the 'obligation scenario' is defined in the FN resource (see Section 5.1). The concept of 'public function', formally modelled starting from the 'obligation' normative position (see Section 5.2) and the derived ontology (see Section 5.3) mainly rely on the taxation norms. In Section 5.4, we suggest an example for linking the two differently-grounded views.

5.1 A FrameNet-Style Description of the 'Obligation' Scenario

In order to provide corpus-evidence of how the 'obligation scenario' is defined in terms of Semantic Frames, we have analysed some sample sentences taken from two different corpora, i.e. a corpus of European Directives on consumer protection and a corpus of Italian and regional regulations on car tax payment domain. Considering two document collections containing texts which regulate two different domains is made fundamental in order to verify that the semantic (conceptual) representation of deontic modalities is domain independent. Moreover, this approach can be suitable to highlight different linguistic realizations of the same deontic semantics.

The study we conducted concerns:

- the selection of which Semantic Frames fully characterize 'obligation';
- the study of the frame-to-frame relations, such as *Inheritance*, *Using*, *Causative_of*, *Perspective_on*, etc., between the selected Semantic Frames, as modelled in the general FN;
- the annotation of some sample sentences containing frame-evoking Lexical Units (e.g. *must*, *obligated*, etc.) with frame information.

According to [35], the frame-to-frame relations are inheritance and «directed (asymmetric) relation[s] between two frames, where one frame (the less dependent, or more abstract) can be called the Super_frame and another (the more dependent, or less abstract) can be called Sub_frame». Figure 1 shows a portion of the net drawn by those relations that link Semantic Frames expressing 'obligation'. Interestingly enough, this deontic modality is seen under different views. For example, the *Perspective_on* relation provides two different perspectives on the non-lexical (with no frame-evoking lexical units) OBLIGATION_SCENARIO frame. The one is offered by the BEING_OBLIGATED frame which represents an obligation situation focusing on the 'Responsible_party' which is required to perform some 'Duty', as shown in the following sentences[7]:

[7] In these and in the following examples the frame-evoking Lexical Unit is bolded; the textual span instantiating the Frame Elements is in squared brackets. It should be noted that the first examples are taken from the corpus of European Directives on consumer protection and the second one from the corpus of Italian and regional regulations on car tax payment domain.

[Unless the parties have agreed otherwise CONDITION], [the supplier RESPONSIBLE_PARTY] **must** [execute the order DUTY] [within a maximum of 30 days from the day following that on which the consumer forwarded his order to the supplier TIME]. (Dir. 97/7/CE, art.7)

[gli autoveicoli adibiti al trasporto del latte, delle carni macellate fresche, delle immondizie e spazzature, dei generi di monopolio e i carribotte per la vuotatura dei pozzi neri RESPONSIBLE_PARTY] **sono soggetti** [al pagamento della tassa sulla portata, ridotta del 50% DUTY] (art. 22. legge 21 maggio 1955, *n.* 463) (lit. [vehicles used to the transport of milk, of fresh slaughtered meats, of garbage and rubbish, of monopoly provisions and liquid manure spreaders used to empty cesspools RESPONSIBLE_PARTY] **are subject** [to the payment of carrying capacity tax, reduced of 50% DUTY])

The other perspective is offered by the the BEING_OBLIGATORY frame which conversely describes the situation from the 'Duty' point of view which needs to be fulfilled by a 'Responsible_party', as the following sentences exemplify:

[This Regulation DUTY] **shall be binding** in its entirety and directly applicable in all Member states. (Reg. (CE) n. 522/96)

[La tassa di circolazione regionale DUTY] **è dovuta** [in misura fissa CONDITION] [per anno solare TIME] (lit. [The local circulation tax DUTY] **is due** [in permanent measure CONDITION] [per calendar year TIME])

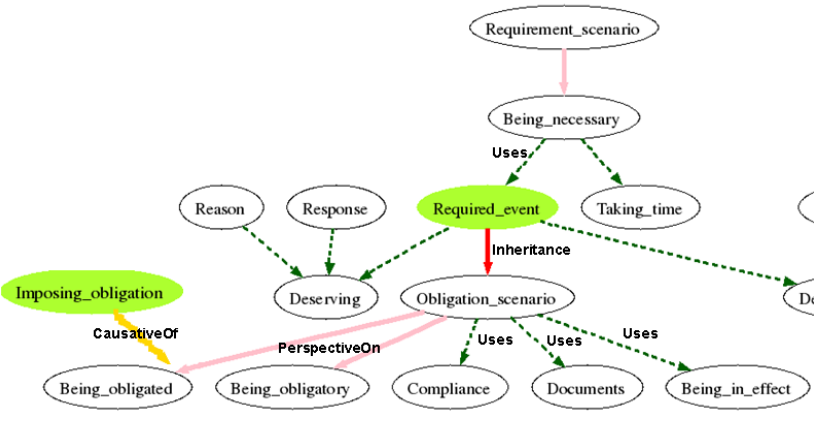

Fig. 1. Some of the relations that link Semantic Frames expressing 'obligation'[8]

[8] The net has been visualized through the FrameGrapher tool available at http://framenet.icsi.berkeley.edu/FrameGrapher/

Moreover, the *Causative_of* relation by linking the IMPOSING_OBLIGATION and the BEING_OBLIGATED frame puts the focus on the situation offered by the IMPOSING_OBLIGATION Frame. Figure 2 reports how this Frame is shown in the FrameNet resource. Firstly, the *Definition* of the Frame describes in details the situation-type framed. Some few examples follow. Secondly, the Frame Elements (FEs) are listed, distinguishing between *Core*, i.e. compulsory to uniquely pinpoint the IMPOSING_OBLIGATION Frame (e.g. 'Duty', 'Obligator', etc.), and *Non-Core*, i.e. optional (e.g. 'Condition', 'Time', etc.). It should be noted that for each Frame Element a short description and a sample sentence are reported. The Frames linked to the IMPOSING_OBLIGATION Frame by one of the listed Frame-to-Frame relations are reported (e.g. the IMPOSING_OBLIGATION Frame *Is Causative of* the BEING_OBLIGATED Frame since they are linked by a Causative_of relation). Finally, the list of frame-evoking Lexical Units are shown (e.g. *bind.v, charge.n,* etc.)[9]. Interestingly, the focus is put on the presence of an 'Obligator' who imposes on a 'Responsible_party' a 'Duty', according to a 'Principle' which regulates how the 'Responsible_party' should respond to a 'Situation', as the following sentences show:

> [Article 3 of Directive 79/112/EEC PRINCIPLE] **made** *it* **mandatory**, [in the labelling of beverages containing more than 1,2 % by volume of alcohol CONDITION], [to indicate the actual alcoholic strength by volume DUTY] (Dir. 87/250/CEE)

> Visto [l'articolo 8 della legge regionale 23 settembre 2003, n. 23, "Disposizioni in materia di tasse automobilistiche" PRINCIPLE_ANT][10], [il quale PRINCIPLE_REL] **dispone** [l'assoggettamento alla tassa di circolazione DUTY] [per le autovetture ed i motoveicoli che abbiano compiuto 30 anni dalla costruzione RESPONSIBLE_PARTY] (lit. Considering [article 8 of the regional law 23rd September 2003, n. 23 "Provisions about car tax" PRINCIPLE_ANT], [which PRINCIPLE_REL] **provides** [the subjugation to the circulation tax DUTY] [for what concerns vehicles and motorcycles 30-year old from the construction RESPONSIBLE_PARTY)

The *Using* relation between REQUIRED_EVENT and the BEING_NECESSARY frame implies that a part of the scene evoked by the Sub_frame (i.e. the REQUIRED_EVENT frame) refers to the Super_frame (i.e. the frame). Namely, a more abstract situation where "a 'Dependent' state-of-affairs has a 'Requirement' as a prerequisite for obtaining or occurring", is specifically referred to a less abstract situation where "unless a particular 'Required_situation' obtains, 'Negative_consequences' will follow.". Examples of the BEING_NECESSARY frame are provided in the following sentences:

> [The labelling REQUIREMENT] **shall** [convey information relating to the three parts of the footwear as defined in Annex I, namely … DEPENDENT] Dir. 94/11/CE, art.1, par.2

[9] Note that each frame-evoking Lexical unit is followed by the corresponding part-of-speech, i.e. verb, noun, etc.

[10] In this example both the antecedent of relative pronoun (i.e. the article 8…) and the relative pronoun (i.e. which) are annotated as instantiation of the 'Principle' Frame Element.

> Infatti, [come prescritto dall'art. 11 della legge 27 luglio 2000, n. 212 CONDITION] e [come ampiamente illustrato nella Risoluzione n. 1/Uff del 23 gennaio 2002 CONDITION], [le procedure di interpello DEPENDENT] **devono** [essere istruite dall'ente impositore REQUIREMENT], [nel caso di specie dalla regione cui è affidata la gestione del tributo REASON]. (lit. [As it is prescribed by art. 11 of law 27th July 2000, n. 212 CONDITION] and [as broadly showed within the Resolution n. 1/Uff of 23rd January 2002 CONDITION], [the summoning procedures DEPENDENT] **must be** [instructed by the assessing body REQUIREMENT], [in this case by the region keeping the duties REASON].

In particular, the frame-to-frame relations link one or more single Frame Element(s) of the two considered Frames. As Figure 3 visualizes in detail, it follows for example from the *Using* relation that the 'Required_situation' Frame Element of the BEING_NECESSARY frame is dependent on the more abstract 'Requirement' Frame Element of the REQUIRED_EVENT frame. This relation highlights a link between the 'Dependent' *state-of-affairs which cannot hold without the 'Requirement'* within the BEING_NECESSARY frame and the 'Explanation', i.e. *the reason why the 'Required_situation' is necessary*, in the REQUIRED_EVENT frame.

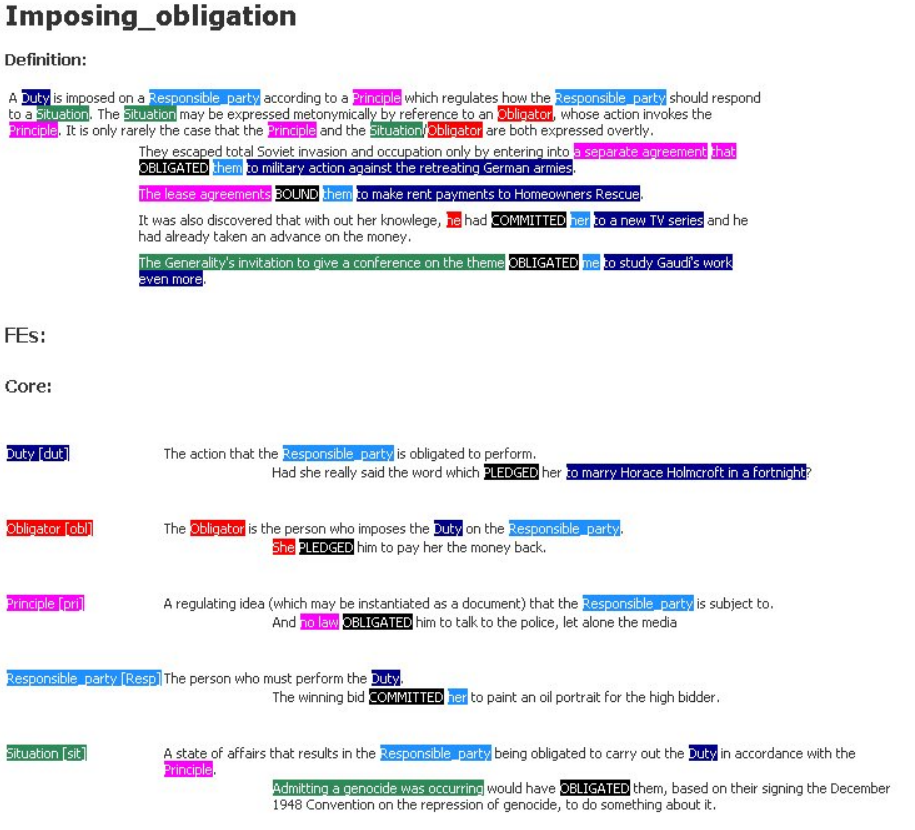

Fig. 2. The Imposing_obligation Frame

Non-Core:

Condition [con] This FE indicates the Condition's under which the Responsible_party is obligated to perform the Duty.

Manner [man] Any holistic description of the details of the action, either comparing to another event or describing the action in terms of characteristics of the Obligator that affect the action holistically.
You COMMITTED me to this maliciously !

Means [mea] An event which brings about the obligation.
She did n't understand that she OBLIGATED me to stay by always getting in trouble .

Place [pla] A location in which the Responsible_party has a specified Duty .
Semantic Type
Locative_relation
At Dayton, the parties OBLIGATED themselves to respect and promote fulfillment of the annexes.

Purpose [pur] The state-of-affairs that the Obligator hopes to bring about by imposing the obligation.
She PLEDGED him to work on the project just to get him out of her hair .

Time [tim] The time interval during which the Duty is imposed on the Responsible_party by the Obligator or the Situation.
Semantic Type Time
The City Council then OBLIGATED themselves to have the sewers made ready and the streets leveled off without any additional cost to the Sisters.

Inherits From: Transitive_action
Is Inherited By:
Subframe of:
Has Subframes:
Precedes:
Is Preceded by:
Uses:
Is Used By:
Perspective on:
Is perspectivized in:
Is Causative of: Being_obligated
See Also:

Lexical Units

bind.v, charge.n, charge.v, commit.v, obligate.v, pledge.v, require.v

Fig. 2. (*continued*)

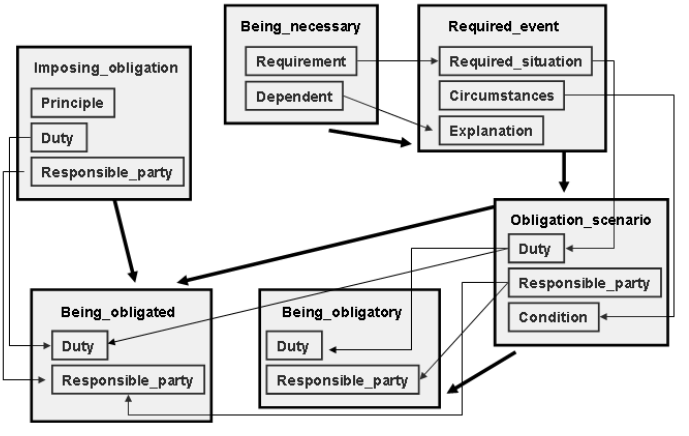

Fig. 3. Some of the FE-to-FE relations

Moreover, the *Causative_of* relation, which links the Super_frame IMPOSING_OBLIGATION and the Sub_frame BEING_OBLIGATED, results in a relationship between the 'Duty' imposed on a 'Responsible_party' within an IMPOSING_OBLIGATION situation and the 'Duty' which the 'Responsible_party' must perform within the BEING_OBLIGATED situation. Interestingly enough, as it will be described more in detail in Section 5.2, such a *Causative_of* relation between the two considered frames is similar to the domain-oriented (ontological) relationship between public bodies and citizens. Namely, similar to the fact that when a 'Principle' *imposes an obligation* on a 'Responsible_party' he/she is *obligated* to perform an action, when a public body *imposes* a duty on citizens they are *obligated* to perform such a duty.

5.2 A Formal Characterization of the Concept of 'Public Function' and of 'Fiscal Function'

The notion of public function has been defined by legal doctrine as the subjective situation of the public body which has a power directed to the satisfaction of objective interests of someone else [44]. Following the formalisation of fundamental legal concepts proposed in [4] we can distinguish:

On the one hand, the notion of *obligation*[11] (since the power exists in the interest of citizens):

O_x Bring (Z): (obligation of *x* of bringing about a certain state of affairs *Z*)

On the other hand, the notion of power:

Pow_x Bring (Z) (power of *x* of bringing about a certain state of affairs *Z*)

A particular subclass of public function is the function of burdening citizens with taxes in order to collect the economic surplus and meet social public needs. Similarly, thus, this function is composed of:

Firstly, the power of imposing the obligation on citizens of paying taxes, which corresponds to the power of creating norms that create an obligation for certain people:

Pow_{State} [Bring ($Obl_{citizens}$ (pay.taxes))] (power of the *state* of bringing about the state of affairs in which *citizens* have the obligation to pay taxes)

Secondly, the obligation of creating these norms:

O_{State} [Brings ($Obl_{citizens}$ (pay.taxes))] (obligation of the state of bringing about the state of affairs in which citizens are obliged to pay taxes)

And thirdly, the obligation of ensuring the fulfillment of the obligation created by the norm:

O_{state} [Brings ($pay.taxes_{citizens}$)] (obligation of the state of bringing about the state of affairs in the world in which citizens pay taxes)

These concepts together with the conceptual framework of the ontology of services suggested in [10], provide the main building blocks for the ontology of fiscal function that we present in the following section.

[11] Formalised in [4] as "Obl $Does_j$": it is obligatory that *j* does something, and "Obl $Brings_j$": it is obligatory that *j* brings it about that something happens.

5.3 The Ontology of Fiscal Function

In the ontological characterisation of services, as reported in [10] "at the core of any service there is a *commitment* situation in which (the *service provider*) guarantees the execution of some kind of *action(s)* in the interest of somebody who agrees (the *service customer*), at a certain cost and in a certain way. This action is executed by the *service producer,* who may coincide with the *service provider*, may be somebody else delegated by the service provider, or even coincide with the service customer [...] service commitment needs to be distinguished from *service content,* which concerns the kind of action(s) the provider commits to guarantee, and service process, which is a set of business processes implementing the service commitment".

In the classification of services an important distinction is between public and private services, which is connected to the delegation of the commitment situation and to the transferability of responsibility in performing the services. This is related to the understanding of services as comprising different levels of responsibility. On the one hand, the obligation of guaranteeing the delivery of the service exists; on the other hand, the obligation of actually delivering the service by performing a set of actions exists. The difference between public and private services lies on the fact that whereas in the case of private services both obligations are transferable, in the case of public services they are not. The public administration committed to guarantee a certain service will always maintain the responsibility of ensuring the delivery of that service towards the citizen (and could thus be held liable in case it was not delivered), even in the case it has delegated the actual delivery of services (actual production of the service) to a third party. Thus we assume that, in public services, the commitment situation is the expression of public function, i.e. both the obligation of public bodies to guarantee the service (for instance to ensure, that tax payers perform their duty) in the general interest of citizen, and their related power to enact norms on which the obligation is grounded. (note the similarity with the *causative_of* relation that in Framenet links Imposing_Obligation with Being_obligated).

For the purpose of our model, the service ontology provides us with the framework on which building the ontology:

- the *commitment situation*, expressed by the formalization of the notion of fiscal function. Since fiscal function must be performed in the benefit of citizens, the previous formalization in terms of power and obligation can be reformulated according to the formalisation of other-directed obligations suggested by [4]: $\text{Obl}^{k}\ \text{Does}_{j}\ \text{A}$ (it is obligatory toward *k*, that *j does* A).

$O_{State}^{[citizens]}$ [Brings ($\text{Obl}_{citizens}$(pay.taxes))] Obligation of the *state*, in *the interest of citizens*, of creating norms that obligate to pay taxes:

$O_{State}^{[citizens]}$ [Brings ($\text{pay.taxes}_{citizens}$)] Obligation, *in the interest of citizens*, of ensuring that taxes are paid.

A particular instantiation of the previous model corresponds to car taxation. In this concrete domain the fiscal function can be translated into an obligation of the state of imposing the obligation of paying taxes to those persons who own a car:

$O_{state}^{[citizens]}$ [Brings ((owns.car$_x$)→ Ob (pay.taxes$_x$)] Obligation of the State, in the interest of the citizens, of bringing about the state of affairs in the world in which if a citizen *x* owns a car, then citizen *x* is obliged to pay taxes.

- a set of legal roles: in the taxation scenario citizen are at the same time services customer and tax-payer; public bodies are both agents empowered to impose obligations and services providers committed to ensure that the obligations are fullfilled
- the class Action in the ontology subsumes not only the *service content,*i.e., the set of activities performed in order to execute the service, (e.g. charging, controlling, sanctioning,etc.), but all actions due to fullfill the obligations: due to the well known limited expressiveness of Description Logic the operator Bring(Z) is represented introducing a CoercitiveAction class that reifies such a relationship [45]. The notion of Power and Obligation of a PublicBody can then be expressed through binary relations hasPowerOver and hasObligationTowards some CoercitiveAction of which for instance ObligationToPay is a subclass. In a similar way the ObligationToPay class reifies the complex relation of Obligation for Citizens to PayTaxes by putting in relation the corresponding classes Citizen and TaxPayment.

A fragment of the ontology is reported in Figure 4.

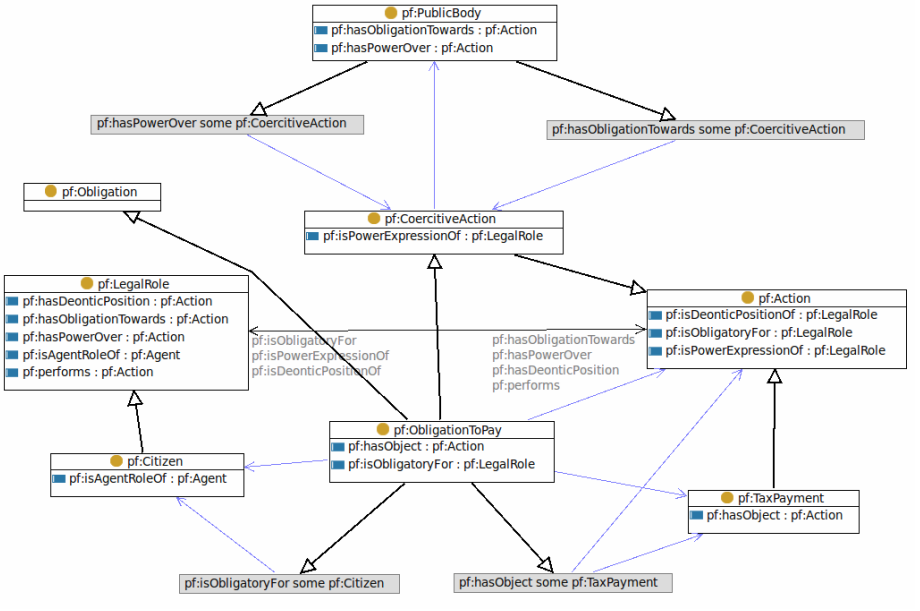

Fig. 4. 'Public function' ontology

5.4 Linking a FrameNet-Style Knowledge Description with the Corresponding Ontological Characterization

Figure 5 sketches out how the textual content represented in a FrameNet-style description can be linked with the corresponding ontological characterization described in Section 5.2. In fact, it is possible to map each Frame Element, belonging to a given Frame and instantiated in a given sentence, to the corresponding class of the provided ontology. For example, given the following sentence, i.e. "Citizens are **obligated** to pay taxes", evoked by the (*are*) **obligated** Lexical Unit, the FE "Responsible_party" (i.e. *citizens*) belonging to the BEING_OBLIGATED frame can be mapped to the "LegalRole" class; and, the "Duty" (*pay taxes*) can be mapped to the "Action" class.

Interestingly enough, the example provided in Figure 5 shows a potentiality of our approach. The FN-style knowledge organization allows to consider the basic 'obligation' normative position from a number of different points of view. Accordingly, it should be noted that even though the two considered sentences (i.e. "Citizens are **obligated** to pay taxes" and "Article 18 **provides subjection** to the payment of circulation tax owners of vehicles") respectively evoke two different frames, i.e. the BEING_OBLIGATED and the IMPOSING_OBLIGATION frame, their Frame Elements can be both mapped to the same corresponding class in the ontology. Thus, both the "Responsible_party" belonging to the BEING_OBLIGATED frame (i.e. *citizens*) and the "Responsible_party" belonging to the IMPOSING_OBLIGATION frame (i.e. *owners of vehicles*) are mapped to the same "LegalRole" class.

Moreover, we foresaw a second level of mapping. It concerns the linking of the lexical filler which instantiates a given Frame Element with a sub-class of the ontology. As shown in Figure 5, the lexical filler *citizens* of the Frame Element "Responsible_party" is mapped to "Citizen" sub-class of the "LegalRole" class; and, *pay taxes* instantiation of the FE "Duty" is mapped to "TaxPayment" sub-class of the "Action" class.

The mapping suggested in Figure 5, only sketched here to give an idea of the whole picture, assumes that a formalization of the FrameNet model in terms of an OWL-DL metamodel such as the OWL version of OntoFrameNet [46] is used.

According to the OntoFrameNet model `Frame`, `FrameElement` and `LexicalUnit` are conceived as classes. Thus the linking of `FrameElement` with a class of the domain ontology is provided by the objectProperty `hasSemanticType`. Frame Elements are then mapped to classes of the domain ontology by linking their Semantic Types with the most specific ontology class in order to enforce the most possible constrained meaning which is useful for semantic parsing purposes.

Similarly the mapping at the Lexical Unit level requires a formalization scheme such as the one introduced in [1] where a mapping between concepts at the ontological level and their possible lexicalizations at the lexical level is formalized introducing the properties `hasLexicalization` ↔ `isLexicalFormFor` between concepts and their lexicalizations.

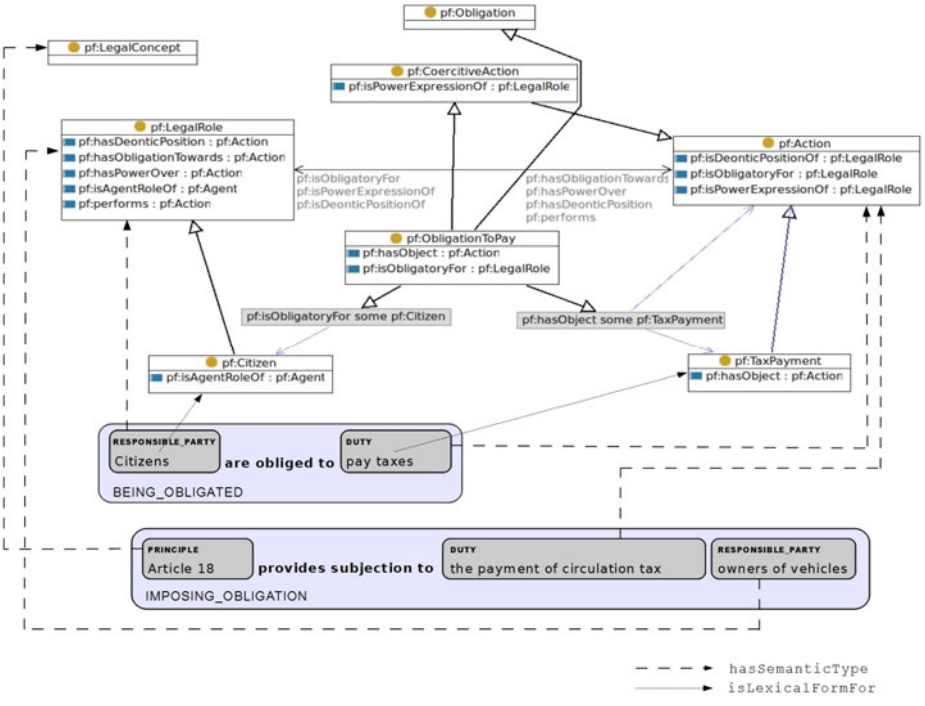

Fig. 5. Mapping Frame Elements to ontology classes

6 Conclusion and Future Directions of Research

This paper was meant to explore evidence for bridging an ontological and a linguistic characterization of Fundamental Legal Concepts. In particular, we carried out a case-study aimed at investigating i) how the 'obligation' Fundamental Legal Concept is differently represented in the FrameNet resource, in terms of Semantic Frames, and ii) how the concept of 'public function' stemmed from the 'obligation' Fundamental Legal Concept can be ontologically characterized. In the latter case, we proved how it is possible to build complex concepts (e.g. the concept of 'public function') by drawing upon a basic normative position (e.g. 'obligation').

Several issues worth discussing follow from this investigation. Firstly, they concern the opportunity offered by the FN-style knowledge organization to consider the basic 'obligation' normative position from a number of different points of view. Interestingly, that affects our proposed mapping approach. This implies that more than one Semantic Frame instantiated in different sentences can be mapped to the same ontology class. Secondly, the case-study pointed out two possible layered approaches to the linking of a linguistic-oriented with a domain-oriented way of modelling the basic 'obligation' normative position. As shown in Section 5.3, the mapping can be carried out at the Frame Element level or at the level of their lexical fillers, respectively linking them to more general classes or to their specializations, providing further constraints on the lexicalization of the involved concepts.

A number of future directions of research can be foreseen. They concern, for example, the use of machine learning techniques to successfully extract semantic structures concerning prescriptive qualifications of facts, in terms of legislative provisions. These semantic structures can be further mapped [47] to FrameNet with the aim of specializing already existing Semantic Frames. An example of a possible methodology which can be followed is reported in [48].

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Application of an Ontology-Based Model to a Selected Fraudulent Disbursement Economic Crime

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Abstract. We present an ontology-based model of a simple economic crime, namely fraudulent disbursement. The extension of a previously proposed ontology model, called the "minimal model", is used to capture the mechanism of the example case. The conceptual minimal model consists of eight layers of concepts, structured in order to use available data on facts to uncover relations. Using these concepts and appropriate relations and rules, we are able to map crime activity options (roles of particular type of managers). This makes it possible to phrase these roles in the language of penal code sanctions. Finally, the roles of persons in the crime are mapped into a set of sanctions. Prospects on future reasoning capabilities of the tool are presented.

Keywords: Financial crime, money laundering, minimal model ontology, reasoning, penal code.

1 Introduction

Economic crimes are particularly difficult to model [1] and code into an expert system. For example, fraudsters use many types of schemes, techniques and transactions to achieve their goals, so it has seemed impossible to construct a simple conceptual model of any generality. Only recently has the integrated use of semantics expressed by means of ontologies and rules achieved the capability of analyzing large practical problems, such as applying reasoning over legal sanctions on the basis of investigation facts and rules appearing in penal codes.

In this work we present an ontology-based model of a simple economic crime, causing damage to a company (Polish: *działanie na szkodę spółki*) in the form of asset misappropriations, including fraudulent disbursement. Such crime is very widespread and intractable across countries and industries. In a 2009 survey [2], asset misappropriation constituted two-thirds of all economic crimes. Such a crime is often accompanied by money laundering schemes.

In previous work we used a simplified version of the *Hydra* case [3, 4]. In this work we cover most of the predicate crime of the Hydra case (we do not present a money laundering thread).

The model is based on the suitable application of an ontology that forms a "minimal layer" - it contains only necessary concepts that follow the logical order of uncovering a crime [3], [4].

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We apply the model to describe over 85% of relevant information for the *Hydra* case [5], and, as a result, are able to effectively infer from these facts the legal qualifications for this case.

As a result a significant extension is made, which makes the model much more realistic. The extended ontology makes it possible to differentiate roles of key people in the crime scheme, and map their crimes into a specific set of penal code articles. The paper is organized as follows. Section 2 presents the Semantic Web Technologies which we use in our approach. Section 3 describes our fraud ontology. In subsection 3.1, state-of the-art ontologies are analyzed with respect to functionalities necessary to meet our requirements. Subsection 3.2 introduces the Hydra case, which is used as an example showing how our approach can be applied in a real case, together with many variants of a given crime typology. In subsection 3.3 we present a fraudulent disbursement minimal ontology model compatible with the Hydra case. In Section 4 we analyze law based on the Polish penal code, related to fraudulent disbursement, and we derive rules that define logical activities appearing in the Penal Code based on physical activities (e.g. signing a document that contains untrue content is a falsification). Section 5 is devoted to mapping logical activities corresponding to legal sanctions for crime perpetrators. Conclusions and future work are presented in Section 6.

2 From Ontology to Reasoning

In information technology, an ontology is the working model of objects (entities) and relations in some particular domain of knowledge. Ontology defines domain knowledge (objects and properties) and also should provide operational knowledge on use (how do we use the objects?, what answers can we get?, and how could we query?). In general, the model represents machine readable projection of a larger domain expressed in formalized language. In Subsection 3.1 we present state of the art ontologies focused on completeness. Here, we follow less general but more practical bottom-up path. We are interested in legal case description we build hierarchy of objects possessing inheritance, along with their properties such as attributes, and restrictions that apply to the class. One may apply rules to support reasoning.

There are various approaches that construct ontologies based of knowledge background (facts). Notable are approaches [6], [7], that from textual description of case facts select applicable factors. Wyner [7] introduced intermediate concepts that allow differentiating between cases. This approach is more general than ours used in this work, as we mostly concentrate on most precise description of a single case. However, we do not limit ourselves with only facts of the case. We consider also possible variants of the case together with their legal implication.

In [6], [7] levels of intermediate concepts were used in a logical relation rather than lattice-theoretic structure. There were designed to achieve a decision a trade secret has been misappropriated.

The minimal model ontology has been developed in language OWL-DL (Web Ontology Language Description Logic) [8] which supports maximum expressive power without loss of decidability and computational completeness. We also use SWRL (Semantic Web Rule Language) [9] language, which, introduces undecidability into our ontology but extends the expressivity of OWL supporting the use of ontology

axioms in rules. We also use SWRLB language (SWRL Built-ins) [10] to extend SWRL with additional functions. Generally, we use SWRLB Comparisons to compare variables and to put some constraints on them.

Such a model with ontology and rules needs an appropriate reasoner. There are several of them, for example: Pellet [11] and KAON2 [12]. Our data are stored in a relational database, so we have to use a reasoner which supports querying 'on-the-fly' according to defined semantics and with the use of rules. We decided to use Jess (Java Expert System Shell) [13, 14], a reasoner tool with SDL (Semantic Data Library) [15] which is much more efficient than KAON2 (it also enables 'on-the-fly' querying).

We stress that some of the presented facts, for example *ApprovalOfWorkNotDone(?d),* will be put into the system by a prosecutor or other person connected with an investigation. We also want to mention that all variables appearing in rules which have different names are treated as having different values. To express that we need to use SWRLB constructions (for example: swrlb:equal ('='), swrlb:notEqual ('!='), swrlb:greaterThan ('>') etc.). But for clarity in this paper we do not use them.

3 Fraudulent Disbursement Minimal Ontology Model

3.1 State of the Art Ontologies

The core of semantic applications are ontologies that are shaping data technology and knowledge representation. Perhaps the most successful project, The Gene Ontology (GO) [16], provides a set of structured vocabularies for specific biological domains that can be used to describe gene products in any organism. GO contains three extensive ontologies that describe molecular function, biological process, and cellular components, and provide a community database resource that supports the use of these ontologies in a massive way (the number of terms now exceeds 28,000).

There has been a very large European Union effort to develop various aspects of design and use of ontologies within the 5th and 6th Research Frameworks. In particular, the Neon project [17], see also its portal [18], is making significant advancement of integrating ontologies in system engineering methodologies.

From our perspective, the most important are legal and financial ontologies, and, particularly, an ontology of fraud.

In general, our minimal model ontology overlaps in many respects with the leading ontologies, but is much narrower and at the same time more specific, allowing for reasoning. There are many ontologies that relate to finance, enterprise or legal areas. According to [19] and [20], ontologies can be classified as:

- Base ontologies,
- Domain ontologies,
- Topical ontologies,
- Application ontologies.

The scope of our work lies in the bottom 3 layers.

Basically, it borrows from norm structure based on Gangemi Content Ontology Design Patterns [21], like Requirement → Consequence (if the factual knowledge is P, then the legal knowledge is Q) , we divide this structure into 3 substructures: Factual

knowledge → Logical meaning of Facts expressed in generic legal language → Legal sanctions with a particular penal code (here Polish Penal Code). Only those facts are analyzed that could became evidence. This is in line with Norm↔Case (if a situation fulfils the conditions for violating a norm, it becomes a legal case), see Fig. 1, CrimeS-cenario (a crime is committed by a perpetrator and comes to the attention of authorities who pursue a criminal process), etc.

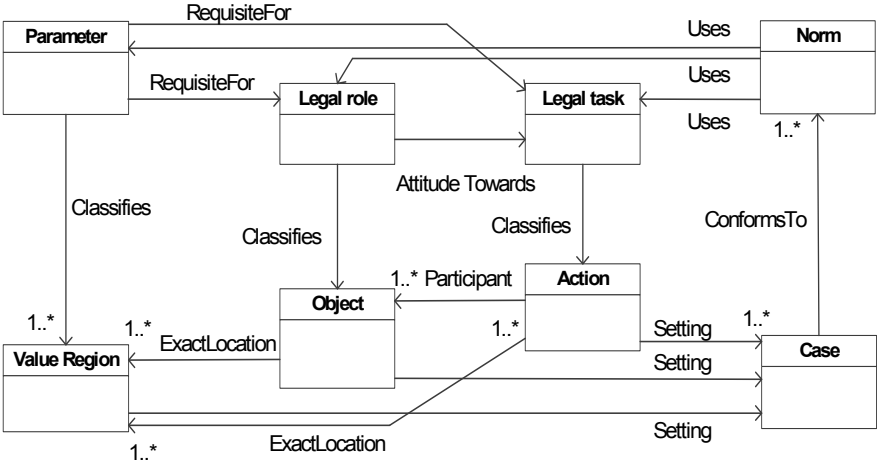

Fig. 1. The Norm ↔ Case structure [21]

However, we do not employ Obligation → Right (if A has an obligation towards B, then B has a right towards A) structure.

As regards to fraud ontology, the one developed within the FF Poirot project [19], [20] is very broad, and consequently difficult to handle. In Fig. 2 we show the package structure of the FF Poirot fraud ontology. Some concepts used there may help to gain evidence, but in an indirect way (perpetrator's personality, or trust, a moral rather than a legal concept). Within a minimal model we do not use such concepts.

3.2 The Hydra Case

In the economic crime considered here, the Chief executive officer, (CEO) of company A (*Hydra*) subcontracts construction work. The work is then consecutively subcontracted through a chain of phony companies (B, C, and D). Each company is getting a commission for money laundering and falsifies documents stating that the contracted work had been done. Actually, what was to be done as "subcontracted construction work" company A did itself.

At the end of the chain, the owner of a single person company D attempts to withdraw cash, and there is a suspicion that this cash reaches the management of company A "under the table". The crime scheme of the Hydra case is presented in Figure 3.

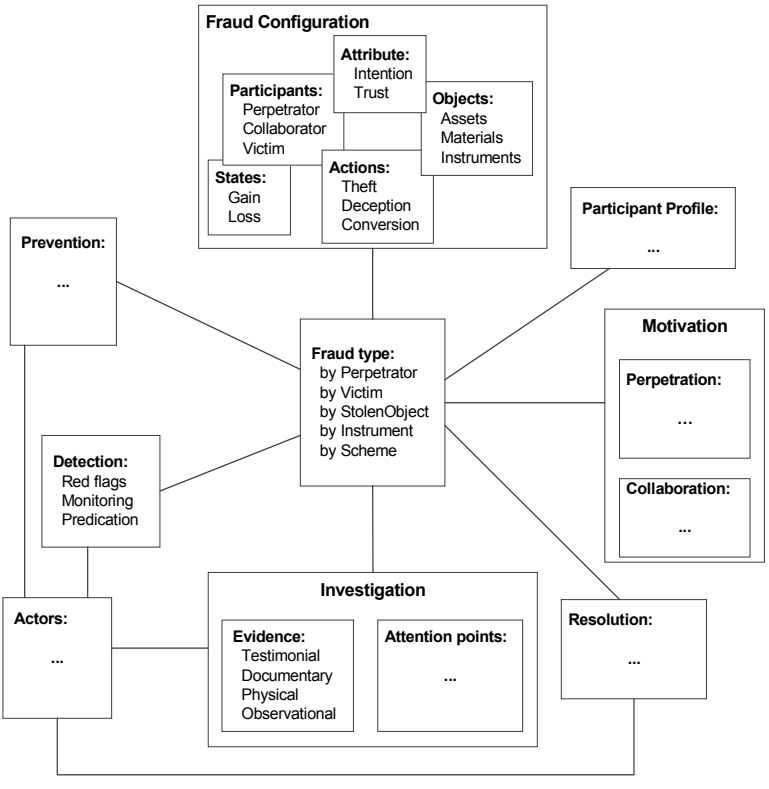

Fig. 2. Packages of Topical Ontology of Fraud

In the previous work [4] we considered a simplified version of the Hydra case, such that only a single level of authorization existed. Basically, it meant that once an approval of the construction job was made, the payment for this work followed without further authorization. Consequently, only one person in company A was responsible for the crime.

The situation was created by the authorization of company A's (CEO) who made payment to a subcontractor for work not done, on the basis of falsified documents stating that the work had been done.

In this work a three-level (real) structure of authorization is taken into consideration.

The facts of the Hydra case are written on 7 pages in a textual form. A formalized scenario description of the Hydra case was obtained by manually transforming natural language description to data structures (no temporal relations shown). The structures related to money, invoices or work flow are the following factors (variables are indicated by a capital letter):

- Company F1 hires company F2 to do work R at location M.
- Company F2 does work R at location M on behalf of F1.
- Company F2 does no work R at location M on behalf of F1.

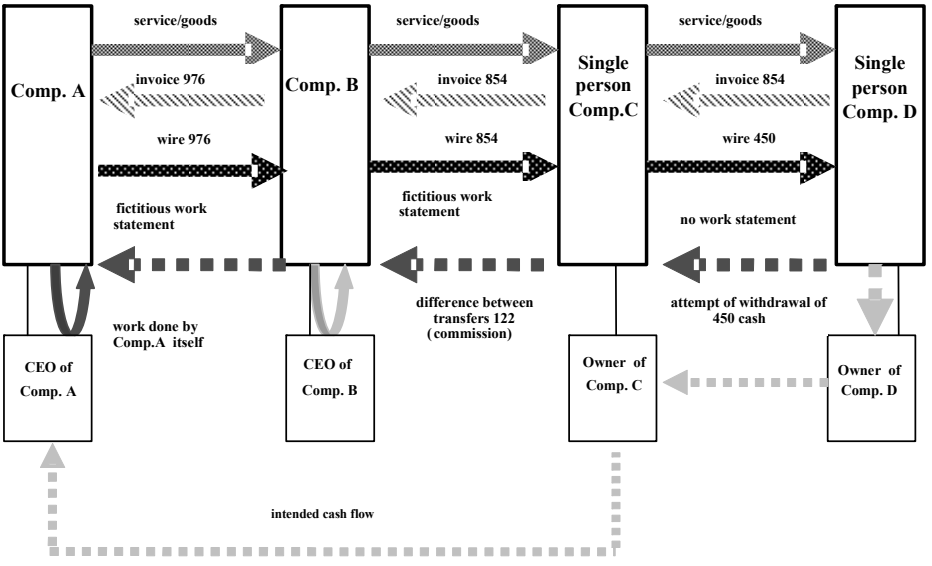

Fig. 3. A basic scheme for the Hydra case

- Company F1 issues invoice FA to Company F2 for work R done at location M.
- Persons X and Y representing Companies F1 and F2 respectively, sign work acceptance document DO related to work R done at location M.
- Company F1 makes payment to Company F2 for invoice FA related to work R done at location M, transferring money from account x in bank B1 to account y in bank B2.
- Person X gives an order to bank B to perform operation O on account x of Company F existing in this bank.
- Bank B performs operation O on account x of Company F existing in this bank, ordered by Person X.
- Bank B blocks operation O on account x of Company F existing in this bank, ordered by Person X.

One can consider these statements as corresponding to the first 3 levels of concepts appearing in Table 1.

In the next stage the sentences were broken into RDF triples, which were the basis for concepts, relations and rules design. We demonstrate with a few examples that such a representation largely facilitates asking relevant questions about connections between financial entities and people associated with them, which is conducive to evidence building and assigning a sanction for a crime.

3.3 Minimal Ontology

Based on analysis of about 10 crime cases, we arrived at the data model (called a minimal model), based on conceptual graphs [3]. This means that an ontology is

crafted to a task rather that attempting to describe the whole conceivable space of concepts and relations (top ontologies). The methodology consists of several steps:

1. Design of a hierarchical data representation with minimal ontology, constructed in the sequence of uncovering a crime scheme. This means using only necessary concepts that follow in the logical order of uncovering a crime. In the first stage, goods/services transfer data is analyzed with relation to 3 basic flows: money, invoices, and documents (i.e., confirming that the service or goods have been delivered - particularly important for fuel mafia type of crimes). In addition, responsible or relevant people within companies are associated with particular illegal activities.
2. Provision of a framework in which the graph building process and queries are executed.
3. Relating answers to queries with crime qualifications.

This approach is limited, but provides an essential model for evidence-building of a very important class of financial crimes: among them acting to do damage to a company and money laundering.

The major features of the minimal ontology model are the following:

- Only facts contributing to evidence or possible sanctions are kept.
- We leave to a human the answer to difficult questions: for example, deciding that the work has not been done. This requires sending an expert to the field, inspection of construction, taking testimonies, finding that a company that presumably did the job was a straw company, with no experience in construction, having no equipment, etc. In some cases finding out that the work was underpriced or overpriced is very difficult but a critical issue in a case.
- Reduction of possible relations or attributes. Here we give some examples:
    - In the case of Hydra, in the first stage it is not necessary to deal with the place of construction. The scheme would be a crime no matter where the construction was taking place (for a given jurisdiction). However, this information has to appear in the indictment.
    - An invoice can be issued or received. We combine these two relations, the only relation for invoices possible in our model. Invoices may be lost or destroyed, and there will be some cases for which these facts will be of importance, and then possibly we would have to enhance the model.
- The knowledge about the case appears explicit as presented by facts, and implicit – such as regular business procedures. Once the payment is approved, it is then executed and we are not interested who actually did it.

  Such an approach of complementing a scenario with "external knowledge" is similar to that taken in Abraxas project [6]. This spares us expressing a trade code in OWL.

Since the previous model was quite rudimentary (the scheme was correct but many details were omitted), we need to extend the minimal model ontology presented in [3-5]. "Minimal model" means that the ontology contains a very small number of concepts and relations to infer about crime schema and legal sanctions.

The minimal model consists of eight layers that are structured in order of uncovering the facts (Table 1). Concepts are introduced to describe the core of these facts. Everything that is not pertinent to legal reasoning is rejected.

Table 1. Layers of concepts for analysis of economic crimes

Type	Concern details
1.	General entities as: Companies, Institutions, Single person companies, levels of authorization, documents having legal meaning. Money transfer between companies
2.	Invoice flow between companies. Tax statements
3.	Work/Services flow
4.	Roles of decisive people in companies who accepted work in the chain of command
5.	Mapping potential roles coming from positions in companies to particular activities resulting in a financial crime
6.	People not related to companies but being a part of crimes. Other relations of people
7.	Information about people, e.g., whether they were sentenced in the last 10 years, their criminal connections; school or business etc., connections
8.	Additional factors (e.g., learning about averted criminal plans)

A definition of the minimal model is application to financial crimes expressed in OWL language using the editor Protégé 4.0 is presented in [5].

This ontology has a modular structure and contains:

- Person.owl module, describing persons as social entities and groups of persons,
- module Document.owl, specifying the legal meaning of documents and their content,
- module LegalProvision, defining legal acts and sanctions,
- module Action.owl specifying activities,
- module Object.owl describing other entities, i.e. goods (work or service are such entities),
- module MinimalModel.owl defining general concepts and relations of the minimal model, it also contains rules,
- module Institution-Organization.owl describing legal entities (rather than dealing with intentions, it is more important to establish who knew about criminal activities, and whether a crime was perpetrated by a group).

In relational database notation, the most important concepts that are currently functional are the following:

Flow (Money Transfer, Invoice, Goods/Service).
Money Transfer (From Entity, To Entity, Method of Transfer, Date, Value, Title of transfer, i.e. for Goods).
Method of Transfer (Electronic transfer, Cash).

In various legal theory texts, fraud must be proved by showing that the defendant's actions involved between five to nine [22] separate elements – Table 2.

Table 2. Fraud attribute representation

No	Fraud attribute	How it is determined
1	a false statement of a material fact (in some works these two are separated)	Explicitly (falsified document as proof)
2	damage to the alleged victim as a result	Explicitly (payment for work not done)
3	knowledge on the part of the defendant that the statement is untrue	Conditional (could know, could not know, should know – these are the variants of the scheme analyzed)
4	intent on the part of the defendant to deceive the alleged victim	Testimony
5	justifiable reliance by the alleged victim on the statement	Implicitly (had fraud been committed payment is automatic – this knowledge comes from normal operation procedures in a company)

Such fraud attribute representation is narrower than that used in [20] p. 28, but much easier for querying.

Figure 4 and Figure 5 present the taxonomy of concepts of the modules Person.owl and Document.owl, respectively. Corresponding relations and rules (not presented here) were used, e.g., to obtain results presented in Tables 3 and 4.

First, the company had a three-level structure of authorization (this is easy to generalize to more levels, but the intent is to make it compatible with the Hydra case). The chain of activities is the following: in the Hydra case, acceptance of construction work done by B at a given site is first signed by a manager in A responsible for a work supervision at this site (MiddleLevelManager); this is followed by a signature of the higher level manager – a Director of the company responsible for supervision of all sites. A Director may be authorized to accept invoices and order a payment – technically this is and was done by a written authorization on the back of the invoice.

The Principal might not have known that the work was not being done. However, he was the one who signed the contract for subcontracting and thus could be implicated.

Had the Principal of company A been a person who on the basis of the work acceptance document had ordered the payment of A to B, upon issuance of an invoice by B, he would be directly implicated.

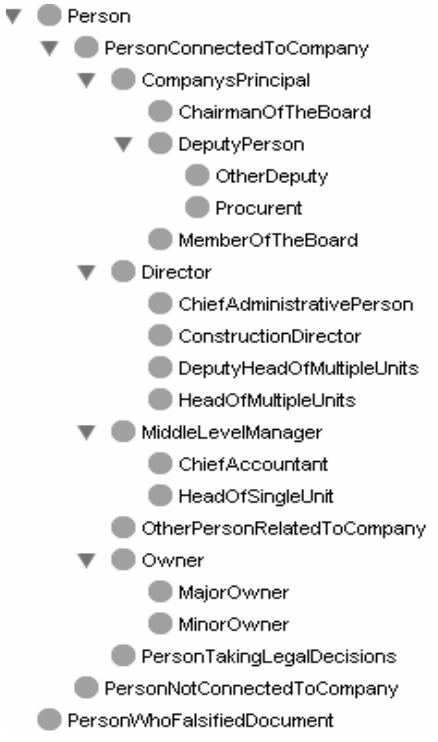

Fig. 4. A Taxonomy of concepts of the module Person.owl

However, in reality the case was more complex. In order to represent elementary activities, we need to formalize:

1. The concept of complex documents.
2. The Hierarchical chain of responsibility in a company.

Several new basic concepts are defined to achieve a more realistic view of the Hydra case, able to describe legal documents:

a. ContractDocument – a document that is drawn up between two parties. This ContractDocument is between two companies, and is signed by principals of these companies. The signature on behalf of the company can be individual or joint, depending on the structure of the company.

The following general rule for the ContractDocument is defined:

```
Document(?d), isSignedBy(?d, ?p1), CompanysPrincipal(?p1),
isSignedBy(?d, ?p2), CompanysPrincipal(?p2) → ContractDocument(?d)
```

b. InternalLegalDocument – a document drawn up in the company that may be authorized in stages up to the highest level of authority. It is signed hierarchically by the persons with different levels of responsibility.

Fig. 5. Taxonomy of concepts of the module Document.owl

c. ComplexInternalLegalDocument – a virtual hierarchical document which could consist of several physical documents, that together authorize a payment (here ComplexInternalLegalDocument consists of a construction work acceptance

document, and a payment authorization signature on the back of an invoice). The series of authorizations reflects the structure of the company from the lowest to the highest rank of management. ComplexInternalLegalDocument is defined with the following rules:

```
Document(?d), concerns(?d, ?w), Work(?w), isSignedBy(?d,
?p1),worksFor(?p1, ?c), hasLevelOfResponsibility(?p1, ?l1),
isCosignedBy (?d, ?p2), worksFor(?p2, ?c),
hasLevelOfResponsibility(?p2, ?l2), swrlb:lessThan(?l1,?l2)
→ ComplexInternalLegalDocument(?d)

Document(?d), concerns(?d, ?w), Work(?w), isSignedBy(?d, ?p1),
worksFor(?p1, ?c), hasLevelOfResponsibility(?p1, ?l1),
isSignedOnBackOfInvoiceBy (?d, ?p2), worksFor(?p2, ?c),
hasLevelOfResponsibility(?p2, ?l2), swrlb:lessThan(?l1,?l2)
→ ComplexInternalLegalDocument(?d)
```

d. FalsifiedComplexInternalLegalDocument – ComplexInternalLegalDocument with approval of work which was not done.
   FalisfiedComplexInternalLegalDocument is calculated with the following rule:

```
ComplexInternalLegalDocument(?d), ApprovalOfWorkNotDone(?d)
→ FalsifiedComplexInternalLegalDocument(?d)
```

e. Company's principal – the highest level person making legally binding decisions in a company (a member of the executive board or an owner in a single person company).
f. Transaction – consists of a contract between two companies, the work, an invoice issued for work and payment. It is defined with the following rule:

```
ContractDocument(?c), concerns(?c, ?w), Work(?w),
ComplexInternalLegalDocument(?i), Invoice(?i), isIssuedBy(?i, ?f1),
concerns(?i, ?w), isReceivedBy(?i, ?f2), MoneyTransfer(?mt),
flowsFrom(?mt, ?f2), flowsTo(?mt, ?f1)
→ Transaction(?c), hasMoneyTransfer(?c, ?mt), hasInvoice(?c, ?i)
```

   If a contract, work or invoice document turns out to be a FalsifiedDocument, then the Transaction will be classified as a FalsifiedTransaction.
g. FormalHierarchy – the management structure in a company. Cardinality of managers at each level is 1. In future, we will allow some decisions to be taken as a group, if roles of managers in the group at the same level were the same.
h. We can also define (in the description logic) the MoneyTransfer concept:

$$\begin{aligned} \text{MoneyTransfer} \subseteq\ & \text{FlowOfMoneyCPTask} \ \wedge \\ & \exists\ \text{flowsFrom.Company} \ \wedge \\ & \exists\ \text{flowsTo.Company} \ \wedge \\ & (=\ 1\ \text{occurs} \ \wedge \forall \text{occurs.TimeInstant}) \ \wedge \\ & (=\ 1\ \text{hasValue} \ \wedge\ \forall\ \text{hasValue.float}) \ \wedge \\ & \exists\ \text{isPaymentFor.Invoice} \end{aligned}$$

This definition means that a money transfer has one distinctive value, it occurs at exactly one time instant between a pair of companies, and it is connected with paying for some invoice. Additionally, it is a specialization of a top level FlowOfMoneyCPTask concept coming from ontology developed for the PPBW, the Polish Platform for Homeland Security project [5].

It is essential to recognize that documents may require a legal signature by a subset of principals within a company according to a statute. In the Hydra case the board consisted of 5 members, and the chairman of the board was authorized to sign documents without the consent of the others. Since no involvement of the remaining 4 members was found, here the principal is the CEO.

In this paper we adopt the 3-level deep company management structure – the "legal view" of hierarchy, which determines corporate lines of accountability. We assume that these 3 levels of PersonTakingLegalDecisions, starting from the highest levels, are: Principal, Director and MiddleLevelManager. In Figure 4, class structure of concepts of the module Person.owl is presented.

Members of the executive board are principals, the only people who authorize contracts. Certain activities are performed by those in lower ranks: here directors and middle level managers are legally bound.

To show versatility and flexibility of the model, here we admit more options for the crime scheme (who could do what), one of which happened in the real case.

4 Rules That Define Logical Activities Appearing in the Penal Code Model

We can also define the PersonWhoFalsifiedDocument as a (social) person connected to a company who can make decisions and is authorized to sign legally binding documents (that within a criminal activity may have a falsified content).

```
PersonWhoFalsifiedDocument ⊆
            PersonTakingLegalDecisions ∧
            ∃ worksFor.Company ∧
            ∃ isAuthorisedToSign. InternalLegalDocument Document ∧
            ∃ Signs.(∃ possesses.FalsifiedContent)

PersonWhoUsedFalsifiedDocument ⊆
            PersonTakingLegalDecisions ∧
            ∃ worksFor.Company ∧
            ∃ isAuthorisedToCoSign. InternalLegalDocument Document ∧
            ∃ Signs.(∃ possesses.FalsifiedComplexLegalDocument)
```

Here we introduce the IllicitPersonalGain concept, which is money that was fraudulently transferred out of company A and returned to a person that had control over company A. This procedure was possible due to a conspiracy between the CEO of company A and the owners/managers of companies B, C, and D. These facts were established by testimonies and pleas.

In order to define the Principal roles, we introduce the following properties: isPartofScheme, hadIntent, and isNegligent.

The MiddleLevelManager and the Director (this is what happened in reality, a version in which the Director approved the payment) committed intellectual falsification. This is established beyond doubt. We can define this role as an UnconditionalFraudster. The principal is UnconditionalFraudster 'Sequence of activities 1' in Table 3 (had known what he signed). The principal is ConditionalFraudster in 'Sequence of activities 4'. We need additional information that he was 'Part of the crime scheme'. This qualification is left to an investigator or a prosecutor.

The Principal's involvement in the crime scheme may be established in several ways:

1. A guilty plea during testimonies or in court.
2. Other members of the scheme testifying that he was part of the scheme.
3. Money transfers to his account which cannot be accounted for.

In principle, we could try to design rules for these concepts. Here, these properties are determined by a human (an investigator or a prosecutor). Even if he was guilty, he could claim being under duress while giving testimony (a victim of coercion by prosecutors), or could claim innocence due to mental incompetence at the time.

For the Principal, the following theoretical possibilities exist, presented in Table 3.

Table 3. Options in the fraudulent misappropriation case of Hydra: detailed activities of key persons of company A having legal meaning

Number		**Sequence of activities 1**	**Sequence of activities 2**	**Sequence of activities 3**	**Sequence of activities 4**
Activities		Principal orders payment	Director orders payment	Director orders payment	Director orders payment
Manager's sequence of activities	Principal	Principal accepts the document and orders payment	Should have known that the work has not been done, if he was not negligent	Might not have known that the work has not been done	Part of the crime scheme
	Director	Cosigns falsified construction work acceptance document	Director accepts the document and orders the payment	Director accepts the document and orders the payment	Director accepts the document and orders the payment
	MiddleLevel Manager	Falsified construction work acceptance document	Falsified construction work acceptance	Falsified construction work acceptance	Falsified construction work acceptance

The Principal could be a part of the scheme (or even the organizer of the scheme), or would have approved a payment without knowing that the work had not been done. Suppose the principal claims he is innocent. If he were not implicated by the MiddleLevelManager and/or the Director of company A, nor by the Principal of B, nor by money coming to his account, then the Principal was not a part of a scheme. The full model should decide whether the Principal was negligent (leading to nonfeasance), since the Principal was obliged to verify work acceptance documents (he may be charged on the basis of Art. 296 § 4 PC).

The success of our model relies on clear separation of the nature of the facts we use:

1. Concepts and facts in the "minimal model ontology".
2. Concepts and facts in the external sources. This, for example, includes knowledge of how a standard company operates. An invoice accepted by a Principal or Director goes through an accountant and an administrative officer who actually executes the money transfer. We do not attempt to describe these activities, unless there is a crime at these stages.
3. Certain facts are left for manual input by an investigator and a prosecutor.

In our approach we explicitly use conditions 1 and 2 from Table 2 in the case of the Director and the MiddleLevelManager. Element 3 is used to judge the involvement of the Principal. Elements 3 and 4 are combined, as knowing about a fraud also indicates intent. Element 5 is not analyzed, because it results from standard procedures in a company: once a payment was authorized, it is executed.

For the sake of clarity, here we are only interested in legal sanctions for people related to company A. The Full Hydra case (10 people sentenced) [23], [24] will be presented in our future work.

The decisive document falsifier (for example, an agent issuing an invoice for work not done) having the intent to do damage to a company by illegally transferring money from it, and who gains some amount of this illicit money, may be defined by the rule:

```
FraudsterInACompany(?x, ?c)    ←
                    PersonWhoFalsifiedDocument(?x)
                    Company(?c) ∧
                    initiates(?x, ?mt) ∧
                    MoneyTransfer(?mt) ∧
                    achieves(?x, ?g) ∧
                    IsPartOfTheScheme(?x, ?k) ∧   //k - given case
                    IllicitPersonalGain(?g) ∧
                    hasValue(?g,?v2) ∧ Value(?v2) ∧
                    hasValue(?mt, ?v1)  ∧
                    Value(?v2) ∧ ?v2≤?v1 ∧
                    hasGoal(?x, ?go) ∧
                    hasIntentToCommitCrime(?x, ?go)
```

The rules for crime activities from Table 3 were defined to obtain results from the current state of the knowledge base. Rules enable users to determine which sequence of activities is appropriate to a crime schema. The following rules were defined for sequence of activities 1:

```
FalsifiedComplexInternalLegalDocument(?d), isSignedBy(?d, ?p1),
isSignedOnBackOfInvoiceBy (?d, ?p2), MiddleLevelManager(?p1),
Director(?p2), Principal(?p3), orders(?p3, ?m), Payment(?m),
accepts(?p3, ?d), knowsAbout(?p3, ?d)
```

→ **FraudulentDisbursementCrime(?p1, 1),**
FraudulentDisbursementCrime(?p2, 1),
FraudulentDisbursementCrime(?p3, 1)

```
FraudulentDisbursementCrime(?p1,1), FraudulentDisbursementCrime(?p2,1),
FraudulentDisbursementCrime(?p3,1), MiddleLevelManager(?p1),
Director(?p2), Principal(?p3), worksFor(?p1, ?f1), worksFor(?p2, ?f1),
worksFor(?p3, ?f1)
```

→ **inConspiracyWith(?p1, ?p2), inConspiracyWith(?p2, ?p3),**
inConspiracyWith(?p1, ?p3)

5 Mapping of Logical Activities to Legal Sanctions for Crime Perpetrators

Analysis of the fraudulent disbursement sanctions in the Polish PC [25] and real cases showed that most defendants were accused of the following crimes (number indicates a component in a SetOfCrimes:

1. Art. 296 § 1-3 PC – strictly: negligence leading to damage to a company (for personal benefit). The asset misappropriations including fraudulent disbursement (FD) are prosecuted in Poland based on this article. The phrasing of the crime in the Polish Penal Code does not exactly agree with its meaning.
2. Art. 296 § 4 PC – unknowing negligence leading to damage to a company.
3. Art. 284 § 2 PC – personal benefit resulting from activities sanctioned under art. 296.
4. Art. 294 § 1 PC – the offense specified in 284 § 2 PC with regard to property of considerable value.
5. Art. 286 § 1 PC – fraud (intentionally deceiving a person (here, a legal person - a company), which results in a damage to the company.
6. Art. 271 § 3 PC – lying or issuance (signing) a false document with regard to a circumstance having legal significance.
7. Art. 273 § 1 PC using a document mentioned in art. 271 § 3 PC.
8. Art. 299 § 1 and 5 PC – money laundering (conscious and together with other persons, constituting a crime group).
9. Art. 18 § 1 PC – directing illegal activity performed by another person.

Using the defined and derived properties, the logical characterization of a suspect's activities are illustrated in Table 4.

Table 4. Logical characterization of activities of key persons of company A in variants of a fraudulent misappropriation scheme. Legal sanctions are thosereached by an expert prosecutor and the judge.

Number		**Variant 1**	**Variant 2**	**Variant 3**
Activities		MiddleLevelManager and Director part of conspiracy. Principal not part of the scheme.	MiddleLevelManager and Director part of conspiracy. Principal not part of the scheme but negligent.	MiddleLevelManager and Director part of conspiracy. Principal part of the scheme, actually the organizer.
Legal sanctions	Principal	Innocent	art. 296 § 4 PC	art. 296 § 1-3 PC (depending on the cost of the damage) and art. 284 § 2 PC and art. 294 § 1 PC
	Director	art. 286 § 1 PC i art. 294 § 1 PC, art. 284 § 2 PC, art. 273 § 1 PC;	art. 286 § 1 PC i art. 294 § 1 PC, art. 284 § 2 PC, art. 273 § 1 PC;	art. 296 § 1-3 PC (depending on the cost of the damage) and art. 284 § 2 PC and art. 294 § 1 PC art. 273 § 1 PC
	MiddleLevel Manager	art. 294 § 1 PC; art. 271 § 3 PC	art. 294 §; 1 PC art. 271 § 3 PC	art. 296 § 1,2, 3 PC and art. 284 § 2 PC; and art. 294 § 1 PC; art. 271 § 3 PC

Legal sanctions reached by an expert prosecutor and the judge can be defined as rules. Here, we present rules for every variant from Table 4:

a) Variant 1:

```
FalsifiedComplexInternalLegalDocument(?d), MiddleLevelManager(?p1),
Director(?p2), inConspiracyWith(?p1, ?p2), Principal(?p3),
NotInConspiracy(?p3), Art_286_1(?a1), Art_294_1(?a2),
Art_284_2(?a3), Art_273(?a4), Art_271(?a5)
→
fallsUnder(?p1, ?a2), fallsUnder(?p1, ?a5), fallsUnder(?p2, ?a1),
fallsUnder(?p2, ?a2), fallsUnder(?p2, ?a3), fallsUnder(?p2, ?a4),
Innocent(?p3)
```

b) Variant 2:

```
FalsifiedComplexInternalLegalDocument(?d), inConspiracyWith(?p1,
?p2), MiddleLevelManager(?p1), Director(?p2), Principal(?p3),
notInConspiracy(?p3), Negligent(?p3), Art_286_1(?a1),
Art_294_1(?a2), Art_284_2(?a3), Art_273(?a4), Art_271(?a5),
Art_296_4(?a6)
→
fallsUnder(?p1, ?a2), fallsUnder(?p1, ?a5), fallsUnder(?p2, ?a1),
fallsUnder(?p2, ?a2), fallsUnder(?p2, ?a3), fallsUnder(?p2, ?a4),
fallsUnder(?p3, ?a6)
```

c) Variant 3:

```
FalsifiedComplexInternalLegalDocument(?d), MiddleLevelManager(?p1),
Director(?p2), Principal(?p3), inConspiracyWith(?p1, ?p2),
inConspiracyWith(?p2, ?p3), inConspiracyWith(?p1, ?p3),
Organizer(?p3), Art_296(?a1), Art_294_1(?a2), Art_284_2(?a3),
Art_273(?a4), Art_271(?a5)
→
fallsUnder(?p3, ?a1), fallsUnder(?p3, ?a2), fallsUnder(?p3, ?a3),
fallsUnder(?p2, ?a1), fallsUnder(?p2, ?a2), fallsUnder(?p2, ?a3),
fallsUnder(?p2, ?a4), fallsUnder(?p1, ?a1), fallsUnder(?p1, ?a2),
fallsUnder(?p1, ?a3), fallsUnder(?p1, ?a5)
```

We have verified our ontology with the Pellet-2.0.1 reasoner [11], which found the ontology to be consistent.

6 Conclusions and Future Work

The minimal model of the fraudulent disbursement crime can be expressed using OWL-DL classes and properties and a reasonable number of rules.

Our analysis accounts only for crimes of people associated with Hydra – company A. We do not here present rules for sanctions for people in companies B, C, and D, nor give sanctions for money laundering (here we concentrate only on a predicate crime). These are similar, although some new elements appear. The model is not yet able to determine the duration of an appropriate penalty.

Because fraudsters may use many types of schemes, techniques and transactions to achieve their goals, we need a conceptual model of economic crime with significant generality. In the future, we intend to demonstrate that we can describe not just one case but a broad class of economic crimes, such as:

- CausingFraudulentDisbursement,
- CausingAssetMisappropriation,
- CausingDamageToACompany.

We do not consider this task impossible, although we will always face additional factors necessary to extend our minimal model. We could, for example ask: was only the CEO of the Management Board in Hydra implicated? At the time of the investigation, there was no proof otherwise. But apparently the rest of the Board knew about the scheme, because several years later they were indicted on a similar count.

We do not dwell on who exactly had the power to sign (in some cases there are disputes on the validity of supervisory board decisions); this fact must be established by a

prosecutor. An extent to which the model can be generalized to treat such more complex schemes will be the subject of a further study. However, after performing quite a number of reasoning experiments on the 5 most common economic crime mechanisms in Poland (some results are presented in [3, 15, 26]), we are convinced that a general model can be constructed that handles a few most common economic crimes with 85% use of all pertinent facts (The *Hydra* case is somewhat easier than average). In this regard, application of intermediate levels of factors [7], [27] could be helpful.

To our knowledge, the work on mapping of crime activities into criminal law articles has been done [28] only for cyber crimes, which have a much narrower scope, although using result of work [7] it could be straightforward for the case. In work [7] only OWL ontology was used for T-Box reasoning (although rules were discussed in a different aspect) , whereas our approach uses ontology and rules.

Currently we are working on implementation of the knowledge base and generation of artificial data to test our approach. In such cases we can assign sanctions to people involved in crime schemes. In the next paper we will present and evaluate these results, as well as discuss scalability of number of concepts, relations and rules for large economic crime cases.

Our ontology is relatively small, but will be enhanced once we add other fraud type typologies. This will make it larger than the ontology used in the well known Spanish system for judges [29]. In the future we plan to automatically obtain RDF triples from documents [30].

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Multi-layer Markup and Ontological Structures in Akoma Ntoso

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Abstract. The XML documents that represent legal resources contain information and legal knowledge that belong to many distinct conceptual layers. This paper shows how the Akoma Ntoso standard keeps these layers well separated while providing ontological structures on top of them. Additionally, this paper illustrates how Akoma Ntoso allows multiple interpretations, provided by different agents, over the same set of texts and concepts and how current semantic technologies can use these interpretations to reason on the underlying legal texts.

1 Introduction

Akoma Ntoso is an open legal XML standard for parliamentary, legislative and judiciary documents. Promoted by the Kenya Unit of the United Nations Department for Economics and Social Affairs (UN/DESA) in 2004, it means "Linked Hearts": a symbol used by the Akan people of West Africa to represent understanding and agreement. Originally meant for African Countries, it is now promoted also in Latin America, Asia and various European countries.

Akoma Ntoso describes structures for legal documents using a vocabulary of common structures based on XML, references to legal documents across countries using a common naming convention based on URIs, and a systematic set of legal metadata values using an ontologically sound approach compatible with OWL [18] and GRDDL [4].

Akoma Ntoso aims at being extensible for the individual needs of any country, preserving the legal digital resources over time (even long spans of time, in decades and centuries even), guaranteeing legal principles and favoring trust by means of authoritative versions, legal copies, etc.

Akoma Ntoso has been designed so that XML documents can be managed in any step of the legislative or judiciary life cycle (for instance, in the publishing phase) without any modifications of the content published by the body empowered by law to endorse it. Additionally, long term preservation of Akoma Ntoso documents must be possible even without access to the extensive original documentation.

The information added by Akoma Ntoso (the markup) can be seen as distributed over multiple layers, each layer addressing a specific problem: the text layer provides a faithful representation of the original content of the legal text,

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the structure layer provides a hierarchical organization of the parts present in the text layers, the metadata layer associates information from the underlying layers with ontological information so that semantic tools can apply inference rules (e.g. simple description logic rules) or perform advanced reasoning using logic frameworks like defeasible logic or argumentation [5].

This paper is organized as follows. Section 2 illustrates the layered architecture of Akoma Ntoso documents. Section 3 describes the lower layers of the Akoma Ntoso document architecture where the legal text is described and the hooks used by upper layers are added. Section 4 shows how authoritative and non-authoritative legal knowledge (metadata) can be codified in an Akoma Ntoso document. Finally, Section 5 illustrates how current semantic tools can use the generic Akoma Ntoso ontology system to reason over legal documents.

Note: throughout this paper we will use the terms *legal text* and *legal resource* for legal texts as endorsed by an official authority; we will use the terms *legal document* or *legal XML document* for their computer representation; we will use the terms *legal content* or *normative content* for pointing out the normative meaning of the text

2 The Akoma Ntoso Document Architecture

The role of Akoma Ntoso is to mark up legal and legislative texts so that the legal knowledge and the legal structure of the text can be *understood* by current and future computer applications. This means that legal texts form the basis on which Akoma Ntoso documents exist. Akoma Ntoso documents add information on top of the actual text (*decorate the text* in the markup lingo). The added information can itself be seen as composed of different stratified layers (text, structure, metadata, etc) [13]. Akoma Ntoso clearly separates the legal text from these different levels of information but still allows higher layers to reference the underlying layers, thus building knowledge on top of other knowledge, with the content of the legal text acting as the base knowledge. This architecture allows different actors with different field experiences (e.g. experts in legal drafting, experts of document classification, experts in legal-knowledge engineering, experts in normative references, etc.) to mark up independent parts of the document.

As with any technology that deals with legal resources, Akoma Ntoso has been designed to work on the original text without changing it. Words, punctuation marks and other typographical symbols are left untouched by the mark up process that transforms a plain-text legal document into an Akoma Ntoso-compliant XML document.

Additionally, Akoma Ntoso maintains a strict separation between *data* and *metadata* and provides an unambiguous definition of them as well as an operational distinction in authoriality: as such, data is any information that has been created or at least approved by the relevant legal author (for example, the whole of the text of an act), while metadata is any information that was not present in the original version of the document as it was approved by the relevant legal author but was added editorially in a later moment of the production process

(e.g., the issue number of the official gazette or, even, the page numbers in the printed version of the same act).

The distinction between data and metadata is not only a theoretical distinction, since the actual layers of markup in Akoma Ntoso *(text*, *structure* and *metadata*) are based on it.

Textual markup identifies, within the content of the legal documents, fragments that have a precise legal or referential meaning, e.g., concepts such as "this piece of text is a date", "this piece of text is a legal reference" or "this piece of text contains the name of a party of the trial". Structural markup identifies and organize the parts of the content that divide it into containers, and especially hierarchical containers: "this piece of text is an article" or "this piece of text is the title of an act", "this piece of text is the background section of a judgment", e*tc.* Metadata markup adds knowledge generated by an interpretation of the legal text performed by a human or mechanical agent: "the phrase *the pre-existing Acts* refers to *Act 32 of 1989* and *Act 2 of 1990*", or "the person cited in the minutes as *Mr. Gidisu* is really *Mr. Joe Kwashie Gisidu, the only member of the current Ghanaian parliament with that name and elected to a seat in it since 2000*".

Moreover, when the typographical styles are used to represent the semantic role of a piece of text, this role is captured in the metadata section so that the specific meaning of that typographical style is not lost.

There are different positions in the literature on which category is the most appropriate for structural data: textual or metadata. In our vision it belongs to a third, separate category. Actually, the structure represents the wish of the author of the legal text to organize that text in a certain order and therefore it is authoritative matter. If an annex is in the third level inside a hierarchical nested list of exhibits of an act (e.g. Table 1 of the Annex A.1) it embeds a legal message that belongs to the theory of law and in particular, a message on the hierarchy of the legal sources. What is finally voted on by a parliament in the assembly is a specific organization of the text that incorporates, through the text structure, a precise legal message (e.g. the article 50 is in that position because there is a certain linguistic and legal message to deploy).

The analysis of the textual and structural information is quite straightforward and its results are rarely disputed. On the contrary, the analysis of more advanced concepts found in the legal text requires some experience and it is easy for different sources to disagree on the generated interpretation. For this reason Akoma Ntoso documents have exactly one textual and one structural layer in each documents while interpretation of the advanced concepts is stored as metadata. Akoma Ntoso allows multiple metadata layers in the same document, each recording various interpretations given by different sources.

Finally, each interpretation added by a specific actor can be linked to a particular ontology of legal concepts (e.g. "date of enter into force" as modeled in the LKIF-core ontology or "High Court of South Africa" as modeled in an ontology about the judiciary system in Africa). This mechanism is used to connect specific ABox assertions, described in legal XML document, to more general TBox concepts, relationships, properties and axioms defined in a core or domain-specific ontology.

3 The Authorial Layers

Any Akoma Ntoso document is based on a legal resource that has been endorsed by an authority empowered by law: an act approved by a parliament, a decree issued by a ministry, a judgment entered by a court. Fidelity to the approved text is, thus, of primary importance; the data layers of Akoma Ntoso have been designed so that it is possible to markup a received legal text while preserving all the information contained in it and without changing its content.

The documents Akoma Ntoso deals with are legal resources whose significance is given by the fact that they have the power to influence citizens' life. Legal texts must, thus, be handled with extreme care and all the measures should be taken to make sure that the technological tools employed to manipulate the texts do not change or interfere with their intended meaning.

In Akoma Ntoso, legal documents are created by enclosing parts of the legal text in XML tags. No pieces of the legal text are discarded, even those that could be generated by an application (e.g. the article numbers in an act). The resulting documents are thus augmented versions of the authentic text; the approved text can be retrieved by simply removing all the XML tags.

The Akoma Ntoso markup process strives to preserve the legal validity of the text as endorsed by the official authority, without adding any additional content to the text. Obviously, the mere act of marking up a sentence involves an act of interpretation or annotation and thus cannot be considered perfectly neutral. However, the kind of markup done at the Akoma Ntoso data layers is almost objective (to the point that some automatic parsers have been developed [12]) and is rarely subject to disputes. For this reason, Akoma Ntoso documents are designed to contain only one interpretation of the text and structure layers.

3.1 Text

The text layer, the first of the data layers, is the XML representation of the legal text. It is the base layer on top of which all the other layers are developed. As discussed in the previous sections, the text layer only adds XML tags to the existing text.

The loose structure adopted by Akoma Ntoso, technically called *mixed content*, contrasts with the more rigid approach used by the first generation of XML standards for legal documents (e.g. EnAct or Formex [10]) which favored an organized structure where each legal text was treated like a database record. While

```
<speech id="sub2-spe02">
    <p>Mr. Opare-Hammond:
    Mr. Speaker, page 4 has a repetition of the numbers
    25 to 47. I do not know whether it was a typographical
    error or from the printing. It needs to be corrected.</p>
</speech>
```

Fig. 1. An example of markup at the *text* layer in a debate of Ghana

database-oriented documents are easier to process in a computer environment, mixed content documents are a better choice when working with already-existing texts, a situation that happens with real-life legal resources and that will keep on happening in the foreseeable future.

3.2 Structure

The structure layer, the second of the data layers, gives roles to the blocks and fragments of the text: anonymous blocks thus become articles or clauses or simple blocks. These associations organize the text in a (often hierarchical) structure that is used to organize the content, provide a reasonable interpretation and even a base for the addresses used in the interpretation of the legal text in the metadata layer, both of the current document and of other documents. Akoma Ntoso defines a set of common section names (for acts they include: part, chapter, tome, book, paragraph, article, clause) but does not impose a rigid structure on the way they can be combined so that they can be used differently in different law systems.

```
<subsection id="sec4-sub2">
    <num>(2)</num>
    <content>
    <p>The appointment of an honorary game warden-</p>
    <list id="sec4-sub2-lst1">
        <item id="sec4-sub2-itma">
            <num>(a)</num>
            <p>shall be notified in the Gazette;</p>
        </item>
        <item id="sec4-sub2-itmb">
            <num>(b)</num>
            <p>shall be effective unless sooner revoked by the
            Director, for a period of three years; and</p>
        </item>
        [...]
```

Fig. 2. An example of markup at the *structure* layer in an act

4 The Editorial Layer

The Akoma Ntoso metadata layer is a collection of pieces of legal knowledge that can be added onto a legal text as the personal interpretation of the written text, for example the analysis of the reasoning being performed by the judge while writing a judgment or the explicit consequences of the text of an amendment over an act. These pieces of legal knowledge by their nature are often subjective and dependent on one's interpretation. Instead of forcing a single interpretation for each legal document, Akoma Ntoso allows multiple, and even contrasting, interpretations to be expressed in the same document, and associates a different actor to each of them. These interpretations of the underlying text form the groundwork upon which semantic technologies can make inferences (as discussed in Section 5).

4.1 Different Kinds of Information

The metadata layer allows agents to provide different kinds of information over the legal text. The following are examples of the information that can be added to Akoma Ntoso.

Reference disambiguation the `references` section links pieces of text to ontological entities. The usefulness of this information is twofold. First, conflicts between ambiguous phrases are resolved: for instance, in a sentence of a speech the text "Speaker" may be related to the TLCRole `/ontology/roles/gha/speaker` while in another sentence the same text "Speaker" may refer to a specific TLCPerson that is in charge as speaker in the specific time when the debate was held: `/ontology/persons/gha/parliament/JohnSmith`.

```
<references>
    <TLCRole id="speaker" showAs="Speaker"
        href="/ontology/roles/gha/speaker"/>
    <TLCPerson id="smith" showAs="Mr. Smith"
        href="/ontology/persons/gha/parliament/JohnSmith"/>
</references>
[...]
<speech id="sub2-spe01" by="smith" as="speaker">
    <from>Mr. Speaker</from>
    <p>Order! Order! Hon. Members, we shall take item 2 -- Correction
        of Votes and Proceedings. Page 1... page 4</p>
</speech>
```

Fig. 3. Disambiguation of different meanings of the word "Speaker"

Additionally, different spellings found in the text are consolidated in a single entity; in a court judgment, phrases like "Ms. Poliey", "Judge Poliey" and "Her Honour" can all be linked to the same TLCPerson `/ontology/Person/Poliey.1954`.

Legal analysis the `analysis` section provides information about many legal aspects that can be inferred by a legal expert when interpreting the text. An example is the interpretation of the effects of an amendment in an amendment act.

```
<textualMod type="substitution" id="am5">
    <source href="#sec4-sub1-itma"/>
    <destination href="/ke/act/1997-08-22/3/main#sec34-sub2-itma"/>
    <old href="#mod10-qtd1"/>
    <new href="#mod10-qtd2"/>
</textualMod>
```

Fig. 4. An example of amendment analysis

Another example is the identification of the role played by citations of precedents in the judgment argumentation of a judge (e.g. the application of a rule of law of a precedent, overriding a previous rule, etc.)

```
<judicial>
    <result type="deny"/>
    <supports id="jdc01">
        <source href="#ref01"/>
        <destination href="/gb/judgement/1829/QB273/eng@/main.xml"/>
    </supports>
</judicial>
```

Fig. 5. An example of judicial analysis on the outcome of a trial

Work identification the `identification` section classifies the document using the FRBR [8] conceptual model. This classification is used to inform the semantic tools that the document is the manifestation (in the FRBR sense) of a certain abstract work, so that they can distinguish between different versions of the same work. A more detailed account of FRBR usage in Akoma Ntoso can be found in [11].

In addition to the shown kinds of metadata, there are other types of metadata currently defined (e.g. `lifecycle` and `workflow` for tracking the events affecting the document) and other are being added as Akoma Ntoso extends to reach more and more types of analysis of the legal text.

4.2 Multiple Interpretations

All the information gathered in the metadata layer is derived from the legal text (using the data layers) though subjective reasoning. Many different interpretation can arise over the same legal text from different legal experts. Take, for instance, the following sentence: "*the subsection 3 of the section 42 states a modification of the section 44 of the same act*". Two different actors OCSA and CIRSFID may disagree on the interpretation of that sentence: OCSA sees this modification as an authentic interpretation, CIRSFID sees it as a derogation. From a legal point of view, the two types of modification produce different effects: the authentic interpretation is applied *ex-tunc* (since the beginning), while the exception is a derogation of a norm under some conditional. Akoma Ntoso allows both interpretations to coexists in the same document, even if they are in contrast.

The Akoma Ntoso XML representation of these two different interpretations would be as shown in the following figure.

```
<analysis source="#ocsa">
    <activeModifications>
        <meaningMod type="authenticInterpretation" id="am1">
            <source href="#sec42-sub3"/>
            <destination href="#sec44"/>
        </meaningMod>
    </activeModifications>
</analysis>
```

Fig. 6. XML representation of two different interpretations of an amendment

```
<analysis source="#ocsa">
    <activeModifications>
        <meaningMod type="authenticInterpretation" id="am1">
            <source href="#sec42-sub3"/>
            <destination href="#sec44"/>
        </meaningMod>
    </activeModifications>
</analysis>
```

Fig. 6. (*continued*)

5 Semantic Technologies and Reasoning over Akoma Ntoso Documents

Currently, there are interesting developments in the area of legal knowledge representation and manipulation. Akoma Ntoso documents, with their rich metadata layer, can serve as the basis upon which various tools can work on. For example, representations expressed at the metadata layer can be used to generate a legal ontology to be used by legal rule modeling technologies like RuleML [7] or the more specialized LKIF [6].

Akoma Ntoso documents are not tied to a particular semantic technology. The current format is very loose and permits the conversion of information into more specific formats (like RDF [3] or OWL [18]). This strategy warrants that semantic technologies of the future decades will be able to convert Akoma Ntoso documents into their own format without going through what, by then, will be seen as ancient formats.

5.1 Semantically Anonymous Entities

Akoma Ntoso implicitly defines an ontological structure for representing metadata that is grounded in a basic set of concepts called *Top Level Classes* (TLC). The word *implicitly* is used because, on purpose, there is no implemented, exhaustive and shared ontology that defines these classes and the relation among them: what exists is a sort of guideline that allows users (especially producers) of Akoma Ntoso documents to develop their own ontology according to their particular needs.

TLCs, even if represented by a clear label and a particular URI, have neither formal (logically defined) nor informal (written in natural language) semantics. The meaning beyond the text of a label of a TLC X does not give implicitly a meaning to X: it is just a label. Technically speaking, Akoma Ntoso do not define classes of a particular ontology but only a naming convention based on URIs and labels that can be used to express particular classes defined in a separate ontology.

This assumption is needed to allow a great degree of flexibility in what can be expressed in the metadata layer of Akoma Ntoso documents, in order to adapt any legal document to any ontological representation of concepts. It is the duty of a third party (e.g. the document creator or the document users) to associate a

clear and formal semantics to each class using a specific formalism (e.g. OWL). This semantical anonymity is an important feature that allows Akoma Ntoso to maintain documents understandable and consumable independently from the passing of time: future toolmakers ("*The 'future toolmaker' is 10 years old now.*" [17]) will have clues about the intended meaning of a marker even in the unfortunate case the formal ontology is no longer available.

Akoma Ntoso makes ten different and disjoint TLCs available to document creators in order to identify individual entities present in the document: Person (`/ontology/Person`), Organization (`/ontology/Organization`), Concept (`/ontology/Concept`), Object (`/ontology/Object`), Event (`/ontology/Event`), Place (`/ontology/Place`), Process (`/ontology/Process`), Role (`/ontology/Role`), Term (`/ontology/Term`), Reference (`/ontology/Reference`).

Using these TLCs and the canonical FRBR classes *Work*, *Expression*, *Manifestation* and *Item*, it is possible to store complex assertions *in* Akoma Ntoso documents and *about* Akoma Ntoso documents. It must be underlined that Akoma Ntoso does not aim at describing neither objective facts nor personal opinions about such facts according to the author of the document. Rather, it allows the expression of an interpretation that is due, in a precise moment, to a particular actor who refers to statements that can be found in the published legal text.

A fundamental step towards being able to reason over an Akoma Ntoso document is to have a mechanism for describing items (actors, legal documents, properties, concepts, etc) that are involved in the assertions (making assertions or being the subject of an assertion). Using the `references` mechanism described in Section 4 it is possible to relate each of these described items to a TLC, making it will possible to assert facts about that document, implicitly producing a data model for its semantic data.

5.2 Ontology URI Naming Conversion

All the items in an Akoma Ntoso document can belong to a particular TLC simply specifying an URI that must follow a particular naming convention [16]. The following example shows a list of URI references, all pointing to the same entity representing a judge.

Even if a human may interpret some of these URIs as references to different entities, from an ontological point of view all these three URIs state the same thing: there exists a resource whose identifier is `lewanika` and that instance belongs to the top level class `Person`. Moreover, all these URI references point exactly to the same resource, regardless of the actual ontology used.

```
/ontology/Person/lewanika
/ontology/Person/judges/lewanika
/ontology/Person/za/judges/lewanika
```

Fig. 7. Different URIs for the same entity

The Akoma Ntoso naming convention contains few precise rules:

- the last fragment of the URI (`lewanika` in this above example) is the identifier of the instance being referred to;
- the first two fragments of the URI (`/ontology/<TLC name>`) specify the TLC the instance belongs to;
- the middle URI fragments (`za/judges/`), when they are present, provide evocative information for the human reader and for the systems that cannot access the underlying ontology used by the document. They suggest, in fact, a clear interpretation from a human perspective, e.g., that Lewanika is a South African person holding the role of judge. Since Akoma Ntoso does not force any given set of properties on the top level classes, the responsibility to choose which, and whether, additional fragments should be added lies with the author of the document.

Taking into account the implicit semantics given to each URI by the Akoma Ntoso naming convention, it is possible to query an Akoma Ntoso-compliant legal XML document using XPath [1], without relying on external ontologies. The following excerpt shows some references to various resources.

```
<akomaNtoso xmlns="http://www.akomantoso.org/1.0">
    <references source="#cirsfid">
        <TLCOrganization id="parliament"
            showAs="Parliament of Kenya"
            href="/ontology/Organization/ke/parliament" />
        <TLCOrganization id="cirfid" showAs="CIRSFID"
            href="/ontology/Organization/cirfid" />
        <TLCPerson id="fv" showAs="Fabio Vitali"
            href="/ontology/Person/fv" />
        <TLCRole id="author" showAs="Author"
            href="/ontology/Roles/author" />
        <TLCRole id="jurist" showAs="Jurist"
            href="/ontology/Roles/jurist" />
        <TLCRole id="editor" showAs="Editor"
            href="/ontology/Roles/editor" />
    </references>
    [...]
```

Fig. 8. `references` section for a Kenyan act

Through XPath, it is possible to perform queries based on the semantic data that is present in the document. For example, the following queries could be performed on the data shown in the above excerpt:

- what roles have been involved in the generation of the legal document,
  `//references/element()[matches(@href,'/Roles/')]`;
- which Kenyan organizations are referred to in the legal document,
  `//references/element()[matches(@href,'/Organization/.*/?ke/')]`.

The naming convention used by Akoma Ntoso, together with the presence of additional middle URI fragments, allows the semantic data available in the document to be queried, even in sophisticated ways, without requiring access to any ontology. When the underlying ontology is available, the additional information provided by the middle URI fragments can be discarded and more complex

queries, based on deductive elements such as those gathered through the use of reasoners, can be performed. The optional middle URI fragments fulfill, thus, two different tasks: on the one hand they provide clues to the human readers who do not have access to the underlying ontologies, on the other hand they allow semantic data about the referenced entities to be carried also in the document itself and not only in external knowledge bases.

5.3 Transformation into a Proper Semantic Data Model Format

In order to be able to carry out even more queries on Akoma Ntoso documents, it is necessary to transform each document into a proper knowledge base based on a complete ontological model, which means binding the abstract Akoma Ntoso classes and instances to more concrete representations that the current semantic tools can work with. Akoma Ntoso does not specify a particular format to use: it is a precise design choice to allow users to choose their favorite formats and tools, a choice that the users will take on the base of current standards, their knowledge and other technical constraints.

An example of a concrete data model format that fits the current technology scenario is RDF [3]. One way to convert an XML document into a set of RDF statements is to use a GRDDL transformation. GRDDL (Gleaning Resource Descriptions from Dialects of Languages) [4] is a way to glean assertions from XML documents. It is a W3C Recommendation that explains how to extract semantic data from XML documents using a combination of one or more XSLT stylesheets [9], in order to obtain a new document containing those data expressed by RDF statements. Note that this particular mechanism is also suggested in the current CEN Metalex proposal [2]:

> If metadata is not available as RDFa[1], it must be systematically translatable from the custom format to RDF. The translation from a proprietary metadata format to RDF must be publicly available following the Gleaning Resource Descriptions from Dialects of Languages (GRDDL) specification.

In order to use GRDDL, the Akoma Ntoso document must specify the GRDDL namespace and the references to the XSLT files used to perform the extraction. These declarations are added as attributes to the document's root element as shown in the following piece of code:

```
<akomaNtoso xmlns="http://www.akomantoso.org/1.0"
            xmlns:grddl="http://www.w3.org/2003/g/data-view#"
            grddl:transformation="xslt/fromAkomaNtosoToRDF.xsl">
[...]
</akomaNtoso>
```

Fig. 9. GRDDL attributes for an Akoma Ntoso document

[1] RDFa is technique used to embed RDF statements in XHTML documents.

Those declarations in an Akoma Ntoso document inform the document readers (both humans and computer tools) that it is possible to glean all the assertions embedded in the document itself using the XSLT stylesheet specified by the attribute `transformation` to transform the document into an RDF document.

Unfortunately, RDF statements are not flexible enough to fit the needs of Akoma Ntoso assertions: while RDF define assertions as subject-predicate-object triples of resources, Akoma Ntoso uses octuples to assert facts. The general schema employed by Akoma Ntoso documents to express assertions is:

> the **author of a manifestation** asserts on the **manifestation date** that **the author of the corresponding expression** asserts on the **expression date** in a particular **context** that **subject** does **predicate** on **object**.

The following example (extracted from the same Akoma Ntoso document already shown in the examples of Section 5.2), embeds some of such assertions.

```
[...]
<analysis source="#cirfid">
    <textualMod type="substitution" id="am5">
        <source href="#art4-cla1-itma" />
        <destination
            href="/ke/act/1997-08-22/3/eng/main#art34-cla2-itma" />
        <old href="#mod10-qtd1" />
        <new href="#mod10-qtd2" />
    </textualMod>
[...]
<FRBRExpression>
    <FRBRthis value="/ke/act/2003-12-10/8/eng@" />
    <FRBRuri value="/ke/act/2003-12-10/8/eng@" />
    <FRBRdate date="2003-12-10" name="Generation" />
    <FRBRauthor href="#parliament" as="#author" />
</FRBRExpression>
<FRBRManifestation>
    <FRBRthis value="/ke/act/2003-12-10/8/eng.akn" />
    <FRBRuri value="/ke/act/2003-12-10/8/eng.akn" />
    <FRBRdate date="2007-07-27" name="Generation" />
    <FRBRauthor href="#cirfid" as="#editor" />
    <FRBRauthor href="#fv" as="#editor" />
</FRBRManifestation>
[...]
```

Fig. 10. Analysis and FRBR records for an Akoma Ntoso document

One of the assertion contained in the above extract is "*CIRSFID and Fabio Vitali assert on 27th July, 2007 that the Parliament of Kenya asserts on 10th December, 2003 in the corresponding expression that the fifth text modification is of type substitution*". As already said, this assertion must be expressed using the format *(marker, marking_time, expression_author, content_time, context, subject, predicate, object)*; in this instance the corresponding octuple is *(CIRSFID and Fabio Vitali, 2007-07-27, Parliament of Kenya, 2003-12-10, expression, fifth text modification, is of type, substitution)*.

While RDF lacks a native representation of octuples like those employed to describe Akoma Ntoso metadata, it is possible to use *reification* to express any

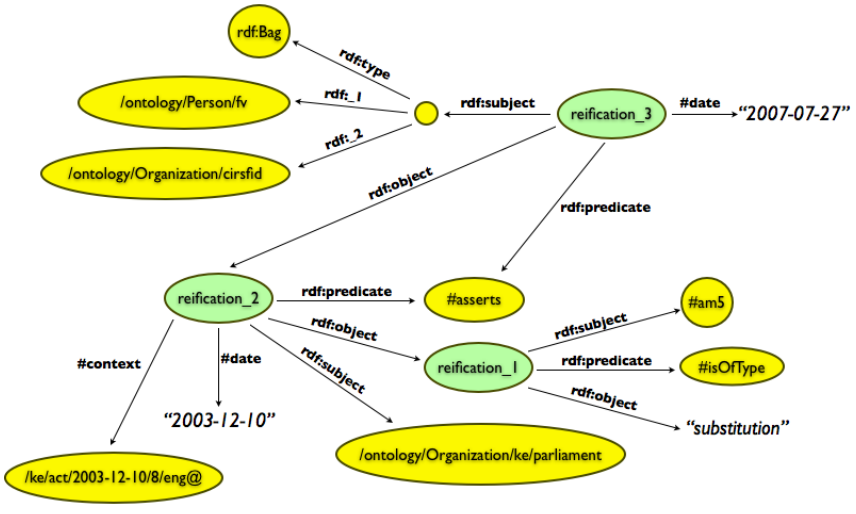

Fig. 11. A possible RDF representation of the octuple *(CIRSFID and Fabio Vitali, 2007-07-27, Parliament of Kenya, 2003-12-10, expression, fifth text modification, is of type, substitution)*

octuple through RDF statements. Using the reification mechanism, it is possible to associate a particular identifier to any RDF statement and then give it the role of subject or object in other statements. Figure 11 shows how the previous octuple can be represented through reified RDF statements (in the figure the oval shapes represent RDF resources, the values in quotation marks are strings and the base for all the relative URIs is the manifestation).

It is clear that there is not a unique way to express these reifications: it depends on how the XSLT stylesheet specified through GRDDL extract those data.

5.4 No Default Formal Ontology

To have an RDF model of the semantic data on an Akoma Ntoso document could be useful, for instance, to share these data among different organizations using a common format. Moreover, one of the most appreciable advantages in using Semantic Web technologies, such as RDF and OWL, is the possibility to infer new data in an automatic way, for example processing the original data through reasoners.

The choice to maintain Akoma Ntoso free from any semantic structure constraint was born out of the desire to guarantee that any user could independently decide which particular ontological model they want to use and which data in an Akoma Ntoso document they are interested in. Independence from a particular technology is a key point for documents that are supposed to last, without modifications, for decades.

In any case, is it easy to convert an Akoma Ntoso document in one of the formats currently available. For example, FRBR data gleaned from a document

```
<FRBRExpression>
    <FRBRthis value="/ke/act/2003-12-10/8/eng@"/>
    <FRBRuri value="/ke/act/2003-12-10/8/eng@"/>
    <FRBRdate date="2003-12-10" name="Generation"/>
    <FRBRauthor href="#parliament" as="#author"/>
</FRBRExpression>
<FRBRManifestation>
    <FRBRuri value="/ke/act/2003-12-10/8/eng.akn"/>
</FRBRManifestation>
[...]
<TLCOrganization id="parliament" showAs="Parliament of Kenya"
    href="/ontology/Organization/ke/parliament"/>
<TLCRole id="author" showAs="Author"
    href="/ontology/Roles/author"/>
```

Fig. 12. Statements in an Akoma Ntoso document

could be linked, via assertions, to an OWL-implemented FRBR ontology. Such assertions could be generated, for example, using an additional XSLT stylesheet linked via the GRDDL mechanism. The following excerpt contains various statements about the legal documents from which it has been extracted, including statements about its FRBR classifications.

Using GRDDL and an appropriate XSLT stylesheet, the following RDF statements[2] concerning the FRBR metadata can be obtained.

```
@prefix za: </ke/act/2003-12-10/8/> .
@prefix an: </ontology/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

za:eng@
    a an:FRBRExpression ;
    an:hasDate "2003-12-10"^^xsd:date ;
    an:hasAuthor an:Organization/ke/parliament .

an:Organization/ke/parliament a an:Roles/author .
```

Fig. 13. RDF extracted from the statements in Figure 12

It should be noted that these are plain RDF statements, unrelated to any ontological structure. To address particular demands (e.g. reasoning, data sharing) all the instances, classes and properties must be associated to well-defined ontologies. The following code example shows the FRBR ontological data extracted from the previous excerpt associated to some external ontologies.

```
@prefix frbr: <http://purl.org/vocab/frbr/core#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .

an:FRBRExpression owl:sameAs frbr:Expression .
za:eng@ frbr:realizer an:person/Organization/ke/parliament .
an:hasDate owl:sameAs dc:date .
```

Fig. 14. Other RDF statements extracted from Figure 12

[2] All the RDF examples will be illustrated using the Turtle syntax.

Note that, even if OWL offers the possibility to define semantics in order to infer automatically new data, OWL is not able to make reified RDF-like statement. To represent in OWL the Akoma Ntoso octuple statement illustrated previously, peculiar approaches have to be used. The NeOn project [15] has developed many elegant and logically-sound techniques to overcome the limitations of OWL; they have been collected under the name of Ontology Design Pattern [14]. The Ontology Design Patterns are a set of guidelines that help the design process of ontologies; each pattern codifies one or more best practices of the ontology-design realm. The following examples will use and briefly introduce some of these patterns; a proper description of each used pattern is out of the scope of our paper.

The most straightforward way to handle complex assertions, such as the octuples used by Akoma Ntoso, in OWL is to use the *n-ary participation* pattern. The n-ary participation pattern is used to describe events happening in a certain moment and that involve one or more entities. This pattern can also be used to simulate RDF reifications in OWL. Figure 15 shows a graphical representation of the previously shown octuple expressed in OWL using the n-ary participation pattern.

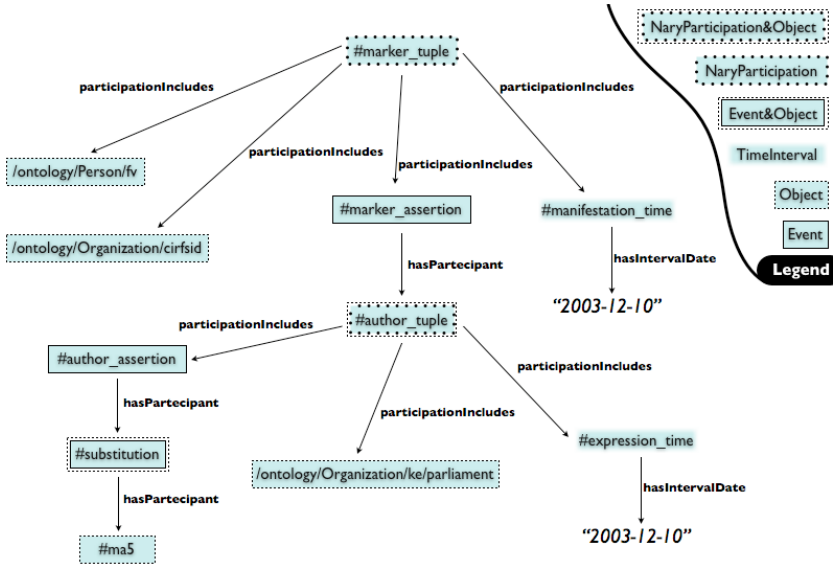

Fig. 15. A possible Akoma Ntoso data extraction into a OWL pattern-based format

Both RDF and OWL offer one or more ways to define the formal semantics of Akoma Ntoso statements. However, none of these techniques can be considered a standard method to express, store and share knowledge like that embodied in Akoma Ntoso documents. While these techniques are fit for today's semantic data exchange, it is not safe to rely on kludges like these (dictated by the current technological constraints) when dealing with legal information that must be preserved for years or decades. For this reason, it is preferable to embed this data within XML documents that use an ad-hoc vocabulary and to convert to

a precise data model only when needed so that it is possible to adapt to the particular needs that are faced in a particular moment.

Another reason to use an ad-hoc XML vocabulary as the base format for Akoma Ntoso semantic data is its readability. Even if RDF and OWL have been developed to define data models, they have been also thought to be machine-readable. For this reason, their simplest serialization is not particularly comprehensible to humans; since legal documents are primarily written by human beings for other human beings, it is clear that expressing such information in a domain-specific XML format ends up being much more understandable by humans than a complex data model expressed in RDF or OWL.

The final goal of Akoma Ntoso is to create legal documents easily understandable and completely free from any unneeded constraint. For the reasons illustrated above, we think XML is the best format in which to represent these kind of documents.

6 Conclusions

Akoma Ntoso has been designed as a format for legal documents that must be read and understood for decades and at the same time be useful to computer reasoners. In order to balance clearness, fidelity to the authentic legal text, interoperability and usability with semantical tools, Akoma Ntoso made some clear choices. In this paper we showed how these choices fit the stated goals: using XML as the base mark-up format and having clearly separated layers allow documents to be preserved without modifications to the endorsed texts. Additionally, multiple agents can provide their own interpretations of certain legal aspects of the given legal text. Moreover, computer reasoners can extract semantic information from Akoma Ntoso document and reason over them.

The approach used by Akoma Ntoso allows the development of systems that use advanced formal logic modeling frameworks, like non-monotonic or non-deductive logics in order to apply sophisticated legal reasoning theories, more suitable for the complex legal domain, filling the gap between all the semantic web layers while preserving interdependency and expressiveness.

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Prescriptive and Descriptive Obligations in Dynamic Epistemic Deontic Logic

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Abstract. Normative sentences can be used to change or to describe the normative system, known as prescriptive and descriptive obligations respectively. In applications of deontic logic it is important to distinguish these two uses of normative sentences. In this paper we show how they can be distinguished and analysed in a Dynamic Epistemic Deontic Logic.

1 Introduction

Alchourrón and Bulygin [1,2] discuss the *possibility* of a logic of norms, which they distinguish from the logic of normative propositions. Roughly, the distinction between norms and normative propositions is that the former are prescriptive whereas the latter are descriptive. In the second sense, the sentence 'it is obligatory to keep right on the streets' is a description of the fact that a certain normative system contains an obligation to keep right on the streets. In the first sense this statement is the obligation of traffic law itself. This distinction goes back to an old philosophical problem discussed by Von Wright [14,15], who was hesitant to call deontic formulas 'logical truths,' because "it seems to be a matter of extra-logical decision when we shall say that 'there are' or 'are not' such and such norms." Makinson [10] turns this fundamental problem into the central challenge in deontic logic, which led to new developments over the past decade such as deontic update semantics [13], input/output logic [11], imperative based deontic logic [8], and more.

The relevance of the distinction between prescriptive and descriptive obligations, and the related fundamental problem that norms do not have truth values, is not only theoretical and conceptual, but it has important practical implications for normative multi-agent systems. For example, assume that you ask the librarian of your university to get a journal paper available on the Springer web-site. The library has a list of journals published by Springer containing the journals for which the library has free access (either a journal of this list is on open access or the university subscribed to it). This list is updated every month but the librarian did not check it for some time, and so he does not know if the

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requested journal is on the list, although he should actually know it. He then logs on the journal and tries to download the paper. We consider two kinds of events corresponding to two different uses of obligations.

Descriptive use. The Springer web-site informs the librarian that he should not pay to download any paper of this journal. As a result, the librarian now knows that this journal was on the list of journals for which the library has free access.

Prescriptive use. The Springer web-site refuses to download the file. However, after the librarian make a new contract with Springer, the web-site declares that he should not pay to download any paper of this journal since for the contract the journal is now on free of charge for the library.

As we see in this example, modeling the distinction between prescriptive and descriptive use of norms is useful for designing normative multi-agent systems. In this paper we therefore study the following question:

– How can the distinction between prescriptive and descriptive use of obligation be captured in a dynamic epistemic deontic logic?

We are going to introduce a general and expressive Dynamic Epistemic Deontic Logic combining a simplified version of Castañeda's deontic logic [6] with a dynamic epistemic logic. This logic can express the conditional character of norms, study the interaction between epistemic and deontic notions, and model norm dynamics. These three features are fundamental to normative systems (and the representation of legal systems), and also to multi-agent systems as far as those are intended to model real life. First, in normative systems it is necessary to express realistic regulations, which have a conditional character. Secondly, communication is an essential part of normative and multi-agent systems, and this raises the issue of what it is permitted, prohibited or obliged to know by agents, for example, when modelling privacy regulations. Thirdly, normative multi-agent systems have a dynamic character, as witnessed by the second definition of normative multi-agent system provided in [5]. These last two issues, communication and dynamics are both useful for distinguishing when existing norms are communicated from the case where a norm is actually put into existence by a declaration, i.e., Alchourrón's distinction between the descriptive and prescriptive use of norms.

The paper is structured as follow. In Section 2 we introduce an epistemic deontic logic. In Section 3 we extend the logic by introducing update operators which change beliefs and norms, and in Section 4 we show how the distinction between descriptive and prescriptive norms can be made in our logic if we map this distinction to the context of agent communication.

2 Epistemic Deontic Logic (EDL)

2.1 Propositions vs. Practitions

Because of its clear and natural distinction between propositions and practitions and its modal-like character, the well known deontic logic of Castañeda [6]

lends itself very well to the introduction of an epistemic logic. Starting from a linguistic analysis, the insight of Castañeda's well known approach to deontic logic is to acknowledge the grammatical duality of expressions depending whether they are within or without the scope of deontic operators [6]. This leads him formally to introduce two sets of propositional letters: Φ^{ϕ} called propositions which cannot *alone* be the foci of deontic operators, unlike Φ^{α} called practitions. The former are usually expressed grammatically in the indicative form and the latter are usually expressed grammatically in the infinitive/subjunctive form. For example, "the librarian does not pay to access a journal" in the indicative form is a proposition, but the same sentence in "*it is obligatory* for the librarian not to pay to access a journal" in subjunctive/infinitive form is a practition. He then defines more general propositions $\mathcal{L}^{\phi}_{DL}$ and practitions $\mathcal{L}^{\alpha}_{DL}$ as follows.

$$\mathcal{L}^{\phi}_{DL} : \phi ::= p \mid \phi \wedge \phi \mid \neg\phi \mid O\alpha$$
$$\mathcal{L}^{\alpha}_{DL} : \alpha ::= \beta \mid \neg\alpha \mid \alpha \wedge \alpha \mid \alpha \wedge \phi \mid \phi \wedge \alpha$$

where β ranges over Φ^{α} and p over Φ^{ϕ}. We define the language $\mathcal{L}_{DL} = \mathcal{L}^{\phi}_{DL} \cup \mathcal{L}^{\alpha}_{DL}$, whose formulas are generally denoted ϕ^*. In the sequel, $P\alpha$ is an abbreviation for $\neg O \neg \alpha$. $O\alpha$ reads 'α is obligatory' and $P\alpha$ reads 'α is permitted'.

We now propose a semantics based on modal logic which is equivalent to the one of Castañeda, in the sense that any 'Castañeda'-model [6] can be transformed into a DL-model satisfying the same formulas, and vice versa.

Definition 1. *A DL-*model *M is a tuple $M = (W, D, V)$ where W is a non-empty set of possible worlds, D is a serial*[1] *accessibility relation on W and V is a valuation which assigns to each propositional letter $p^* \in \Phi^{\phi} \cup \Phi^{\alpha}$ a subset of W, such that for all $w \in W$, all $p \in \Phi^{\phi}$,*

$$V(p) \cap (D(w) \cup \{w\}) = D(w) \cup \{w\} \text{ or } \emptyset \qquad (*)$$

Let $M = (W, D, V)$ be a DL-model, $w \in W$ and $\phi^* \in \mathcal{L}_{DL}$, (M, w) is called a pointed DL-model. We define $M, w \models \phi^*$ inductively as follows.

$$\begin{array}{lll} M, w \models p^* & \textit{iff} & w \in V(p^*) \\ M, w \models \phi^* \wedge \psi^* & \textit{iff} & M, w \models \phi^* \textit{ and } M, w \models \psi^* \\ M, w \models \neg\phi^* & \textit{iff} & \textit{not } M, w \models \phi^* \\ M, w \models O\alpha & \textit{iff} & \textit{for all } v \in D(w),\ M, v \models \alpha. \end{array}$$

Condition $(*)$ above ensures formally that conditional norms of the form "it is obligatory that if the librarian knows that a journal is in the list" $O(p \rightarrow \alpha)$ are equivalent to "if the librarian knows that journal is on the free access list then he should not pay" $(p \rightarrow O\alpha)$:

$$\models O(p \rightarrow \alpha) \leftrightarrow (p \rightarrow O\alpha).$$

More generally, condition $(*)$ allows us to show that any deontic formula with practition(s) $\mathcal{L}^{\alpha}_{DL}$ involving proposition(s) is actually equivalent to a deontic formula with 'pure' practitions $\mathcal{L}^{\alpha'}_{DL}$, i.e. a formula of $\mathcal{L}'_{DL} = \mathcal{L}^{\phi}_{DL} \cup \mathcal{L}^{\alpha'}_{DL}$:

[1] A relation R is serial iff $R(w) \neq \emptyset$ for all $w \in W$.

$$\mathcal{L}'^{\alpha'}_{DL} : \alpha ::= \beta \mid \neg\alpha \mid \alpha \wedge \alpha$$

where β ranges over Φ^α.

Proposition 1. *Let $\phi \in \mathcal{L}_{DL}$. There is $\phi' \in \mathcal{L}'_{DL}$ such that $\models \phi \leftrightarrow \phi'$.*

In other words, instead of dealing with formulas of $\mathcal{L}_{DL}$, we could equivalently deal only with formulas of $\mathcal{L}'_{DL}$.

2.2 Adding Beliefs

Just as practitions are the foci of deontic operators, propositions are dually the foci of knowledge operators, as pointed out by Castañeda [7]. An expression ϕ in the scope of a belief operator $B\phi$ is always in the indicative form and never in the subjunctive/infinitive form, even if $B\phi$ is in the scope of a deontic operator O. We extend Castañeda [7]'s intuition to the context of epistemic permissions and obligations. In a deontic setting the reading of the term knowledge or belief can also be twofold: either as a proposition or as a practition. On the one hand, in the sentence "it is obligatory that the librarian *knows* / for the librarian *to know* that he should not pay" the verb 'to know' is the focus of a deontic operator and is in the subjunctive/infinitive form. On the other hand, the sentence "The librarian *knows* that he should not pay' alone describes a circumstance and the interpretation of the verb 'to know' in the indicative form matches the one usually studied in epistemic logic. The former use of the term knowledge within the scope of a deontic operator is not studied in epistemic logic. For these reasons we enrich the language $\mathcal{L}_{DL}$ with two knowledge modalities, one for propositions and the other for practitions. This yields the following language $\mathcal{L}_{EDL} = \mathcal{L}^\phi_{EDL} \cup \mathcal{L}^\alpha_{EDL}$ whose formulas are generally denoted ϕ^*.

$$\mathcal{L}^\phi_{EDL} : \phi ::= p \mid \neg\phi \mid \phi \wedge \phi \mid B\phi \mid O\alpha$$
$$\mathcal{L}^\alpha_{EDL} : \alpha ::= \beta \mid \neg\alpha \mid \alpha \wedge \alpha \mid \alpha \wedge \phi \mid \phi \wedge \alpha \mid B'\phi$$

where p ranges over Φ^ϕ and β over Φ^α. As argued above we do not allow formulas of the form $B\alpha$ or $B'\alpha$ because they are linguistically meaningless, which is actually in line with Castañeda [7]. $B\phi$ reads 'the agent believes ϕ'.

Definition 2. *An EDL-*model *M is a tuple $M = (W, D, R, R', V)$ where W is a non-empty set of possible worlds, R, R' and D are accessibility relations on W, D being serial, and V is a valuation such that:*

> *for all $w \in W$, all $v, v' \in D(w) \cup \{w\}$, (M, v) is RD-bisimilar to (M, v').*[2] *$(**)$*

The truth conditions for B and B' are given by:

$$M, w \models B\phi \quad \textit{iff} \quad \textit{for all } v \in R(w),\ M, v \models \phi$$
$$M, w \models B'\phi \quad \textit{iff} \quad \textit{for all } v \in R'(w),\ M, v \models \phi$$

$M \models \phi$ if for all $w \in W$, $M, w \models \phi$. (M, w) is called a pointed EDL-model.

[2] Two pointed models (M, v) and (M', v') are RD-bisimilar if there is a relation on $W \times W'$ satisfying the base condition for Φ^ϕ and the back and forth conditions for R and D (see Blackburn *et al.* [4] for details).

Note that condition $(**)$ is a generalization of condition $(*)$ to the epistemic setting: the worlds of $D(w) \cup \{w\}$ are not only 'propositionally bisimilar' as in $(*)$, but also 'epistemically (and deontically) bisimilar'. Two worlds being propositionally bisimilar intuitively means that they satisfy the same propositional formulas, and two worlds being epistemically (and deontically) bisimilar intuitively means (in a finite model) that they satisfy the same epistemic (and deontic) formulas (see [4] for details). Therefore, our conditions $(*)$ and $(**)$ somehow intuitively mean that the actual epistemic and propositional context is fixed for a given normative situation (represented by $D(w)$).

We do not assume any logical property for our notion of belief (such as consistency or introspection) because it is not really relevant for the topic of this paper. For the same reason, the operator B stands alternatively for knowledge or for belief.

Just as for $\mathcal{L}_{DL}$, we can show that the language $\mathcal{L}_{EDL}$ is actually 'equivalent' to the language $\mathcal{L}'_{EDL} = \mathcal{L}^{\phi}_{EDL} \cup \mathcal{L}^{\alpha'}_{EDL}$ with 'pure' practitions $\mathcal{L}^{\alpha'}_{EDL}$:

$$\mathcal{L}^{\alpha'}_{EDL} : \alpha ::= \beta \mid \neg\alpha \mid \alpha \wedge \alpha \mid B'\phi$$

Proposition 2. *Let $\phi \in \mathcal{L}_{EDL}$. There is $\phi' \in \mathcal{L}'_{EDL}$ such that $\models \phi \leftrightarrow \phi'$.*

In other words, instead of dealing with formulas of $\mathcal{L}_{EDL}$, we could equivalently deal only with formulas of $\mathcal{L}'_{EDL}$.

Theorem 1. *The semantics of $\mathcal{L}_{EDL}$ is* sound and complete *with respect to the decidable logic L_{EDL} axiomatized as follows:*

A_1	*All propositional tautologies based on $\Phi^{\phi} \cup \Phi^{\alpha}$*
A_2	$\vdash (\phi \to O\alpha) \leftrightarrow O(\phi \to \alpha)$
A_3	$\vdash O\alpha \to \neg O\neg\alpha$
A_4	$\vdash O(\alpha \to \alpha') \to (O\alpha \to O\alpha')$
A_5	$\vdash B^*(\phi^* \to \psi^*) \to (B^*\phi^* \to B^*\psi^*)$
R_1	*If* $\vdash \alpha$ *then* $\vdash O\alpha$
R_2	*If* $\vdash \phi^*$ *then* $\vdash B^*\phi^*$
R_3	*If* $\vdash \phi^* \to \psi^*$ *and* $\vdash \phi^*$ *then* $\vdash \psi^*$

where B^* stands for B or B'.

Note that axioms A_1 to A_4 and rules R_1 and R_3 provide an alternative axiomatization of Castañeda's language $\mathcal{L}_{DL}$.

2.3 Example

Our logic can express conditional norms, like Castañeda's deontic logic does (i.e., $\vdash (\phi \to O\alpha) \leftrightarrow O(\phi \to \alpha)$). Due to its combination of deontic and epistemic notions, it can also express the knowledge-based obligations of Pacuit and Parikh [12]. But because our combination is quite general, we can also express *epistemic norms*.

Example 1 (Journal example). Assume that the librarian does not know whether the journal requested is on the list of journals to which the library has free access ($\neg B\neg JInList \wedge \neg BJInList$). As a matter of fact, according to the library regulations, he should know whether it is a journal to which the library has free access (n_1). Besides, he should also know that if it is a journal for which the library has free access then he should not to pay to download any paper of this journal (n_2). These two epistemic norms are formalized as follows:

$$n_1 = O(B'JInList \vee B'\neg JInList)$$
$$n_2 = OB'(JInList \rightarrow O\neg pay)$$

where $JInList$ stands for 'the Journal requested is *in* the *List* of journals for which the library has free access' and *pay* stands for 'pay Springer to download any paper of the journal'.

This situation is depicted in the EDL-model M of Figure 1, where $JInList$ stands for the proposition 'the journal is in the list of journals for which the library has free access' and *pay* for the practition 'pay Springer to download any paper of the journal'. The dotted arrows correspond to the deontic accessibility relation D and the plain arrows correspond to accessibility relations R and R'. Reflexive arrows are omitted, which means that for all $v \in M$, we have that $v \in R(v)$, $v \in R'(v)$ and $v \in D(v)$. w corresponds to the actual world. We therefore have $M, w \models (\neg BJInList \wedge \neg B\neg JInList) \wedge O(B'JInList \vee B'\neg JInList)$: the librarian does not know whether the requested journal is on the list of journals free of charge for the library (some of the R accessible worlds contain $\neg JInList$). However, he should know whether this is the case (in all D worlds it is possible to access via R' either only worlds where *pay* is true or $\neg pay$ is true. $M, w \models B(JInList \rightarrow O\neg pay) \wedge B(\neg JInList \rightarrow (\neg Opay \wedge \neg O\neg pay))$: the librarian knows that if the journal is in the list then he should not pay to download any paper of the journal (in no world where $JInList$ is true it is possible to access via D a world where *pay* is true) and he knows that if it is not in the list then he might or might not have to pay to download papers of the journal (in each world where $JInList$ is false, it is not possible to access via D worlds where only *pay* or $\neg pay$ is true). For example, because the journal is then on limited access and some papers might be available for free whereas some others might not.

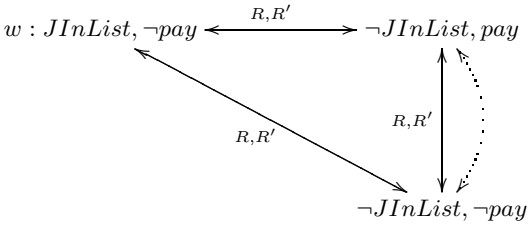

Fig. 1. Journal example

3 Dynamic Epistemic Deontic Logic (DEDL)

3.1 Changing Norms and Beliefs

We now want to add dynamics to the picture by means of communicative acts made to the agent. The content of these communicative acts can affect the situation in two ways: either it affects the epistemic realm (represented in a EDL-model by the relation R) or it affects the normative realm (represented in a EDL-model by the relations R' and D). This leads us to enrich the language $\mathcal{L}_{EDL}$ with two dynamic operators $[\phi!]$ and $[\phi^*!!]$, yielding the language $\mathcal{L}_{DEDL}$, whose formulas are generally denoted ϕ^*:

$$\mathcal{L}^{\phi}_{DEDL} : \phi ::= p \mid \neg\phi \mid \phi \wedge \phi \mid B\phi \mid O\alpha \mid [\phi!]\phi \mid [\phi^*!!]\phi$$
$$\mathcal{L}^{\alpha}_{DEDL} : \alpha ::= \beta \mid \neg\alpha \mid \alpha \wedge \alpha \mid \alpha \wedge \phi \mid \phi \wedge \alpha \mid B'\phi \mid [\phi!]\alpha \mid [\phi^*!!]\alpha$$

where p ranges over Φ^{ϕ}, β over Φ^{α}.

$[\psi!]\phi$ reads 'after learning ψ, ϕ holds', and $[\psi^*!!]\phi$ reads 'after the promulgation/enforcement of ψ^*, ϕ holds'. Note that it is possible that $\psi^* \in \mathcal{L}^{\phi}_{EDL}$ because propositions can affect the normative realm via R'. The semantics of these dynamic operators is inspired by Kooi [9] and defined as follows.

Definition 3. *Let $M = (W, D, R, R', V)$ be an EDL-model, $\phi \in \mathcal{L}^{\phi}_{EDL}$ and $\psi^* \in \mathcal{L}_{EDL}$. We define the EDL-models $M * \psi!$ and $M * \psi^*!!$ as follows.*

- $M * \psi! = (W, D, R!, R', V)$ *where for all* $w \in W$,
  $R!(w) = R(w) \cap ||\psi||$.
- $M * \psi^*!! = (W, D!!, R, R'!!, V)$ *where for all* $w \in W$,
  $$R'!!(w) = \begin{cases} R'(w) \cap ||\psi^*|| & \text{if } \psi^* \in \mathcal{L}^{\phi}_{EDL} \\ R'(w) & \text{otherwise.} \end{cases}$$
  $$D!!(w) = \begin{cases} D(w) \cap ||\psi^*|| & \text{if } \psi^* \in \mathcal{L}^{\alpha}_{EDL} \text{ and } M, w \models P\psi^* \\ D(w) & \text{otherwise.} \end{cases}$$

where $||\phi^*|| = \{v \in M \mid M, v \models \phi^*\}$. The truth conditions:

$$M, w \models [\psi!]\phi^* \quad \text{iff} \quad M * \psi!, w \models \phi^*$$
$$M, w \models [\psi^*!!]\phi^* \quad \text{iff} \quad M * \psi^*!!, w \models \phi^*.$$

Just as for $\mathcal{L}_{EDL}$ and $\mathcal{L}_{DL}$, we can show that the language $\mathcal{L}_{DEDL}$ is actually 'equivalent' to the language $\mathcal{L}'_{DEDL} = \mathcal{L}^{\phi}_{DEDL} \cup \mathcal{L}^{\alpha'}_{DEDL}$ with 'pure' practitions $\mathcal{L}^{\alpha'}_{DEDL}$:

$$\mathcal{L}^{\alpha'}_{DEDL} : \alpha ::= \beta \mid \neg\alpha \mid \alpha \wedge \alpha \mid B'\phi \mid [\phi!]\alpha \mid [\phi^*!!]\alpha$$

where p ranges over Φ^{ϕ} and β over Φ^{α}.

Proposition 3. *Let $\phi \in \mathcal{L}_{DEDL}$. There is $\phi' \in \mathcal{L}'_{DEDL}$ such that $\models \phi \leftrightarrow \phi'$.*

In other words, instead of dealing with formulas of $\mathcal{L}_{DEDL}$, we could equivalently deal only with formulas of $\mathcal{L}'_{DEDL}$.

3.2 Examples

Changing beliefs: $[\phi!]$. Our logic is a dynamic epistemic logic, which allows to express communicative acts changing the beliefs of agents.

Example 2. Let us take up Example 1. A colleague of the librarian informs him that the journal is actually on the list of journals free of charge for the library because the university subscribed to this journal.

$$M, w \models JInList \wedge [JInList!]BJInList$$

After the communicative act the librarian knows that the journal is on the list of journals for which the library has free access. The resulting situation is depicted in Figure 2. To evaluate the formula $[JInList!]BJInList$ in M, w it is necessary to move to $M * JInList!$ (illustrated in Figure 2) and evaluate $BJInList$. All worlds where $JInList$ is false are not accessible anymore via the R relation. In particular, from the real world w only itself is accessible via R.

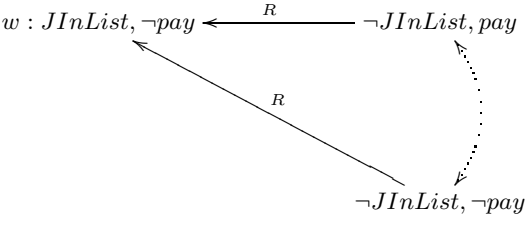

Fig. 2. Update by $JInList!$

Changing norms: $[\phi!!]$. Our logic is a dynamic deontic logic, which allows to express communicative acts changing the norms.

Example 3. Let us take up Example 1 again. The Springer web-site declares that this journal is now free of charge for the library since today to fulfil the newly stipulated contract. This event can be modeled by the communicative act $[\neg pay!!]$:

$$M, w \models [\neg pay!!](O\neg pay \wedge BO\neg pay)$$

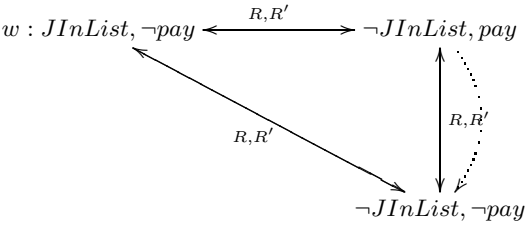

Fig. 3. Update by $\neg pay!!$

After this communicative act, one should not pay to download any paper of the journal and the librarian knows this (it is not possible to access from an R world a world via D where *pay* is true). This resulting situation is depicted in Figure 3. The only difference with the EDL-model of Figure 1 is that there is no dotted arrow from the bottom world to the top world on the right. This modification ensures that the only D world where *pay* is true is not accessible anymore.

4 How to Model Prescriptive and Descriptive Obligations

Alchourrón and Bulygin [1,2] discussed the *possibility* of a logic of norms, which they distinguish from the logic of normative propositions. Alchourrón explains the distinction with the following box metaphor.

> "We may depict the difference between the descriptive meaning (normative propositions) and the prescriptive meaning (norm) of deontic sentences by means of thinking the obligatory sets as well as the permitted sets as different boxes ready to be filled. When the authority α uses a deontic sentence prescriptively to norm an action, his activity belongs to the same category as *putting something into a box.* When α, or someone else, uses the deontic sentence descriptively his activity belongs to the same category as *making a picture of* α *putting something into a box.* A proposition is like a picture of reality, so to assert a proposition is like making a picture of reality. On the other hand to issue (enact) a norm is like putting something in a box. It is a way of creating something, of building a part of reality (the normative qualification of an action) with the purpose that the addressees have the option to perform the authorized actions while performing the commanded actions." [1]

In our logic we can distinguish Alchourrón's distinction between descriptive and prescriptive norms. We map this distinction to the context of agent communication. The descriptive communicative act of the Springer web-site announcing that he should not pay can be modeled by the communicative act $[O\neg pay!]$. Note that informing about the existence of a norm can enable the audience to know more information: for example, if the librarian should not pay for downloading any paper of a journal then he knows that this journal is on the list of journals for which the library has free access. The prescriptive communicative act of the librarian being informed that the journal is now free of charge can be modeled by the communicative act $[\neg pay!!]$.

This mapping allows to understand the role of agent systems in deontic logic, since a traditional problem can be solved by stating it in terms of interaction among agents.

Example 4. Let us take up Example 1. Concerning the descriptive character of norms, we model the action of communicating that there is a norm obliging not

to pay to download any paper as the announcement of the obligation $O\neg pay!$. The resulting situation is the same as the one depicted in Figure 2. After such announcement to the librarian, not only he believes that he should not pay to download any paper of the journal but also that the journal is in the list of journals for which the library has free access:

$$M, w \models \neg BJInList \wedge [O\neg pay!](BO\neg pay \wedge BJInList)$$

The inference $[O\neg pay!]BJInList$ is possible if one should not pay Springer to download any paper of a journal which is in the list:

$$JInList \rightarrow O\neg pay$$

Note that *pay* is a practition, since it is in the scope of a deontic operator.

Concerning the prescriptive character of obligation, we model the action of putting a norm into existence, for example, by the Springer web-site announcing that from now on the library should not pay to download any paper of the journal as the announcement of the practition $\neg pay!!$. The resulting situation is depicted in Figure 3. Note that, in this case, even if $JInList \rightarrow O\neg pay$, we cannot derive that the librarian knows that the journal is in the list. This is intuitively correct: the new norm has just been introduced today so there has not been enough time to update the list (it is updated every month).

$$M, w \models \neg BJInList \wedge [\neg pay!!](O\neg pay \wedge \neg BJInList).$$

5 Conclusions

Distinguishing the prescriptive and descriptive use of language is a classical challenge from deontic logic with practical consequences. If one agent tells another agent that he is obliged to do something, but the second agent would like to disagree, then the second agent should know whether the agent is creating a norm for him, or whether he is describing an existing normative system. In the first case he may disagree by responding that the agent is not authorized to create obligations for him, in the second case he may argue that the norm does not apply to him, or that the norm does not exist. Several formal systems therefore distinguish between prescriptive and descriptive obligations, but thus far the distinction was not analyzed in more detail, and the two kinds of obligations were not related to each other in an integrated framework.

In this paper, we give a more detailed analysis by modeling besides the normative system also the epistemic states of the agents, and how norms can be changed over time. Few articles in deontic logic deal with the interaction among deontic and epistemic notions, though they often entertain a tight relationship. Citizens *must* often *know* their *obligations*, e.g., people should know that it is forbidden to speed. Moreover, some obligations hold only in an epistemic context, e.g., the librarian is *obliged* not to pay if he *knows* that the journal is on the free access list [12]. To specify such examples of autonomous agents acting

within a normative system, there is a need for the logical formalization of these relationships. To model the interaction between epistemic and normative notions in a dynamic setting we introduced a general Dynamic Epistemic Deontic Logic. The logic extends a simplified version of Castañeda's deontic logic of practitions and propositions with epistemic and dynamic update operators.

In [3] we adapt this Dynamic Epistemic Deontic Logic to the problem of privacy regulations, introducing the notion of permitted and obligatory announcement, and the notion of compliance. The extended framework can deal with a new version of the Chinese wall problem, meta-policies specifying if a user can know the privacy policies and it distinguishes between permissions and obligations to let the user know with respect to the permissions and obligations to communicate information by means of messages.

Further research concerns making the logic multi-agent, to study the implications of our approach for contrary to duties and deontic detachment.

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Lex Minus Dixit Quam Voluit, *Lex Magis Dixit Quam Voluit*: A Formal Study on Legal Compliance and Interpretation

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Abstract. This paper argues in favour of the necessity of dynamically restricting and expanding the applicability of norms regulating computer systems like multiagent systems, in situations where the compliance to the norm does not achieve the purpose of the norm. We propose a logical framework which distinguishes between constitutive and regulative norms and captures the norm change power and at the same time the limitations of the judicial system in dynamically revising the set of constitutive rules defining the concepts on which the applicability of norms is based. In particular, the framework is used to reconstruct some interpretive arguments described in legal theory such as those corresponding to the Roman maxims *lex minus dixit quam voluit* and *lex magis dixit quam voluit*. The logical framework is based on an extension of defeasible logic.

1 Introduction and Motivation

An important research issue in AI is to design computer systems whose performance is constrained by suitable sets of legal norms: in this sense, norms establish what legality criteria should apply to their functioning [22]. However, the general idea of regulating computer systems with norms can be modelled in different ways. As, e.g., Boella and van der Torre [4] pointed out in the field of normative multiagent systems, norms may work either as hard or soft constraints. In the first case, computer systems are designed in such a way as to avoid legal violations. In the second case, norms rather provide standards which can be violated, even though any violations should result in sanctions or other normative effects applying to non-compliant agents. To do that, it is necessary to monitor the behaviour of agents and enforce the sanctions.

Soft constraints allow agents to optimize their performance by reasoning about the trade off between respecting the norm – thus incurring in the related compliance costs – and the risk of being sanctioned. However, this additional flexibility of norms as soft constraints is not enough, because it could lead the agent to respect the norm (or otherwise to be sanctioned) even in circumstances where the respect of the norm does not give any advantage to the system, thus wasting his resources while the whole system achieves only a suboptimal state.

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Norms are like plans which aim at achieving the social goals the members of a society decided to share [5]. The legislator tries to specify all the circumstances which a norm applies to and all the exceptional contexts where it does not apply, but, as well known in the planning community of AI, universal plans rarely are a practicable strategy [7]. An agent should rather produce a partial plan and revise it when part of it becomes unfeasible. In the same way as replanning allows an agent to revise its plans while keeping fixed its original goals, law has a mechanism, called interpretation, to allow norms to be adapted after their creation to the unforeseen situations in order to achieve the social goal they have been planned for. After all, not only the world changes, giving rise to circumstances unexpected to the legislator who introduced the norm, but even the ontology of reality can change with respect to the one constructed by the law to describe the applicability conditions of norms (see, e.g., all the problems concerning the application of existing laws to privacy, intellectual property or technological innovations in healthcare). This adaptation can be made only at the moment of evaluating whether a given behavior in a particular situation should be considered as a violation, i.e., by judges in courts.

Thus, the research question of this paper is: how to formalize the interpretation mechanism of law, so to design more flexible computer systems regulated by norms? This splits in the following subquestions: How does the law model the ontology of concepts to which norms refer to? How can the applicability of norms be restricted or expanded in some situations? How to model the goals associated to norms and how goals are used to evaluate the compliance to a norm in unforeseen circumstances? How to model and at the same time limit the power to interpret norms?

To answer the first subquestion we use the notion of constitutive norms besides regulative ones (henceforth, legal rules). While the latter ones specify the ideal behaviour, the former ones provide an ontology of institutional concepts to which the conditions of legal rules refer to. To model the revision of norms, we use as methodology an extension of Defeasible Logic (DL) [10], which allows us to model constitutive and legal rules and the norm change process, while keeping linear the complexity of the overall process. DL allows us as well to reason about goals assigned to norms and to use them to frame the norm change process within limits.

The layout of the paper is as follows. Section 2 describes the structure of a normative system and the role of interpretation. In Section 3 we explain the distinction between norm restriction and norm expansion together with the role of goals in the interpretation process. Section 4 introduces the variant of DL we use in this paper and Section 5 uses DL to model the norm restriction and norm expansion processes.

2 Legal Rules and Legal Concepts

2.1 The Structure of a Normative System

As well known, norms have a conditional structure such as $b_1, \ldots, b_n \Rightarrow_O l$ (if $b_1, \ldots, b_n$ hold, then l is obligatory), an agent is compliant with respect to this norm if l holds whenever the obligation l follows from $b_1, \ldots, b_n$. Most logical models of legal reasoning often assume that conditions of norms give a complete description of their applicability (see Sartor [18]). However, this assumption is too strong, due to the complexities

and dynamics of the world. Norms cannot take into account all the possible conditions where they should or should not be applied, because the legislator cannot consider all the possible contexts which are exceptional, he cannot foresee unexpected changes of the world and of the ontology of concepts the norms refer to.

Normative systems regulating real societies have two mechanisms to cope with this problem. First they distinguish legal rules (obligations, prohibitions and permissions) from constitutive rules. While the former, which are changed only by the legislative system, specify the ideal behaviour, the latter ones provide, by means of counts-as definitions, an ontology of institutional concepts. The applicability conditions of legal rules very often refer to these institutional concepts, rather than to the so called brute facts.

Second, the judicial system, at the moment in which a case concerning a violation is discussed in court, is empowered to interpret, i.e., to change norms, under some restrictions not to go beyond the purpose from which the legal rules stem. The distinction between legal and constitutive rules (norms vs ontology) suggests that legal interpretation does not amount to revising norms, but to interpreting legal concepts, i.e., to revising constitutive rules [19].

In this paper we adopt the view that the ontology of legal concepts is built via constitutive rules having the so-called counts-as form [20]: $r : a_1, \ldots, a_n \Rightarrow_c b$ For example, a bicycle is considered as a vehicle by the following constitutive rule:

$$r_0 : \mathit{Bike}(x) \Rightarrow_c \mathit{Vehicle}(x)$$

This counts-as rule, if instantiated by any bicycle a, says that a counts as a vehicle.

Constitutive rules have a defeasible character, for example, a bicycle for children cannot be considered as a vehicle:

$$r_1 : \mathit{Bike}(x), \mathit{ForChildren}(x) \rightsquigarrow_c \neg \mathit{Vehicle}(x)$$

$$r_0 \succ r_1$$

As usual in DL, our language includes (1) a superiority relation $\succ$ that establishes the relative strength of rules and is used to solve conflicts, (2) special rules marked with $\rightsquigarrow$, called defeaters, which are not meant to derive conclusions, but to provide reasons against the opposite.

In general, note that in legal systems counts-as rules may either specify conceptual links between "brute" facts or acts (i.e., non-institutional facts or acts whose status is independent of the existence of any constitutive rule; example: being over 18 years) counts as types of institutional facts or acts (e.g., being adult), or rather specify conceptual links where institutional facts or acts (e.g., a contract made by person j in the name of person k) have the same effects of other institutional facts or acts (e.g., a contract made by k). This view basically implies that the consequents of constitutive rules always correspond to institutional facts or acts. Indeed, constitutive rules are meant to "constitute" and define legal concepts whose existence precisely depends on the existence of constitutive rules. Moreover, there are two sources of constitutive rules, explicit norms like the one defining what means to be adult, but also the usual meaning of the terms, as they appear in a law according to the normal (day to day) meaning and intention of the lawmaker, e.g., 'Good pater familiae', 'Due diligence'.

Here, we will deal with such a type of constitutive rules following the approach described in [11], where it is convincingly argued that an effective way to capture the basic properties of the counts-as link is to reframe it in terms of standard DL.

The set of legal rules is kept to be fixed: any judge during the interpretation process can argue about their applicability conditions but cannot either add new rules nor cancel them. Only legislators have the power to change legal rules.

Legal rules are for example:

$$r_2 : Vehicle(x), Park(y) \Rightarrow_O \neg Enter(x, y)$$

This rule reads as follows: if x is a vehicle and y is a park, then it is (defeasibly) forbidden for any x to enter y.

For the sake of simplicity, we will assume that legal rules only impose duties and prohibitions, and state permissions: they are captured within a suitable extension of standard DL [10].

Finally, as usually assumed in legal theory [16,18], we assign goals to legal rules. In the social delegation cycle [5] norms are planned starting from goals shared by the community of agents. However, such goals play also another role: they pose the limits within which the interpretation process of the judicial systems must stay when interpreting norms.

Note that the goal alone is not sufficient to specify a norm, since there could be many ways to achieve that goal and some guidance should be given to the citizens. Thus, the norm works like a partial plan the legislator set up in advance. The judicial system is left with the task of dynamically adapt the applicability of the regulative norm by revising the constitutive norms referring to its applicability conditions, in order to fulfil the goal of the norm also under unforeseen circumstances. This is why law can be considered as a synecdoche: a term denoting a part of something is used to refer to the whole thing.

In this paper, we define a set Goal of goals and a function $\mathscr{G}$ which maps legal rules into elements of Goal. For example, if $\mathscr{G}(r_2) = \mathbf{road\_safety}$, this means that the goal of the rule prohibiting to enter into parks is to promote road safety[1]. The idea is quite standard in legal theory [16,18,19] and has been already investigated in AI&Law, even though most works were mainly devoted to case-based reasoning and modeling case-law [2]. Note that, in this paper, goals are considered here as directly specified by the legal rules themselves. In general, the task to determine what goals are supposed to be promoted by rules is usually accomplished by judges by developing suitable arguments during the trial.

As largely acknowledged in legal theory, when it is possible to establish the relative weight of rule goals, this can be used both to determine the relative strength of any legal rule in case of conflicts with other rules and to interpret any legal rule when it is not clear whether this rule can be applied to a given concrete case [16]. As regards the first issue – solving conflicts by referring to rule goals – it seems natural then to define a partial order $>$ over Goal to capture cases where any goal g is more important than any other goal g'. If $g > g'$ then g is more important than g', otherwise they have equal importance. Hence, $>$ may be used to solve conflicts between legal rules. Consider the following rules:

[1] Hereafter, we will use bold type expressions to denote goals.

$$r_3 : HighWay(x), \neg Authorized\_Area(x) \Rightarrow_O \neg Stop(x)$$
$$r_3' : HighWay(x), \neg Authorized\_Area(x), Crash(y) \Rightarrow_O Stop(x)$$

Rule r_3 states that it is forbidden for drivers to stop in highways except in authorized areas; rule r_3' says that drivers have to stop when they are responsible for serious car crashes in highways. Suppose that the legal system does not explicitly state what rule should prevail here. If so, resorting to rule goals can help. In fact, we may assume that the goal of r_3 is to promote road safety, while the one of r_3' is to protect life when it is in serious and imminent danger. Since the latter goal should be more important than the former one, r_3' will have to prevail over r_3.

This mechanism for solving conflicts will be added in our framework to the standard one adopted in Defeasible Logic [1], which is based on a superiority relation $\succ$ directly applied to rules.

2.2 Revising Constitutive Rules

Checking legal compliance requires to establish if a legal rule $r : b_1, \ldots, b_n \Rightarrow_O \neg l$ is violated by a fact or action l happened under some circumstances H. Let us assume that r states that $\neg l$ ought to be the case. However, l is not necessarily a violation, because we also have to check whether H, via the constitutive rules, matches with the applicability conditions $b_1, \ldots, b_n$ of r. In easy cases, these match and l directly amount to a violation. However, jurists argue that we have cases where this does not hold, as for example when there is a discrepancy between the literal meaning of $b_1, \ldots, b_n$ and the goal assigned to the rule r by the legislator. If so, even though H matches with $b_1, \ldots, b_n$, we do not have a violation because H should not match with $b_1, \ldots, b_n$. A non-literal interpretation of $b_1, \ldots, b_n$ would exclude H as a circumstance falling within the scope of r, since the goal of the norm would be achieved anyway: *lex magis dixit quam voluit*, the law said more than what the legislator was meaning to say. Analogously, not all cases in which H mismatches with $b_1, \ldots, b_n$ are not violations. We could have that *lex minus dixit quam voluit*, the law said less than what the legislator was meaning to say: here a non-literal, goal-based interpretation of r would lead to broaden its applicability scope to match H, thus making the agent a violator [16].

3 Interpreting Legal Rules

In this section we describe the interpretation process using a running example, first considering a scenario of norm restriction and second a norm expansion.

Suppose Mary enters a park with her bike, thus apparently violating rule r_2 above about vehicles' circulation. Police stops her when she is still on her bike in the park and fines her. Mary thinks this is unreasonable and sues the municipality because she thinks that here the category "vehicle" should not cover bikes.

3.1 Restricting the Applicability of Norms

In the first case the conceptual domain of the normative system, corresponding to a set of constitutive rules, allows us to derive that any bike a is indeed a vehicle. The goal

of the norm r_2 is reducing pollution $\mathscr{G}(r_2) = \neg$**pollution**. In court, the judge has to establish if Mary violated r_2 or not.

If T is the case, the judge could argue that Mary should be fined, as r_2 clearly applies to her:

$$T = \{r_0 : Bike(x) \Rightarrow_c Vehicle(x),$$
$$r_4 : 2\_wheels(x), Transport(x), \neg Engine \Rightarrow_c Bike(x)\}$$

But suppose that the judge can show that, if Mary's case fulfils the applicability conditions of r_2 (Mary's bike is a vehicle) then a goal which is incompatible with the goal assigned to r_2 would be promoted. Since $\mathscr{G}(r_2) = \neg$**pollution**, prohibiting to circulate with bikes in parks would encourage people to get around parks by car and then walk. This would be against the goal of r_2 and so the judge has good reasons to exclude that bikes are vehicles when r_2 should be applied. Accordingly, when arguing in this way, the judge may interpret r_2 by reducing its applicability conditions as far as Mary's case is concerned, and so by contracting T in order to obtain in T that Mary's bike is not a vehicle in the context of the current situation.

3.2 Expanding the Applicability of Norms

Alternatively, the conceptual domain could exclude that bikes are vehicles and the goal of r_2 could be the safety of people walking in the park **pedestrian_safety**:

$$T' = \{r_4 : 2\_wheels(x), Transport(x), \neg Engine(x) \Rightarrow_c Bike(x),$$
$$r_5 : Bike(x) \Rightarrow_c \neg Vehicle(x),$$
$$r_6 : Transport(x) \rightsquigarrow_c Vehicle(x)\}$$
$$\succ = \{r_5 \succ r_6\}$$

T' also includes r_6, which states that, if we know that some x has purpose of transport, then we have reasons to block other rules which would lead to exclude that x is a vehicle. However, in T' r_6 is made weaker than r_5 via the superiority relation $\succ$, and so, if x is a bike, we conclude by r_5 that x is not a vehicle.

Now, suppose the judge has to settle Mary's case starting from T'. Again, the goal of legal rules such as r_2 may be decisive. The judge could argue that Mary should not be fined, as r_2 clearly does not apply. But suppose that, since r_2 is not fulfilled, this would be against the goal of r_2, which is now **pedestrian_safety**. In this case, the judge has rather good reasons to consider bikes as vehicles when r_2 is concerned. Hence, the judge may interpret r_2 by broadening its applicability conditions as far as Mary's case is concerned, and so by revising T' in such a way as Mary's bike is a vehicle.

3.3 Constraints on the Revision

In general, we should note that such types of revisions have to satisfy some requirements (let's still bear in mind the case of Mary's bike):

1. there is no other $g' \in$ Goal such that
   - the revision of T (or of T') promotes r_2's goal g which is incompatible, in the application context of r_2, with respect to the goal g' of another applicable rule r, and
   - $\mathcal{G}(r_2) \not> \mathcal{G}(r)$ ($\mathcal{G}(r_2)$ is not more important than $\mathcal{G}(r)$);
2. our set of constitutive rules should suggest us that the concept of *Bike* can be subsumed under the concept of *Vehicle*;

Point 1 above states that, if by contracting or revising the concept of *Bike*, we undermine at least one equally or more important goal, which is supposed to be promoted by another applicable rule, then such a contraction or revision is not acceptable. This limit is well-known by lawyers and legal theorists [18,16], who often argue that any legal interpretation should be coherent within the legal system as a whole.

Point 2 above is rather connected with the fact that the set of constitutive rules should inherently provide some conceptual limits for any interpretation. Indeed, suppose that Mary enters the park with a gun. We could have reasons for arguing that entering with a gun is dangerous for all people in the park, and so for pedestrians too. However, this is not enough, of course, for arguing that guns are vehicle. In other words, if we do not have any other legal rules prohibiting to enter parks with guns, this behaviour will be permitted. Hence, point 2 has to do with Hart's [15] theory of penumbra: we have a core of cases which can be clearly classified as belonging to the legal concept and a penumbra of hard cases, whole membership in the concept can be disputed; but hard cases should exhibit some conceptual link with the core of cases. This idea is formally captured here by confining the revision of the set of constitutive rules only to those situations where such a set, though failing to prove that a bike is a vehicle, already contains reasoning chains suggesting that this may be the case. For example, if we have

$$r_4 : 2\_wheels(x), Transport(x), \neg Engine(x) \Rightarrow_c Bike(x)$$
$$r_7 : Bike(x) \rightsquigarrow_c Vehicle(x)$$

r_7 states that, if we know that some x is a bike, this is not sufficient to prove that x is a vehicle (r_7 is a defeater), but it is sufficient to block other rules which would lead to exclude that x is a vehicle. This means that, possibly, if x is a bike, then it could not be unreasonable to consider x as a vehicle (for a similar reading of defeaters in terms of $\Diamond$, but applied to the concept of permission, see [10,12]). Hence, the revision would require, for example, that r_7 is replaced by

$$r_0 : Bike(x) \Rightarrow_c Vehicle(x)$$

The framework we have informally depicted above suggests that we also need a logical component to reason about goals. Such a component should enable us to check whether some situations promote goals or their negations. For our purpose it is sufficient to introduce a suitable set of rules for goals [11] which should be used to establish what are the effects of situations where legal rules are violated or complied with, and, in doing so, to see whether they are consistent with the goals. In other words, we have to devise a set of rules like $d_1, \ldots, d_n \Rightarrow_G e$: if applicable in a given context, this rule allows for deriving $G\,e$, meaning that e is a goal promoted by the underlying normative

theory D. Consider once again rule r_2; suppose that its goal is **pedestrian_safety** and that Mary's case is described by the following set H of facts:

$$H = \{Bike(b),\ Park(p),\ Enter(b,p),\\ NarrowSpace(p),\ UnprotectedChildArea(p)\}$$

H states that Mary enters the park p with her bike b. The park has narrow spaces for walking and there are unprotected children's play areas. This set assumes that r_2 is violated, at least in the hypothetical perspective in which Mary should not enter.

Suppose now that rules for goals correspond to the following set:

$$R^G = \{r_8 : Bike(x), Park(y), Enter(x,y) \Rightarrow_G \textbf{fast\_circulation},\\ r_9 : NarrowSpace(x), UnprotectedChildArea(x),\\ G\,\textbf{fast\_circulation} \Rightarrow_G \neg\textbf{pedestrian\_safety}\}$$

Rule r_8 states that entering parks with bikes promotes the fast circulation of people in those parks; rule r_9 says that, if fast circulation is promoted (i.e., it is possible to derive as goal of the normative theory **fast_circulation**, that is, G**fast_circulation**) and parks have narrow spaces and unprotected children's play areas, then the promoted goal is the negation of pedestrians safety. If so, if Mary's bike is allowed to enter, then we would promote a goal which is incompatible with the goal of r_2.

4 The Logical Framework

The following framework is an extension of DL; such an extension is in line with works such as [10,11]. In particular, on account of the informal presentation given in the previous section, while counts-as rules do not prove modalised literals, the system develops a constructive account of those modalities that rather correspond to obligations and goals: rules for these concepts are thus meant to devise suitable logical conditions for introducing modalities. For example, while a counts-as rule such as $a_1,\ldots,a_n \Rightarrow_c b$, if applicable, will basically support the conclusion of b, rules such as $a_1,\ldots,a_n \Rightarrow_O b$ and $d_1,\ldots,d_n \Rightarrow_G e$ if applicable, will allow for deriving $O\,b$ and $G\,e$, meaning the former that b is obligatory, the latter that e is a goal promoted by the facts used to derive it (as previously explained).

Note that the framework is restricted to essentially propositional DL. Indeed, rules with free variables are interpreted as rule schemas, that is, as the set of all ground instances; in such cases we assume that the Herbrand universe is finite. This assumption is harmless in this context, as the rule applicability domains at hand always refer to finite set of individuals.

In our language, for $X \in \{c, O, G\}$, *strict rules* have the form $\phi_1,\ldots,\phi_n \rightarrow_X \psi$. *Defeasible rules* have the form $\phi_1,\ldots,\phi_n \Rightarrow_X \psi$. A rule of the form $\phi_1,\ldots,\phi_n \rightsquigarrow_X \psi$ is a *defeater*. A rule can be understood as a binary relationship between a set of premises and a conclusion. Accordingly, the mode determines the type of conclusion one can obtain, and the three types of rules establish the strength of the relationship. Strict rules provide the most stronger connection between a set of premises and their conclusion:

whenever the premises are deemed as indisputable so is the conclusion; then we have defeasible rules: a defeasible rules, given the premises, allows us to derive the conclusion unless there is evidence for its contrary; finally we have defeaters. A defeater suggests that there is a connection between its premises and the conclusion, but this connection is not strong enough to warrant the conclusion on its own; on the other hand a defeater shows that there is some evidence for the conclusion, thus it can be used to defeat rules for the opposite conclusion.

Definition 1 (Language). *Let* PROP *be a set of propositional atoms,* Goal *be a set of goal atoms,* $\mathrm{MOD} = \{c, O, G\}$*, and* Lbl *be a set of labels. The sets defined below are the smallest sets closed under the given construction conditions:*

Literals and goals

$$\mathrm{Lit} = \mathrm{PROP} \cup \{\neg p | p \in \mathrm{PROP}\}$$
$$\mathrm{GoalLit} = \mathrm{Goal} \cup \{\neg g | g \in \mathrm{Goal}\}$$

If q is a literal or a goal, $\sim q$ denotes the complementary literal or goal (if q is a positive literal or goal p then $\sim q$ is $\neg p$; and if q is $\neg p$, then $\sim q$ is p);

Modal literals and modal goals

$$\mathrm{ModLit} = \{Ol, \neg Ol | l \in \mathrm{Lit}\}$$
$$\mathrm{ModGoal} = \{Gl, \neg Gl | g \in \mathrm{GoalLit}\};$$

Rules. $\mathrm{Rul} = \mathrm{Rul_s} \cup \mathrm{Rul_d} \cup \mathrm{Rul_{dft}}$*, where* $X \in \{c, O\}$ *and* $\mathrm{Rul_s} = \mathrm{Rul_s^X} \cup \mathrm{Rul_s^G}$, $\mathrm{Rul_d} = \mathrm{Rul_d^X} \cup \mathrm{Rul_d^G}$*, and* $\mathrm{Rul_{dft}} = \mathrm{Rul_{dft}^X} \cup \mathrm{Rul_{dft}^G}$ *such that*

$$\mathrm{Rul_s^X} = \{r : \phi_1, \ldots, \phi_n \rightarrow_X \psi | r \in \mathrm{Lbl}, A(r) \subseteq \mathrm{Lit}, \psi \in \mathrm{Lit}\}$$
$$\mathrm{Rul_s^G} = \{r : \phi_1, \ldots, \phi_n \rightarrow_G \psi | r \in \mathrm{Lbl}, A(r) \subseteq \mathrm{Lit} \cup \mathrm{ModLit} \cup \mathrm{ModGoal}, \psi \in \mathrm{GoalLit}\}$$
$$\mathrm{Rul_d^X} = \{r : \phi_1, \ldots, \phi_n \Rightarrow_X \psi | r \in \mathrm{Lbl}, A(r) \subseteq \mathrm{Lit}, \psi \in \mathrm{Lit}\}$$
$$\mathrm{Rul_d^G} = \{r : \phi_1, \ldots, \phi_n \Rightarrow_G \psi | r \in \mathrm{Lbl}, A(r) \subseteq \mathrm{Lit} \cup \mathrm{ModLit} \cup \mathrm{ModGoal}, \psi \in \mathrm{GoalLit}\}$$
$$\mathrm{Rul_{dft}^X} = \{r : \phi \rightsquigarrow_X \psi | r \in \mathrm{Lbl}, A(r) \subseteq \mathrm{Lit}, \psi \in \mathrm{Lit}\}$$
$$\mathrm{Rul_{dft}^G} = \{r : \phi_1, \ldots, \phi_n \rightsquigarrow_G \psi | r \in \mathrm{Lbl}, A(r) \subseteq \mathrm{Lit} \cup \mathrm{ModLit} \cup \mathrm{ModGoal}, \psi \in \mathrm{GoalLit}\}$$

We use some obvious abbreviations, such as superscripts for the rule mode (c, G, O), subscripts for the type of rule, and $\mathrm{Rul}[\phi]$ *for rules whose consequent is ϕ, for example:*

$$\mathrm{Rul}^c = \{r : \phi_1, \ldots, \phi_n \hookrightarrow_c \psi | \hookrightarrow \in \{\rightarrow, \Rightarrow, \rightsquigarrow\}\}$$
$$\mathrm{Rul_{sd}} = \{r : \phi_1, \ldots, \phi_n \hookrightarrow_X \psi | X \in \mathrm{MOD}, \hookrightarrow \in \{\rightarrow, \Rightarrow\}\}$$
$$\mathrm{Rul_s}[\psi] = \{\phi_1, \ldots, \phi_n \rightarrow_X \psi | X \in \mathrm{MOD}\}$$

We use $A(r)$ to denote the set $\{\phi_1, \ldots, \phi_n\}$ of antecedents *of the rule r, and $C(r)$ to denote the* consequent *ψ of the rule r.*

A normative theory is the knowledge base which is used to reason about the applicability of legal rules included in the theory itself.

Definition 2 (Normative Theory). *A normative theory is a structure*

$$D = (F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$$

where

- $F \subseteq \text{Lit} \cup \text{ModLit} \cup \text{ModGoal}$ *is a finite set of facts;*
- $G \subseteq \text{GoalLit}$ *is a set of rule goals,*
- $R^c \subseteq \text{Rul}^c$ *is a finite set of counts-as rules,*
- $R^O \subseteq \text{Rul}^O$ *is a finite set of obligation rules,*
- $R^G \subseteq \text{Rul}^G$ *is a finite set of goal rules,*
- $\succ$ *is an acyclic relation (called superiority relation) defined over* $(R^c \times R^c) \cup (R^O \times R^O) \cup (R^G \times R^G)$,
- $\mathscr{G} : R^O \mapsto G$ *is a function assigning a goal to each obligation rule,*
- $>$ *is a partial order over G defining the relative importance of the rule goals.*

Proofs are sequences of literals and modal literals together with the so-called proof tags $+\Delta$, $-\Delta$, $+\partial$ and $-\partial$. If $X \in \{c, O, G\}$, given a normative theory D, $+\Delta^X q$ means that literal q is provable in D using only facts and strict rules for X, $-\Delta^X q$ means that it has been proved in D that q is not definitely provable in D, $+\partial^X q$ means that q is defeasibly provable in D, and $-\partial^X q$ means that it has been proved in D that q is not defeasibly provable in D.

Definition 3. *Given a normative theory D, a proof in D is a linear derivation, i.e, a sequence of labelled formulas of the type* $+\Delta^X q$, $-\Delta^X q$, $+\partial^X q$ *and* $-\partial^X q$, *where the proof conditions defined in the rest of this section hold.*

Definition 4. *Let D be a normative theory. Let* $\# \in \{\Delta, \partial\}$ *and* $X \in \{O, G\}$, *and* $P = (P(1), \ldots, P(n))$ *be a proof in D. A literal q is* #-provable *in P if there is a line* $P(m)$, $1 \leq m \leq n$, *of P such that either*

1. *q is a literal and* $P(m) = +\#^c q$ *or*
2. *q is a modal literal or a modal goal* Xp *and* $P(m) = +\#^X p$ *or*
3. *q is a modal literal or a modal goal* $\neg Xp$ *and* $P(m) = -\#^X p$.

A literal q is #-rejected *in P if there is a line* $P(m)$ *of P such that*

1. *q is a literal and* $P(m) = -\#^c q$ *or*
2. *q is a modal literal or a modal goal* Xp *and* $P(m) = -\#^X p$ *or*
3. *q is a modal literal or a modal goal* $\neg Xp$ *and* $P(m) = +\#^X p$.

The definition of Δ^X, $X \in \{c, O, G\}$ describes just forward (monotonic) chaining of strict rules[2]:

$+\Delta^X$: If $P(n+1) = +\Delta^X q$ then
(1) $q \in F$ if $X = c$ or $Xq \in F$ or
(2) $\exists r \in R_s^X[q] : \forall a \in A(r)$ a is Δ-provable.

[2] For space reasons, in the remainder we present only the proof conditions for $+\Delta$ and $+\partial$. Conditions for the negative tags are obtained using the so-called principle of strong negation and the notion of #-*rejected* [10].

To show that a literal q is defeasibly provable with the mode X we have two choices: (1) We show that q is already definitely provable; or (2) we need to argue using the defeasible part of a normative theory D. For this second case, some (sub)conditions must be satisfied. First, we need to consider possible reasoning chains in support of $\sim q$ with the mode X, and show that $\sim q$ is not definitely provable with that mode (2.1 below). Second, we require that there must be a strict or defeasible rule with mode X for q which can be applied (2.2 below). Third, we must consider the set of all rules which are not known to be inapplicable and which permit to get $\sim q$ with the mode X (2.3 below). Essentially, each such a rule s attacks the conclusion q. For q to be provable, s must be counterattacked by a rule t for q with the following properties: (i) t must be applicable, and (ii) t must prevail over s. Thus each attack on the conclusion q must be counterattacked by a stronger rule. In other words, r and the rules t form a team (for q) that defeats the rules s. Note that in our framework, in addition to $\succ$, also goals can be used to determine the relative strength of any legal rule in case of conflicts with other rules; the following definition enables us to handle together goal preferences and the superiority relation $\succ$.

Definition 5. *Let $D = (F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$ be a normative theory. A rule r* prevails *over another rule s iff*

- $\mathscr{G}(r) > \mathscr{G}(s)$ *or*
- $r \prec s$ *and* $\mathscr{G}(s) \not\succ \mathscr{G}(r)$

$+\partial^X$: If $P(n+1) = +\partial^X q$ then
(1) $+\Delta^X q \in P(1..n)$ or
(2) (2.1) $-\Delta^X \sim q \in P(1..n)$ and
(2.2) $\exists r \in R^X_{sd}[q]$ such that $\forall a \in A(r)$ a is ∂-provable, and
(2.3) $\forall s \in R^X[\sim q]$ either $\exists a \in A(s)$ such that a is ∂-rejected, or
(2.3.1) $\exists t \in R^X[q]$ such that $\forall a \in A(r)$ a is ∂-provable and
t prevails over s

Definition 6. *Given a normative theory D, $D \vdash \pm\#^X l$ (i.e., $\pm\#^X l$ is a conclusion of D), where $\# \in \{\Delta, \partial\}$ and $X \in \{c, O, G\}$, iff there is a proof $P = (P(1), \ldots, P(n))$ in D such that $P(n) = \pm\#^X l$.*

It is worth noting that our logic enjoys nice computational properties:

Theorem 1. *For every normative theory D, the conclusions of D can be computed in time linear to the size of the theory, i.e., $O(|U^D| * |R|)$, where U^D is the Herbrand base of the normative theory D.*

Proof. The proof comes directly from the result provided in [11,10]. In fact, the current logic is structurally similar to those presented there.

5 A Framework for Revising Constitutive Rules

5.1 Legal Compliance: Why Interpret?

The informal discussion presented in Section 3 requires to formally characterise those situations where a context and an action or fact make a norm applicable, fulfil it and

those situations where the behaviour of the agent either promotes or undermines the goal of a norm.

Definition 7 (Context). *A context H is a set of literals $\{f_1, \ldots, f_m\}$.*

The context just identifies a set of literals 'relevant' for a particular case. In particular we will use the context as the set of factors used to determine whether we need to extend or restrict the interpretation to terms. Another possible use of the context is to set up hypothetical scenarios.

Definition 8 (Rule Applicability). *Given a context H, let*

$$D = (F \cup H, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$$

be a normative theory.

A rule $r \in R^O$ is applicable *in D iff, for all $b \in A(r)$, b is ∂^c-provable in D.*

Remark 1. The notion of rule applicability is technically straightforward. It expresses the idea that a norm r is applicable iff all the antecedents of r are provable using the constitutive rules of the theory. Notice that we focus only to the case where the antecedents are defeasibly provable (∂-provable). This does not mean that, given the rule r, if the antecedents are indisputably provable (Δ-provable), the rule is not applicable at all. Quite the contrary. The reason why we work only on defeasible provability is that, in our framework, the process of revision of the applicability conditions of a rule is possible only when the antecedents are defeasibly derivable. Indeed, as we will see, blocking the applicability of a rule requires resorting to defeaters and so can be done only when the applicability of a rule is not indisputable (defeaters are weaker in our logic than strict rules).

We now introduce the notion of compliance to a norm and violation:

Definition 9 (Rule Fulfilment and Violation). *A normative theory*

$$D = (F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$$

and a context H fulfil *$r \in R^O_{\mathrm{sd}}$ iff,*

- *if we have that*

$$D' = (F \cup H, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) \vdash +\partial^O C(r)$$

- *r is applicable in D'*

then, either

- *$D' \vdash +\partial^c l$ when $C(r)$ is a positive literal l (r is a conditional obligation) or*
- *$D' \vdash -\partial^c l$ or $D' \vdash +\partial^c \neg l$ when $C(r)$ is a negative literal $\neg l$ (r is a conditional prohibition).*

D and H violate *the rule r whenever D and H do not fulfil r.*

Remark 2. For the notion of rule fulfillment and violation it is not sufficient for a norm to be applicable, but the conclusion of the norm should be derivable $+\partial^O C(r)$ too, since other rules with higher priority could defeat it. In this case, the norm is fulfilled if the object of the norm l is defeasibly derivable, $+\partial^c l$, (or the contrary is not derivable, $-\partial^c l$ in case of prohibitions, i.e., obligations concerning a negated literal $\neg l$). It is violated in the opposite case.

Example 1. Suppose we have a context H with the following facts:

$$H = \{Park, Bike, Enter\}$$

The set of constitutive rules contains only the following

$$r_0 : Bike \Rightarrow_c Vehicle$$

while the set of legal rules only includes

$$r_2 : Vehicle, Park \Rightarrow_O \neg Enter$$

Clearly, rule r_2 is violated because it is applicable, we can obtain $+\partial^O \neg Enter$ (rule r is not defeated) but we have *Enter*.

Before revising a rule, the judge has to consider whether the goal of the norm has been violated or promoted.

Definition 10 (Goal Violation and Promotion). *A normative theory*

$$D = (F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$$

and the context $H = \{f_1, \ldots, f_m\}$ violate the goal g *of* $r : b_1, \ldots, b_n \hookrightarrow_O l \in R^O_{\text{sd}}$ *iff*

$$(F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) \vdash -\partial^G \neg g$$
$$(F \cup H, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) \vdash +\partial^G \neg g$$

D *and* H promote the goal g *of* r *iff*

$$(F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) \vdash -\partial^G g$$
$$(F \cup H, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) \vdash +\partial^G g$$

Remark 3. The goal is violated if the opposite goal is derived, while it is promoted if it follows from the normative theory using the goal rules. Note that to verify whether the goal of the norm is violated, it is not sufficient that the opposite goal is defeasibly derived from the context ($+\partial^G \neg g$), but it is necessary to verify that from the normative theory itself does not defeasibly derive the opposite goal. The same must be done for goal promotion.

Example 2. Let us assume to have the rules of Example 1 and the following context H:

$$H = \{Park, Bike, Enter\}$$

Table 1. Violation and Interpretation

	Applicable	Rule Fulfilment	Rule Goal	What-if	Judiciary	Law-making
0	no	no	no	no		ineffective
1	no	no	no	yes	**expand**, violation	restrictive
2	no	no	yes	no		contradictory
3	no	no	yes	yes		superfluous
4	no	yes	no	no		like 0
5	no	yes	no	yes		like 2
6	no	yes	yes	no		**expand**
7	no	yes	yes	yes		like 3
8	yes	no	no	no	**restrict**	ineffective
9	yes	no	no	yes	violation	
10	yes	no	yes	no	**restrict**	like 2
11	yes	no	yes	yes	**restrict**	superfluous
12	yes	yes	no	no		ineffective
13	yes	yes	no	yes	contradictory	**restrict**
14	yes	yes	yes	no		
15	yes	yes	yes	yes		superfluous

Suppose now that the goal of r_2 is **pedestrian_safety**. The set of goal rules consists of

$$r_{10} : Bike, Park, \neg Enter \Rightarrow_G \textbf{pedestrian\_safety}$$
$$r'_{10} : Bike, Park, Enter \Rightarrow_G \neg\textbf{pedestrian\_safety}$$

We can apply rule r'_{10} and so we obtain $+\partial^G \neg$**pedestrian_safety**, which could not be proved if we did not consider the context H. Hence, H and D violate the goal of r_2. On the contrary, if H contains $\neg Enter$ instead of $Enter$, we obtain $+\partial^G$**pedestrian_safety**, thus promoting the goal of r_2.

The concepts above are sufficient to define an exhaustive taxonomy of cases among which we can identify those that require the restriction or expansion of the applicability conditions of legal rules.

Let us consider in Table 1 a normative theory D and a legal rule $r : b_1, \ldots, b_n \hookrightarrow_O l$ ($\hookrightarrow \in \{\rightarrow, \Rightarrow\}$) in it, such that the goal of r is g. As informally discussed before, we have to assess if $\sim l$ and a certain set of circumstances H amount to a violation of r or not. There are several parameters to consider: the applicability of the norm, its fulfilment or violation (whether we have l or $\sim l$), and the satisfaction or not of the goal associated to the norm. Besides these factors, we should consider for each combination whether a different behaviour of the agent would result in a situation which is advantageous for the law or not (column "What if" considers the goal satisfaction assuming the opposite of what indicated in the column Rule Fulfilment)[3]. The last two columns classify the cases under two dimensions: first ("judiciary"), the judge should or should not change the applicability conditions of the norm in the case under exam

[3] In other words, if the column "Rule Fulfilment" indicates "no" ($\sim l$), the column "What-if" indicates whether the rule goal is promoted by having l, and viceversa.

of the judicial system (with the two subcases of restricting or expanding applicability conditions); second ("Law-making"), the norm is not adequate from the juridical point of view (the legislator should change it).

We focus on the cases which are relevant for the judiciary point of view: the agent fined by the police goes to a court to defend his case. Case 1 is the prototypical case for expansion: the norm is not applicable but if it were applicable, the agent would have violated it by not achieving l. This behaviour does not satisfy the goal g of the norm, so considering the agent a violator would be useless. Before deciding that it is necessary to enlarge the norm applicability conditions to cover the current case, the judge must make a what-if hypothetical analysis and verify that the goal would have been achieved if the agent complied with the norm. Otherwise we have just an ineffective norm, whose satisfaction does not contribute to the goal (see Case 0). Case 6 requires expansion too, but only from the point of view of the legislator, since the agent is fulfilling the norm.

The situation for norm restriction is more complicated. In Case 8 the agent should considered as a violator, since he did not respect an applicable norm. His behaviour does not achieve the goal of the norm, but before declaring him a violator the judge has to check if a compliant behaviour would have achieved the goal of the norm. If yes, the agent is really violating the norm (Case 9), otherwise the norm must be restricted since in the current situation the norm is useless (Case 8). Cases 10 and 11 do not instead require a what-if analysis since the agent is achieving the goal even if he violates the norm. In both cases the judge declares the agent non violator and restricts the applicability conditions of the norm to exclude the current situation. The two cases differ only from the juridical point of view, but discussing this dimension is beyond the scope of the paper.

5.2 Revising the Rule Scope

Before formally presenting the operations of expansion and contraction of the applicability conditions of rules, let us introduce an auxiliary concept, which is needed to identify possible reasoning chains leading to a conclusion we want to contract (in the case *Lex magis dixit quam voluit*), or reinstate or introduce (in the case *Lex minus dixit quam voluit*).

Definition 11 (Reasoning chains). *Let*

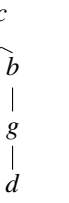
$$D = (F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$$

be a normative theory. A counts-as reasoning chain $\mathscr{C}$ in D for a literal l is a finite sequence $\mathscr{R}_1, \ldots, \mathscr{R}_n$ where

- $\mathscr{R}_i \subseteq R^c$, $1 \leq i \leq n$,
- $\mathscr{R}_n = \{a_1, \ldots, a_m \hookrightarrow_c l | \hookrightarrow \in \{\rightarrow, \Rightarrow, \rightsquigarrow\}\}$,
- $\mathscr{R}_k \subseteq R^c$, $1 < k \leq n$, *is such that* $\forall\, r^k \in \mathscr{R}_k$, $\forall b \in A(r^k) : \exists r^{k-1} \in \mathscr{R}_{k-1} : b = C(r^{k-1})$.

For all $s \in \mathscr{R}_i$, $1 \leq i \leq n$, we will say that s is in $\mathscr{C}$. If a literal p occurs in the head or the body of any s in $\mathscr{C}$, we will say that p is in $\mathscr{C}$. We define analogously a goal or an obligation reasoning chain $\mathscr{C}$ in D for a literal l when all rules in $\mathscr{C}$ are in R^G or R^O, respectively.

Remark 4. The concept of reasoning chain is nothing but the proof-theoretic version of the notion of argument for a literal l in the Argumentation Semantics for DL [8]. Consider the following example:



$r : e \Rightarrow_c f$
$s : f \Rightarrow_c a$
$t : d \Rightarrow_c g$
$u : g \Rightarrow_c b$
$w : a, b \Rightarrow_c c$

The tree on the left side is the argument for the literal c we can build using the rules r, s, t, u, w on the right side (provided that e and d hold). The structure can be reframed in terms of a reasoning chain: $\mathscr{R}_n$, $n = 3$, contains the rule w; $\mathscr{R}_{n-1}$ contains the rules s and u; finally, $\mathscr{R}_{n-2}$ contains r and t. Note that the main difference between the notion of argument and that of reasoning chain is that we allow in reasoning chains to have defeaters in any sets, whereas the arc of an argument can correspond to a defeater only if it is at the top of the tree. Indeed, a defeater cannot prove anything but only block conclusions. On the contrary, we want to select here also those chains in which defeaters can be replaced, for instance, by defeasible rules in order to reinstate or introduce new conclusions (*Lex minus dixit quam voluit*).

We are now ready to formally define the operations of expansion (*Lex minus dixit quam voluit*) and contraction (*Lex magis dixit quam voluit*) of the applicability conditions of a norm corresponding to the cases 1, 8, 10, and 11 of Table 1. The following operations thus implement the intuitions we have illustrated above and in Section 3.

Definition 12 (Rule Expansion). *Let*

$$D = (F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$$

be a normative theory, $r : b_1, \ldots, b_n \hookrightarrow_O l \in R^O$ be a legal rule, and H be a context. If

1. $\{b_k, \ldots b_{k+j}\} \subseteq A(r)$ *and, for all* b_t, $k \leq t \leq k+j$,

$$(F \cup H, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) \not\vdash +\partial^c b_t$$

2. *D and $H \cup \{\sim l\}$ violate the goal g of r, and*
3. *D and $H \cup \{l\}$ promote the goal g of r, and*
4. *there exist the counts-as reasoning chains $\mathscr{C}_k, \ldots \mathscr{C}_{k+j}$ in D for $b_k, \ldots b_{k+j}$, such that for each $f \in H$, f is in $\mathscr{C}_h$, $k \leq h \leq k+j$,*

then the expansion of the applicability conditions of a legal rule r with respect to the context H corresponds to the following operation $D^*_{b_k,\ldots,b_{k+j}}$ over D:

$$D^*_{b_k,\ldots,b_{k+j}} = (F, G, R'^c, R^O, R^G, \succ', \mathscr{G}, >)$$

where

$$R'^c = R^c - \{r' : d_1, \ldots, d_n \rightsquigarrow_c e | r' \text{ is in } \mathscr{C}_h\} \cup \{r' : d_1, \ldots, d_n \Rightarrow_c e\}$$
$$\succ' = (\succ \cup \{r' \succ s | r' \text{ is in } \mathscr{C}_h, s \in R^c[\sim C(r')]\}) - \{t \succ r' | t \in R^c[\sim C(r')]\}$$

such that

$$D' = (F \cup H, G, R'^{c}, R^{O}, R^{G}, \succ', \mathscr{G}, >) \vdash -\partial_G \neg g'$$

where g' *is the goal of any rule* $z \in R^{O}_{\mathrm{sd}}$ *applicable in* D' *such that* $g \not\succ g'$.

Remark 5. This definition considers the situation where a norm r is only partially applicable since some of the conditions cannot be derived from the facts F and context H (1). However, in this situation, not respecting the norm (i.e., $\sim l$) leads to a violation of the goal g of norm r (2). This violation of the goal would be avoided by complying with the norm, i.e., by achieving l (3). Moreover, the constitutive rules suggest that some elements of the context could be interpreted as the missing applicability conditions of the rule r (4). Thus, the normative theory should be expanded by transforming some defeater rules among the constitutive rules, in defeasible rules. The resulting normative theory is however subject to the final constraint that no other more important goal g' of any norm would be violated ($-\partial_G \neg g'$).

Example 3. Consider the following normative theory augmented with the context H regarding Mary's case[4]:

$$\begin{aligned}
F &= \{\mathit{Park},\ \mathit{UnprotectedChildArea},\ \mathit{NarrowSpace}\}\\
H &= \{\mathit{2_wheels},\ \mathit{Transport},\ \neg \mathit{Engine}\}\\
G &= \{\textbf{fast_circulation},\ \textbf{pedestrian_safety}\}\\
R^{c} &= \{r_4 : \mathit{2_wheels},\ \mathit{Transport},\ \neg \mathit{Engine} \Rightarrow_c \mathit{Bike},\\
&\qquad r_7 : \mathit{Bike} \rightsquigarrow_c \mathit{Vehicle},\\
&\qquad r_{11} : \mathit{Transport}, \neg \mathit{Engine} \Rightarrow_c \neg \mathit{Vehicle}\}\\
R^{O} &= \{r_2 : \mathit{Vehicle}, \mathit{Park} \Rightarrow_O \neg \mathit{Enter},\\
&\qquad r_{12} : \mathit{Vehicle}, \mathit{NarrowSpace} \Rightarrow_O \neg \mathit{Stop}\}\\
R^{G} &= \{r_8 : \mathit{Bike}, \mathit{Park}, \mathit{Enter} \Rightarrow_G \textbf{fast_circulation},\\
&\qquad r_9 : \mathit{NarrowSpace}, \mathit{UnprotectedChildArea}, G\,\textbf{fast_circulation} \Rightarrow_G \neg \textbf{pedestrian_safety},\\
&\qquad r_{13} : \mathit{NarrowSpace}, \mathit{Vehicle} \Rightarrow_G \textbf{fast_circulation},\\
&\qquad r_{10} : \mathit{Bike}, \mathit{Park}, \neg \mathit{Enter} \Rightarrow_G \textbf{pedestrian_safety}\}\\
\succ &= \{r_{11} \succ r_7\}\\
\mathscr{G} &= \{\mathscr{G}(r_2) = \textbf{pedestrian_safety}, \mathscr{G}(r_{12}) = \textbf{fast_circulation}\}\\
> &= \{\textbf{pedestrian_safety} > \textbf{fast_circulation}\}
\end{aligned}$$

Suppose *Enter* holds. This may correspond to a potential violation of r_2. This is not the case, because r_2 is not triggered and we do not derive *Vehicle*. However, we obtain the negation of the goal **pedestrian_safety** via r_9, i.e., the goal of r_2 is undermined. Condition 3 of the definition above is satisfied, since, via r_{10} the compliant situation ($\neg \mathit{Enter}$) promotes the goal of r_2.

Since we have r_7 we can construct a counts-as reasoning chain supporting *Vehicle*, and so the judge can expand the applicability conditions of r_2 by transforming it in the defeasible rule r_4:

[4] Rules with free variables are interpreted as the set of all ground instances. Hence, we represent the facts and rules discussed in Section 3 as constituted by propositional literals.

$$r_4 : Bike \Rightarrow_c Vehicle$$

By considering bicycles as vehicles we trigger r_{13} and promote **fast_circulation**, which is incompatible with **pedestrian_safety** (via r_9). However, **pedestrian_safety** is more important than **fast_circulation**.

The remaining case concerns contracting the applicability conditions of a norm in the cases illustrated in Table 1.

Definition 13 (Rule Contraction). *Let*

$$D = (F, G, R^c, R^O, R^G, \succ, \mathscr{G}, >)$$

be a normative theory, $r : b_1, \ldots, b_n \hookrightarrow_O l \in R^O$ be a legal rule, and $H = \{f_1, \ldots, f_m\}$ be a context. If

1. *D and $H \cup \sim l$* violate *the rule r, and*
2. *either*
   - *Case 8 of Table 1:*
     (a) *D and $H \cup \{\sim l\}$, and D and $H \cup \{l\}$, violate the goal g of r, and*
     (b) *there exists a $b_k \in A(r)$, such that b_k occurs in every goal reasoning chain $\mathscr{C}$ for $\neg g$ in at least one of the following normative theories*

$$\begin{array}{ll} (F \cup H \cup \{\sim l\}, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) & \text{if } \sim l \text{ is in } \mathscr{C} \\ (F \cup H \cup \{l\}, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) & \text{if } l \text{ is in } \mathscr{C} \end{array}$$

   - *Case 10 of Table 1:*
     (a) *D and $H \cup \{\sim l\}$ promote the goal g of r, and D and $H \cup \{l\}$ violate the goal g of r,*
     (b) *there exists a $b_k \in A(r)$, such that b_k occurs in every goal reasoning chain $\mathscr{C}$ for $\mathbf{X}$ in at least one of the following normative theories*

$$\begin{array}{ll} (F \cup H \cup \{\sim l\}, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) & \text{if } \sim l \text{ is in } \mathscr{C},\ \mathbf{X} = g \\ (F \cup H \cup \{l\}, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) & \text{if } l \text{ is in } \mathscr{C},\ \mathbf{X} = \neg g \end{array}$$

   - *Case 11 of Table 1:*
     (a) *D and $H \cup \{\sim l\}$, and D and $H \cup \{l\}$, promote the goal g of r,*
     (b) *there exists a $b_k \in A(r)$, such that b_k occurs in every goal reasoning chain $\mathscr{C}$ for g in at least one of the following normative theories*

$$\begin{array}{ll} (F \cup H \cup \{\sim l\}, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) & \text{if } \sim l \text{ is in } \mathscr{C} \\ (F \cup H \cup \{l\}, G, R^c, R^O, R^G, \succ, \mathscr{G}, >) & \text{if } l \text{ is in } \mathscr{C} \end{array}$$

then the contraction of the applicability conditions of a legal rule r with respect to the context H corresponds to the following operation $D^-_{b_k}$ over D:

$$D^-_{b_k} = (F, G, R'^c, R^O, R^G, \succ', \mathscr{G}, >)$$

where

$$\begin{aligned} R'^c &= R^c \cup \{r : f_1, \ldots, f_m \rightsquigarrow \sim b_k\} \\ \succ' &= \succ - \{s \succ r \mid r \in R'^c - R^c\}. \end{aligned}$$

– *such that*

$$D' = (F \cup H, G, R'^{c}, R^{O}, R^{G}, \succ', \mathscr{G}, >) \vdash -\partial_G \neg g'$$

where g' *is the goal of any rule* $z \in R^{O}_{\mathrm{sd}}$ *applicable in* D' *such that* $g \not\succ g'$.

Remark 6. The applicability conditions of a legal rule should be contracted if the rule is applicable in the current context and it is violated by $\sim l$ according to Definition 9 (1) and one of the conditions 8, 10 and 11 of Table 1 is satisfied (2).

In Case 8 we have that the goal is violated not only by $\sim l$ but also by complying with the norm (a); moreover, there exists at least one of the antecedents of the legal rule which is used in all goal reasoning chains, in which either l or $\sim l$ occur, to prove $\neg g$ (the goal violation of the legal rule) (b). Thus, we have reasons to block the counts-as derivation of such an antecedent.

In Case 10, we have that the violation of the norm ($\sim l$) unexpectedly promotes the goal g of the norm, while compliance (l) doesn't (a); moreover, there exists at least one of the antecedents of the legal rule which is used in all goal reasoning chains, in which l occurs, to prove g (the goal promotion of the legal rule), while an antecedent is used in all goal reasoning chains, in which $\sim l$ occurs, to prove $\neg g$ (the goal violation of the legal rule) (b). Thus, we have reasons to block the counts-as derivation of such antecedents.

Finally in Case 11, we have that the goal of the norm is promoted independently from the fulfilment or violation of the norm (a); moreover the same as part (b) of Case 8 must hold.

If (1) and (2) hold, the normative theory can be contracted by adding defeaters to the rules which can make true the condition b_k identified in the (b) steps of the cases above.

As for the case of expansion, the resulting normative theory is however subject to the final constraint that no other more important goal g' of any norm would be violated ($-\partial_G \neg g'$).

Example 4. Let us simplify the normative theory of the Example 3 to illustrate Case 10 of Table 1. (The other cases of contraction in the table have a similar treatment.)

$$\begin{aligned}
F &= \{Enter\} \\
H &= \{Bike, Park\} \\
G &= \{\textbf{fast_circulation}\} \\
R^{c} &= \{r'_7 : Bike \Rightarrow_c Vehicle\} \\
R^{O} &= \{r_2 : Vehicle, Park \Rightarrow_O \neg Enter\} \\
R^{G} &= \{r_8 : Bike, Park, Enter \Rightarrow_G \textbf{fast_circulation}, \\
&\qquad r_{14} : Park, Vehicle, \neg Enter \Rightarrow_G \neg\textbf{fast_circulation}\} \\
\succ &= \{r_{14} \succ r_8\} \\
\mathscr{G} &= \{\mathscr{G}(r_2) = \textbf{fast_circulation}\} \\
> &= \emptyset
\end{aligned}$$

The facts in F and H make all rules applicable, with the exception of r_{14}. The violation of r_2, which allows for deriving $+\partial^{O} \neg Enter$, leads to promote the goal of this rule,

while the compliance implies the violation of the goal. Hence, conditions 1 and (a) of Case 10 in Table 1 are satisfied. The only literal we can contract is *Vehicle*, which occurs in the goal reasoning chain supporting $\neg$**fast_circulation** (*Bike* and *Park* are facts and cannot be removed). Thus, we can contract the applicability conditions of r_2 by adding a defeater $r_{15} : Bike, Park \rightsquigarrow_c \neg Vehicle$ and by stating that r_{15} is stronger than r'_7.

Note that the operations $D^*_{b_k,\ldots,b_{k+j}}$ and $D^-_{b_k}$ introduced in Definitions 12 and 13 correspond to special cases of AGM revision and contraction of conclusions in DL [3]. Indeed, under some preconditions, expanding the applicability conditions of a norm amounts to modifying the rules and the superiority relation even if the negation of one or more elements in $b_k, \ldots, b_{k+j}$ are derivable in D. However, due to the sceptical nature of DL, we still do not get a contradiction. On the other hand, under suitable preconditions, contracting the applicability conditions of a norm corresponds to preventing the proof of b_k. R'^c ensures that if b_k has been proven, a defeater with head $\neg b_k$ will fire. [3] provided a reformulation within DL of AGM postulates for revision and contraction: the results provided there can be trivially extended to our framework.

Theorem 2. *If preconditions 1, 2, 3, and 4 of Definition 12 hold, $D^*_{b_k,\ldots,b_{k+j}}$ satisfies the reformulation of AGM postulates for revision given in [3]. If preconditions 1 and 2 of Definition 13 hold, $D^-_{b_k}$ satisfies the reformulation of AGM postulates for contraction given in [3].*

6 Related Work and Conclusions

In this paper we proposed a formal method for modelling extensive and restrictive interpretations in statutory law. The contribution is based on the idea that the interpretation of legal concepts may require to change the counts-as rules defining them. Indeed, if our ontology does not classify a bike as a vehicle, but we have reasons that this is the case, then this implicitly leads to conclude that the ontology must be revised and that a bike, at least in the contexts under consideration, is a vehicle. In this paper we assume that a reason is a chain of rules (or better a tree) a set of premises (corresponding to the context) to the conclusion we want to support, and that we can revise it if there are defeaters in the chain that prevent a positive derivation of the conclusion. The operation we perform for expansion is to strengthen such defeaters to defeasible rules, while for contractions we simply introduce new defeaters. In the expansion case, the transformation of defeaters in defeasible rules allows us to derive the desired conclusion; in the case of contraction the new defeaters prevent its derivation, but at the same time they do not allow for the derivation of the opposite. The technique presented here is not the only possible; another option, not considered in this paper is to look again at chain of rules, and instead of changing the strength of the rules we can change the superiority relation (i.e., the relative strength of rules), as proposed in [9].

This revision operation presented in this paper are driven and constrained by considering the goal of the legal rules in which these concepts occur. To the best of our knowledge, there is no work so far devoted to the dynamics and revision of constitutive rules, and no proposal regarding how to model the interpretation of legal rules in these terms. In our perspective, it is possible to identify some interesting logical links between

the process of legal interpretation and AGM operations of contraction and revision in rule-based systems such as DL (Theorem 2). In addition, our work has the advantage of using a logical framework which is computationally feasible (see Theorem 1).

An extensive literature is devoted to legal ontologies (see, e.g., the survey in [6]), but it is oriented to develop applications in the field of semantic web and rule interchange languages for the legal domain, applications which are not our primary concern. Also, these approaches usually fail to deal with the defeasibility and dynamics of legal concepts.

The possibility to model legal and normative ontologies via constitutive rules has a solid philosophical backgrounds (see [20,19]). In the field of normative multi-agent systems, the only work which addressed the problem of the penumbra of legal concepts within a complete theory of counts-as rules is [13]. [13] provides very complex modal account of counts-as rules in which the problem of the penumbra is analysed here in terms of the notion of context. A 'penumbral meaning' is then nothing else but the set of individuals on which the contextual interpretation of the concept varies. However, [13] does not explain how the different extensions of a concept are related to the contexts depending on the regulative norm whose violation is discussed. In addition, what is lacking in that work is that it does not address the problem of the dynamics of constitutive rules and does not consider the role of normative goals in determining the applicability conditions of legal rules.

Several works in the literature of AI & Law have considered the role of teleological reasoning in the legal interpretation. Indeed, this idea is standard in legal theory and the goals of legal rules are recognised by jurists as decisive in clarifying the scope of the legal concepts that qualify the applicability conditions for those rules [2,17,21,14]. [2,17] use goals and values in frameworks of case based reasoning for modelling precedents mainly in a common law context. [21] analyses a number of legal arguments even in statutory law, which include cases close to the ones discussed here. The proposal which is closer to our contribution is [14]. In [14] Jaap Hage addresses, among others, the problem of reconstructing extensive and restrictive interpretation. This is done in Reason-Based Logic, a logical formalism that can deal with rules and reasons: the idea is that the satisfaction of rules' applicability conditions is usually a reason for application of these rules, but there can also be other (and possibly competing) reasons, among which we have the goals that led the legislator to make the rules.

All these approaches in AI & Law highlight the importance of rule goals, and [14], in particular, follows this idea to formalise extensive and restrictive interpretation. However, it seems that no work so far has attempted to couple this view with a framework for reasoning with counts-as rules and their dynamics. In this perspective, we believe that this paper may contribute to fill a gap in the literature.

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Legal Electronic Institutions and ONTOMEDIA: Dialogue, *Inventio*, and Relational Justice Scenarios

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Abstract. Since the seminal work by Perelman, Olbrechts-Tyteca, Toulmin, Ong, Giuliani and many others in late fifties and sixties, dialogue and argumentation have increasingly been at the center of philosophical discussions. Modelization of arguments and "argumentation schemes" constitute one of the main domains within the AI & Law field. The construction of Legal Electronic Institutions (LEI), and Ontomedia, an Online Dispute Resolution (ODR) platform in the context of the research carried out within the Catalan White Book on Mediation, has enhanced the discussion about fundamental issues on the theoretical approach taken in building such Web 2.0 and Web 3.0 tools. In this paper, I will address the question of how the content of ancient *stasis*, *ekphrasis* and *inventio* may be captured and reelaborated to define their theoretical backbones. I will call "relational justice" the conceptual legal framework in which Semantic Web strategies can be nested to offer a better user-centered service.

Paraules clau: argumentation, dialogue, dialectic, rhetoric, Semantic Web, ODR, Electronic Legal Institutions, *stasis*, *inventio*, relational justice.

1 Introduction

During the last year, the Institute of Law and Technology (IDT-UAB) and many other research Institutes and Universities in Catalonia are currently developing the Catalan White Book on Mediation.[1] Those are the preliminary works to draft a general statute introducing and defining mediation as a complementary dispute resolution tool for courts, local and regional administrations (municipalities and regional councils, e.g.), and social and economic institutions (such as hospitals, schools, consumer agencies or chambers of commerce).

This is a sustained effort covering many fields of law —divorce and family problems, adult and juvenile crimes, labor conflicts, consumer complaints, commercial disputes, etc. Technology is certainly an issue. It is one of the areas being explored to set up online tools to facilitate business, citizens, customers and consumers to solve, or at least better manage, their disputes before suing and going to the courts.

[1] See http://llibreblancmediacio.com

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A twofold strategy is being followed. First, in the spirit of the CONSOLIDER Project *Agreement Technologies*[2] and the COST initiative ICO801,[3] an automated protocol and negotiation prototype is under construction by Pablo Noriega and Carlos López using electronic institutions technologies [1]. Second, Ontomedia, a general platform for mediation services, is being developed within two adjacent national projects as well. Several objectives have been already reached. The state of the art of ODR services has been established and updated [2, 3],[4] and a preliminary middle-out mediation core-ontology is ready to be populated and worked out [7].

In this paper, I will reflect on the general purposes and theoretical background of these approaches to foster an interdisciplinary dialogue, and to open up the discussion to a broader audience. The paper is structured as follows. I will introduce, first, Legal Electronic Institutions (LEI) and Ontomedia. Section 3 and 4 will reflect on their theoretical grounds, linking both strategies with the revival of the ancient traditions of dialectics, rhetoric and logic. Finally, in section 5, I will introduce the idea of *relational justice* to make sense of the technology and philosophical grounds described in the previous sections.

2 LEI Strategy and Theoretical Approach

It may be quickly noticed that, in fact, there is not a unique generic platform under construction, but two. In what it follows, the two strategies and theoretical approaches will be briefly described.

2.1 ODR as Legal Electronic Institution

The prototype proposed by Noriega and López [1] is based on the notion of electronic institution (EI) and assembled through the EIDE tools developed in the IIIA.[5] It corresponds to an attempt to automate as much as possible the ongoing interaction flow between two sides within conflict scenarios. In this situation, a multiagent system (MAS) may perform several interactive moves towards an eventual agreement. The whole process is plotted in Fig. 1, assuming a standard of non-intrusive mediation, arbitration and some forms of negotiation, not necessarily mediated.

I will follow briefly now the authors' own description. For a more complete and detailed explanation, the reader is invited to go directly to [1].

Electronic Institutions (EI) assume that all interactions are among autonomous agents, and that all interactions among agents are speech acts (that *count as* actions in the world). Noriega and López mention three main EI components: (i) the dialogical framework (specifying the content and interpretation of the admissible speech acts); (ii) the performative structure (indicating how the interactions are organized within the institution); (iii) the *rules of behavior* that put *constraints* on the actions (illocutions) that individuals who are playing a given role may take at some point in the enactment.

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[2] http://www.agreement-technologies.org/

[3] http://www.agreement-technologies.eu/

[4] "None of the service providers reviewed seems to have truly sophisticated ODR technologies like the ones reported in academic *fora*." [1]. See the previous technical reports by Stranieri, Yearwood and Zeleznikow [4], Tyler and Bretherton [5], and Thiessen and Zeleznikow [6].

[5] http://e-institutions.iiia.csic.es

When an EI is entitled to perform legal acts, or at the end of successive steps may produce a result with legal value, or an agreement that can be alleged in Court or before other appropriate ruling institutions, we face an Legal Electronic Institution (LEI). LEIs pose some interesting problems to the current legal theory that can be treated separately. I will not go deeper here.

The authors show the complete *performative structure* of a mediation institution in Fig. 2, where the first box and the last one correspond to scenes and dark boxes correspond to mediation activities: (i) a scene where the claimant chooses the type of negotiation she wants to use, (ii) four different negotiation conventions, (iii) a scene for standard non-intrusive mediation, (iv) and two ensuing scenes for arbitration and recommendation.

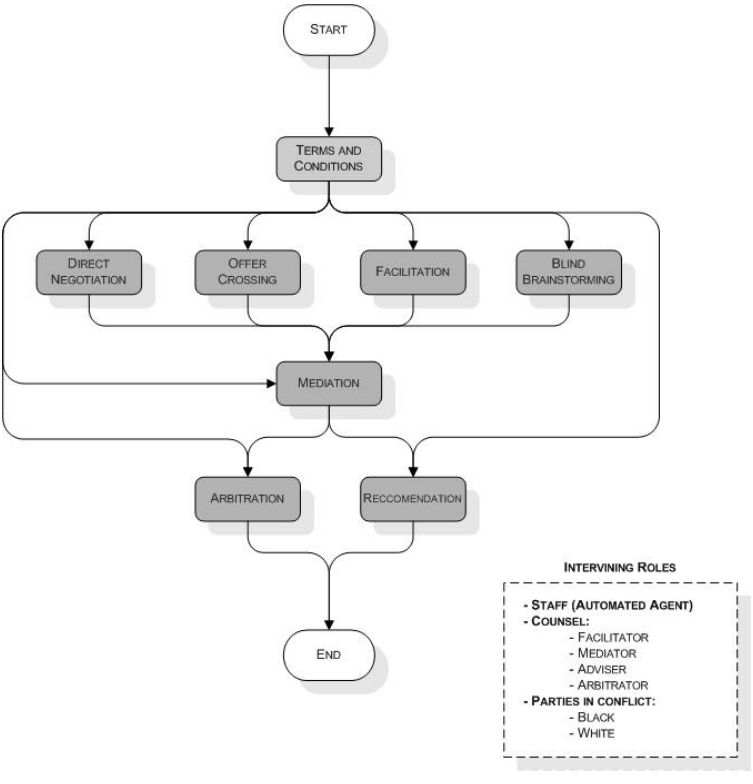

Fig. 1. Prototype structure. Source: [1].

The two starting and ending boxes start and terminate enactments. Lines connecting boxes (and widgets) indicate transitions, labeled with the roles that may move from one scene to another. In this particular institution three roles have been modeled: *parties* (the two sides of a mediation process), *staff* (taking care of institutional functions like time-keeping or record handling) and *mediator.*

It may be noticed that this performative structure allows different institutional ways of ODR (negotiation, mediation, arbitration) following iterative cycles. However, it is

not necessary to complete one full cycle (e.g. negotiation). It may be possible to go directly to the arbitration process, if this is the case.

The important point is that in each separate box may be nested an autonomous argumentative process between the parties. This process may contain procedural rules which can be (at least partially) operated trough automated reasoning inferences.

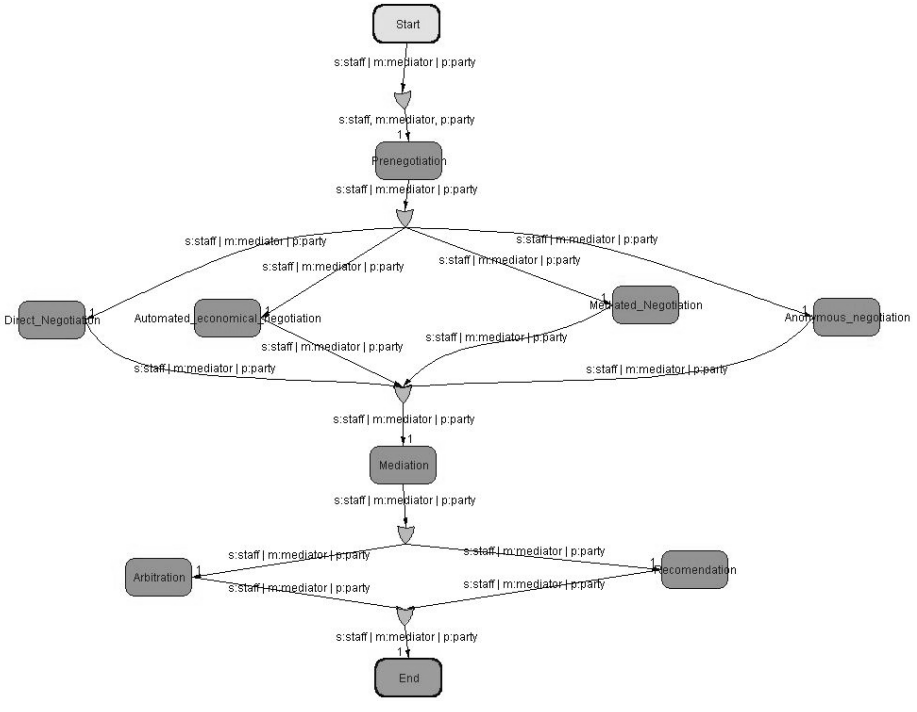

Fig. 2. Performative structure of a Legal Electronic Institution. Source: [1].

2.2 The Ontomedia Strategy

Let's go to the second model, now. Ontomedia follows a different strategy, a user-centered approach which takes into account a more restricted definition of negotiation and mediation as ODR institutional devices, following the spirit of the EU Directive 52/2008.[6] It is not intended, at least primarily, to cover conciliation or arbitration

[6] Art. 3.a. "'Mediation' means a structured process, however named or referred to, hereby two or more parties to a dispute attempt by themselves, on a voluntary basis, to reach an agreement on the settlement of their dispute with the assistance of a mediator" ; art. 3.b. 'Mediator' means any third person who is asked to conduct a mediation in an effective, impartial and competent way, regardless of the denomination or profession of that third person in the Member State concerned and of the way in which the third person has been appointed or requested to conduct the mediation." It is worth to mention R. (9): "This Directive should not is in any way prevent the use of modern communication technologies in the mediation process."

issues. They are not excluded of the underlying model, but what is intended to build up is a multi-layered and indirect strategy to assist either lay or professional people in their dispute resolution processes. This is a platform to be used by citizens, administrations, institutions and professional mediators as well.

In a nutshell, Ontomedia will allow users and professionals to meet in a community-driven Web portal where contents are provided by users and annotated by the ODR Web Platform [7, 8]. Its usability is tailored on the domains previously identified within the Catalan White Book: commercial and business disputes, consumer complaints, labor conflicts, family, restorative justice (adult and juvenile mediation in criminal issues), community problems, local administration, health care, environmental management, and education.

It is worth noticing that to the extent that these are broad domains, the platform is conceived as generic. However, the means used to solve or manage a conflict are close up to the nature of the conflict. In a quarrel among teenagers in a high school, race, culture, family and class may constitute separate issues. The dispute components may be different from those in a contract-breaching problem between providers and consumers. A collective quarrel about the placement of a new mosque—not an infrequent social problem in Spanish towns—usually requires different interventions and several negotiation techniques in addition to mediation. To the extent that such conflicts may need a set of different negotiation tools, the use of an online platform requires different functionalities linked to a previous definition of the available tools. This is usually called a "bus of services" or "service bus" [7, 8, 9].

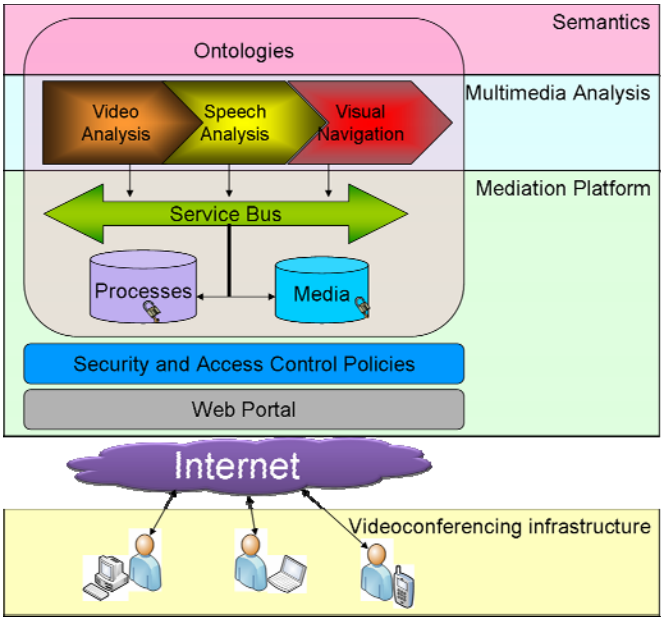

Fig. 3. Layered Diagram of Ontomedia Mediation Platform. Source: [8] [9].

Citizens (both professionals and users of mediation services) may use any kind of device to access the portal (computers, mobiles), and in any format suitable for their purposes (text, speech, video, pictures). We are confident that this flexibility will allow users to participate in mediation services as in a face-to-face basis, but with the advantages of distributed and even remote access.

Some ontologies are being constructed to annotate all kind of contents and also to help analyze multimedia content (see Fig. 3). The multimedia analysis is devoted to enhancing the information a mediator possess during a mediation session, capturing mood changes of the parties and any other psychological information that can be useful for mediators, just as if they were in a room with the users of the mediation service. All types of metadata can be automatically extracted and stored to be further used within the mediation process (provided the previous authorization by users).

Ontomedia will also develop tools to encourage users to exploit the advantages of sharing information and experiences with others. In this way, users have the possibility to tag and store content that are useful or interesting to them, and to find similar cases. In doing so, they can create social communities of people with common interests.

2.3 Inner and Outer Strategies between Web 2.0 and Web 3.0

Conceptual models underlying strategies for the mediation LEI and Ontomedia are not incompatible, and they may be envisaged into the broader framework of the second generation of Semantic Web developments.

Both may comply with the features pointed out by Motta and Sabou [10, 11]: (i) reuse (vs. semantic data generation); (ii) multi-ontology systems (vs. single-ontology systems); (iii) openness with respect top semantic resources, (iv) scale as important as data quality, (v) openness with respect to Web (non-semantic resources), (vi) compliance with the Web 2.0 paradigm, (vi) openness to services.

LEI may incorporate the necessary flexibility to be interoperable and nested into a structure such Ontomedia. Easy and friendly access to justice can be offered through the so-called "Web of data".[7] The usage of RDF Schema (RDFS) and the Web Ontology Language (OWL) allow the inference of relationships between data in different applications or in different parts of the same application. Objects, and not only websites, can be directly linked among them. Diagram of Fig. 4 shows a simple way to draw the encroachment between both LEI and Ontomedia. I have developed elsewhere what it does mean for future developments of law [13]. I have lean on recent work from James Hendler to analyze the link between the two approaches (Fig. 3). The first one remains highly theoretical, on top of the intertwined Webs 2.0 and 3.0, but able to be nested within the Ontomedia environment. The second, on the contrary, offers a park of legal services on mediation.

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[7] "RDF Schema (RDFS) and the Web Ontology Language (OWL) provide the ability to infer relationships between data in different applications or in different parts of the same application. These Semantic Web languages allow for the assertion of relationships between data elements, which developers can use, via custom code or an emerging toolset, to enhance the URI-based direct merging of data into a single RDF store" [12].

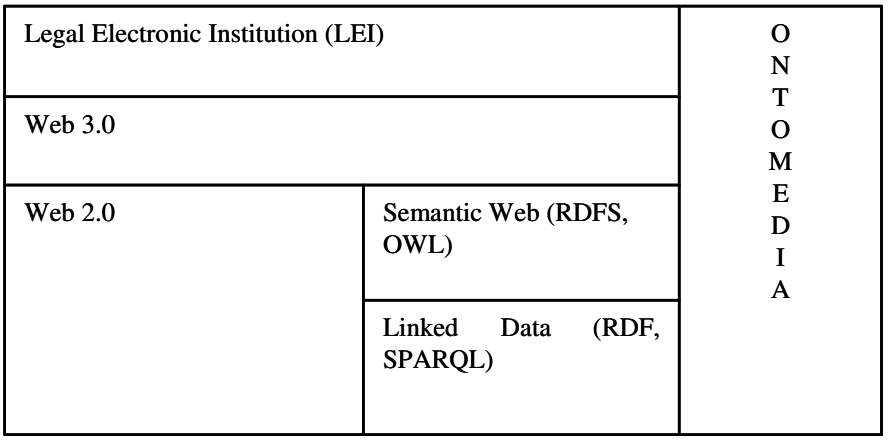

Fig. 4. James Hendler's diagram. Source: [12], modified by P.C.

3 Discussion: Dialogue, Dialectic and Rhetoric

I will split up the discussion of the legal philosophical groundings of these models in two different parts. For the sake of clarity, in this section I will consider the general foundation for dialogue, and the revival of dialectic and rhetoric in argumentation and philosophy of law. Section 4 will face the pragmatic developments of such a revival.

It would be naïve to link the whole conception to a single philosophical source. LEI models follow previous theoretical approaches made by Douglas North (on institutions) [14], Cristiano Castelfranchi (on rationality, and normative and interactive behavior—trust, deception…) [15], and John R. Searle (on speech acts and social institutions) [16]. Collective properties emerging out of the process, and the accurate conceptual representation of the whole process (e.g. turn taking, decision making, iterative cycles, and final move forward…) are taken into account.

It seems to me that the disputation model figured out by Noriega and Lopez fits nicely into the main flow of contemporary argumentation theory and formal dialectic systems. However, it should be immediately noticed that the main structure of the proposal is not necessarily related to automated reasoning, but rather to the way of conceiving the architecture of the system of dialogue interactions.

3.1 Dialogue Systems

Dialogue systems built up in the AI & Law domain use to be symmetrical, iterative, cyclic and procedurally-driven [17]. Legal procedural rules have received a privileged attention [18], and their main requirements are defining the parties, describing their positions, and setting a controlled step-by-step process to manage the disputes. The ODR model recently presented by J. Zeleznikow, A. Lodder and E. Bellucci [19, 20, 21] is following this well-trodden path too. It combines game-theory, case-based reasoning and the Harvard model for dispute resolution (BATNA) to offering advice in divorce situations.

The main dialogue structure assumed by all these developments comes from the ancient dialectic and has been described several times by D. Walton [22, 23] as the "fundamental building blocks" of any dialectical system: (i) the two participants, called the proponent and the respondent, (ii) the types of moves (taking the form of various speech acts) that the two participants are allowed to make, as each takes his or her turn to speak, (iii) the sequence of moves, in which the appropriateness of each move depends on the type of preceding move made by the other party, (iv) the goal of the dialogue as a whole.

Walton identifies four kinds of moves in such systems: (i) the asking of questions, (ii) the making of assertions, (iii) the retracting of assertions, and (iv) the putting forward of arguments.

Similarly, dialogue types may be classified according to their main objectives as follows: (i) persuasion, (ii) inquiry, (iii) negotiation, (iv) information-seeking, (v) deliberation, (vi) eristic. These types of dialogue would proportionate the main scenarios in which different dialogues may take place.

From a legal point of view, stemming from a goal-oriented approach, Sartor has expanded this taxonomy adding three more types of dialogue: (i) epistemic inquiry, (ii) practical inquiry, (iii) and reconciliation [24].

This means that such a structured valued framework —more specifically, a teleological notion of law as a cognitive technology being organized through a valid normative system— may determine the structure of dialectic interactions.

Sartor's position is far from simple. The thesis is "that legal reasoning has a collective (interactive) dimension, in regard to which diverse dialectical patterns may be required, according to the goals to be achieved and the context in which they are to be pursued" [24].

I would say that this collective, interactive dimension, especially if it is produced through the Internet, is a regulatory one. There is a regulatory order that emerges out from the interactions. However, not all regulatory patterns are "law" or "legal" in the normative sense. Law components, as we know them so far —i.e., rules (norms), statutes, judicial decisions, rulings, and legal rights and duties— have to be combined with social emergent patterns of behavior and social rights and duties to operate through the Web. Governance, soft-law, reputation systems and, especially, trust, are not mandatory elements. Dialectic systems and argumentative models have to represent conceptually this kind of hybrid, mixed, mashed-up scenarios as well if they are going to be used or taken into account.

3.2 Dialectic, Rhetoric and Logic

This is linked to another line of arguments. But I should warn the reader at this point that I will follow a historical thread. Only at the end I will come back to the mediation models. The main scope of this historical turn is setting a broader interpretative legal context on dialogue and law in which our proposals may acquire an added sense to be properly understood and evaluated.

It seems to me that Walton and Sartor's taxonomies, and the procedural way in which they face the modeling of dialogues, are deeply rooted in a conception of reason that stems from the classic (and complex) relationships between logic, dialectic and rhetoric. It has been observed many times that ancient dialectic and rhetoric have

a strong legal flavor. Dialectic mirrors legal dialogical controversies, and ancient rhetoric, as it may be found e.g. in the works by Cicero and Quintilian, mirrors speeches in judicial settings [25, 26].

Leff [27] sketches four points of contrast between the two disciplines: (i) dialectic deals with general, abstract issues, rhetoric with specific, circumstantial issues; (ii) dialectic considers the link of propositions and follows logical rules of rationality, rhetoric considers the relationship between propositions and situations and follows rules (or norms) that refer to appropriate social relationships; (iii) dialectic proceeds through question and answer (and the interlocutors seek to persuade each other), rhetoric proceeds through a flow of uninterrupted discourse, and the speakers seek to persuade the audience; (iv) dialectic employs a technical language, rhetoric uses plain natural language for persuasive purposes.

This is a schematic, but still useful summary to realize the complexity of the issue. Regarding logic, Aristotle and the ancient tradition tried to maintain separated reasoning related to truth, dialogical reasoning regarding opinions and beliefs, and the places or *topoi* regarding the ways in which these beliefs are conveyed and shared (that is to say, rhetoric). The medieval tradition played endlessly with those distinctions, until the coming of Humanism in the 15th, 16th and 17th centuries. Conflicts, disputes, controversies, were placed at the center of this *ars discendi et disserendi* [28].

It is generally accepted by historians of philosophy that the humanist tradition of German, Dutch, English and Italian Universities [29, 30, 31] worked out the Greek and Latin texts and mixed up the medieval syllogistic logic (e.g. from Petrus Hispanus) to elaborate an educational discourse, more adapted to everyday life, to social and economic new problems, and to the structures of political power of the recently born European states. Even the Catholic and Imperial Spain, crashed under the Inquisition, received their impact [32, 33].

Dialogue emerged at the beginning as a new framework to contain the classical *topoi*; and, in this way, logic became a part of dialectic. That is to say, inner discourse with the soul could convey truth (and not only beliefs), and outer discourse could reflect the moves of what was intended as "thought" (and not only language). Rhetorical speech (*verba*) was the way to concrete this thought in different dramatic, legal or political scenarios [28].

There is a string line going from the works by Agricola, Melanchton and Sturm, to Talon and Ramus [34, 35]. This common thread was cut up with the violent defeat of Ramism and the Jansenist Logic of Port Royal under the Ancient Régime. But it was weaved by protestant countries and transferred into the common law [36, 37].

Interestingly enough, the subject/object philosophical approach was reversed in this long history, as the judicial object was.[8] Paradoxically, it was the influence of Ramism into judicial procedures what excluded the discussion of facts out from dialogue and left them entirely to the decision of an authoritative judge. As W. Ong [39],

[8] Pozzo [32] has shown convincingly how the pair of Greek concepts 'subject' (*hupokemeinon*) and 'object' (*antikemeinon*) actually mean the opposite of their post-Cartesian usages. The former refers to what we call today a formal approach (the logical mind), and the latter to the investigative activity of senses (the subjective conditions of experience).

C. Perelman [40] and A. Giuliani [37], among others, explain, a judicial *asymmetric order* would substitute to the *isonomic order* of ancient dialectic.[9]

It would be worth noticing here that almost all the discourses on the revival of ancient dialectic and rhetoric in the second half of the 20th c. escape the response to the question of what happened in between with the topics of legal dialectic and rhetoric during the 18th and 19th centuries. This is surprising, because we have detailed accounts on humanistic and rationalistic thought. It seems that dialogue had just disappeared from legal and political theory.

Still, this is not an easy issue. However, at least regarding to legal reasoning, the answer could lie on the prevailing of syllogistic judicial reasoning after the Code de Napoleon (1804), and the coming of the German Historical School, Pandectas and the conceptualist schools of law. The answer points then to the establishment of a new political and administrative form of government called *Rechtstaat*, *État de Droit*, *Estado de Derecho*, *Rule of Law*, in which the old *topoi* were subjected to the procedural ring of constitutions and systems of legal norms. However, as Tocqueville early noticed [*L'Ancien Régime et la Révolution*, 1856], all the legal administrative apparatus (including the judiciary) of the legal state built up in the *Ancient Régime* would remain along the Enlightenment and the 19th century.

3.3 The Legal Methods

I will pursue elsewhere this historical explanation [41]. The point I would like to stress here is that, with independence of the guaranties, constraints and requirements of the judicial decision, the modern state, and not society, community or individual interactions, built up the main framework for the setting, procedures, roles and development of legal arguments. Under those conditions, arguments, *topoi*, places and reasoning were bound to be put under a legal *interpretation theory* (the legal content of *Sätze*, *Instituta, Normen* or rules addressed to an authoritative judge). "Legal method" or the "science of law" were the umbrella under which this interpretative turn took place.

In this way, from Savigny, Puchta, Jhering and Gerber (19th c.), to Gény, Jellinek, Kelsen and Hart (20th c.), dialogue was definitively excluded from law and legal theory, and left to the more "insecure" domain of political arena or private economic markets. Decisions were placed under a set of norms which would constitute the choice for a judicial syllogism, based on the burden of proof and the consistency of a non-contradictory argumentation as warrants or pre-requisites for the judicial induction —assigning probable truth values to inferences sorted out from premises containing insufficient information.

Along with fallacies, these constitute precisely the points chosen by Walton to reelaborate the problem of innovation and creation of new arguments [23, 42]. This goes directly to the core of one of more pervasive and persistent problems of cognitive sciences and philosophy. How the potential creativity of the mind can be described and explained? Are there rules or patterns to be followed for innovation? Or, as the ancient philosophy would put it, how can be filled up the gap between rhetoric and logic?

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[9] « Puisque la preuve judiciaire n'est pas différente de la preuve scientifique. Il faut que controverse et dialogue soient exclus du *procès* ; la 'questio facti' —considérée comme autonome par rapport à la 'questio iuris'— est confiée tout court à l'arbitrium iudicis » [37].

4 Discussion: Pragmatics, Mediation, and Innovation

Argumentation schemas may be defined as "forms of arguments representing premise-conclusion and inference structures of common types of arguments" [43]. For Walton's "new dialectic" the old *topoi, loci* or *places* constitute "defeasible argumentation schemas" to be combined and aligned to produce a full chain of reasoning. Argument schemas are presumptive and open to revision and change.

As we will see, these inferences are conceived to be "rationally binding" between the participants engaged in any dialogue [42]. This approach fits particularly well in a judicial perspective, in which either the judge or the lawyer have to find new and convincing arguments to sustain proof. According to Walton's proposal, the gap between logic and rhetoric may be filled up leaning gradually on the identification, analysis, and evaluation processes (dialectic), and on the innovative one (rhetoric). Heuristics are used to find new arguments, but the crucial point is called *dialectic relevance*, a method of chaining both forward and backward to get the chain of argumentation to match up in the middle [23, 42]. The whole process is recursive and iterative, going from (i) acceptable premises to (ii) rules of inference, and (iii) a chaining recursive device. Diagrams may be plotted for visualization.[10]

4.1 Dialectic Systems and Pragmatics

Dialectic relevance is not the only way proposed to connect truth and persuasion. There is another tradition to be taken into account. Models by Sartor, Walton and Lodder lean heavily on logic (dialectic). On the contrary, the second set of models stems from pragmatics and focus on communication.

Pragma-dialectics is an approach to argumentation which tries to combine both perspectives, but leaning on the use of language for resolving disputes [44]. Walton's pragmatic perspective on conversation tries to deepen into it to reconstruct the propositional content of the hidden or tacit arguments of both sides: their "argumentative reasoning patterns" [43]. On the contrary, the Pragma-dialectics school (van Eemeren, Grootendorst, Jackson, Jacobs…) lean on the techniques of practical persuasion. They define dialectics as "a method of regimented opposition" in verbal communication and interaction "that amounts to the pragmatic application of logic, a collaborative method of putting logic into use so as to move from conjecture and opinion to more secure belief" [44]. Therefore, they are much more interested in the effects of communication than in its truth. They consider three different aspects of "strategic manoeuvring": (i) the *topical potential* associated with a particular discussion stage, (ii) the *audience demands* in this stage, (iii) the *presentational demands* appropriate for the moves made in that stage.

It is worthwhile to mention here that we owe to the works carried out by Jackson [45], Jacobs [46], and Aakhus [47, 48, 49] some detailed accounts of mediation experiences and practices. The new wave of Pragma-dialectics faces the "pragmatic reconstruction" of arguments[11], the "collaborative design of the disagreement space", and the types of rationality that mediators employ in interpreting conflict situations

[10] http://araucaria.computing.dundee.ac.uk

[11] "The hallmark of pragmatic reconstruction lies in the way a form of argumentative dialogue is tailored to circumstances of the dispute in order to achieve a particular type of outcomes" [47].

(critical discussion, bargaining, and therapy). "We do not take the central problem of pragmatics to be how communicators assign functional meaning to specific messages or disambiguate speaker intention, but how is that people mutually negotiate social activity with language and thus participate in everyday life" [50].

4.2 Inventio and Judicium

Both ways to tackle innovative arguments have their roots in dialectics and rhetorics. However, it seems to me that this second perspective takes more into account the shift of Humanist tradition we mentioned before, and more specifically, the discursive side of Agricola's notion of dialectic.

Rudolf Agricola (1444-1485) set a phenomenology of language and speech which originated a revolution in the way old rhetorical texts were interpreted [51]. We may find in his major contribution, *De Inventione Dialectica Libri Tres* (1479) at least five new starting points that lead to an abductive notion of interaction and reasoning: (i) human interaction as a negotiated and complex shared dialogical object (ii) thought as a product of discourse (speech), (iii) cognitive and emotional empathy as the basis for a common human (inner and outer) understanding, (iv) context as a shared sequence of already known scenarios which help the selection of features given to a term to produce meaning, (v) discovering as a collective process to build a systematic path through dialectic from the known to the unknown.

We usually find in the literature on Agricola that his notion of *place* and his taxonomy of topics would allow him to reason in a new pedagogical way, but through the syllogistic "middle term" that would relate his logical perspective to the Middle Age and not to the formal developments of Descartes and Leibniz.[12] Agricola extends the scope of dialectic to include all kind of (reasoned) discourses, and the places of dialectic to the level of concepts. Doing so, his philosophy attends less to the truth and validity of arguments than to their effects.

This is right. But we may interpret it as "psychologism" or, from a cognitive science perspective, as closer to contemporary notions such as "schema", "script", "folk model", "category" and "difference".

As it is well known, the art of rhetoric was divided in five parties: *inventio*, *dispositio*, *elocutio*, *memoria* and *declamatio*. During the Renaissance, *Inventio* was situated as the first part of dialectics, while its second part, *judicium,* was supposed to temper, modulate and guide in a syllogistic manner the subject matter discovered or created in the first one [51].[13]

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[12] See e.g. [39], following Bochenski.

[13] "The instrument of 'inventio' was one of the main tools of classical rhetoric, and paired with *judicium*, it was the first and most important of the five parts of classical rhetoric. It was the art of finding and searching suitable ideas, reasons and arguments for a specific purpose, by using the search formulas 'topoi' or 'loci'. These 'arguments' were intended to approach the truth as closely as possible, and were often classified according to the dominant means of persuasion: by employing reason or logic (logos), arousing emotion (pathos), or demonstrating trustworthy character (ethos). But the instrument of *inventio* did not so much intend to lead the user to new metaphysical insights; is purpose was of a more practical nature, it was designed to produce an object or work: a poem, a speech, an emblem or proverb, etc…" [51, esp. chap. 2].

Agricola argues for an extension of places or 'seats of arguments' related to the nature of language "by whose instruction as if by signs of some sort [*velut signis quibusdam*], we surround the mind with the things themselves and thereby perceive what is in each thing both probable and suitable to the purpose of our discourse" [Inv. I, 1], "A place therefore is nothing else but a certain common characteristic of a thing [*communis quedam rei nota*], by observing which all that is probable about a given thing can be discovered. Let then a place be so defined by us." [Inv. I, 2] [52, 53, 54].

4.3 Stasis and Ekphrasis

Stasis (*status*) is the proper manner of discovering the question to be answered in every situation. *Ekphrasis* (*descriptio*) is the ability to elicit suitable contents on any subject from any of the places: the description of one term relatively to another to discover agreement and difference.

Status, in the classical rhetoric of Hermogenes, Cicero, and Quintilian, intended to define the different stages of a judicial plea between accusation and defense. It was translated into the common law tradition as *issue* (e.g. by Thomas Wilson and Blackstone), although this legal term does not express exactly the original meaning [55]. First, the *status* was supposed to give the litigants an understanding of their dispute through a categorization of the conflicting statements. But it indicated too the disposition to reason and to debate what the conflict was about.[14] There is a procedural *dynamic* within the status.

We should emphasize here the visual or pictorial side of the arguments as conceived dialectically: *ekphrasis* is the graphic or discursive description in visual terms of *stasis* [56]. People, literally, may *see* in one single shot the object of dispute and the content of the arguments used to describe their positions and to eventually solve the issue at dispute.

To Agricola, language, but also the interactive capacity of the mind to recognize and understand other minds, are extraordinary important to depict this narrative object and to convey emotions: "To me an emotion seems to be nothing else but a certain impulse of the mind by which we are driven to desire or avoid something more intensely than we would in a calm state of mind. Every emotion, therefore, arises from interest in objects of desire or avoidance. We desire whatever things are in fact or in appearance good, and we avoid those which are, or are felt might be, harmful. *Nor are we moved only by those things which we think are good or bad for ourselves; we also grieve, rejoice, become angry or sad because of the situation of another.*" (emphasis added) [De Inv. III.1] [52]

5 Relational Justice: Dialogue, Abduction and Reasoning

There are several ways to understand the old tradition of dialectic and rhetoric from contemporary theory of argumentation. Logical, rhetorical and dialogical approaches are usually considered as theoretically different [57]. *Stasis* and *ekphrasis* may be

[14] "The suggestion that the *status* or issue had to be *espied,* that it was not given, that questions required work, that, for issue to be joined, much debating was sometimes necessary is characteristic of the common law pleading tradition." [55]

considered from the dynamics of the strictly judicial point of view [26], in which the issue at stake is identified with the object of dispute, or from a broader perspective, in which *stasis* is produced through an abductive process of reasoning among the different parties [55]. Similarly, it seems to me that the old notion of *ekphrasis* may be (partially) captured by the notion of *visual abduction* [58].

5.1 Mediation as a Transformative Process

Context, environment and possible argumentation scenarios constitute a big issue. There is a common trend towards *normativity* in the contemporary argumentation theorists: (i) implicit contexts considered as norms within the language and discourse [59, 60], (ii) implicit contexts linked to types of dialogues that guide the functioning of dialectical relevance [22, 23], (iii) implicit contexts linked to the notion of practical reasoning and intention [24], (iv) implicit contexts linked to the environment of Multi-Agent Systems, where actions of electronic agents shape a social and institutional behavior [15] (v) implicit contexts linked to a pragmatic normative version of dialectic, in which "dispute mediators, in the course of their work, perform normative construction like a critical analyst" [49].

Perhaps the legal perspective of the old rhetoric still weights in the way norms are conceived. However, with mediation processes in mind, the construction of the "inner" and "outer" environments through dialogue—in Herbert Simon's sense [61]—is not a predetermined task. In a mediation process, in real conflicts, contexts may shift within types of dialogues, and they cannot be easily categorized as belonging to a single type. Imagination, or "moral imagination", as Paul Lederach puts it, is an essential feature of mediators [62]. Listen to this narration from a professional mediator:

> Two guys take a car after having a drink. The guy who was driving was not the owner of the vehicle. The car went up in fire and the driver could get out and save his life. The other guy died. The mediation process takes place two years later between the mother of the dead guy and the surviving driver. He asks for mediation. The mediator (a woman) ought to understand de conflict first, and she prepared the individual session with the mother. The key questions were: *How do you feel? Because I believe that you blame yourself, while everyone knows that you are not guilty at all; who are you angrier with over the death of your son?* She cried for more than 30 minutes, and so did the mediator. They embraced each other. They went for a coffee. In a week there was no more need for mediation. She could rebuild again her relationship with him without being helped, and she could accept as well the therapy that she had been rejecting so far.[15]

Some of the taxonomies built up to capture these transformative features reflect this creative character, especially in hard cases of restorative justice [63]. Victim-offender mediation styles may be also combined to form typologies of dialogue, depending upon the ordered preferences of the different styles: (i) *therapeutic* (mediator-conducted), (ii) *empowerment* (victims' healing, offenders' assumption of responsibility), (iii) or *narrative* (management of the memories and expression of feelings) (Fig. 4).

[15] I thank Maria Munné (mediator), for writing down this personal communication.

	Type I	Type II	Type III
Rank OF*	Therapeutic	Narrative	Empowerment
Rank OF	Narrative	Empowerment	Narrative
Rank OF	Empowerment	Humanistic D.	Therapeutic
Examples	Canadian VOM	Humanistic Mediat. Dial.	Ohio VOD

* Rank Ordered Foci

Fig. 5. Victim-sensitive Offender Mediation Typology. Source: Adapted from [64]. Umbreit, Bradshaw and Coates were reporting on crimes with severe violence.

5.2 Ontomedia and LEI

Let's go back now to the models underlying Legal Electronic Institutions and Ontomedia. After the examination of some of their philosophical foundations, our conclusion is similar to Leff's assertion: "In sum, neither the rhetoric of effective persuasion nor the logic of rational persuasion should adopt theoretically purified goals." [27]

Fig. 6 shows how LEI and Ontomedia strategies may be related. The rational side of dialogue an its discursive, expressive or emotional side are understood not as separate sets of discrete entities but rather as a *continuum* covering intertwined processes and outcomes. The link between *inventio* and *judicium*, or between the propositional content of assertions and creative innovative moves, can be assumed following the same *continuum* line.

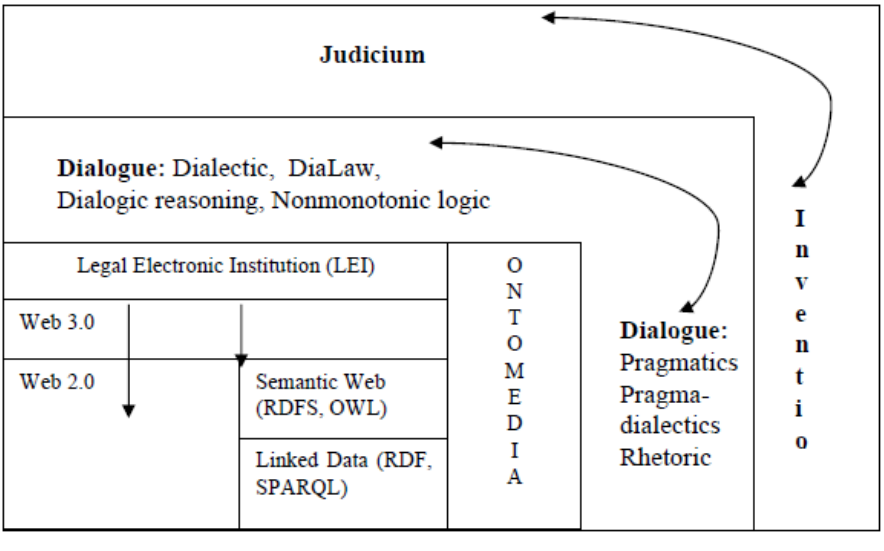

Fig. 6. Dialectic and rhetorical links related to LEI and ONTOMEDIA

This *continuum* is not meant to equate eclectically different theoretical trends. Differences can and should be maintained. Contemporary argumentation theories closer to the dialectic approach tend to assume speech act theory, felicity conditions and rules of inference, combined with some heuristics. Non-monotonic logic is usually applied leaning on Toulmin's shoulder. Pragma-dialectics, on the contrary, lies more on the heuristic side of rhetoric and explicitly rejects speech act theories based on non-situated or unbound conditions [50]. Still, Ducrot's notion of *argumentation dans la langue* leads to a semantic notion of pragmatics in which every utterance has an enunciative and argumentative value [60].

However, LEI and Ontomedia may adopt different notions of pragmatics and different pragmatic approaches as well that may be combined and operated according to the chosen functionalities.

Ontomedia adopts a user-centered approach, in which the professional mediator may chose among a box of tools to perform her work. LEI tends to guide the user through a process that automates the procedural parts of mediation through successive stages.

5.3 Web 3.0 and Relational Justice Scenarios

Justice, reason and argumentation have been linked to power since the beginning. It would be naïve, then, trying to understand the functions, intentions and meaning of Greek and Latin literature on the subject without any understanding of the underlying principles of ancient societies. To put only one example, the Aristotelian notion of "distributive justice" is better understood through some notion of the market (or "proto-market") in which distributive problems arose and the concept was coined [65]. Recent empirically-based studies on organizations state clearly that "justice and power are intertwined: one cannot really understand justice dynamics without understanding power dynamics and vice versa, because the concern for justice acts check on the use of power" [66].

As I showed before, conflict and argumentation as we know them today are linked to the emergence of the modern state. Legal reasoning has been historically shaped as well through concepts, procedures and structures related to a kind of judiciary often tensioned by the king and parliamentary powers. Not surprisingly, rhetoric and reason in the 16th and 17th centuries are linked to the emergence and counterbalance of *raison d'état* [67, 68].

Therefore, Ontomedia and LEI cannot be conceived in a vacuum, but having into account that new scenarios of conflict resolution and management are arising in the broad technological environment of the Internet. It is my contention that the implementation and use of technology changes the nature of law, in any way we may conceive it. Through the Internet environments, law cannot be defined solely as related to the national state or even to the institutions of the Rule of Law, but to all the regulatory devices at stake, including languages, protocols, electronic agents and reputation systems.

Therefore, disputes, controversies, and conflicts may be better represented and nested as *scenarios of relational justice*. In computing, a scenario is a representation of the types of interactions end-users will maintain with the system, the way in which the system faces the interface with them in their daily activity. In the case of Ontomedia, the

different domains from the White Book on Mediation (health, education, family, consumers' complaints, and so on) are being used as scenarios. What these scenarios have in common is that they have been chosen and constructed in social fields where some experiences on mediation and Alternative Dispute Resolution (ADR) have already arisen.

This means that these are fields in which some conflicts (social, political or economic) have originated some kind of social bottom-up resilience to fix the problem. In some cases as well, increasingly, administrations have reacted to give the opportunity to citizens to maintain a more effective interaction with them. In both cases, some forms of Online Dispute Resolution can be (or have been already) adopted. Therefore, we have chosen a middle-out strategy as ontological methodology, and we have situated our intervention under the label of *relational justice*.

I broadly define *relational justice* as *the justice through the Internet*, that is to say, by means of a technological framework in which controversies, disputes, conflicts and litigation may be managed (and sometimes solved) online, or in a mixed combination of economic, social or political organizations and institutions [3, 13]. It is important to keep in mind that these *scenarios of relational justice* do not belong exclusively to a virtual reality, but rather to the interface between the Web and the real world. Therefore, they may be used in several ways, and systems and platforms may contain a set of tools to be used only in a single phase of the conflict or in some steps of the process.

6 Conclusions and Further Work

I have briefly examined in this paper the rational grounds for the two strategies for ODR being followed in the context of the Catalan White Book on Mediation. Several historical threads have been followed to understand the roots of the revival of argumentation theories. I have argued that history has to be taken in a whole, explaining the contexts in which models of state and legal methodology emerged.

I have showed how dialectical and rhetorical traditions may be assembled to produce a technological outcome.

Rationality is another issue. Normative approaches can be tempered with a vision of rationality taking into account the expressivity and creative heuristics of the stakeholders [69]. It is worth to point out that at the present level of Web 2.0 and 3.0 developments, rationality is affected by the integration of data. This will have an impact on the original models of dialectic, rhetoric and argumentation.

E.g., scalability affects reasoning: "[…] because the Semantic Web combines heterogeneity, variable data quality, and scale, the applications we envision will exhibit intelligent behavior owing less to an ability to carry out complex inferencing than an ability to exploit the large amounts of available data. That is, as we move from classic KBSs to Semantic Web applications, intelligence becomes a side effect of scale, rather than of sophisticated logical reasoning. An important corollary here is that, as logical reasoning becomes less important and scale and data integration becomes key issues, other types of reasoning —based on machine learning, linguistic, or statistical techniques— become crucial, especially and because they frequently need to integrate and use other, non-semantic data" [11].

These conditions concerning the Web environments have to be integrated in the design of platforms and tools.

Finally, in the next future, use cases and cognitive walkthroughs will be developed, measured and tested in some relational justice scenarios.

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Mediation, ODR, and the Web 2.0: A Case for Relational Justice

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Abstract. Dialogue, negotiation and mediation are renewed sources of contemporary law, and technology plays an active role in this process. User-centered strategies of the next Web generation are most suited to a relational justice model based on cooperative behavior, agreement, negotiation, and dialogue among both natural and artificial actors. In this paper we introduce Ontomedia, a project implementing the relational justice model by developing a web platform for online mediation. Ontomedia is designed as a semantically-driven web service that allows end-users to negotiate and mediate their conflicts in different domains (i.e. family and commerce). We situate this project within the next generation of Semantic Web services, and the so-called Web 2.0 (and Web 3.0) developments.

Keywords: Mediation, online dispute resolution, relational justice, Web 2.0, social Web.

1 Introduction: Relational Justice and ODR

Law and legal practices are evolving fast in the contemporary world. However, some of the new legal trends rely heavily on the cherished old forms of dialogue—the subject-matter of dialectical systems [1]. This is the case of negotiation, conciliation, and mediation, widely adopted practices in courts, law firms, counseling services, etc.

In a broad sense, relational justice (RJ) may be defined as the justice produced through dialogue and cooperative behavior, negotiation, and agreement among natural or artificial actors [2, 3]. To our perspective, online dispute resolution (ODR) and its different standard and hybrid techniques—negotiation, conciliation, mediation, arbitration—are instantiations of the relational justice model. ODR is often seen as the online equivalent of alternative dispute resolution methods (ADR) that fall outside the judicial domain. However, there are two reasons to refrain from an exact correspondence between the two. On the one hand, ODR procedures might not necessarily satisfy the "alternative" aspect of ADR, since they may form part of the judicial process (i.e. online

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mediation to assist divorcing couples in drafting parenting plans). On the other hand, the technical aspects of ODR pave the way to specific procedures that vary from those applicable in ADR (i.e. automated, blind-bidding negotiation) and facilitate flexible, hybrid forms of mediation and arbitration (Med-Arb). A basic typology of ODR procedures is shown in Fig. 1 below:

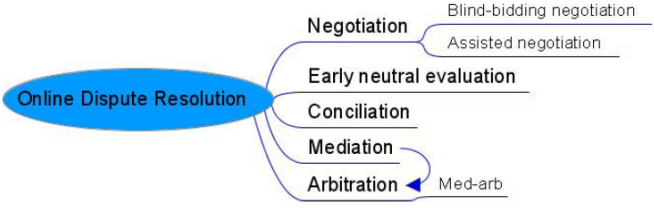

Fig. 1. Online Dispute Resolution standard techniques

Curiously enough, technology fuels this return to dialogue [4, 5, 6]. Take one of the salient trends of the present Web: personalization. As Fromm puts it:

The Internet is shifting from discrete units of websites and Web pages to discrete units of information (e.g. people, organizations, articles and videos, product offerings, store listings, and blog posts) and associated meta data (e.g. images, addresses, reviews, ratings) that move seamlessly around the Web, being slotted where appropriate. These units of information can be organized in ways that are relevant and personal to each individual, using data gleaned from social graphs as well as recommendation and personalization services that allow users to set their preferences [7].

From a technological point of view, relational justice may be defined as well as "the substantive and formal structure that allows end users, in the broader sense (as citizens, consumers, customers, clients, managers, etc.) to participate in the making of their own regulation and legal outcomes through all the mixed and plural strategies of the Semantic Web. This implies the coexistence of legal and social norms, rights and duties to be shared by subjects (artificial or natural agents) in a flexible and dynamic structured environment" [3].

The goal of this paper is to show how state-of-the art technologies of the Web 2.0 are critical to facilitate the full transformation of the ODR domain in an area of human-machine interaction where agents can freely discover, organize, and exchange information, data, as well as experiences of users (user-contributed content) related to disputes affecting them. In this regard, we present Ontomedia, a web-based platform that uses a combination of Web 2.0 and Semantic Web technologies for online mediation. The Ontomedia focus, yet, is neither the online component nor the disputes to be resolved, but the users who have to deal with disputes and use the Web to get them resolved in a more effective, efficient, and inexpensive way.

2 ODR 1.0

ODR services have flourished in the Internet since the mid 1990s, counting different failures and successes throughout these fifteen years. At present, the main ODR service

Table 1. ODR service providers

Product	*AdDResS*	BBB	*Cyber Settle*	*eBay*	*Der Internet Ombudsmann*	*DisputeManager*	*ECODIR*	*Electronic Corthouse*	*iQua-Confianza Online*	*Juripax*	*MARS*	*Mediateur du net*	*Mediation Room*	*National Arbitration Forum*	*Net Neutrals*	*ODRWorld*	*PayPal*	*Risolvi Online*	*Smart Settle*	*Square Trade*
Owner	WebAssured	Council of Better Business Bureaux	CyberSettle	eBay	Der Internet Ombudsmann	Singapore Mediation Center	European Commission	Electronic Corthouse	AECEM, AUTOCONTROL Consejos Audiovisuales, Red.es	Juripax	MARS	Le Forum des droits sur l'internet	Mediation Room	National Arbitration Forum	DeMars & Ass.	ODRWorld	PayPal	Milano Chamber Commerce	iCan Systems	Square Trade
Country	USA	USA, Can	USA	USA	Austria	Singapur	Europe	USA	Spain, Andorre	Holland	USA	France	UK	USA	USA	UK, India	US	Italy	USA	USA
Domain	e-T	e-T	*G*	*e-T*	*e-T*	*e-T, dn*	*e-T*	*G*	*e-T, dn, Iar*	*G*	*e-T*	*e-T, dn, Iar*	*G*	*G*	*T*	*G*	*e-T*	*e-T*	*G*	*Gel*
Negotiation			X	X		X	X				X				X	X	X		X	
Mediation	X	X	X			X	X	X	X	X		X	X	X	X	X		X		
Arbitration		X	X			X		X			X			X	X	X	X		X	
Complaints	X	X	X		X	X				X				X	X			X		
Conciliation		X													X					X
Recommendation	X					X	X	X	X					X	X					
Mediators' roast	X											X	X	X	X	X		X	X	X
Trustmark	X	X			X				X		X									
Training						X					X		X	X	X				X	
Other services	X	1				X				2			3	4						
Control of flows	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Registry of cases	X		X					X	X	X	X		X		X					
Structured forms		X	X	X			X	X	X	X					X	X	X	X	X	
Messages to parties	X	X					X	X	X	X			X	X	X	X		X	X	
Asynchronous communication	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X
Synchronic communication (chat, videoconference)			X							X	X		X	X	X	X			X	
Confidential registries			X				X	X	X	X			X	X	X			X		
Optimization algorithm																			X	
Cross-offers algorithm			X			X				X									X	
Web provider		X		X		X			X			X					X	X		
ODR simplified	X		X				X				X				X					X
Sofisticated ODR								X					X	X		X				
Licenses selling										X			X			X			X	

G generic domains ***e-T*** electronic Transactions (B2C, B2B, C2C) ***dn.*** Domain names Iar Internet related rights (privacy, access, copyright) ***T*** eBay specific transactions ***Gel*** Electric appliances guarantees

Other services 1. Standards 2. Premediation 3.Psychometric profiling 4. Express mediation and arbitration

providers are primarily US-based, and only a few are provided from Europe and third countries. While different in scope and procedures offered, they all share three features: (i) proprietary software licenses, (ii) stable platforms, (iii) PC-based. We call the present ODR service providers as ODR 1.0, to distinguish them from the upcoming generation of open source, unstable platforms (or "perpetual beta"), and crowdsourced software systems [8] that are increasingly used to manage conflicts and emergencies. Table 1 below summarizes recent research done in comparing ODR 1.0 services [9]. The classification distinguished different services:

- Negotiation. The system facilitates the exchange of offers between the parties at different degrees of automatization: full (SmartSettle, e-Bay-PayPal) or partial (DisputeManager).
- Mediation. The process is also automatized at different degrees. The mediation parties may interact online (by videoconference, as in *MARS*) or through structured messages, as in *ODRworld*). In some cases, the service provider selects the mediator, and in some others the parties choose him from a list.
- Arbitration, recommendation, conciliation. The service provider in those cases holds the responsibility to make a recommendation which is as binding for the parties as they have previously decided. In some cases, the ODR service provider arbiters and executes the decision (PayPal). In some others, recommendations are calculated automatically (SmartSettle).
- Complaints management: Usually, ODR service providers receive complaints and manage them through a mediation-like process.
- Ancillary services, such as training for mediators and arbiters, trust marks, or psychometric profiling for mediators. Express mediation and arbitration are also provided on demand.

3 ODR 2.0

The notion of "Web 2.0" has a half-baked, conversational, and collaborative genealogy. Quoting Scott Dietzen, Eric Knorr welcomed Web 2.0 in December 2003 as a "universal, standards-based integration platform" [10]. Shortly after, the term popped up in a brainstorming session between Dale Dougherty (co-founder of O'Reilly Media) and Craig Cline, and reached larger audiences after the O'Reilly Media Web 2.0 conference in late 2004. The notion would then spread rapidly to become one of the most successful paradigms of the recent Internet era.

Perhaps as the clue of its nearly immediate success, there was no clear consensus on what Web 2.0 was, neither where the precise boundaries where.[1] Again, and following discussions with other commenters, O'Reilly posted in a forum a compact definition of Web 2.0 which included as a chief rule for success "to build applications that harness network effects to get better the more people use them" [12]. And, indeed, as people

[1] Greg Boutin provides a humorous view of the story: "First, let me clarify that both Web 2.0 and Web 3.0 are marketing concepts (think Tim O'Reilly). Actually, I suspect they might even have been sponsored by venture capitalists...! And obviously, they were relayed by journalists. So what we had was perhaps the three most reviled professions on the planet uniting to package a mix of innovations and labeling it with a simplistic term whose definition could morph on demand..." [11].

started using them, the focus gradually shifted towards the social component of Web 2.0, to the point that Web 2.0 became equivalent to "the social Web". Today's social Web breeds an ever-growing number of online communities that share all types of contents (documents, images, videos, music, etc.), knowledge, and expertise in a number of areas. Some recent figures may give an idea of the impressive growth rate of online social communities. From a time spent perspective, Nielsen Online reports that member communities surpassed e-mail for the first time in February 2009 [13]. Previously, video audiences had already surpassed e-mail audiences in November 2007 [13].

Social networking has also a transformational role for specific profiles of users. Data on the digital behavior of moms reveals that "new moms (younger, one child), are much more likely to visit social networking sites and publish or own a blog than most other online users" [12]. For instance, new moms "are 85% more likely to spend time with Facebook compared to the average online consumer" [13]. To Nielsen analysts, "becoming a mother is a dramatic inflection point and drives women to the Web in search of advice and a desire to connect with others in her shoes" [13].

To what extent are new moms connected to ODR potential users? Well, even though in a very different sense, being involved in a dispute may also be sensed as a singular event inducing a disputing party to search the Web for appropriate venues to get the dispute handled and, eventually, resolved. Especially when the judicial system alternative is perceived too costly or inappropriate for a number of reasons (nature and/or value of the dispute, physical location of the parties, etc.) ODR has the potential to become an efficient default system. This is certainly the case for disputes emerging from online interactions, as the e-Bay community has largely proved.[2] But it can also be expanded beyond the successful domain of e-commerce.

So, how may ODR benefit from both the trends and opportunities of Web 2.0? Colin Rule predicted in 2006 that "ODR will be one of the biggest beneficiaries of these new technologies, because they are squarely aimed at ODR's core functionality areas: communication, collaboration, and interactivity" [15]. However, he also warned that "too many ODR providers rely on outdated platforms and technology because they are reluctant to make the investments in time and resources needed to bring their platforms up to Web 2.0 standards" [15]. Sanjana Hattotuwa went a step further anticipating unwanted consequences of ODR lagging behind the curve of Web 2.0, [T]he most obvious being that ODR itself may cease to exist. With the ubiquity of broadband wired and wireless connectivity, the ability to roll-out dispute resolution service online is possibly going to be seen as a normal service provision of ADR service providers, just like automated online tech support is now part and parcel of customer support mechanisms of many large software companies [16].

The Ontomedia project is an attempt to incorporate state-of-the-art Web technologies to offer, use, and organize IT supported mediation services online. The main aim of Ontomedia is to provide a domain independent platform for both mediation services and users flexible enough to adapt to multiple mediation sub-domains, procedures, and cases. With Ontomedia we expect to comply with the Web 2.0 rule that "it gets better the more people uses it", a golden rule entwined with the preexistent scholarly debate on the positive externalities of belonging to a network ("network externalities" or "network effect") [17].

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[2] The dispute resolution center at e-Bay and PayPal handles roughly 40 million disputes a year using software and automated processes to assist parties in solving their disputes [14].

4 The Ontomedia Mediation Platform

The Ontomedia project combines technologies and trends aimed to the effective provision of a set of functionalities to a broad community of professionals—mediators—and users of mediation services. The platform development is based on three main paradigms: Open Source, Semantic Web technologies and SOA.

Open Source appears as a clear alternative in situations where features such as scalability, stability, security and performance are requested. This approach guarantees the community to be part of the project, contributing with ideas, enhancements and facilitating the maintenance.

From the technological standpoint, the adoption of Semantic Web technologies promotes the reutilization of the information generated by the platform. Such information can be used by the platform and third parties alike—humans or machines accessing the platform guided by the library of ontologies developed. As a result, the platform will generate a common understanding framework. Moreover, the development of the platform oriented to SOA, promotes the reutilization of the developed components as services.

Figure 2 represents the high level architecture of the platform. Citizens can play two different roles: mediator or mediation party. Since a key element for success depends on the devices that can connect to Ontomedia we envisage a version available for mobile and Smartphones with multimedia capabilities.

The architecture is composed of five main components: a repository, a library of ontologies, communication services, an enterprise service bus, and management tools.

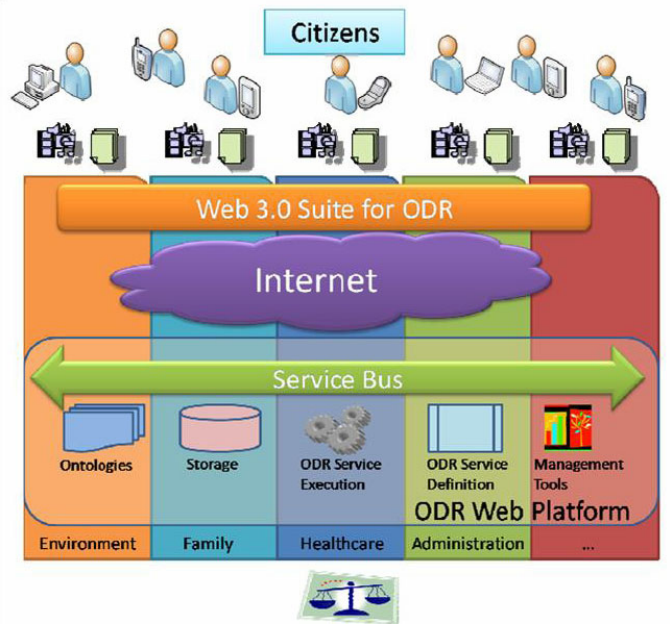

Fig. 2. Ontomedia high level architecture

4.1 Repository

Although this component is treated as a unique element, the repository is actually a group of different storage systems with different capabilities:

- *Ontology repository*. It provides functionalities to locally store and access ontologies and ontologies instances.
- *Multimedia repository*. A very specific component in charge of store and retrieve, via streaming, the modified version of the videoconference sessions.
- *Shared Folders*. A regular data repository with advanced permission capabilities.

4.2 Ontologies

Ontologies will play the role of structuring all the information related with mediation cases and the mediation process. Thus, ontologies facilitate to retrieve and share the stored data and they will provide platform personalization for different mediation scenarios (e.g. family mediation and consumer mediation). The Mediation Core Ontology (MCO) has already been developed to capture the nature of the mediation process [18].

4.3 Communication Services

The platform has been conceived as an initial core that will grow adding new services to satisfy upcoming users' demands. Figure 3 below shows a list of the initial features provided. This set can be easily transformed into the software components we intend to integrate. As key elements we highlight:

- *e-mail.* The platform will provide e-mail server and client capabilities.
- *IM*. Instant messaging has been rapidly adopted by Internet users, helping them to communicate synchronously. Thus the platform will work as IM server.
- *Shared Calendar* to organize and communicate different events or simply to show personal availability.
- *Videoconference* to enable synchronic visual communication.

4.4 Enterprise Service Bus

Enterprise Service Bus (ESB) [19] is a message-based, open standard solution to integrate distributed components. The main function of an ESB is to provide a reliable framework to communicate different technological resources. ESB constitutes a basic building block within SOA and can be complemented with features such as Service Orchestration. ESB will be the core of the platform, providing functionalities for the invocation, discovering and publication of the new mediation oriented services.

4.5 Management

Management includes a group of services focused on the platform maintenance. This category consists of different tasks, namely machine monitoring, network monitoring, fault detection, fault corrections or platform adaptation.

5 Functionalities of the Ontomedia Platform: The Mediator Side

To citizens, Ontomedia may be viewed as a reference point when they need to resolve a dispute. Through Ontomedia they will be able to ask for a piece of advice, collect information, share their experience with other citizens or even decide if it is suitable to start a mediation process.

While the main goal of Ontomedia is to facilitate citizens' access to a faster, cheaper and more efficient justice, the platform is two-sided to meet the needs of mediators (i.e. to establish communication with other colleagues or to supervise or review different mediation processes). Ontomedia will therefore provide a set of functionalities for users acting as mediators, divided into five different sets: information, repository, training, communication and management.

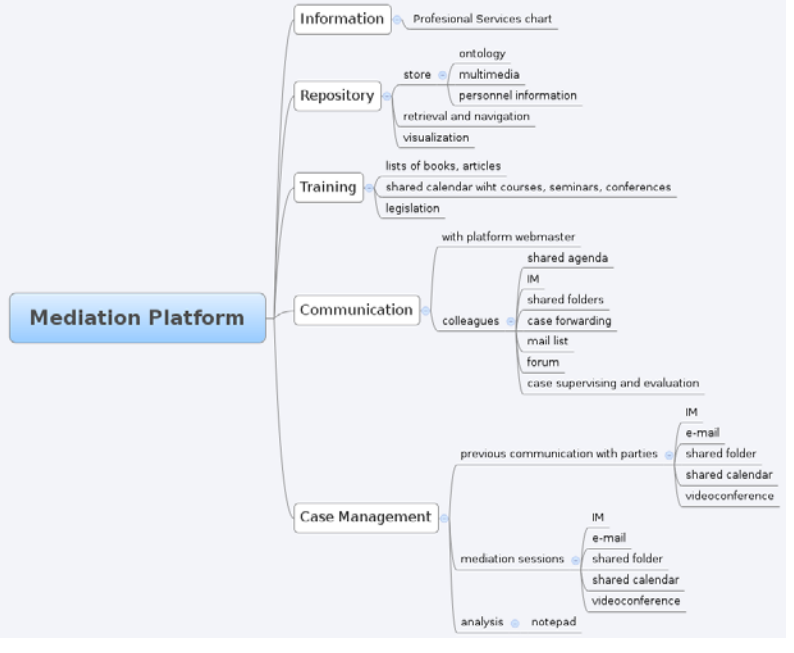

Fig. 3. Ontomedia functionalities to fulfill mediator's needs

The *Information* layer bundles all the platform capabilities that help users to share and show different corporate data and retrieve information related with the current legislation. For example, in this section we may find lists of companies or people offering mediation services, links to books, articles and sentences. It is the project intention to create a community of mediators that populates this section.

The next group of functionalities composes the repository layer, which can be viewed as a case store with retrieval and visualization capabilities. The repository will store all the information available related to mediation cases and provide functionalities for data and metadata management (working as an ontology repository, metadata registry and data repository) [20]. All data generated within the mediation process

will be stored, according to MCO, in the repository layer. The information we expect to manage includes multimedia sessions, e-mails, text documents, chat sessions, and mediators' personal notes.

The repository is also in charge of the information retrieval and visualization functionalities. Again, the MCO will play a main role since it will be the schema helping users to formulate and to recover the information stored in the platform. This functionality can be classified as Semantic Search [21]. Finally, visualization will provide functionalities at the visual user interface level, helping users to navigate and extract reports with relevant information (i.e. a timeline representing the evolution of the mediation process).

Training can be viewed as a showcase where different users will post events, courses, call for papers, etc. Next, the *Communication* layer is oriented to facilitate discussion among mediators and help them to get in contact with the platform webmaster. The first goal can be achieved by providing instant message capabilities, mailing lists, forum, etc. Other specific functionalities considered are a monitor to let other mediators supervise and evaluate mediation processes, a shared calendar to see which people is busy or free to help or accept a case, or even case forwarding capabilities.

The last group of functionalities is labeled *Management* and it covers the part of the mediation process in charge of the communication between parties and the mediator, that is, the core mediation process. Since the platform offers functionalities before, during, and after the mediation process, we can group them in two main categories: (i) services enabling the communication (i.e. audio conference, video conference, e-mail, shared folders or instant messaging), and (ii) services helping the mediator to create a post-session diagnostic and maintain a registry of events.

5.1 An Example of Use Case

In this section we present a use case[3] that shows a regular interaction between the mediator and the platform.

Use Case: Mediator plans a meeting with the parties.

Goal in Context: Mediator reviews data from a mediation process and decides to plan a new meeting with the parties.

Scope: Mediation Platform

Level: Summary

Preconditions: Mediator has an account on the platform, has logged in and is watching his homepage. The mediation process had started before, and the platform has stored different kind of information related to previous sessions.

Primary Actor: Mediator

Success End Condition: Mediator sends citations to parties, and the event is reflected in the mediator's agenda.

Main Success Scenario

1. Mediator asks the platform all the cases he is involved in.

[3] http://alistair.cockburn.us/Basic+use+case+template

2. Platform shows a list of the active mediation processes that belong to the mediator.
3. Mediator selects one of the list and clicks on it.
4. Platform shows a timeline where the summaries of previous sessions are marked as milestones. Close to each milestone there is a panel with annotations made by the mediator.
5. Mediator clicks on the last session (i.e. the last milestone).
6. Platform shows a new page, where mediator can replay a modified version of the last recorded session that was performed by videoconference. This page also contains a notepad to write comments.
7. Mediator reviews the last session video, adds new comments and saves them.
8. The platform saves changes within the repository.
9. Mediator clicks on the homepage link.
10. Platform shows a personalized homepage.
11. Mediator clicks on a shared calendar.
12. Platform shows a calendar.
13. Mediator clicks on a day of the calendar, creates a new event, and invites the parties.
14. Platform registers the event, and sends e-mails to the parties and the mediator.

6 Conclusion and Future Work

In this paper we have presented the Ontomedia platform as a tool for online mediation that includes state-of-the-art technologies of the Web 2.0. At this stage of research, Ontomedia is also a proof of principle of how ODR may benefit from the latest Semantic Web technologies. Even though the development of the Ontomedia platform is on early stage, and it is relatively soon to extract definitive conclusions, we can point out the advantages of using SOA and Semantic Web technologies to obtain reusable components, both software artifacts and data gathered. Furthermore, ontologies will be a key element to personalize and adapt the platform to different scenarios (e.g. familiar mediation or consumer mediation).

Future work includes the tailoring of end user functionalities from the citizens' side and the implementation of a broader spectrum of devices, namely mobile phones.

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Legal "Neutral Dialogue", Implementing the Work of Bruce Ackerman in the Field of Law

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Abstract. This legal theory paper deals from a strictly jus philosophical perspective with the work of Bruce Ackerman and relates to the configuration of a theory of neutral dialogue applied in the field of law .The core of this essay is the analysis and complementation of some of the characteristics of this Ackerman's theory with other less abstract theories such as Prakken's formal model of adjudication, Walton's and Krabbe's commitment in dialogue, and Sartor's double face of legal concepts. The major and long term purpose is to achieve a feasible and comprehensible notion of neutral dialogue among these different notions. The more realistic and immediate goal is to provide theoretical data to a more general and multidisciplinary notion of hybrid dialogue. This paper aims to supply legal theoretical background to empirical fields such as the Online Dispute Resolution and Relational Justice. The final thesis of this article is to state that neutrality does not necessarily means denaturalized of the arguments used by parties in law and politics.

Keywords: Dialogue, Constrictiveness, Principle of Neutrality, Relational Justice, Alternative Dispute Resolutions.

1 Introduction

The paper is segmented in three main parts, the first segment deals with a preliminary characterization and definition of legal language. Can we define legal language as a sort of distinctive communication? To answer this question I will analyze the differing doctrines [22, 18, 31, 32].

In the second segment of this paper I figure out if is possible to achieve a feasible notion of neutral or hybrid dialogue in a liberal society. I define in this epigraph from a theoretical perspective the notions of dialogue and neutral dialogue through the premises of Bruce Ackerman. Subsequently the work is complemented with the dialectical debate between Ackerman and Fishkin supplemented with Prakken's theory in [25]. In this segment the essay moves from the world of the theory to the world of praxis make use of Habermas terminology [17].

Once the concept of dialogue is characterized I link the resulting theory of neutrality with the field of law. To do this exercise I make use of the main definitions of Relational Justice and Restorative Justice that Casanovas employs [8]. The last segment of the paper is a short conclusion advocating the necessity of complementing

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the jus-philosophical theories of dialogue with the real experiences and programs of Artificial Intelligence. This essay is an exercise of legal theory that tends to consolidate the Ackerman's neutral dialogue as an input to be taken into consideration by the more specialized and empirical theories of legal dialogue.

2 Peculiarity of Legal Language

The first issue that I address in this paper is to answer the question, if oral and written language used by lawyers, judges and other juridical operators has a specific peculiarity that generates a different language? Or if otherwise is the legal language different from the standard language in a relevant way? If we check the different doctrine that deals with this issue, we will appreciate that there is no unanimous answer to this important question. In order to simplify the exposition of this issue I divide this doctrine in two main parts. The first doctrinal sector, which I call (*Objectivists)* considers that legal language is an autonomous type of communication. In this sense, as affirmed in [35] all the anomalousness and idiosyncrasies of the speech and writing of lawyers have some historical basis. As stated in [16]: "*this specifically distinctive evolution caused a gap between legal and ordinary language consolidating a parallel development where even different signifies are given to identical signifiers… Globalization and communication issues have also affect the legal field, where an international perspective is becoming more and more widespread. When the difference became large enough, there were generally protests and attempts to improve the situation*".

Jurists themselves have traditionally regarded language as the primary means for the formulation and interpretation of legal concepts. Jackson in [21] remarks upon a number of characteristics of legal language the following two: a) the diversity of forms of legal language; b) the much-discussed problem of comprehensibility of legal writing, and the solutions which have been proposed to improve it. Written legal language may be considered a particular register of the "*grapholect*": *it shares the grammar of the standard form of the language, and is capable of utilizing any part of lexicon*. In the autopoietic theory of Luhman [22], law is understood as a self-referential, self-reproducing system, rather than a form of social integration. As affirmed in [20]: *Autopoiesis* is a term derived from evolutionary biology, referring to the systems that reproduce themselves autonomously: "law produces by itself all the distinctions and concepts which it uses". This author continues remarking that one of the main practical issues related with this paper is how to come through of the "operative *clousure*" that is law. *Clousure* does not mean total isolation, but refers to the autonomy of the internal self-referring, communicative order in Luhmann terms "informational" or "semantic" *clousure*. There is an absolute boundary between law and non-law that we need to overcome to enable a feasible public sphere [6] where citizens will be able to participate in legal issues. This legal semantic clousure may have direct repercussions for the development of fields such as Mediation or Online Dispute Resolution; therefore as suggested in [13], we should at least qualify the direct application of this principle to the field of law.

However there is no unanimity about this "radical objectivism" [18]. The second doctrinal sector (*Deniers)* considers that legal language is not an autonomous type of communication.

As stated in [35], law is framework for human action, and law itself is essentially based on communication: communication between legislators and citizens, between courts and litigants, between the legislator and the judiciary, communication between contracting parties, communication within a trial. This author continues stating: *that human interaction and communication have to be at the center of any theory of law, rather than individuals or legal systems as such*, he continues stating that: *The meaning of law is never entirely determined by its author, but constantly refined and sometimes thoroughly changed through the interpretation and adjudication process, which is codetermined by its background of legal culture. This legal culture is the product of general culture.*

According to [20] Habermas is concerning with the legitimation of law in democratic societies where traditional sources of authority are discredited. He (Habermas) seeks to elaborate an ideal of democratic participation where public sphere and the principle of discourse play a nuclear role. Habermas argues in [18] that systems theory cannot offer a coherent view of how social sub-systems interact, and how they impact and act though the ordinary "lifeworld" of members of society, without assuming some underlying general social communication (e.g. ordinary language) which is at odds with the "architectonic of system theory".

Habermas does not establish any type of specialty for legal language because he reduces the concept simply to language in general, without taking into account the fact that legal language has a series of characteristics of its own. Consequently, as asserted in [24], Habermas reduces the concept of legal discourse to linguisticity. The German author applies a foreign discourse to the law in order to legitimate legal norms and general legal principles regardless of their hierarchical rank. I understand that neutrality cannot be built on this type of acculturation. In law, we find propositions that can be qualified as metalinguistic. The linguistic analysis of legal norms involves, among other things, their interpretation.

Inevitably, the same legal norms establish their own interpretative criteria, differentiating between those that are interpretative and those that are not. The application of Ackerman's constructivist theory of language to the Habermasian principle of discourse can be a good theoretical exercise in order to improve a comprehensive notion of neutral dialogue applied to legal norms, and even to propose a more responsive democracy. In order to develop this theoretical exercise, we must take in account Ackerman's definition of the concept of dialogue. He establishes two varieties of legal discourse: the discourse of reactive legislation, and that of interventionist legislation. The use of one or other type will depend on the role granted to the law in society. Reactive legislation is generated by social, economic or political agreements produced in society. In this kind of legislation no legal debate is acceptable if it requires the jurist to question the social agreements mentioned.

Therefore, the jurist, making use of Habermas's terms, will be guided by the *de facto* existence of a social act and not by the validity or legitimation of a particular social agreement. As stated in [24]: this category of legal discourse reacts to social agreements; it does not intervene or generate them. The consensus on dialogue in Ackerman is not based on a sociological understanding of the contextual distortions

caused by the instrumental and institutional power. In this kind of legal debate, dialogue is limited to the reactive imperative and to the evaluation of specific actions against the background of a prevailing social practice; the legitimacy of a practice will never become a legal question.

In the legislation based on reactive discourse, in reference to the law the only decisive question raised is whether the sanctionable conduct does not comply with the institutionalized positive norms. The legitimacy of legal norms per se is not questioned. The syllogism that is produced is direct: social agreement as a premise and legal discourse as a consequence; the order or the content of the initial premise can never be altered. The other kind of discourse is based on interventionist legislation. This discourse is not limited to the appraisal of individual acts against the background of the presumably legitimate social practice. Habermas [18] and Ackerman [1] both support a kind of interventionist legal discourse, because the application of legal rules questions the legitimacy of agreements of all kinds. This type of legal discourse is the one that affects the constitutional norms of the State.

The practical inability of Habermas's position from the legal standpoint derives from the very nature of the normative idealism of his theory, but furthermore, it must be possible to consider this ideal theory as a benchmark. I believe that Ackerman's hypothetical condition is superior to Rawls and Habermas starting points, the original position and the Principle of Discourse. As remarked in [34] Ackerman affirms that his own approach is more realistic because it accepts people as they are, permitting them to know their life plans. In this sense, Fishkin [14] makes an excellent comparison between Rawls and Ackerman. There are obvious similarities between both works. Both seek to figure out a solution to the issue of distributive justice under ideal conditions and both are based on a kind of impartial decision-making process. For Rawls this procedure is the original position, and for Ackerman is the principle of neutral dialogue under ideal conditions of perfect technologies of justice.

Besides these similarities there are certain connections between the two works that should be highlighted:

a) The two theories provide structural principles of justice. These principles are a sort of ethical criteria that compare the status of certain situation in terms of results (payoffs). For "payoff" Fishkin [14] refers to a specific characterization of what is valuable (i.e. necessary items, utility, health, etc) by individuals. The structural principle must take into consideration these criteria of results and which values individuals give to these assessments. In relation with these assessments both theories prescribe a sort of rating.
b) Both theories aim to be unique (uniqueness). The characterization of Rawls's original position is configured to regulate exclusively the principles of his own theory. Ackerman similarly aspires to this feature, although is not supported throughout his work.
c) Both theories try to maintain equality. As stated in [14] that the principle of equality in Ackerman is so strict that its implementation could have devastating consequences for equality.

I consider that the principle of neutrality sterilizes partially the question about the nature of legal language. The principle of neutrality filters some of the main distinctive characters related by the *Objectivists* and empirical experiences such as the

popular Jury confirms the possibility of overcoming the dialectical differences. In this sense, I highlight the critic of linguistic approaches that Sartor in [31] has made. As synthesized in [31] Dworkin has stated that legal concepts have an interpretative nature, in that need to be understood and developed by considering how they can contribute to legal practice to the values that inhere it.

In [31] Sartor links legal validity with its *consequential side*, namely, with *legal bindingness*, and must examine the role of the latter concept in legal decision-making and more generally in legal reasoning. Legal decision-making is aimed at providing solutions to single cases, solutions that may be coercively enforced upon their addressees (in case they do not spontaneously comply). Similarly, legal reasoning by officers and citizens, even outside a disputational framework, aims at establishing normative determinations that are to be implemented by the individuals concerned and, if necessary, publicly enforced. In many cases legal reasoning can be performed without taking a reflexive attitude: One just uses the facts and norms that come to mind, without further reflection. Consider, for instance, the reasoning of a police officer who stops a car exceeding the speed limit: On the basis of the rule establishing the speed limit and of the fact that the car is running at a higher speed, the police office concludes, without any further ado, that the car is breaking the limit, and acts accordingly.

Once highlighted the peculiarity of legal language and some of the characters of this specific communication. We need to know if legal dialogue is suitable and which are the real possibilities of dialogue in the field of law. In other words, we need to know where dialogue produces effects in the field of law.

Sartor in [31] brings clairvoyance to this question by differentiating between the double face of legal concepts – one face being precondition-oriented and the other being consequence –oriented. This division explains why legal debates make sense even in situations of apparent conceptual disagreement, and why they cannot be overcome by conceptual stipulation. As stated in [31] when we are discussing the preconditions for applying a concept we view the consequences of the concept as fixed in relation to our debate, when we are discussing the consequences of a certain concept we view the preconditions for applying such a concept as fixed. The Italian author continues affirming, the preconditional side and the consequential side of a legal concept are not always susceptible to debate in the same way: While both sides of certain concepts are equally controversial, other concepts are characterized in such a way that only the preconditional side is likely to be subject to debate, while their consequential side is usually controversial. Sartor continues defining in [31] both fields and how can dialogue decisive when a norm passes his justificatory test (the reasons supporting its use as a premise of legal reasoning outweigh the reasons against it) and how legal validity can be checked as an evaluative concept. As stated in [31] legal validity is indeed an evaluative attitude and therefore dialogue plays a major role. Dworkin seems to omit the well-know distinction between internal and external models of law that Sartor [30] employs in order to develop the two different uses of legal information systems. This division is shows how dialogue can affect to the core of law.

The next segment commences with an introduction of the concept of dialogue in Ackerman's works and afterward it deals with the process of "purification" or "filter" of this language through the principle of neutrality.

3 Ackerman's Notion of Neutral Dialogue

Ackerman [3] concedes a special role to the concept and functions of dialogue in his work. For this author dialogue is the first obligation of citizenship. *As a citizen I had an especially strong obligation to participate in the dialogic search for the moral truth……a refusal to talk simply disqualifies her (liberal citizen in dialogue) as a participant in a liberal state unless she is willing to participate.* Dialogue is therefore a nuclear element of liberal societies. Ackerman [4] considers that these sorts of societies must create places where dialogue between citizens can be developed. Dialogue has a fundamental social function but also it is a compulsory element for our moral self-definition, since it is the mechanism through we take into consideration the rest of citizens.

Ackerman assumes that dialogue between citizens of a liberal society is of constrictive, that is, the citizens through the dialog attempt to convince the other members of the society in a competitive way and not in a neutral way. The Yale professor highlights among the functions of dialogue the fact that it serves to control in a sensitive way the power of repression, the establishment of moral truth in both individual and collective levels is something crucial when implementing the legal framework that regulates the State or certain rules that should serve as general principles of law. As Ackerman states [1] the best way to understand the liberal tradition is precisely through the effort to define and justify a large force in the power of dialogue. The notion of constrained conversation should serve as the organizing principle of liberal thought. Ackerman [3] considers that in undertaking this exercise in liberal conversation, citizen P not try to convince the rest other fellows P2, to change their minds and see, at long last, the compelling truth of P. Instead, the conversation has a more pragmatic intention. Therefore as Ackerman states in a liberal dialogues citizens do not feel free to introduce moral arguments to the field of conversation, but they try to reach a conversational win far away from the dialogical ideal situation.

I understand that the definition of constrained dialogue is applicable to the communication between legal operators. Certainly there are differences between legal and political validity. At this point I should mention [23]: "Legal norms do not by themselves constitutive reasons for justifying actions and decisions (like those of judges), unless they are conceived as deriving from moral judgments; normative propositions that exhibits the distinctive traits of autonomy, justificatory finality, universalisability, generality, supervinience and finality".

Dialogue between parties in a court of justice is constrictive as Ackerman characterizes. The main objective is to convince the jury or mediator about my own claims. After the analysis of the transcendence of dialogue in modern societies, Ackerman introduces the concept of neutrality, which is the one that should rule the modern liberal societies. As affirmed in [1]: *In these sorts of societies (liberals) a sort of purification of the "constrictiveness" is done. A political community of diverse individuals can organize its power struggle consistently with Neutral discourse if it takes steps to assure that*:

a. *No citizen genetically dominates another.* One of the basic requirements in order to be able to define dialogue under conditions of neutrality is to prove that there

are no differences based on genetics. In this regard, I extend the concept to other aspects such as race, religion or language;

b. *Each citizen receives a liberal education.* Education has a fundamental role in Ackerman's work. Education must provide the basis to establish the liberal principles. Regarding education, I want to remark the risk of normalization (Foucault) and standardized education; liberal education may be address to generate self-determined citizens in a Derrida sense [11, 12].
c. *Each citizen begins adult life under conditions of material equality.* According to [34], this requirement disables the feasibility of Ackerman's theory sentenced to the realm of the ideas.
d. *Each citizen can freely exchange his initial entitlements within a flexible transactional network;*
e. *Each citizen, at the moment of his death, can assert that he has fulfilled his obligations of liberal trusteeship, passing on to the next generation a power structure no less liberal than the one he himself enjoyed.*

All discussions about the legitimacy of relations of power must be subject to the principle of neutrality. The Principle of neutrality limits the types of arguments that are acceptable in a liberal debate, no reason is good if it requires the force to state a) that the argument given is better than another expressed by another fellow, b) despite the conception of good (the argument) is inherently superior to another fellow's argument. Fishkin grounds part of his criticism on Ackerman's assumption that many people in developed Western societies do accept the neutrality principle. As stated in [34], (Ackerman) attempts to show that the consequences of this presupposition lead to a much more extensive egalitarianism than is generally accepted in liberal society. In the particular issue analyzed in this paper, the application of the principle of neutrality to the field of law, this controversy could be settled by establishing a procedural requirement to the parties. These procedural requirements are focus in the principle of neutrality enforcement.

I believe that this constrictiveness, a nuclear element of Ackerman's theory of neutrality, is an essential feature of the language employed by the juridical operators, especially in courts. Therefore, this contrictiveness may be purified in order to facilitate the implementing of alternative dispute resolution processes. In this sense, Neutral dialogue, in short, marks the boundary of the most extensive form of dialogic community- embracing all who can participate in a mutually intelligible effort to control the power struggle that is their common predicament. In this sense I consider really enlighten [36, 37] to figure out the commitment and how parties attempt to advance in their own interest (What Ackerman calls in a "constrictive way". In this sense, see esp. Chapters three and for [37].

Ackerman offers in [1] a four part arguments to shape his liberal dialectical vindication. In my understanding this four step theory merits Ackerman's notion of neutral dialogue to be implemented in the field of law. His *first* central aim is that is possible to conceive of a world where a band of citizens might solve their problem entirely through Neutral dialogue; *Second*, if we consider Neutral dialogue as a coherent conceptually option, only a step-by step approach will permit us to confront a second intellectual challenge. Ackerman purpose is to frame empirical issues in ways that permits specialists to see the broader normative implications of their

particular empirical studies. Following this goal I try to implement the Neutral dialogue theory to the field of law. The *third* is the "egalitarian decision rule". The author recognizes that this sort of rule will lead to a great deal of frustration, nor that some will feel more pain than others. Equality is justified not on the basis of what is felt but what is said by people trying to make sense of their predicament. The last requirement consists in Ackerman's hope to persuade contractarians to abandon their basic political metaphor and shift their allegiance to the concept of liberal dialogue.

As stated in [2] his main aim is to provoke dialectical engagement and response – *if a reader will explain why he finds each of the four arguments unpersuasive, these reactions may provide grist for the further dialogical defense of Neutrality; and on and on so long as the questioner finds further dialogue necessary to resolve his doubts about liberalism. In short rather than fearing rigorous dialectical examination, the liberal's last, best, hope lies in the encouragement of philosophical reflection:"The only proper response to liberal political philosophy is more philosophy"*.

It seems clear to me that some of these requirements are not exclusive to the sphere of politics. I claim an application of this main dialogical content to different fields of law, i.e. an egalitarian decision rule can be adopted in some of the alternative dispute resolution procedures.

Thigpen and Downing in [34] detract Ackerman's neutrality principle stating: "*that perhaps Ackerman's background as a law professor has affected his conception of neutral decisions, for although he never acknowledges it, he has an adversarial approach to decision making. It is adversarial in several senses. First, the procedure is designed to settle disputes, not to answer abstract questions apart from cases. Second, the parties to the procedure must have what* we *(Thigpen and Downing) can call standing; they must be living beings who have a stake in the outcome decision and who capable of engaging dialogue. Third the people must speak for themselves"*.

The principle of Neutral dialogue and a feasible appliance has been hardly criticized. I consider that Ackerman's theory has been misinterpreted. Criticism mixes two different spheres, rules of dialogue and arguments channelized by this rules. Ackerman's neutrality affects the first sphere and no arguments, whereas the goal is to introduce dialogical rules to facilitate understanding and agreement instead of vanish the constrictiveness.

Prakken's formal model of adjudication in [26] is an example of integration of logical models of legal reasoning (especially in those using tools from nonmonotonic logic) with dialogue models of argumentation. The author considers in [25] that the resulting models regulate the use of argumentative speech acts, such as making, disputing and conceding claims and putting forward arguments and counterarguments, and they define the outcome of a dispute in terms of effects of these speech acts on the "information state" of the dispute. Prakken's goal in [25] is to show how procedural models of legal argument can give more realistic accounts of the judge's role in legal disputes. I consider that Ackerman's theory of neutral dialogue main goal is to depurate the dialogical constrictiveness between juridical operators. From a strict abstract level Ackerman introduces a device to facilitate legal disputes. If we want to enable a suitable application of Ackerman's neutral dialogue to the field of law, Prakken's formal model of adjudication [26] can be the best empirical example to do so.

While Benhabib considers in [7] that the principle of neutrality is not very useful since it merely states that the law must be neutral. I believe that some of the principles and notions of Ackerman's "adversarial approach" are applicable to the different spheres of litigation, arbitration and mediation in law. In this same sense, Sartor in [31] when defining the double face of legal concepts he affirms that any characterization of the ultimate preconditions of legal validity appears to be based upon assumptions pertaining to morality, and cannot therefore hope to have any merit of neutrality stretching beyond such assumptions.

Despite Sartor, I consider that neutrality is feasible even recognizing moral assumptions. Ackerman's [1] dialogical patterns (in an abstract sense) may facilitate the implementation of a hybrid dialogue between juridical operators that encourages mediation or agreement. Therefore one of the main goals of this essay is to initiate a sort of complementation between the work of Sartor and Ackerman.

Ackerman's work can be a theoretical complementation to relational law, relational justice and restorative justice. Both notions (Ackerman's & Casanovas) are focus in the procedure without distorting the arguments of the parties.

To figure out the real possibilities of a juridical implementation of the neutrality principle, we need to check as characterized in [8] how are evolving some of the main experiences of law.

As Casanovas defines in [9] *citizens - as individual persons as much as citizens belonging to a political boby – require a greater participation and faster and more effective ways of facing their legal activities. Dialogue, flexibility and autonomy seem to be the aim of new legal forms of relational justice. Originally, we coined this concept for the sake of Restorative Justice, in a broad sense. Relational Justice was defined as a bottom –up justice produced through cooperative behavior, agreement, negotiation, or dialogue among actors in a post-conflict situation. The Restorative Justice field included Alternative Dispute Resolution and Online Dispute Resolutions, mediation, commercial, labor and economic mediation, victim-offender mediation, restorative justice (dialogue justice un criminal issues, for juveniles and adults), transactional justice (negotiated justice in the aftermath of violent conflicts in fragile, collapsed or failed states), community justice, family conferencing and peace processes.*

In seems clear that all these concepts related (*cooperative behavior, agreement, negotiation*) require the dialogue among actors. As stated [8] this fact evidences the main transcendence of dialogue also in the future of law. I consider that the theory of neutral dialogue will help to achieve this sort of agreements. Actors in this post-conflict situation still using *"constrictiveness"* to win, not only from a dialogical way but also from a juridical perspective therefore the purification that neutrality brings to dialogue should be understood as constructive.

Casanovas continues affirming in [9] that Relational Justice may be defined as: *the substantive and formal structure that allows end users, in the broader sense (as citizens, consumers, customers, clients, managers, officials…) to participate in the making of their own regulation and legal outcomes through all the mixed and plural strategies that the semantic web framework allows. This implies the coexistence of legal and social norms, rights and duties to be shared by subjects (artificial or natural agents) in a structured environment…..*

Legal theorist with a high degree of commitment with the Restorative Justice movement use to emphasize the role of privileged actors to counter-balance power in the political arena. Neutral dialogue will "equalize" or at least dismiss this privileges.

Casanovas continues stating that global justice and governance have been described many times as relational, to emphasize the contrast with public law theories based on the abstraction of a social contract to found some kind of sovereignty. In this sense, I refer to the last requirement of Ackerman's neutrality principle addressed to the contractarians in order to abandon their basic political metaphor and shift their allegiance to the concept of liberal dialogue.

4 Conclusion

This paper is the first step of a theoretical major project related with the concept of dialogue, the principle of neutrality and law. Neutral dialogue has enormous potentialities in the field of law that we need to engage. This paper promotes the development of the "neutrality in second – best theory", when Ackerman in [3] moves from theory to praxis. I understand that the highest level of practicability of Ackerman's theory makes it suitable to be applied in the field of law, and concretely to the compulsory dialogue between parties and judges, mediators and the rest of juridical operators. I understand that neutrality in Ackerman's sense does not mean denaturalized the arguments used by parties in law and politics. Neutral dialogue affects procedural rules of dialogue and not the argumentation of parties.

I wonder if the most specialized doctrine in legal dialogue, [32, 29] analyzing legal reasoning and linking artificial intelligence and law (e.g. especially logical research on nomonotonic or defeasible legal reasoning) In this sense [30, 27, 15, 28, 19, 36] are developing from a more empirical perspective the main goals of Ackerman's principle of neutrality. That is to purify the constrictiveness of dialogue, and to ensure some commitment (Ackerman's second-best conditions) by the parties confronted without affecting the argumentations. I understand that Ackerman's neutrality principle has been misinterpreted; neutrality does not mean denaturalized the arguments used by parties, but to introduce dialogical, (dialogue and logic) rules to facilitate understanding and agreement.

In this sense, I also wonder if HYPO, CABARET and CATO [29] (implemented systems and abstracts models that are a useful complement to the development of actual systems and computational models) are devices to implement neutrality. I really think so, especially considering that regardless the differences between these systems, they do not implement a notion of "winning" a dispute (purification of constrictiveness), but they assume that the final choice is made outside the system, (outside the rules of dialogue).

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Legal Multimedia Management through JPEG2000 Framework

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Abstract. In the judicial domain, the multimedia contents have become an important source of data, producing severe storage requirements. Nevertheless, there is no protocol establishing how to obtain and store these legal multimedia files. JPEG2000 is one of the latest standards developed by the JPEG committee. It is composed by 13 different parts addressing the encoding, transmission and manipulation of still images and video. In this work, we discuss the suitability of some parts of the standard to deal with legal multimedia contents. We also propose a centralized database scheme where all the multimedia contents are stored. Furthermore, taking advantage of the features provided by the JPEG2000 framework, these files could be compressed and transmitted over the network, ensuring the access control and the data integrity, among other security tools.

Keywords: Legal multimedia and JPEG2000 standard.

1 Introduction

Nowadays, multimedia has become an important issue in many different fields. The recent explosion of multimedia legal contents and the improvements achieved by sensors and video recorders in the last years increase the size of these files, producing an enormous demand of storage capability. The compression can help to reduce the huge storage requirements and the transmission bandwidth. Images and videos usually contain highly redundant information, which can be exploited to compress and reduce, in some degrees, the amount of data needed to store these files. In addition, in some environments, the encoding process can allow a loss of information, which helps to enhance the compression efficiency. When multimedia files are encoded through a process that produces some loss of the original information, the compression is called lossy. On the other hand, when no loss of information is produced, the compression is named lossless.

Apart from compression, the manipulation of multimedia currently requires other advanced features. Some of these features are the availability to transmit images and videos interactively over the network, to support error resilience or even to supply capabilities of watermarking and fingerprinting. Encoding systems must take these needs into account to provide a flexible framework that allows an

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efficient management. JPEG2000 [1] is one of the latest standards developed by the Joint Photographic Experts Group (JPEG) and is structured in 13 different parts, addressing the encoding, transmission, security, and manipulation of still images and video.

In Spain, the Civil Procedure Act of January 7th, 2000 (1/2000) introduces the video recording of oral hearings. Consequently, Spanish civil courts are currently producing a massive number of multimedia files that have substituted the written transcripts and have become part of the judicial file, together with suits, indictments, injunctions, judgments and pieces of evidence. Lawyers, prosecutors and judges need to access these contents when preparing similar cases or when appealing to superior courts. Furthermore, the 1/2000 Civil Procedure Act does not include a protocol establishing how to obtain audiovisual records. In addition, the procedures to store, classify and retrieve audiovisual records may vary even from court to court, with no common database available to store the audiovisual records.

In this work, we discuss the suitability of the standard JPEG2000 to compress and manage multimedia files provided by legal procedures, and propose a scheme of a centralized database to store indexed and/or tagged multimedia documents (see [2] and [3]), monitoring the access by parts and ensuring the integrity of the data, among other security features.

The paper is organized as follows: Section 2 reports an overview of the JPEG2000 standard; Section 3 describes the parts of JPEG2000 framework suitable to handle legal multimedia files and proposes the centralized database scheme to store and manage this kind of data; and Section 4 summarizes the work.

2 JPEG2000 Overview

JPEG2000 has become a powerful standard that provides even more features than those initially planned. The technologies supported by the standard have been described in many different works. To mention only some of them, the JPEG2000 features and the most important techniques used in it are reviewed in [4,5]; an in-depth overview is described in [6,7]. Although the standard was initially structured in six parts, in 2001 seven more parts were proposed. The main purposes of each part are summarized in Table 1. Among other features, the JPEG2000 Part 1 provides scalability by quality, spatial location, resolution, and component. These scalabilities fulfill most of the requirements of applications and scenarios where images are used.

The scheme depicted in Figure 1 reports the basis of the JPEG2000 standard, that is composed by two main stages: 1) an encoder to compress the image producing a binary file that contains the compressed image (JP2 file format); and 2) a decoder to decompress the binary stream, obtaining a recovered image. In Figure 1, the input for the JPEG2000 Encoder is a color image (RGB) taken from the repository of the Institute of Law and Technology (IDT), that is composed by many still images and videos produced by different legal procedures. It corresponds to a Preliminary Audience celebrated on 2007. From the

Table 1. Description of the 13 parts of the JPEG2000 standard

- **JPEG2000 Part 1 Core coding system** [8]: description of the minimal decoder and a simple file format. This part has a limited number of options in order to facilitate the interchange among applications. It is the basis of the other parts, and allows lossy and lossless compression for still images.
- **JPEG2000 Part 2 Extensions** [9]: extensions of the core coding system, providing advanced coding features which can be used to enhance the coding performance or to manipulate unusual data types. This part also provides an enhanced file format.
- **JPEG2000 Part 3 Motion JPEG2000** [10]: extensions of the core coding system devised to support the manipulation of image sequences (motion).
- **JPEG2000 Part 4 Conformance testing:** information for the compliance and conformance among JPEG2000 implementations.
- **JPEG2000 Part 5 Reference Software:** two implementations of the core coding system: JJ2000, developed in Java, and JasPer, developed in C.
- **JPEG2000 Part 6 Compound image file format** [11]: additional file format for tailored and compound documents.
- **JPEG2000 Part 7:** this part has been abandoned.
- **JPEG2000 Part 8 Secure JPEG2000** [12]: description of a file syntax for interpreting secure image data and a normative process for registering security tools.
- **JPEG2000 Part 9 Interactivity tools, APIs and protocols** [13]: description of the transmission protocol JPIP, devised to interactively transmit JPEG2000 images.
- **JPEG2000 Part 10 Volumetric JPEG2000:** coding of volumetric data, providing enhanced coding features for floating point data.
- **JPEG2000 Part 11 Wireless JPEG2000:** description of error protection techniques for JPEG2000 files aimed to detect and correct errors produced during the data transmission.
- **JPEG2000 Part 12 ISO base media file format:** definition of the ISO file media file, providing an extensible format which facilitates interchange, management and editing.
- **JPEG2000 Part 13 An entry level JPEG2000 encoder:** defines a normative entry level JPEG2000 encoder providing one or more optional complete encoding paths that use various features defined in ISO/IEC 15444.

JP2 file, the JPEG2000 Decoder is able to obtain either a recovered image with different degrees of quality (scalability by quality), or a reduced version of the original image (scalability by resolution), or a random access to the JP2 binary file aimed to recover only certain regions within the original image (scalability by spatial location), or a concrete component of the input image (scalability by component). One of the most important features of JPEG2000 is the possibility to decode a selected image taking into account these scalabilities without needing to decompress the whole compressed file (*compress once decompress many ways*).

The JP2 file format contains the compressed image and the required information to allow the scalabilities mentioned above (see Figure 1). However, many applications could find useful to store additional information to enhance the interpretation and classification of the compressed data. In order to address this issue, JPEG2000 framework considers the definition of metadata boxes to store this relevant information in the same file. The JP2 file format provides two mechanism for embedding metadata into a file:

- **XML** (Extensible Markup Language) boxes allow XML documents to be embedded within the JP2 file. The meaning of the data is specified through the XML Document Type Definition (DTD).
- **UUID** (Universal Unique Identifier) boxes allow binary data to be embedded within the file. The UUID number is generated by the application developer when the format of the data to be contained in the box is determined.

Both methods allow to add metadata to image files. Additionally, XML and UUID boxes may be placed almost anywhere in the file, where it is more appropriate for the target application.

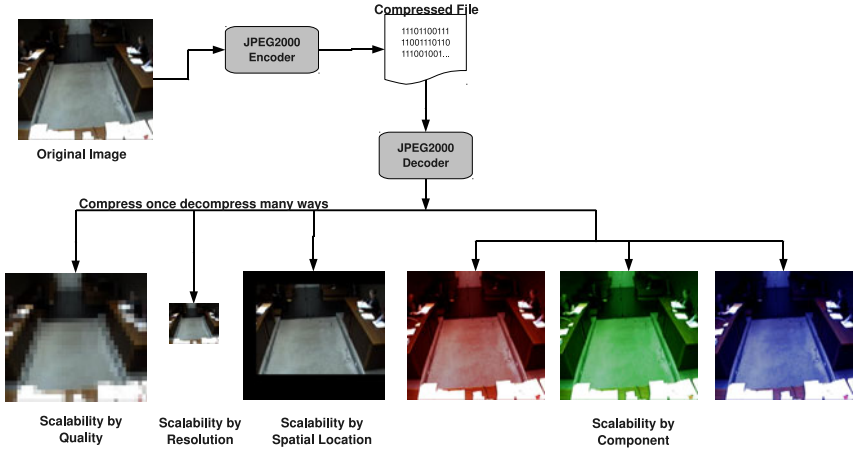

Fig. 1. Basis of the JPEG2000 standard (Part 1)

3 Multimedia Management

In the judicial domain, lawyers and judges are used to consume an important part of their time searching, retrieving and managing legal files. The metadata boxes enables to index, tag or annotate every file. In the literature, several works have been presented to implement an automatic and semantic annotation for legal multimedia files. On the other hand, there are works to carry out a semantic search among these files (see [14,15,16]). Consequently, the save of time and resources is considerable. Ontologies provide many tools to carry out the knowledge acquisition, enabling the semantic search and different annotations in the legal multimedia files [17].

The Moving Pictures Experts Group (MPEG) committee has developed many standards for still image and video compression. The last one is the MPEG-7 [18] that improves the MPEG-4 [19] including: Description Definition Language, audio-visual Descriptor, and Description Schemes (see [20]). All of them aimed to define, at different levels, syntax and semantic capabilities [21]. These standards are used in a commercial application named as *e-Sentencias* [22]. The aim of the e-Sentencias Project is to develop a software-hardware system for legal professionals to access and manage the multimedia files related to their cases. Nevertheless, the JPEG2000 framework provides support for semantic information through the metadata boxes, and several features and capabilities to manage multimedia contents as different scalabilities, efficient compression of compound documents, security tools, and interactivity tools, APIs and protocols for the transmission over the network.

In this section, five different parts of the JPEG2000 standard are presented, and the suitability to handle legal multimedia files is discussed. Part 2 [9], reported in Section 3.1, presents several extensions for the JP2, an enhanced file format, and stores unusual data. Part 3 [10] is reported in Section 3.2 and enables the coding and display of timed sequences of images (motion). Part 6 [11], reported in Section 3.3, can be used to store multi-page documents with many objects per page (document imaging, for pre-press and fax-like applications, etc.). Part 8 [12] that addresses security aspects as encryption, source authentication, data integrity, conditional access, and ownership protection is reported in Section 3.4. The last part, Part 9 [13] of the standard, is reported in Section 3.5 and defines tools for supporting image and metadata delivery through the network. Finally, Section 3.6 shows how to combine the JPEG2000 parts of the standard to manage legal multimedia files.

3.1 Extensions to the JPEG2000 Part 1

The JP2 file format is devised for applications that are limited to the storage of RGB and grayscale images. The JPX file format defined in Part 2 of the standard expands its capabilities to allow other types of images and transformations devised to improve the compression efficiency, and defines a set of standard metadata fields. The JPX file format also allows the specification of multiple images within a single file, and the combination of those images through composition

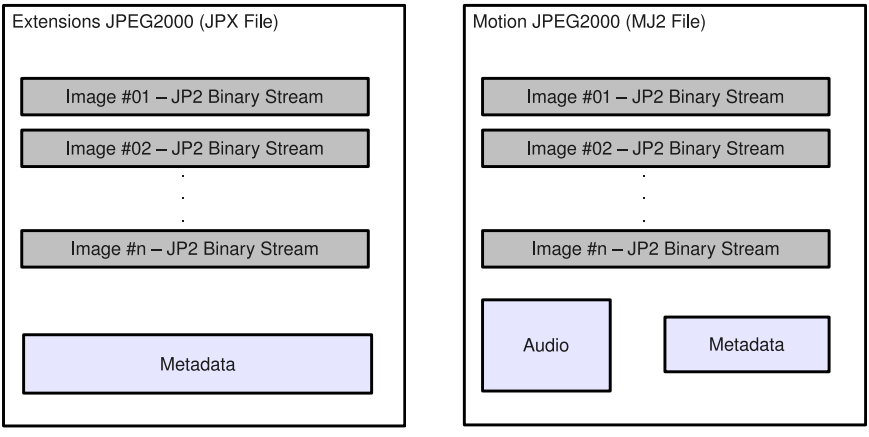

Fig. 2. JPEG2000 standard file formats. *Left*: Part 2 of the standard stores several compressed images and their corresponding metadata information to provide semantic capabilities. *Right*: Part 3 of the standard enables the management of motion sequences and the metadata aimed to provide semantic capabilities.

and animation. While this is similar to the capabilities of the motion JPEG2000 format, it is aimed at simpler applications that do not include synchronized sound or real-time frame rates.

In the legal multimedia management scenario, the most important features that the Part 2 of the standard provide are: the possibility to store several compressed images in the same file, a defined metadata structure in XML to enable an Intellectual Property box, and the inclusion of metadata to provide semantic capabilities to each image. Figure 2 *(Left)* depicts a scheme of this file format.

3.2 Motion JPEG2000

Motion JPEG2000 is expected to be used in a variety of applications, particularly where the coder and decoder are already available for other reasons. The application areas include, but are not limited to, digital still cameras, PC-based video capturing, error-prone environments such as wireless and the internet, and high quality digital video recording for professional broadcasting and motion picture production. Motion JPEG2000 is a flexible format, permitting a wide variety of usages such as editing, display, interchange and streaming from streaming servers using a variety of protocols.

MJ2 file format is composed of media-data (eg. video frames and sound samples) and metadata. The metadata can be subdivided into "structural" metadata that is required to allow the file decompression and "descriptive" metadata. While the structural metadata is described in detail in the standard, the descriptive metadata is an open box to store information from different scenarios where the MJ2 file format is used.

A simple MJ2 presentation may be composed by a single video and a single mono or stereo audio track. However, a more complex one might have multiple video tracks overlapping in time, such as in layers. Stored in the disk, the presentation may be in two forms: self-contained in a single file or in multiple files. In the last case, a parent MJ2 presentation file conforms the MJ2 format and contains all the conforming metadata. Figure 2 *(Right)* depicts a schematic description of the MJ2 file format.

The MPEG-4 specification supports the edition, local playback and streaming for multimedia files. So, the MP4 file format resulting from this work is able to contain a variety of multimedia data, and it uses the same box structures as the JP2 format. Motion JPEG2000 is based on the MPEG-4 MP4 file format, and JPEG2000 is represented as a peer coding system to MPEG-4 visual. In addition, the JPX file format is able to include a metadata box containing the metadata provided by the MPEG-7 in a binary format. Consequently, we provide a common file format for multimedia data, including motion JPEG2000, MPEG-4 and MPEG-7.

For our purposes, focused on legal multimedia management, the motion JPEG2000 is able to provide a video compression format that allows: video streaming, edition and the inclusion of metadata. In our scenario, the metadata boxes are aimed to provide semantic capabilities to the multimedia files. This file format is also able to manage information from the MPEG-4 and MPEG-7 standards.

3.3 Compound Documents

This format, named as JPM, is an extension of the JP2 file format and uses boxes defined for both the JP2 and the JPX file formats. This part of the standard is useful for applications storing multiple pages, images with mixed content and/or images that need more structure than the provided in JP2.

This International Standard is based on the multi-layer Mixed Raster Content (MRC) [23] imaging model. It makes provisions for processing, interchange and archiving of these image types in multiple layers, and defines composition models which regenerate the desired image. The efficiency is realized in the segmentation in layers of different types of images, since it allows an image specific compression.

Figure 3 shows an example of how the JPEG2000 Part 6 handles the compound documents. In this figure, the original document is composed by a color and grayscale images and text. First, a segmentation process is applied to divide the document in three different layers: color image, grayscale image and text. The JPM file format allows to encode each layer with a different compression algorithm, so if we consider the text as a bi-level image (black and white), we can apply the JBIG2 [24,25] standard that is specifically devised to encode bi-level images and documents. Metadata boxes are also considered in this file format to store some additional information about documents and to provide semantic capabilities.

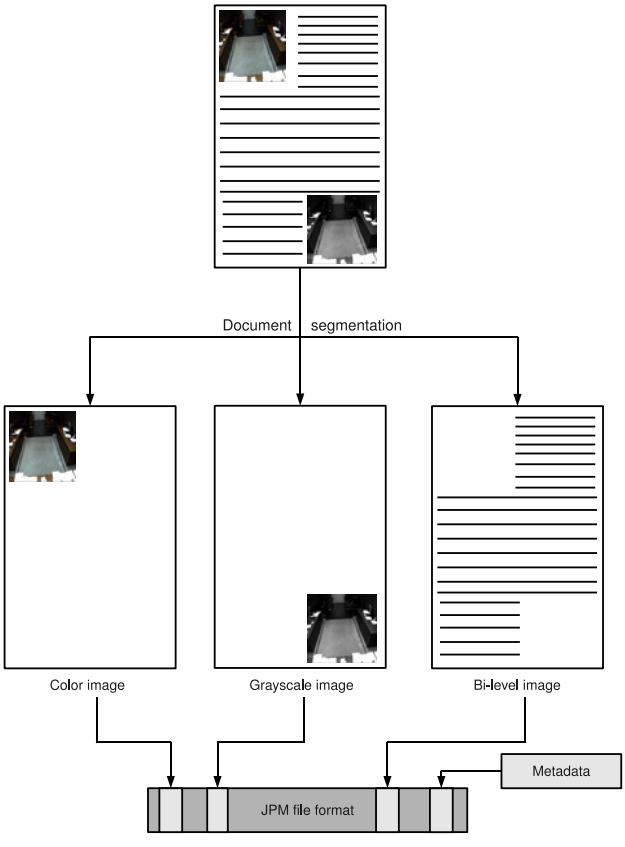

Fig. 3. JPEG2000 Part 6 (JPM file format). The original document is composed by color and grayscale images and text. Then, the document is segmented in three different layers and a specific encoding is applied. The compressed binary streams from the three layers and the needed metadata are store in an unique file.

3.4 Security Tools

The Internet, and the new information technology radically simplifies the access of content for the user. Therefore, it is expected that tools and protective methods that are recommended in JPEG2000 must ensure the security of transaction, protection of content (IPR), and protection of technologies. Security issues, such as authentication, data integrity, protection of copyright and Intellectual Property, privacy, conditional access, confidentiality, transaction tracing, to mention a few, are among important features in many imaging applications targeted by JPEG2000.

The protection of digital contents is described and can be achieved in many ways such as digital watermarking, digital signature, encryption, metadata,

authentication and integrity checking. Part 8 of JPEG2000 standard intends to provide tools and solutions in terms of specifications that allow applications to generate, consume and exchange Secure JPEG2000 binary streams. This is referred as *JPSEC*.

Some interesting features for the legal multimedia management are:

- **Access control**: The prevention of unauthorized use of a resource, including the prevention of use of a resource in an unauthorized manner.
- **Authentication**: The process of verifying an identity claimed by or for a system entity.
- **Source authentication**: Source authentication is the verification that a source entity is in fact the claimed source.
- **Confidentiality**: Confidentiality is the property that information is not made available or disclosed to unauthorized individuals, entities or processes.
- **Encryption**: Transformation of data by a cryptographic algorithm to hide the information content of the data.
- **Fingerprints:** Fingerprints are characteristics of an object that tend to distinguish it from other similar objects. They enable the owner to trace authorized users distributing them illegally.
- **Data integrity**: Image data integrity denotes the property that data has not been altered or destroyed in an unauthorized manner.
- **Watermarking**: Watermarking inserts imperceptibly data representing some information into multimedia data.

This is a summary of the features provided by the JPEG2000 framework considering security aspects. The interested reader is referred to [12].

3.5 Protocols for Transmission over the Network

Part 9 of JPEG2000 defines tools for supporting image and metadata delivery. The main component of Part 9 is a client-server protocol called *JPIP*. JPIP may be implemented on top of HTTP, but is designed with a view to other possible transports. To facilitate its deployment in systems with varying degrees of complexity, JPIP handles several different formats for the image data returned by the server: these include ordinary image formats such as complete JPEG or JPEG2000 files. JPIP also supports both stateless and stateful modes of operation, enabling cache-modelling to eliminate the redundant transmission of data.

JPIP provides selective access to the image metadata that may be contained within JPEG2000 files. Although Part 9 is focused on the application of technology from Part 1, including the JP2 file format, it supports some file format extensions from Part 2. A mechanism has also been provided for selection from amongst multiple binary streams in JPX (Part 2), MJ2 (Part 3) and JPM (Part 6) files. Potentially this could be applied to any file format containing images, not just to the JPEG2000 framework.

In our scenario, focused on legal multimedia management, the JPIP protocol is useful to transmit these files and their corresponding metadata information over the network.

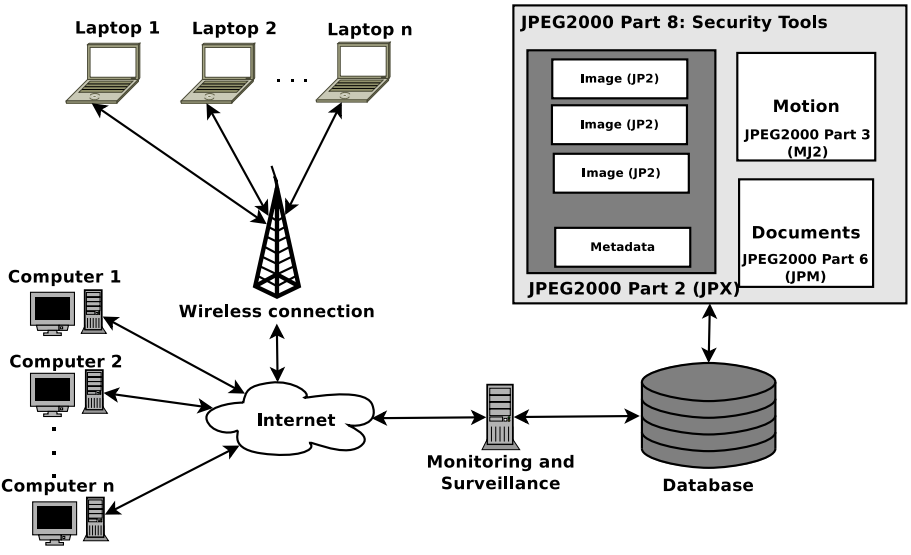

Fig. 4. Representation of the centralized scheme. The documents are stored in a JPEG2000 standard file format in a database, where the access is monitored to prevent external attacks and unauthorized connections. JPSEC provides security features and JPIP allows the transmission of these files over the network.

3.6 Centralized Scheme

In the previous sections, the suitability to handle legal multimedia files through the JPEG2000 standard has been discussed. In this section, we propose a centralized scheme with two main features: 1) it stores all the legal digital documents in a centralized database in a JPEG2000 file format, and 2) all of these legal multimedia files could be transmitted over the network taking into account many security aspects.

Figure 4 depicts the main idea of the proposed scheme. The still images are compressed through the JP2 and JPX file formats, the MJ2 is the file format for motions, and JPM is used for compound documents. For every file, the JPSEC provides security aspects to ensure the data integrity, source authentication, access control, etc. Finally, the JPIP protocol allow the transmission of these files over the network. The access to the database is monitored to prevent either attacks devised to affect the normal operation of the system, or the attempt to compromise evidences and documentation produced by a judicial procedure.

4 Summary

In the last years, the use of multimedia legal contents has been increased, becoming part of the judicial profiles. Furthermore, in Spain, the Civil Procedure Act

of 7th January, 2000 (1/2000) introduces the video recording of oral hearings, producing an enormous demand of storage capability. Nevertheless, the 1/2000 Civil Procedure Act does not consider any protocol establishing how to obtain audiovisual records.

The compression can help to reduce the storage and bandwidth requirements. However, besides the compression, the manipulation of images requires other advanced features as: transmition of images over the network, error resilience and supply of security tools. JPEG2000 is one of the latest standards developed by the Joint Photographic Experts Group (JPEG) and it is structured in 13 different parts addressing the encoding, transmission and security of still images and video. JPEG2000 fulfills most of the requirements in many different scenarios. The JPEG2000 standard also considers the inclusion of additional useful information through the metadata boxes. In the judicial domain, legal professionals consume an important amount of their time searching, retrieving and managing legal files. Therefore, this metadata boxes enables to index, annotate and tag every file, providing semantic capabilities.

In this work, we discuss the suitability of some parts that compose the JPEG2000 standard to the legal multimedia scenario as well as we propose a scheme of a centralized database to store indexed and tagged multimedia documents. This scheme, based on the JPEG2000 framework, allows the monitoring of the access to the legal data and takes into account several security aspects.

Part 1 is the core coding system and the basis of the other parts. It produces the JP2 file format that contains the compressed image and the minimal information to allow the recovering of the input image. Part 2 is an extension of Part 1, providing XML metadata boxes and the possibility to store many images in the same file with their corresponding metadata. It produces the JPX file format. Part 3 is devised to the compression, edition and streaming of motion sequences, defining the MJ2 file format. Part 6 is focused on the encoding of compounded documents and produces the JPM file format. It carries out a segmentation process to divide the document into different types of images and text, enabling the encoding of each part with different methods to improve the compression efficiency. Part 8 is named as JPSEC and addresses the security issues. Finally, the Part 9 defines protocols and APIs to enable the delivery of compressed images and metadata over the network. In our proposed centralized scheme, legal multimedia files are stored in a centralized database in the corresponding JPEG2000 standard file format. All of these legal files are also accessible through the net, monitoring the access and providing security tools to ensure the integrity of evidences and other legal files as the data integrity, source authentication, watermarking, etc.

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Author Index