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AI Approaches to the Complexity of Legal Systems

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

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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].

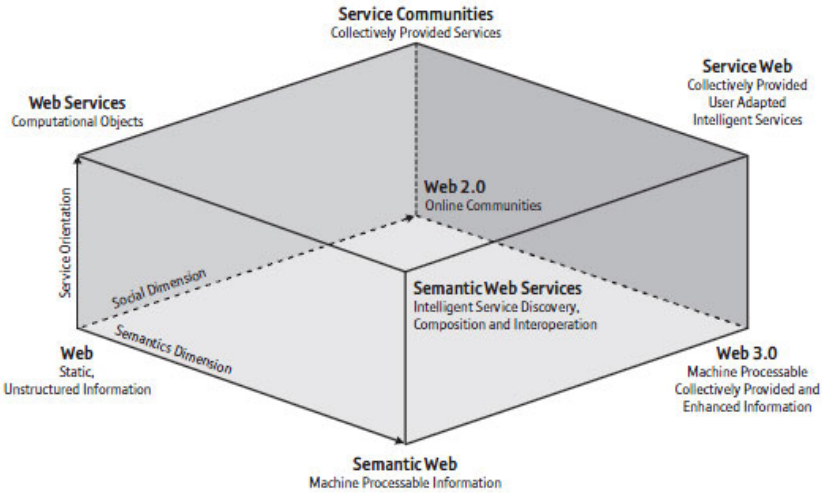

Fig. 1. SWS technological pillars. Source: [43] (reproduced with permission).

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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