A Framework for Open Mechanized Legal Reasoning

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Abstract. We build on the analogy between theorem proving and legal reasoning. In the former case it was shown that mechanized reasoning is always achieved provided there is a theory, a control on this theory and some rules governing this controlled theory once introduced in a given environment. We show that it is possible to identify similar conditions for cognitive systems and also in the legal world. We outline how this can be illustrated in the case of publication rights. We propose a social network approach to improve some features of the management of publication rights.

Keywords: legal reasoning, mechanized reasoning, publication rights, social network

1 Introduction

We are entering an area which will see methodologies based upon artificial intelligent surpassing human capabilities. At the same time knowledge is becoming the building stone of our society. The amount of available knowledge is blowing up. This implies that knowledge management can be modeled along new abstraction paradigms. These remarks are valid in the legal area as well. We outline ideas in this field that are not really new but from a point of view which is fully new. In this paper we investigate the link between legal reasoning and open mechanized reasoning frameworks. More precisely, we ask whether it is possible to abstract the concept of legal reasoning as we do abstract and extend the concept of automated theorem proving [1]. This implies to see laws as being equivalent to theorems. This concept is not new. Several attempts, notably by Kowalski [7], towards a logical approach to law have been proposed. This is indeed an abstraction mechanism since it supposes to select a particular logic and then to translate laws into clauses of this logic. It is however a rather restricted abstraction since it depends on the choice of a given logic. A state-of-the-art of legal reasoning and thus the relevant references can be found in the seminal book of Sartor [10]. But, our approach is much more general than the usual view of legal reasoning as a logical system.

We extend the concept of open mechanized reasoning framework to cognitive sciences in general. It is worth noticing that the attempts to introduce

abstraction mechanism in Artificial Intelligence (AI) have been made mainly in reasoning. Abstraction supposes here a generic process that is proven to lead to the right processing of a problem. This goes beyond the selection of a specific logic since the abstraction concept must be goal oriented, not method oriented. The proposed methodology is articulated along the following ideas. In section 2 we introduce the open mechanized reasoning framework and the basic results obtained in the domains of theorem proving and symbolic computation. Open means that the methodology is generic and not specific to a particular methodology. The original framework for this approach lies at the heart of AI. Indeed, to mechanize mathematics was indeed a goal of the founding fathers of the field at the Dartmouth meeting in 1956. The achieved results show that successful ones have a three level structure: a theory, a control on this theory and a well-understood interaction with the computing environment. The following section points out that this structure can be extended to almost any domain of knowledge, including law. This leads to the concept of Abstraction Based Information Technology (ABIT). Section 4 is devoted to legal reasoning and is illustrated in the domain of publication rights and more specifically some facets that are seldom acknowledged. Then, we ask ourselves whether specialized social networks could be helpful in this area. At this stage, we did outline the thesis that a concept of abstraction is suitable for cognitive sciences including legal knowledge. The next section is devoted to a possible implementation of some of the ideas proposed here. We review some techniques from multiagent systems and knowledge management that have been implemented and enable to implement some required features. A brief discussion of knowledge methodology is introduced. The goal is to design tools that are also mandatory to introduce naturally methodologies to assess trust and security features in the context of knowledge representation, a central concept to design any system based upon legal agents. The last section is devoted to some brief comments and conclusions.

2 The Open Mechanized Reasoning Framework

In [6], the Open Mechanized Reasoning System (OMRS) architecture was introduced as a mean to specify and implement reasoning systems (e.g., theorem provers) as logical services.

$$\begin{aligned} \textit{Reasoning Theory} &= \textit{Sequents} + \textit{Rules} \\ \textit{Reasoning System} &= \textit{Reasoning Theory} + \textit{Control} \\ \textit{Logical Service} &= \textit{Reasoning System} + \textit{Interaction} \end{aligned}$$

In [2], a similar approach was designed for symbolic computer algebra systems under the name of Open Mechanized Computational System architecture.

$$\begin{aligned} \textit{Computation Theory} &= \textit{Objects} + \textit{Algorithms} \\ \textit{Computation System} &= \textit{Computation Theory} + \textit{Control} \\ \textit{Algorithmic Service} &= \textit{Computation System} + \textit{Interaction} \end{aligned}$$

In [1], an unified description of both classes of systems was derived and called Open Mechanized Symbolic Computation Systems (OMSCS). It synthesizes the previous definitions into that of Symbolic Mathematical Service. It is based upon definitions of symbolic entities and operations which include the previous definitions of sequents and objects, and of rules and algorithms respectively.

Symbolic Computation Theory = Symbolic Entities + Operations
Symbolic Computation System = Symbolic Computation Theory + Control
Symbolic Mathematical Service = Symbolic Computation System + Interaction

A key feature is that this is the only example where such a generic approach (e.g., open) is clearly available. Indeed, for logical services and symbolic computation it is possible to prove that a computation always exists and always terminates. In plain words, we have a theory as the initial level, we exercise some control on this theory in the second level while the third one describes how the controlled theory is linked to any environment. In these specific cases, the environment is a computer universe. In [3] an extension to scientific computing was investigated. In this case there is no longer a generic approach but, one may either rely on the standardized arithmetic operations in floating-point arithmetic (IEEE-754 standard) or on specific arithmetics (interval arithmetic for instance) or on routines specific to a given specific available software). In terms of the previous analysis, this means that instead of considering a generic theory, one may consider various possible theories. For each selected theory, one has to specify the control imposed upon it and the way the interaction with the environment is managed. A general remark is that even for the domains where the problem may be seen as solved, to identify a theory and to analyze the control are rather simple tasks while to formalize the interaction with the environment is always a challenging task.

3 Abstraction Based Information Technology

A motivation to extend this work is coming from the state-of-the-art of artificial intelligence (AI) resulting from the extraordinary progresses achieved in recent years by computer technology, both at the hardware and software levels. The claim that within a few years computers will be more efficient than (most) human brains can no longer be disregarded, although this may sound very unpleasant for many scientists or sociologists or humanists. In addition, the hypothesis that brains have mainly a virtual perception of the world enables to investigate a concept of abstraction in AI. A reason is that the images transmitted by the retina to the brain are possibly virtual images. An underlying assumption is that AI is not simply a subfield of CS but a paradigm to mechanize reasoning processes when dealing with the real world. This includes clearly legal reasoning. A second assumption is that we interact with the world through computers and thus we need to model information technology through abstract models. We call this abstraction ABIT (Abstraction Based Information Technology). It is summarized as follows.

– A theory
– A control on this theory
– An embedding environment

It turns out that the three levels of the open mechanized reasoning framework can be used as a basis to design such an abstraction. In [4] an Agent Oriented Abstraction (AOA) was proposed to abstract a multiagent system and also what is a society of agents (along the line of Weber's fundamental work in Sociology). For our purposes here, it is enough to state that AOA is summarized by 6 definitions which can be divided into the 3 levels of the OMRS framework already quoted. A remark is that tools coming directly from AOA include the so-called virtual knowledge communities (VKC) that are the topic of the last section. The design of AOA was not inspired by the works on mechanized reasoning. It was solely a will to abstract concepts in multiagent technology and thus in distributed AI. Only the link to virtual enterprises was noticed and used from the very beginning to model them through their corporate knowledge. This comment becomes meaningful for the legal paradigm when accepting that this paradigm is part of the cultural domain of any society and that culture is part of the corporate knowledge of a society [5].

A further step was to understand that this ABIT approach is suitable to introduce a concept of abstraction into domains as diverse as physics, philosophy, sociology or culture [5]. A possible exception is Mathematics, a domain where only theories look to be meaningful since control and link to the environment belong to applications rather than to Mathematics itself. In the next section we turn to law.

4 Open Mechanized Legal Reasoning

4.1 Legal reasoning

Legal reasoning is thoroughly described in [10] that we adopt for reference purposes. The second part of the volume, entitled Legal Logic, provides a large collection of possible theories. Each section or even sub-section can be selected to be a theory. The choice is not limited however to this second part since already in the first part several facets of legal reasoning are presented. The domain is known to be very complex and it is thus not surprising to be faced with a large number of optional theories. Some notions, such as for instance doxification, could be used to describe a possible control on theories as well as the embedding into an environment. However, we select a different scheme to introduce legal reasoning. The three following facets define mechanized legal reasoning.

– A theory is a set of laws (as voted by legislators),
– The control consists in application decrees,
– The environment is defined by jurisprudence and litigation procedures.

A first limitation is that such a scheme is not universal. For instance, the second step does not look to exist per se in England. In fact, laws are valid in a country or in a cluster of countries as anyone working on ciphering for instance quickly notice. The above mentioned scheme may appear as an over simplified view of legal reasoning but it is very often the view non-experts have. Also, it is suitable to be extended to less trivial approaches. The control may be extended to rules and regulations also as shown for plagiarism or copyright protection. In fact the theory and the control are defined by the administrative, political and judicial instances. They are also responsible for the third level but the next sub-section illustrates that there are domains with some ambiguities. We want to illustrate mainly the latter aspect. A straightforward application domain would be to select one of the methodologies described in [10] and to verify that the three level architecture is suitable. We concentrate however on comments on two specific examples. The first one is the French new set of laws on copyright protection (and intellectual property right) knwon as DADVSI, that has recently been voted by the French parliament. The second example deals with publication rights and plagiarism. The following comments are obviously from a non legal expert. This is why we do not discuss the levels of identifying a theory or the control of this theory. We concentrate on the third level since non experts must decide how to use the existing legal knowledge. In fact some of the questions we raised were put to lawyers and always got as a generic answer: there is a solution since there are laws governing this domain. But, it turns out that either as the editor-in-chief of a journal, or as researcher investigating security of mobile systems or as a professor having to fire a student from the university because of a stupid case of plagiarism, some disturbing features and consequences of fully relevant law have been encountered. This is a motivation to introduce a heuristic tool: a legal social network.

4.2 Intellectual property example

There is a very large literature on intellectual property rights. This is a very hot and actual problem and research topic in information technology because of the P2P technology for instance. The European Union has issued in 2001 the "Copyright Directive". Any web search will return the relevant document. It goes further than international agreements (for instance the so-called TRIPS plus) but, this directive fails the principle of subsidiarity and thus, implies changes to the legal procedures of member states. A first comment is that a similar set of laws have been voted in the USA after some challenging discussion. There, the resulting laws seem to have been adopted by practitioners without much trouble. Coming back to the EU, it looks like most of the fuzz is taking place in France. A rough analysis is as follows. On the international side, Apple computers protested loudly because of the consequences of this French law for iPod and iTunes. This had however very little impact in France. The French authorities aimed to enforce the cultural exception of preserving French culture. In the IT field, there was a strong opposition from part of the community motivated by the will to preserve the development of "open software". An even smaller part of

the community was unease because it is becoming an offense to destroy cookies placed by checking agencies on PCs. This, at a time when fighting cyber attacks requires to "kill" such cookies. A feature is that the discussions leading to the adoption of the law lead to interesting exchanges of opinions among members of parliament, lawyers and experts in IT. Most of them were conducted in very good faith by all "partners". In the end the cultural aspects won. Both the one already mentioned but also the cultural French bias when coming to laws that can be roughly summarized as "do not worry, when a law is "bad" it is not implemented". The trouble is that France is not alone in the EU and that consequences for European research projects as well as for ordinary citizens must be addressed. This is a domain where good faith prevails but cannot hide technical difficulties. In this area, a law abiding IT expert is facing trouble to assess exactly what is the relevant legal knowledge. Could a social network for such a problem be useful?

4.3 Example of publication rights

Let us turn to a problem becoming increasingly bothering in the education world with the facilities provided by internet: plagiarism in projects or thesis. Tools exist, such as the Turnitin or Copy Tracker or Plagium or Nopliagia or many others software, to check whether part of a report is extracted from a previous publication. Plagiarism is reaching enormous growth since it has been estimated that 20 % of all German master thesis suffer from some sort of plagiarism. We need an informative tool to make the students aware of the existence of plagiarism detectors. Since a student signs a form stating that the work presented is his/her own only, plagiarism has legal consequences and a guilty student is thrown out of the university. The silliest case encountered is a foreign student producing a genuine original work written in English. But, since a several pages summary is required in such cases and the student did not master German well enough, s/he copied such a summary from a second rate research report written in German and available on the web. This summary was firstly not accurate and then identified as not genuine. At the time of a world economy and education, it is worthwhile to have tools warning foreign (and local) students that such rules are enforced in many universities. Here again a legal social net could be useful.

We look now at the facet of publication right linked to research evaluation mainly. Any professional association has published guidelines relevant for its own field (ACM and IEEE in computer science, ACS in chemistry, APS in physics, AMS in mathematics just to quote a few). Research misconduct has been identified quite a few times in recent years. Research misconduct is defined as fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. Research misconduct does not include honest error or differences of opinion (origin: [8]). A first example is the topic of [8]. The authors produced experimental results that were arranged to support their expected results. The result was that the main researcher was fired from his position and his career as physicist was terminated. Another famous case took place in 2003 in India where the Vice-Chancellor of Kumaon university had

to resign. In some instances there is no obvious consequence. This is for instance true for the Bogdanov's cases. The Bogdanov, who are twin brothers and famous in France as hosts and producers of TV series, defended with success two PhDs with emphasis in theoretical physics and in mathematical physics respectively. This remained mostly unnoticed until their results were published in journals. The physics community reacted immediately. In this case the question was to decide whether a proposed theory was correct or not. Although the latter is most probable, no harm was done to anyone (except to the referees, the two thesis advisors and the journal editors). Since the thesis were accepted in an university that is not famed for any kind of outstanding quality but does not charge registration fees, one cannot say that the physics students registering to this university were mislead. The case is widely illustrated in blog sites on the web. We are thus faced with a situation in which the rules and regulations for publishing research results are agreed upon and enforced but leave some holes for cheaters as well as for non-state-of-the-art results. It must be said that the situation depends strongly on the discipline. It looks like physics and health sciences see a large number of unethical cases. As editor-in-chief of a journal publishing papers in mathematics and theoretical computer science, we can say that we try hard to avoid such problems. The price to pay is to have reviewing processes lasting up to two years. In CS, publication in conference proceedings is widely accepted as (almost) equivalent to journal publication. Since the number of conferences is blowing up, a referee may see a papers s/he has rejected for several conferences accepted by another one. Another feature not properly taken into account by publication guidelines is the protection of already published false results by a well-structured community of researchers.

4.4 A legal social network?

The previous sub-sections do illustrate the fact that if we consider open mechanized legal reasoning, we have many possible theories that can be controlled. But, when setting a controlled theory in a working environment, we are faced with heuristic difficulties that neither the laws nor the applicants of these laws can fully master. In the case of publication rights, we have an impressive number of well-defined laws and regulations, extensive guidelines (control) on how to enforce them and nevertheless some very practical problems. One of them could be summarized by saying: how to stop protecting published wrong results or to forbid publishing wrong or banal results? Indeed, the number of top experts in some fields is too low to get three meaningful reports on any conference submission for instance. Another default can also be the fact that our society is becoming fully interdisciplinary and very few people, including law makers have the capability to master very advanced technical domains and the art of designing laws and regulations. This was the case for the DADVSI law when most of the legislators decided finally to vote as suggested by their party since to master the involved technological problem was proven impossible.

A possible solution could reflect the way our society is working nowadays, that is through social pressure and trust. Such a solution could be achieved through

social networks. In a first instance, one could think of a social net dealing with European laws and regulations regarding the ciphering of data or the exchange of P2P files. It is surprising that no informative survey is telling users what are the differences among the 27 European countries. May be that lawyers have this knowledge but, IT experts surely do not. A second social net could deal with conferences in a given subfield of science. Publishers are encouraging the federation of conferences to limit the number of published proceedings. This could be an incentive to design such a social net.

An advantage of social networks making technical information available to non experts is to contribute to trust building. Indeed, it could be seen as a reputation building mechanism. This is not restricted to the examples cited hereabove. There are several domains where comparative knowledge of the various European laws are simply not available. Some obvious examples are for instance: comparative laws to start a company in the 27 European countries, fiscal status of such companies, list of existing patents. The latter knowledge is known to exist but as been gathered mostly by companies and is very difficult to access. It is probable that such knowledge bases do exist and expert lawyers have certainly this knowledge but it is not readily available. This is maybe why so many "limited" companies are started in the UK from many places outside UK: the information and the procedure are simple, the costs are low and both are displayed in web sites. This is much easier than questioning several chamber of commerce or national lawyers. It is obvious that several technical problems are present when coupling several social nets together. In particular privacy rights have to be considered. This is under investigation.

5 Virtual Knowledge Communities

Since we plan to switch from logical framework to cognitive systems to identify abstraction concepts, we must decide wether to use existing knowledge methodologies or design new ones. In this section, we outline a methodology that is being developed to implement the concept of abstraction based information technology. First, it is set in the framework of the agent technology which has been largely adopted for legal software agents. Second, it relies on knowledge engineering. Third, it allows to address the problem of security and of trust in a same framework. Fourth, it is linked to the concept of virtual organizations that could be worth being considered also for legal software agents. An important remark is that to build trust requires to share and to exchange knowledge. From a technical point of view, this is difficult to achieve through learning when knowledge is uncertain as it is here as we have seen in the previous section. A facet of the Agent Oriented Abstraction (AOA) mentioned previously is to enable to select virtual knowledge communities (VKC) as a methodology to represent knowledge.

Virtual organizations (VO) are emerging as a requirement in the information society as a new information distribution scheme. It can be defined as a collection of individuals, companies or organizations who have agreed to work together to achieve a purpose. The concept of virtual knowledge communities (VKC) is an

interesting aspect of knowledge management in the frame of VO. A reasonable denition for VKC can be: Groups of people or agents with similar interests and purposes communicating and interacting by means of information technologies. VKCs are built upon three ground concepts: different entities (the members), similar interests of the members, and electronic communication channels. Since VOs are based on interaction between different entities, it appears natural to consider the concept of virtual knowledge communities using an agent-based abstraction. Indeed, Multiagents systems (MAS) are based on the model of autonomous entities (agents) interacting with each others. AOA considers that agents are composed of two entities: A knowledge component and a decision mechanism. There are several ways to define the knowledge component. VKC is one of them. It is then possible to design the basic operations that can be performed on VKCs and to implement them. Relevant references can be found in [9] and [11].

6 Discussion and Conclusion

An important motivation lies in the belief that artificial intelligence will be more effective than human actors shortly. At a time when a car is able to run 1,000 km without a driver, we may think that managing and exploiting legal knowledge bases may be partly mechanized. We must prepare to design relevant new software. A probably safe assumption is that knowledge methodologies along learning ones will become mandatory. We also assume that trust is a feature of security. When bypassing the usual approaches to trust mainly based upon reputation mechanisms, and assessing how implicit knowledge affects trust confidence, we notice that large scale classical approaches to knowledge engineering such as mediators or federated bases are no longer suitable. One must start from much smaller entities such as virtual knowledge communities. Our technical view of the world is becoming more and more virtual. This concept is changing the way enterprises do collaborate. It is worth designing methodologies that will enable to think of collaborative international legal systems. Although this feature was not considered in this paper, it is suitable to this approach. The main goal of this paper is to outline how a concept of abstraction can be defined for information technology seen from a cognitive point of view. The paper is mixing some theoretical, heuristic and technical concepts. Similarly, although it defends the thesis that law can be addressed in the described framework, it is by no means claiming to introduce new concepts on legal agents. One of its goals is to illustrate that several of the notions already introduced in the context of legal or logical agents are well suited to be introduced in the proposed cognitive formalism through a new concept of cognitive abstraction. Finally, we have outlined the point of view of a "user" of laws, as everyone is, trying to identify a classification mechanism bridging the gap between lawyers and IT experts. This is probably why the author is not aware of similar works in this area.

Acknowledgements

The author thanks John Campbell for insights on how British laws are implemented.

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