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Editors:
J.S. Svensson
J.G.J. Wassink
B. van Buggenhout

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More information about the JURIX foundation and its activities can be obtained by contacting the JURIX secretariat:

Mr. C.N.J. de Vey Mestdagh
University of Groningen, Faculty of Law
Oude Kijk in 't Jatstraat 26
P.O. Box 716
9700 AS Groningen
Tel: +31 50 3635790/5433
Fax: +31 50 3635603
Email: sesam@rechten.rug.nl

 http://jurix.bsk.utwente.nl/

WHY SOME HARD CASES REMAIN UNSOLVED

Julia Barragán

Summary

In KBS Legal Expert System, refinement tools have been used to permit adding new information to previously available data without getting contradictions, and to turn the inference engine more complex and powerful.
The development of these refinement techniques have made it possible not only to reach better solutions to existing problems but also to improve the efficiency of the explanation system. Thanks to this explanation system we could see that, when KBS Legal Expert System cannot reach the right solution to a case, either the procedures used by the human experts to solve such a case are so intricate that it is almost impossible to express them in a formal way, or that some piece of legal information used in the inference process is wrong.
After the analysis of the second cause of failures, we are convinced that though KBS was not originally conceived in order to check the correctness of the legislation, it could be successfully used to detect logical or semantical weaknesses in the bills or the laws.

1. Introduction

In a general way an expert system should satisfy two main conditions: first, it should exhibit a set of well formed rules and executable algorithms and secondly it should bear a direct correspondence to a certain domain of knowledge. Many authors support that in the legal domain both conditions are hardly compatible because rules meet clear standards while legal reasoning does not. This point of view is closely related to the approach of the standard theory of legal argument, which is based on well defined concepts of validity, information and conclusions.

In the frame of this theory, validity is supposed to be a formally demonstrable and absolute feature of the arguments; a question of all-or-nothing and not a matter of degree. About the issue of the information, the standard theory works on the supposition that the normative system provides all the necessary information for legal inference and it also gives the rules for supplanting the essential missing pieces for the legal decision making. This approach would never tolerate any form of conflict which could lead to an inconsistency in the sense of the classical logic which is supposed to apply well to every issue in the legal domain. In such a context the conclusions must necessarily be definitive and non-revisable. It is not surprising that an expert system based on this approach breaks down when applied to the legal domain; this happens because though such a system is able to exhibit well formed rules, it cannot bear a direct correspondence to the legal reasoning.

As a mather of fact, legal arguments by their very nature, deal with issues of plausible hypotheses, disputed facts and approximately correct analogies. Furthermore, in the process of legal reasoning the experts, using accepted methods of analysis can reach quite differing legal conclusions, something which is not permitted in classical logic. In such cases the standard theory of legal argument seems to be incompetent to address the real problem and to capture all the nescessary factors when we have to model a real piece of legal argument. As an answer to the problem of the inefficiency of the tools of the standard theory to shape the actual legal arguments, several non formal theories of legal argument have emerged and surprisingly they coexist with the logical point of view that the very concept of a non formal theory is absurd.

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Certainly, at least in the legal field such concept could hardly be considered as absurd, taking into consideration that the cultivation of skills in legal reasoning requires among other things a good understanding of *different types* of legitimate inference. These different types of legitimacy in legal arguments depend on many non-formal factors such as the evaluation of pros and cons, the credibility of the witness, the interpretation of the context and so on. In this approach, the expertise seems to apply better than the formal rule to the reconstruction of these factors.

Beyond any doubt, when the non-formal theories of legal argumentation provocatively address the incompetence of the classical logic-based methodology to legal expert systems, they have made an important contribution to understanding the relations between the algorithms and the patterns of reasoning. In spite of this, we should be alert about the danger of assuming a complete rejection of representing the knowledge by means of a logical language.

In our approach we assume that only Logics if used in the right way, can provide a systematically interpretable means of justification, which ensure that the actual legal knowledge represented in the formalism is understandable and the inference methods are verifiable. But facing the complexity of forms of legal reasoning, it seems pointless to think that a single type of formalism or a single logical approach would be capable of representing this wide variety, where the lawyers using non-orthodox means are capable of reasoning even when the available information is incomplete and in spite of this to obtain plausible conclusions. Thus we cannot avoid to deal with the large number of problems raised by such multiple ways of reaching a conclusion in the legal field. In order to attack these problems we fixed four basic postulates: 1.- validity is supposed to be a matter of degree, 2. the conclusions are temporary and based on knowledge considered only as “generally true”, 3. in the legal field the inference and the decision making are generally made under incomplete information, 4. the knowledge representation should not be independent of the programs.

In order to overcome the limitations of the classical rule-based approach in expert systems, we have freely used some concepts of non-formal theories of legal argument in the so called knowledge refinement processes. On this basis, we can support that in a wide number of questions the limitations of that approach derive from the wrong idea that the standard theory of legal argument and its associate the classical logic are the only logic tools available for knowledge representation [Barragán, 1991].

Since we basically agree with the idea that no legal expert system can be truly called expert unless it deals with an adequate analysis of the nature of legal expertise, our approach includes a careful characterisation of the many problems involved in the exercise of legal argument, a concept that can not be easily confined to classical logic. In a general way, many different issues have to be solved in shaping a legal expert system. In the first place we find important difficulties with the specific features of the legal domain (softness, ambiguity, vagueness, etc.). Further difficulties emerge with the many ways used by lawyers in order to reach conclusions; among others: probabilistic inference, inductive inference, common sense reasoning and analogical reasoning. Finally it should be considered that the many subjective points of view, inevitably introduced in judgmental expertise, can be hardly grasped by the formal system of classical logic.

From our basic postulates it is possible to infer that knowledge representation is always provisional and we can iteratively improve it. Thus, we propose to use knowledge refinement with the intention of improving the empirical adequacy of a system by incorporating plausible modifications of existing rules. This refinement process is driven by comparison of the conclusions reached by the system with that of the human experts about a case.

In solving the refinement problems, we have freely used structures of the classical logic, the analogical reasoning approach, the logic of hypothetical-cases analysis and the rules of rational decision making under uncertainty.
Our KBS Legal Expert System™ is a rule-based system, as its set of rules is the formal definition of an act. But as we have educed these rules from multiple dimensions (among others the positive law) and have formalised them by many different means (among others the formal classical logic) the solutions that the system is capable to reach, deal with a wide variety of cases in the legal domain.

2. The acquisition and refinement of knowledge

In order to be called an "expert system" a computer program must have the ability to perform well in the different cases of a certain domain; the best way to do that, is trying to emulate the human-expert's way in solving the problems in the specific field. For this reason, when developing an expert system, we have to give special attention to the characterisation of the rules of inference and to the study of the expert's performance. There is no question that the knowledge acquisition and knowledge refinement are the key problems in the field of Artificial Intelligence and consequently in the field of Expert Systems.

The main task of knowledge acquisition and refinement processes is to construct a set of rules of the system (RS) which represent an efficient and accurate formal representation of the expert's domain of knowledge. We assume that the best way to do that, is trying to reproduce by the interaction with the experts, their own knowledge acquisition and refinement processes. This activity is a complicated one in any case but in the legal field it becomes even more complex because of the special features of the normative system, the legal reasoning and the legal decision-making [Alchourrón and Buligyn, 1971]. The ambiguity and vagueness of the concepts, a certain laxity in the formal relations, the open-textured language generally employed in the legal arguments and the common sense reasoning frequently used to grasp the broad range of situations involved in legal issues, make the task of educing the relevant rules very hard [Barragán, 1990]. On the other hand, as legal problem-solving involves and describes many complex activities, any attempt to gather these rules, demands a very serious effort in order to capture the pattern of the reasoning. With respect to the process of refinement, it should be added that many technical problems have to be solved when knowledge-base refinement is designed, since in a general way legal issues tend to resist being broken up into subissues (the procedure generally used in refinement activity) because they often involve extremely complex situations, and are not easy to simplify.

Conceptually we can view the complete knowledge acquisition process as consisting of three types of activities: 1. educing a set of rules from the expert performance. 2. educing the strategy used by the expert to reach the right solution. 3. testing and eventually revising the knowledge base.

In order to attack the problem of knowledge acquisition and knowledge refinement in KBS Legal Expert System, our first activity was directed to elicit the rules and the structures of inference from the human experts. We found that in order to reach a solution, the experts do not apply the law in one unchanging way; they generally do more with the rules than just follow them. For instance, they can argue about the rules themselves, can propose refinements and even newly formulated rules. (see Gardner, 1985).

During the activity of eliciting the (RS) we found that when a certain law is directed to an specific person, the experts use just the legal rules (LR) to reach the conclusion; in these cases, the (RS) is the direct representation of (LR). In a second group of cases, the experts use the (LR) and the formalisms of the classical logic for the inference, these

are the prototypical rule-based representations. There exist a third group of cases, in which the (RS) is educed from the (LR) introducing the formalisms of the logic of analogical reasoning; and finally we dealt with group of cases where the (RS) is shaped from the (LR) using the rules of rational decision making.

During the second stage in constructing the knowledge base, our activity was directed to elicit the strategy used by the experts to resolve easy and hard cases. In easy cases, experts use the law and the facts as premises, and by the means of the classical logic reach the solution. When the law does not give a direct answer to the case, the experts mainly use the analogical reasoning, which consist in bringing together two particular situations considered as analogous, in order to indirectly use the solution given by the law. In deciding hard cases, the experts try to analyse them from different points of view, comparing the diverse rationales and they finally apply the rules of rational decision making, in order to reach a solution which is acceptable for the patterns of legal reason.

In order to construct the base of knowledge, our third activity was directed to testing the performance of KBS under different situations. We have first tested the system on 30 cases, and have made the necessary revisions trying to improve its empirical adequacy. In order to refine the (RS) the human experts were encouraged to review the chain of inference given by the explanation facilities and so the rules could be modified on the basis of the reviewer comments.

The construction of the knowledge base in KBS have involved six cycles of the three activities before described. Extra difficulties have emerged when in a large number of cases the problems of refinement could not be solved by just adding new rules, and it was nescessary to modify the existing rules.
In general, we found:

S1: the previous system
R : the new rule
Cn: the logical consequences

(CnS1+CnR) is not equal to Cn(S¡+R)

For this reason the interaction with the human experts, in order to test the correctness of every new incorporation, is very important.

The expertise of KBS™ was educed from many different sources: legislation, legal texts, legal decisions and interviews with legal experts such as judges, law professors and litigators. Specifically the extensive interviews with legal experts have indicated that in their decisions on the matter they generally consider a common set of relationships between facts and legal conditions involved in the case to be decided on. These conditions are the core of the (RS). During the interviews we found that the structure of these relationships makes it possible to elicit the patterns of representation of the cases that come under the Venezuelan Criminal Law. Such relationships can be represented by a scheme that describes them. The scheme organises the rules and provides a framework for controlling the application of the rules to the case. The (RS) that were educed directly from legislation have the logical form of the “if-then” relations. In this case the (LR) generally address the conditions (or rules) which directly constitute the frame of reasoning. In this case, as the production rule has the form: “if A1 and A2 and..... An then B” the language, the set of axioms and the inference rules of the classical logic are capable of providing an efficient representation

In the case of (RS) educed from analogical reasoning, the rule of incorporation is not so simple: the logical specificity of reasoning by analogy consists of inferring that what is true in a particular situation x0 should still be true in another situation y0 considered the similarity to x0 in some respect.

In this case being:
P and P' are properties of x0 and y0 respectively
P and P' are similar in a relevant respect
Q is true for x0
the production rule has the form:
P(x0).....P(y0)
if Q(x0) is true, Q(y0) must be true

As we can see, this supposes to extend the language of the classical logic, to add a new scheme of axioms and to define a new notion of inference; but in order to accept that this logical form provides an accurate representation of the analogical reasoning it is also necessary to postulate a certain dependency between the concerned properties P and P'.

In understanding the experts' reasoning by analogy about a case, we had to deal with two different issues: first, which properties should be considered relevant in each analogy and secondly, the degree of dependency required between the cases involved in the reasoning by analogy. It seems to be clear that depending on the type of analogy proposed it is possible to obtain more than one reasonable solution to a certain case.

Taking into consideration the agreement about the relevant attributes and the intensity of the dependency between them we found the following situations:

Case Nº 1: agreement about properties
agreement about intensity
Case Nº 2: agreement about properties
disagreement about intensity
Case Nº 3: disagreement about properties
agreement about intensity
Case Nº 4: disagreement about properties
disagreement about intensity

In the cases Nº 1 and Nº 2, (RS) could be represented by using the rules of analogical reasoning. Case Nº 1 (when among the experts there exists agreement about the properties and the intensity) may be considered as a "if-then" case. Case Nº 2 (agreement about the relevant properties and disagreement on the intensity of the dependency) could be solved with a fuzzy function. Cases Nº 3 and Nº 4 (when the experts disagree about the relevancy of the properties) can not be solved by using the rules of analogical reasoning because they represent adverse rationales.

As we can see, in the cases Nº 1 and Nº 2 the solution could be reached in a two-steps process. In the first step, which is common to both cases, we tried to encourage the experts to discuss about the proposed analogy and to give it a logical formulation. In the second step concerning to the case Nº 1 we have used the logic of the standard theory of legal argument; while in the second step of the case Nº 2 we have applied a quite different approach, the fuzzy logic, which fitted better to the situation. In the cases Nº 3 and Nº 4, the presence of divergent rationales generates a range of possible right answers; in this frame the logic rules of rational decision making may contribute to choose one right solution among the range of answers.

3. The Refinement Procedures

In contrast with the knowledge acquisition which deals mainly with the activities that are directed to bring entirely new rules into the knowledge base, the knowledge base refinement deals with modifications of some components of the existing rules. These modifications are incorporated in the rules in order to improve the empirical adequacy and the judgmental expertise of the knowledge base. The knowledge base refinement

process involves the activity of testing the reliability of existing rules and eventually the incorporation of plausible modifications to those rules in order to improve the judgmental expertise of the system and also its ability to correctly classify the cases in its domain.

The scope of the refinement process is to reach in time t1 a better solution to the judgmental question than in time t0. If we define the domain of jurisprudential expertise as a kb-space and kb0 as the rule under consideration in time t0, any "north-east" solution will be a better solution to the problem of expertise. We assume that kb0 represents accurate knowledge concerning the domain of expertise; but as it happens in human judgmental expertise, the knowledge base of an expert system needs some refinements. In the process of refinement the emphasis is on correcting a number of flaws in a complex structure which is assumed to be basically correct. In order to attack this problem, as the kb-space is not an Euclidean vector-space, refinement systems will adapt better to the problem than mathematical optimisation methods. The procedure generally used in this activity tries to break up the issues in subissues in order to focus the effort on the flaws of the structure. In the legal field this procedure involves many extra difficulties, as in a general way legal issues tend to resist being broken up because they often involve extremely complex relations. In order to solve this problem in actual cases, human experts make use of many various sources of knowledge and meta knowledge. We support that in a wide number of question the limitations of the rule-based reasoning could be overcome if the rules of the system are built and refined through an intense interaction with the experts and using the appropriate refinement procedures. If in solving the legal cases the experts are systematically encouraged to analyse the logical structure of their reasoning in order to incorporate modifications to the rules which feed the system, this will be capable of reproducing the expert's performance in a larger number of cases.

In the process of knowledge base refinement we have worked with strategies and concepts for extracting knowledge through the interaction with an expert, and the analysis of hypothetical cases made by an expert [Davis, 1979], [Eshelman and McDermott, 1986]. This approach to the refinement problem does not exclude the consideration of other forms [Grinsberg, Weiss and Politakis, 1985], [Waters, 1985]; but taking into account the special features of the legal domain and the many difficulties in grasping the complexity of its rules (generally expressed in an open-textured language and even in a jargon) our decision has being made in favour of a conservative- step by step strategy which prefers less radical refinements to the more radical.

In developing this strategy we have used hard/easy paradigm [Gardner, 1984] in order to sift easy from hard questions. During the refinement cycles, the experts were encouraged to resolve the question by first using the conditions addressed in the law and the rules of the classical logic; If not successful, they tried to solve the question by using analogical reasoning and finally by arguing with hypotheticals which introduce the opponent point of view or rationale. To summarise the approach: we tried to transform hard questions into easy questions by the help of experts, in order to transform analogical reasoning and arguments on hypotheticals into rules of the system (RS).

During the different cycles of the refinement process we have reviewed the set of rules and have introduced rules of analogical reasoning both as a source of evidence for generating refinements, and as a source of testing the cases; we have also introduced the HYPO' analysis schema [Rissland, 1985], [Ashley, 1988]. This last approach seems to be more explicative than the analogical reasoning since it emphasises the importance of the adversarial reasoning process and permit the incorporation of alternative points of view about the case.

The construction of the current version of KBS has involved six cycles of interleaved instances. Technically speaking, during the refinement of KBS, we have added and deleted some rules, but we mainly used the rule transformation strategy in order to define each time a new set of conditions under which the knowledge base reaches a conclusion. In order to test the "goodness" of the refinement operation, after each cycle we have evaluated the effects of the operation on the errors in the knowledge base and on the misunderstood cases. We also have evaluated the plausibility of the operations which was defined as the number of misunderstood cases that each operation of change has actually corrected.

4. Testing the performance of KBS

The general point of the question under consideration in KBS Expert System™ is whether or not the Venezuelan Criminal Law should be applied to a certain case. This point is mainly considered in the art. 3º and art. 4º (with its 14 subdivisions) of the Venezuelan Criminal Law. KBS Expert System has many different sets of rules (RS) elicited from various sources, by diverse means; for instance the set of rules number one, was directly educed from the Code of Criminal Law (art. 3º). Set number nine was educed from the Code of Criminal Law (art. 4º, sub. 8º), from the Code Bustamante (art. 300º) and from the Code of the Army (art. 123, sub. 1º) by using the logic of analogical reasoning. Finally, the set of rules number ten , was educed from the Code of Criminal Law (art. 4º, sub. 8º), from the Law of Civil Aviation (art. 18º) and from the analysis of a hypothetical case argued by Sosa Chacin. While testing the performance of the system we found that the (RS) that incorporate the logic of analogical reasoning and the logic of analysis of hypotheticals carried out by experts have shown more ability to solve interesting questions about interpretation and content, while the (RS) which use just formal logic patterns only apply well to non-interesting cases.
We have tested the performance of the system and controlled the ability of the refinement procedures to improve that performance, in three stages: t0, t1 and t2. In t0 the system had rules , just educed from a well- defined body of the law by the tools of formal logic; in this stage only cases prototypically clear were resolved (18 of the 102 cases); and the legal experts agree that the solution to the other situations (the most interesting) was just wrong and in other cases simple minded. In t1 we could introduce into the system a set of new rules, and conditions educed from many different dimensions of the law by using analogical reasoning; in this stage a good number (45 of the 102 cases) of non-trivial questions were resolved. In the time t2 we introduce rules educed from the analysis of hypothetical cases. This analysis was carry out from two alternative rationales; but just the "majority' rationale" was considered as a source of new rules. In this stage a small number (14 of the 102 cases) of hard controversial questions was resolved . In 25 of the 102 cases KBS did not succeed in making the correct inference and it took off in the wrong direction. As a side consequence of the testing process we have analysed the cases that remain unsolved and we found that in about 9 of the 102 cases the System could not emulate the patterns of the expert because these were based in a very intricate net of qualitative reasoning mixed with vague political principles or with expert common sense about the situation. In these cases we could not discover how to make human heuristic knowledge usable on the computer. In the remained 16 of the 102 cases the failure did not come from the inability of the system to emulate the human patterns, but from some logical imperfections of the legal text that make the inference impossible. This weakness in the basis of the inference chain in many cases is so imperceptible, that can not be easily detected by using the methods of logical analysis; it generally turns evident just when the System shows its inability to provide reasonable results in a number of similar cases.

5. Conclusion

The current version of KBS is capable of dealing with a wide variety of cases in the legal domain, and it provides the expressive power needed to ensure that the model bears a direct correspondence to the activity it is modelling (empirical adequacy).

In developing the processes of knowledge acquisition and knowledge refinement in KBS legal expert system we have found that there is a number of questions about legal arguing and legal argument that cannot be answered if we use just the standard theory of legal argument and its favourite tool: the classical logic. Things are even worse if we consider that these non-answered questions have proved to be of considerable legal interest. Taking into consideration the great importance of actual legal arguments as a social institution for inter-personal persuasion and debate, it does not look reasonable to use just classical logic which at best, will apply to the arguments after virtually all interesting questions were dropped. In this point we should not ignore that there are many types of good legal arguments and the standards for sound legal argumentation depend upon many circumstances which sometimes are quite close to classical logic and in other cases very close to the so called expertise. This is the very difficulty when developing a legal expert system: if we use the standard theory of argument and the formal logic we can easily reach rigor and certainty in the set of RS but in many cases such qualities are achieved at the cost of an oversimplification of the argument. On the contrary, if what we want is to develop an efficient expert system that bears a direct correspondence to the legal arguments, we have to face hard difficulties in order to educe exact rules and executable algorithms from vague standards of soundness and by using non-formal criteria. In KBS we have used the knowledge acquisition and knowledge refinement processes to elicit from the LR and from the skills of the experts the necessary information to build a set of RS which gave the system its ability to perform well in the different cases of legal domain.

The tests have evaluated the performance of KBS in three different times showing that on t0 (by using just the standard theory and the standards of the classical logic) we have easily reached formal impeccable results in 18/102 trivial cases at the cost of 84/102 interesting cases without answer. In t1 and t2 (by adding the logical patterns of analogical argument and the logic of rational decision making t0 the standard theory of legal argument and formal logic) the performance of system and its empirical adequacy to actual legal arguments was improved. In these stages 59/102 new right answers were grasped; among them 45/102 interesting topics of controversy and 14/102 hard cases were solved. This consequence seems suggest that in developing experts systems in law, the qualities of the classical logic approach: simplicity, rigor and certainty could be reasonably complemented by the richness and ability to perform in legal field of the second approach. So the great divide between two exclusive ways to build the set of RS in legal experts systems is theoretically unfruitful and it may make easy to ignore that the very nature of the legal field consists with the coexistence of many different types of arguments as means of debate; and certainly those different types of arguments demand more than one method of representation.

As a side consequence of our research work, we have focused our attention on the analysis of the explanatory system in the 25 hard cases that remained unsolved; the performance of KBS in nine of them put into clear evidence the inability of the System to correctly model the entire range of human legal experts skills. In the other sixteen cases the tests that evaluated the refinement process has demonstrated that the efficiency of the inference engine was beyond any doubt and the failure came from the quality of the legal information. Laws and regulations form the main informational basis that feeds the inference engine; if they show semantical ambiguities, logical contradictions or loosing of syntactical structure it is almost impossible to reach a right conclusion, no matter how correctly the expert system represents the patters of the legal arguments. In general, the ambiguities, contradictions and imperfections of the legal texts cannot be easily detected by means of logical analysis only, they become evident

when an inference engine that beyond any doubt bears a direct correspondence to legal reasoning is iteratively unsuccessful in solving a number of similar cases. By means of the analysis of the explanatory facilities we can easily detect when and why the inference engine of the expert system runs in the wrong direction; if the point concerns to the rules of inference we face a problem of refinement, but if we doubtless can assert that the difficult comes from imperfections of the legal text this is an issue to be solved in the field of the techniques of legislation. In spite of its simplicity this last consequence shows that the analysis of the explanation systems carried out during the refinements is a powerful tool to detect imperfections in the bills and laws during different stages of the legislative process. This method has the important advantage of being at the same time logical and empirical grounded.

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