KNOWLEDGE ACQUISITION AND KNOWLEDGE BASE REFINEMENT PROBLEMS IN DEVELOPING THE KBS LEGAL EXPERT SYSTEM

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Abstract

In this paper we analize the approach used to solve knowledge acquisition and knowledge base refinement problems in order to improve the performance of a legal expert system (KBS). We will support that in a wide number of questions the limitations of the rule-based approach could be overcome if the rules of the system are built and refined by using a sistematic interaction with the experts.

1. Introduction

During 1989/90, in Caracas, Venezuela, the KBS (a legal expert system which deals with the application of Venezuelan Criminal Law) was developed. This research work has been supported by the "Consejo de Desarrollo Científico y Humanístico - Universidad Central de Venezuela" (Council for the Development of Science-Central University of Venezuela).

Since we have 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 research work view point includes a careful characterization of the many problems involved in the exercise of legal judgment, a concept that can not be easily represented just as a system of rules. In a general way, many different issues have to be considered in building 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 legal knowledge acquisition and refinement processes which are not entirely rule-based, and finally it should to be considered that the many subjective points of view, inevitably introduced in judgemental expertise, can hardly be grasped by a formal system.

In solving these points, we decided to use the hierarchical rule-based approach in the knowledge acquisition problem, and both the analogical reasoning approach and the logic of hypotetical-cases analysis to improve knowledge acquisition and to attack the issue of knowledge base refinement. As a matter of fact, KBS is a rule-based system, where a certain act comes under the Venezuelan Law if it satisfies a set of rules. So this set of rules is the formal definition of that act. But taking into consideration the several sources of knowledge in legal domain the rules of the system are educed from multiple dimensions and by many different means.

The complete system has the following structure:

1.- The program starting
2.- The main body of the program
  2.1.- Dialogue with the user about act-input
  2.2.- Checking on an act
    2.2.1.- Classification of an act as a punishable one
    2.2.2.- Classification of an act as a crime
    2.2.3.- Database inclusion of the new punishable act
  2.3.- Specification of the relationship between the punishable act and the Criminal Law.
  2.4.- Verification of the applicability of Criminal Law
    2.4.1.- The dialogue with the user about fact-inputs
    2.4.2.- Decision
    2.4.3.- Laying out the decision and the jurisprudential references
  2.5.- Saving the databases

The dialogue with the user is carried on in a natural language, and it becomes a source of new information for the KBS System. This data may be used both to improve KBS knowledge and also to test its performance in modeling legal reasoning.

The explanation facilities developed to be used with the KBS System provides a reduced inference chain for the user, and also a display of the jurisprudential references concerning the case.

2. The KBS Expert System

2.1 An Overview of the System

We will now give a brief overview of KBS expert system, and then describe its design and operation, which includes the explanation facilitities developed for it.

The KBS expert system tries to model the legal expert reasoning when it decides under which conditions the Venezuelan Criminal Law should be adjudged to in certain cases. It was implemented in Prolog, specifically **Turbo Prolog™** from **Borland International Inc.** It is compounded by a file which contains a Prolog program called the KBS.PRO. **Turbo Prolog™** which compiles and links the file KBS.PRO that also generates another one called the KBS.EXE. It also contains the crimes, the punishable acts, and the legal doctrine databases.

The complete system fits into a single diskette (3 1/2" or 5 1/4"). KBS runs on any PC or compatible computer equipped with a color or monochrome monitor and 512 Kbytes of RAM.

KBS contains approximately 150 rules organized in a matrix scheme . It makes intelligent decisions very similar to the judge's actual ones. The rules are compounded by facts and conditions. KBS represents facts as following:

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diagnosis ("Applicable","Art. 4º, Subdivision 6º").
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The representation of the conditions in KBS is as following:

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condition(four) :- positive("Has the suspect come to
  Venezuela (y/n)?",four).
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Finally, the rule may be as following:

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diagnosis("Applicable","Art. 4º, subdivision 6º") :-
  condition(one),
  not(condition(two)),
  condition(five),
  condition(six),
  not(condition(eight)).
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In the interface with the user, KBS acts as a consultant, carrying on a dialog with him or her to obtain the inputs. The user only has to answer the questions put forth by KBS in a natural language. KBS answers about formal requisites and relevant actual circumstances (suspect' nationality, plaintiff' nationality, where the crime took place etc). KBS has the ability to modify its representations of the object domain in the light of empirical information given by the user. KBS is capable of learning if a certain act should be considered as a crime or not, so it is able to refine its own rules and associated knowledge in order to improve its future performance.

We have developed explanation facilities to use with KBS. On this point it should be considered that the acceptability of an expert system depends not only on its present performance but also on the mechanism that it uses to explain its performance. This mechanism called explanation facility encourages the interaction of the system with the user and plays a decisive role in the process of refining and improving the system performance, since it shows the user how the expert system reached a conclusion and why this conclusion could be considered justified [Waterman et al./86].

Concerning the explanation facilities it is very importantant to reach an equilibrium point, giving the user the needed basis (no more) to encourages the interaction with the system in order to decide how to incorporate new knowledge and how to learn from the system' reasonig. On this crucial point we disagree with the most common explanation procedure which displays the complete inference chain. A reduced inference chain has been used in order to avoid the great amount of details that is so frequent when the inference chain's display mechanism is used. KBS completes its explanation with a jurisprudential reference concerning the case.

2.2 The Knowledge Acquisition Problem

There is no question that the knowledge acquisition problem is the key problem in the field of Artificial Intelligence and consequently in the field of Expert Systems. To have the right to be called an "expert system" a computer program must have the ability to perform well in the different cases of a certain domain; and the best way to do that, is to reproduce the expert's knowledge-acquisition process. For this reason when developing in an expert system the characterization of the rules of inference, a careful study of the expert's performance in the cases, the clear definition of the refinement meta-rules and the attention given to the demanding aspects of the design should be considered most of the time.

This process is a complication in any case and in the legal field it becomes an even more complex because of the special features of the normative system, of the legal reasoning and of the legal decision-making [Achourrón and Buligyn/71]. The ambiguity and vagueness of concepts and formal relations in the normative system, 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 [J.Barragán/90]. Since legal problems involves and describes many complex activities, case-knowledge is mainly analogically based; so any attempt to gather it, demands a very serious effort. Similar 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.

In a general way, the problem of knowledge acquisition concerns the process of performing an appropriate and efficient representation of the expert's domain of knowledge. In the legal domain such a process consists of two main sub-processes. The first one is related to the incorporation of new knowledge to the base and the second sub-process is concerned with the attempt to test and revise the knowledge base in order to minimize the rate of error. In order to carry out these sub-processes two different activities are needed; the first one involves an attempt to educe from the actual juridical inferences, the rules or set of rules used by the legal expert to reach the conclusions. The second activity involves an attempt to educe the main features of the expert's ability to perform correctly in certain cases of a very large set of cases associated with the legal domain (judgemental expertise). The first described activity is called the *rule-knowledge*, the second one is the *case-knowledge*.

As we can see the first activity is more related to the so called juridical inference which deals with **if-then** relations, while the second activity mainly takes into account the features of analogical reasoning. In the case of if-then relations the law states generally the conditions (or rules) which directly constitute the frame of reasoning; but in the case of the reasoning by analogy the process is more complex. First it is necesary to compare the precedent with the new case, to analize each context from different points of view and finally to decide about the analogy. In certain cases these solutions are stereotypical enough to be represented in a rule scheme.

The expertise of KBS was gathered 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 have generally considered a common set of relationships between facts and legal conditions involved in the case to be decided on. Such relationships can be represented by a scheme that describes them. During these interviews we found that from these relationships it is possible to elicit the rules for defining the cases that come under the Venezuelan Criminal Law. The scheme organizes the rules and provides a framework for controlling the application of the rules to the case. The set of rules comes from legislation, from the experts' analogycal reasoning and from experts' analisys of hypotheticals.

2.3. The Knowledge Base Refinement Problem

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 judgemental expertise of the knowledge base.

The knowledge base refinement process involves the testing of existing rules and eventually the incorporation of plausible refinements to those rules in order to improve the ability of the system to correctly clasiffy the cases in its domain and also its judgemental expertise.

If we want to define a "truly expert system" or an "adequate legal system" we could say that this is the system which is able to grasp the the "deep structure" [L.T.Mcarty/84] of the law or we could say that it is the system that has a jurisprudential foundation [Susskind/87]. In order to reach the goal of a "truly expert system" we have to deal with two main issues: 1. the scope of the process of knowledge refinement and 2. the fact that in this process the lawyer is forced to deal with different sources of refinement.

The scope of the refinement process is to reach in time t_1 a better solution of the judgemental question than what the solution got in time t_0. If we define the domain of jurisprudential expertise as a kb-space and kb_0 as the rule under consideration in time t_0, any "north-east" solution will be a better solution to the problem of expertise. In order to reach this solution since the kb-space is not an euclidian vector-space, refinement systems will adapt better to the problem than mathematical optimization methods.

We maintain that since kb_0 has been obtained through interaction with an expert it represents an accurate knowledge concerning the domain of expertise. But exactly the same as what happens with actual judgemental expertise, it needs refinements both through the analysis of the many dimensions of the law made by the experts, and through the legal analysis of hypotetical cases .

In order to reach this goal, in KBS we specifically have used the analogical knowledge both as a source of evidence for generating refinements, as well as a source of test cases for determining the empirical adequacy of the knowledge base. This is the same process used in the knowledge

acquisition which basically consists in reasoning by analogy. But in order to improve the performance of the system we have introduced the HYPO' underlying philosophy, and its analysis schema [Rissland/85 and Ashley/ 88]. In order to strengthen the legal reasoning we have used hypothetical cases [drawn by Bello/88] analysed by experts. This approach is more powerful than the analogical reasoning since it emphasizes the importance of the adversarial reasoning process and incorporates alternative points of view about the case.

In solving the KBS knowledge base refinement problem 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/79 and Eshelman and McDermott/86]. This approach to the refinement problem does not exclude the consideration of other forms [Grinsberg, Weiss and Politakis/85 and Waters/85]; but taking into account the special features of the legal domain and the many difficults in grasping the complexity of its rules (generally expressed in an open-textured language and even in a jargot) our decision has being made in favor of the interaction strategy. 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. For this purpose we have to considered the existing diference between legal rules and the rules of the system. The rules of the system could be educed from legal rules, from analogical reasoning and by arguing with hypotheticals. If in solving the cases the experts are systematically encouraged to use analogical reasoning and they argue with hypothetical it is posible to translate their reasoning into rules which feed the system.

In developing this estrategy we have used hard/easy paradigm [Gardner/84] in order to sift easy from hard questions. The experts are encouraged to resolve the question by first using the rules and formal conditions stated in the law. If not successful they will try to resolve the question by using analogical reasoning and finally by arguing with hypotheticals which introduce the opponent point of view or rationale. To summarize the approach: we tried to transform hard questions into easy questions by the help of experts, in order to tranform analogical reasoning and arguments on hypotheticals into rules of the system. It must be taken into consideration that in Venezuela the law, as source of legal knowledge, is much stronger than the precedents and doctrine.

We have tested the performance of the system and controlled the ability of the refinement procedures to improve that perfomance, in three stages: t_0, t_1 and t_2. In t_0 the system had rules just educed from a well- defined body of the law; in this stage only cases prototypically clear were resolved. In t_1 we could introduce into the system a set of new rules and conditions educed from many diferent dimensions of the law by using analogical reasoning ; in this stage a good number of non-trivial questions were resolved. In t_2 we introduce rules educed from the analysis of hypothetical cases. This analysis was carry on from two alternative rationales; but just the "majority' rationale" was considered as a source of new rules. In this stage a small number of hard controversial questions was resolved . For instance, the set of rules number one, was directely educed from the Code of Criminal Law (art. 3º). In the case of the set number nine, it 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). 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 analisys of a hypothetical case argued by Sosa Chacin.

As a matter of fact 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 developing model bears a direct correspondence to the activity it is modeling (empirical adequacy).

Bibliography

Alchourrón, C. and Buligyn, E. Normative Systems. Springen Verlag, Vienna-New York,1971.

Ashley K. D. Modeling Legal Argument: Reasoning with Cases and Hypotheticals. Ph.D. thesis, Departament of Computer and Informations Science, University of Massachusetts.1988.

Barragán, J. "La Inferencia Jurídica". Revista de la Facultad de Derecho, Universidad Central de Venezuela, Nº 73, Caracas,1990.

Bello, C. S. Derecho Penal General-Estudio de Casos U.C.V. Caracas, 1988.

Davis, R. "Interactive Transfer of Expertise: Acquisition of New Inference Rules". Artificial Intelligence 12, 1979.

Eshelman, L. and McDermott, J. "MOLE: Aknowledge Acquisition Tool that Uses Its Head". In Proceeding of the 5th. Annual National Conference on Artificial Intelligence, Philadelphia, 1986.

Gardner, A. "An Artificial Intelligence Aproach to Legal Reasoning" PhD Dissertation, Departament of Computer Science, Stanford University. 1984.

Ginsberg, A.,Weiss, S. and Politakis, P. SEEK2: A Generalized Approach to Automatic Knowledge Base Refinement In Proceedings of the 9th. International Joint Conference on Artificial Intelligence, LA. CA, 1985

McCarty, L. Th. Intelligent Legal Information Systems: Problems and Prospects In Data Processing and the Law ed. C Campbell, London, 1984.

Rissland, E. L. "Arguments moves and hypotheticals" In C. Walter, Ed. Computing Power and Legal Reasoning, St Paul MN. West Publishing Co. 1985.

Susskind, R. Expert Systems in Law, Oxford, 1987.

Waterman,D.A., Paul,J., McArthur,D., Bankes,S., Kipps, S. and Sowizral, H. "A Survey of Explanation in Expert Systems" Rand Papers, The Rand Corporation, Santa Monica, CA. 1986.

Waters, R. "KBEmacs: A Step Toward the Programer's Apprentice" In IEEE Transactions on Software Engineering, 1985.