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OPJK and DILIGENT: ontology modeling in a distributed environment

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Abstract. In the legal domain, ontologies enjoy quite some reputation as a way to model normative knowledge about laws and jurisprudence. This paper describes the methodology followed when developing the ontology used by the second version of the prototype *Iuriservice*, a web-based intelligent FAQ for judicial use. This modeling methodology has had two important requirements: on the one hand, the ontology needed to be extracted from a repository of professional judicial knowledge (containing nearly 800 questions regarding daily practice). Thus, the construction of ontologies of professional judicial knowledge demanded the description of this knowledge as it is perceived by the judge. On the other hand, due to the distributiveness of the environment, there was a need for controlled discussion and traceability of the arguments used in favor or against the introduction of a concept X as part of the domain ontology. This paper presents the Ontology of Professional Judicial Knowledge (OPJK), extracted manually from the selection of relevant terms from judicial practice questions and modeled according to the DILIGENT methodology. We will show that DILIGENT has proved to be a methodology that facilitates the ontology engineering in a distributed environment, although appropriate tool support needs to be developed.

Key words: legal ontologies, methodology, ontology modeling, professional knowledge, rhetorical structure theory

1. Introduction

The development of *Iuriservice* will provide Spanish judges with access to frequently asked questions (FAQ) through a natural language interface. The system will respond to the question posed by the judge with a list of question-answer pairs that offer solutions to the problem and a set of related and relevant case rulings. Thus, the software will be capable of clearing up doubts concerning judicial practice and caseload resolution by providing justified and uniform answers to the questions raised by newly recruited judges. Ontologies are used to provide more accurate search results than the basic keyword search.

The accuracy and the validity of the knowledge repository are critical. For this reason, two national surveys were conducted as a primary source of data regarding both the context of use and the contents of the question-answer pairs.[1] An example of a question-answer pair is shown below:

Question: While on duty, a judge receives a call from a hospital reporting a sexual assault. The victim has not made yet an official report of the incident. Procedures to be followed? Which rules apply?

Answer: As for the procedures to be followed, a forensic scientist should be sent to the hospital in order to examine the victim and to take samples. If the crime has not yet been officially reported, the judge except in very exceptional circumstances may begin no procedures. Provided that it is clear from the telephone call alone that this is a case of sexual assault and that no other crime has been committed, then criminal proceedings must be initiated by the victim.

These surveys also offered interesting and important data to elaborate the user's profile. There were three aspects of the professional profile of judges most relevant to our project. The first one involved the frequency of information exchange regarding cases between newly recruited judges and other colleagues. Only 4.71% of the judges interviewed stated that they never exchanged information concerning their cases with other peers (or other legal professionals). Second, the majority of judges demanded a decision-making support site for problems raised during judicial practice, when asked about 'what would you want a web service system to provide?' Finally, the surveys allowed us to identify questions related to three main areas which presented some difficulties to newly recruited judges: (i) the organization and management of judicial staff (clerks working in judicial units); (ii) the interpretation and implementation of new procedural statutes; (iii) the 'on-duty' period (a period of one week per month when a single judge is in charge of all incoming cases to local courts).

These questions concerning judicial practice obtained from the judges were the corpus used for ontology learning and were analyzed using two different software applications, TextToOnto and ALCESTE [*Analyse des Lexèmes Co-occurants dans les Énoncés Simples d'un Texte*], in order to extract relevant terms and to identify knowledge domains, respectively.

Finally, we followed the Distributed, Loosely-controlled and evolving Engineering of oNTologies (DILIGENT) methodology during the ontology engineering process (Pinto et al. 2004). With DILIGENT we have used a process template suitable for the distributed engineering of knowledge structures and it has been proven that it can foster fast consensus reaching and especially a stronger commitment to the reached shared conceptualization formalized in the resulting ontology, since part of this commitment is externalized. This means that the reasons behind an ontology change are always explicitly stated and then archived. Especially since the ontology engineering team was geographically dispersed, we had to rely on a methodology, like DILIGENT, in order to allow every member of the ontology engineering team to add up its full potential.

2. OPJK developmental requirements

2.1. INTRODUCTION TO LEGAL ONTOLOGIES

Legal ontologies have played a part in the process of helping to structure legal knowledge and to create knowledge management tools, and many legal ontologies have been built so far.

In the legal field, the modeling process usually requires an intermediate theoretical level in which several concepts are implicitly or explicitly related to a set of decisions about the nature of law, the kind of language used to represent legal knowledge, and the specific legal structure covered by the ontology. There is an interpretative level that is commonly linked to general theories of law. This intermediate level is a well-known layer between the upper-top and the domain-specific ontologies, especially in the so-called 'practical ontologies'.

The interpretative middle level in which all fundamental concepts are defined is usually known as a Legal-Core Ontology. Breuker and Winkels (2003) have recently distinguished between legal ontologies originally based on normative knowledge (legal theory) and legal ontologies in which modalities play the role of knowledge categories. This would be the case for McCarty's LDD or for deontic logic formulations applied to the legal domain (rethinking the hohfeldian conceptions or based on modal linguistic functions: obligatory, forbidden, permitted, etc.). However, in both cases, the fundamental concepts are epistemologically set within a Legal-Core Ontology, that is to say, an ontological representation of basic legal knowledge, in which the theoretical representation of abstract rights and duties count much more than the practical aim of a hypothetical user. Legal reasoning prevails over practical purposes.[2]

2.2. MODELING PROFESSIONAL KNOWLEDGE: PLK AND OPLK

We could say that a counsel shares with the judge, the prosecutor or other court staff only a portion of the legal knowledge (very likely the legal language and the most general acquaintance of statutes and previous judgments). But there is another kind of legal knowledge, the one having to do with personal behavior, practical rules, corporate beliefs, effect reckoning and perspective on similar cases, which remain implicit and tacit within the relation among judges, counsels, prosecutors, attorneys and lawyers.

Although the legal domain remains very sensitive to the features of regional or national statutes and regulations, some of the legal-core ontologies (LCO) are intended to share a common kernel of legal notions. Therefore, LCO remain in the domain of a general knowledge shared by legal theorists, national or international jurists and comparative lawyers. Our data indicate that there is a kind of specific legal knowledge, which belongs to the expert domain and that is not being captured by the current LCO. Thus, there is a different kind of legal knowledge, a professional legal knowledge (PLK) to be represented (Benjamins et al. 2004a, b; Casanovas et al. 2005a, b; Casellas et al. 2005).

In this regard, the design of legal ontologies requires not only to represent the legal, normative language of written documents (decisions, judgments, rulings, partitions, etc.) but also those chunks of professional knowledge from the daily practice at courts.

One of the main features of this professional legal knowledge is that it is context-sensitive, anchored in courses of action or practical ways of behaving. In this sense, it implies: (i) the ability to discriminate among related but different situations; (ii) the practical attitude or disposition to rule, judge or make a decision; (iii) the ability to relate new and past experiences of cases; (iv) the ability to share and discuss these experiences with the group of peers.[3]

Especially in the judicial field, the professional legal knowledge presents two additional features: (i) the attunement process produced in the everyday decision making with previous 'organizational memory' of senior peers (institutional process); (ii) the need to ground each new ruling on past jurisprudential decisions (legitimacy process). The first process is almost completely tacit, but the second is totally explicit in the judicial ruling: there is a substantial part for it within the written ruling named *fundamentos de derecho* [legal grounds]. To accomplish the ruling task it is required to carry out these two parallel information processes.

In order to build ontologies of professional legal knowledge (OPLK), we believe that we have to take into account the kind of situated knowledge that judges put into practice when they store, retrieve and use their knowledge to make their most common decisions. We use 'situated knowledge' in a similar way in which Clancey et al. (1998) talks about 'situated cognition': the concrete use of knowledge which is partially shared and unequally distributed through a certain 'community of practice' who is able to use and reuse this same knowledge while transforming it.

Building ontologies means entering a process in which this tacit knowledge is made conceptually explicit in a formal machine-readable language.

But, because of its own nature, this is not made without some tensions. For all practical purposes there is no such thing as absolute meaning: everything must ultimately be the result of agreements among human agents such as ontology engineers, domain experts and users (Jarrar and Meersmann 2001).

Previous work has shown that ontology modeling methodology makes an extended use of many underlying assumptions about the user, about the task and about the domain (Visser 1998). For example, Visser's methodology for legal knowledge-based systems (LKBS) divides the design process into four separate phases: (i) an analysis phase, (ii) a conceptual modeling phase, (iii) a formal modeling phase, and (iv) an implementation phase (Visser et al. 1997). We think that there is a previous phase, concerning the acquisition of the social knowledge to be modeled. Capturing professional knowledge is a time consuming and often painstaking process implying different types of social techniques (usually surveys, interviews, participant observation, focus groups and expert panels). This means inferring social knowledge from protocols. The way in which this set of tasks is performed usually influences the ontological modeling.

This problem deserves a separate reflection on what we will call 'pragmatic integrated cycle' (from knowledge acquisition and ontology construction to the users' validation plan). We will just point it out in this paper, without going much further. A pragmatic integrated cycle represents the common research path of lawyers, social scientists and ontology engineers. It may be loosely defined as the sequential steps followed by researchers from the knowledge acquisition process to their final involvement in the social implementation of technological outcomes. Namely: (i) generation of statistical data, (ii) generation of qualitative data (institutional ethnography), (iii) transcription of the textual protocols; (iv) protocol analysis and annotation process, (v) knowledge modelisation; (vi) prototype design, (vii) prototype implementation, (viii) prototype evaluation, (ix) prototype refinement. The integrated pragmatic cycle comes to an end once the conditions of the users' environment have been changed by the implementation of the AI prototype. That is to say, when the final technological product acquires an aggregated social value.

2.3. CONSTRUCTION REQUIREMENTS:OPJK

From the above section, we can extract one of the main requirements for the construction of the ontology for the *Iuriservice* application: ontologies of professional legal knowledge model situated knowledge of professionals at work. In our particular case we have before us a particular subset of professional legal knowledge belonging to the judiciary. Therefore, modeling this professional judicial knowledge demanded the description of this knowledge as was perceived by the judge. The way in which judges produce a different kind of knowledge through dogmatic legal categorizations it is not clear yet. But the assumption that their reasoning process follows some specific dogmatic patterns is not required. According to this starting point, we will term the conceptual specification of knowledge contained in our empirical data Ontology of Professional Judicial Knowledge (OPJK).

However, there was another requirement not related to content but to circumstances. This ontology was being modeled by two partners within the Semantically Enabled Knowledge Technologies (SEKT) European project. The Institute of Law and Technology (IDT-UAB), based in Barcelona (Spain) which provided the domain experts and the iSOCO team of ontology engineers, based in Madrid (Spain). Thus, due to the distributiveness of the environment, there was a need for controlled discussion and traceability of the arguments used in favor or against the introduction of a concept X as part of the domain ontology.

In order to model this ontology, first, we had to acquire the professional judicial knowledge, collected and reconstructed from regular data. The work on the ethnographic field offered us a set of corpora (transcriptions of the interviews, completed questionnaires and a corpus of questions regarding practice) containing this knowledge. Once the knowledge was obtained, the construction of the ontology was based on the term and relation extraction from the questions regarding practical problems posed by the judges during their interviews. Due to the fact that at that time semi-automatic extraction software for Spanish was not available, the extraction was performed manually; nevertheless, tools such as TextToOnto and ALCESTE were used to support manual term extraction and subdomain detection.

Finally, in order to control de discussion and trace the decisions taken during the modeling process, DILIGENT argumentation model was followed, as described in the next section.

3. DILIGENT methodology

3.1. AN INTRODUCTION TO DILIGENT

An ontology engineering methodology can be defined as an organized, documented set of procedures and guidelines for one or more phases of the ontology life cycle, such as analysis or design. Many methodologies include a diagramming notation for documenting the results of the procedure; a step-by-step 'cookbook' approach for carrying out the procedure; and a set of objective and ideally quantifiable criteria for determining whether the results of the procedure have an acceptable quality.

Currently, a number of methodologies are available: CommonKADS, Cyc, DOGMA, The Enterprise Ontology, KACTUS, SENSUS, TOVE, HCOME, METHONTOLOGY, Otc Methodology, etc. DILIGENT differs from other methodologies as it puts special emphasis on the argumentation that is delivered while creating the ontology.

First attempts were made to combine findings from argumentation theory and ontology engineering. However, as it is argued in (Potts and Bruns 1998; de Moor and Aakhus 2003) argumentation is best supported when the methodology – such as IBIS – is customized with respect to the domain which is argued about. Hence, we headed towards the following goals:

- Identifying the most relevant arguments in ontological discussions.
- Support synchronous as well as asynchronous discussions.

We will now describe the general process, roles and functions in the DILIGENT process. It comprises five main activities: (1) build, (2) local adaptation, (3) analysis, (4) revision, and (5) local update (see Figure 1). The process starts by having domain experts, users, knowledge engineers and ontology engineers building an initial ontology.

In contrast to known ontology engineering methodologies available in the literature (Uschold and King 1995; Gangemi et al. 1998; Gómez-Pérez et al. 2003; Pinto and Martins 2001) we focus on distributed ontology development involving different stakeholders with different purposes and needs and usually not at the same location. Therefore, they require online ontology engineering support.

A central issue in the DILIGENT process is keeping track of threads of exchanged arguments. We can identify several stages in which arguments play an essential part:

- an ontology is defined as ‘a shared specification of a conceptualization’ (Gruber 1995). Although ‘shared’ is an essential feature, it is often neglected. In DILIGENT, experts exchange arguments while building the initial shared ontology in order to reach consensus;

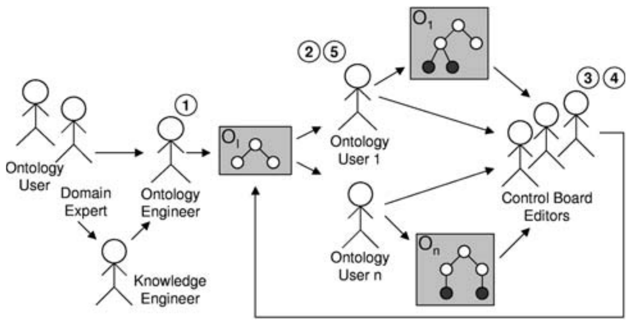

Figure 1. General process, roles and functions in DILIGENT.

- when users make suggestions for changes in the ontology to the control board, based on their local adaptations, they are requested to provide the arguments supporting them;
- while the control board analyses the changes introduced and requested by users, and balances the different possibilities, arguments are exchanged and balanced to decide how the shared ontology should change.

The arguments are all captured and archived, thus making the 'sharedness' of the ontology explicit and traceable. People who later adapt the ontology may check the argumentation that enhances the documentation and find the reasons that led to the modeling of a certain domain.

There is evidence that distributed ontology development can be rather time consuming, complex and difficult, in particular getting agreement among domain experts. Therefore, one needs an appropriate framework to assure it in a speedier and easier way. In order to provide better support, we identify the kind of arguments that are more relevant and effective to reach consensus and restrict the discussion accordingly. The rhetorical structure theory (RST) (Mann and Thompson 1987) was applied to classify the kinds of arguments most often used in an ontology engineering discussion and identify the most effective argument types.

Previous experiments performed (Tempich et al. 2004; Sure et al. 2005) provide strong indication – though not yet full-fledged evidence – that a restriction of possible arguments can enhance the ontology engineering effort in a distributed environment. Moreover, a middle-out approach combined with appropriate argumentation and management can be used to quickly find a shared, consensual ontology even when participants must provide all and only written arguments.

3.2. FOLLOWING DILIGENT DURING THE OPJK MODELING PROCESS

The construction of the ontology has focused on, first, the discussion within the IDT-UAB legal expert's team over the terms which appear on the questions and, second, on the discussion between legal experts and ontology engineers towards the best way to represent those concepts, instances and relations agreed upon.

The discussion among the IDT-UAB legal expert's team started with the selection (marking up) of all nouns (usually concepts) and adjectives (usually properties) contained in the competency questions. Taking into account the ones obtained by the TextToOnto and ALCESTE analysis.[4] Then, once those terms had been identified, the team discussed the need to represent them within the ontology and their place within the taxonomy. For that, the middle-out strategy was followed (Gómez-Pérez et al. 2003), so, first, we identified the terms and then we specified and generalized them if necessary. Finally, the relevant relations between those terms were also identified.

As an example of the use of the middle-out strategy in the legal case study ontology and in relation to the questions analysed above, modelers considered that the concepts Auto [interlocutory decision], Recurso [appeal], Demanda [civil lawsuit] and Querella [criminal lawsuit] needed to be represented in the ontology. Moreover, a concept Documento [document] had to be created as all those terms Auto, Recurso, Demanda and Querella described documents. The result was the construction of a more general concept from the specific terms found in the competency questions. However, the team also agreed that Demanda, Auto, Recurso and Querella were not only instances of Documento but also constituted a specific class of documents used only within the judicial process. For that reason, DocumentoProcessal [procedural document] had to be created as a subconcept of Documento. At the same time, there are different types of appeals and court orders stated in the questions, which have to be considered instances of Recurso and Auto. In this case, the terms where specified, not generalized (Figure 2).

However, difficulties in reaching consensual decisions and the lack of traceable lines of argumentation for both the decisions agreed within the expert's team and the modeling refinement agreed between legal experts and ontology engineers was slowing down the construction of the ontology. For that reason, the introduction of DILIGENT, provided by the AIFB research

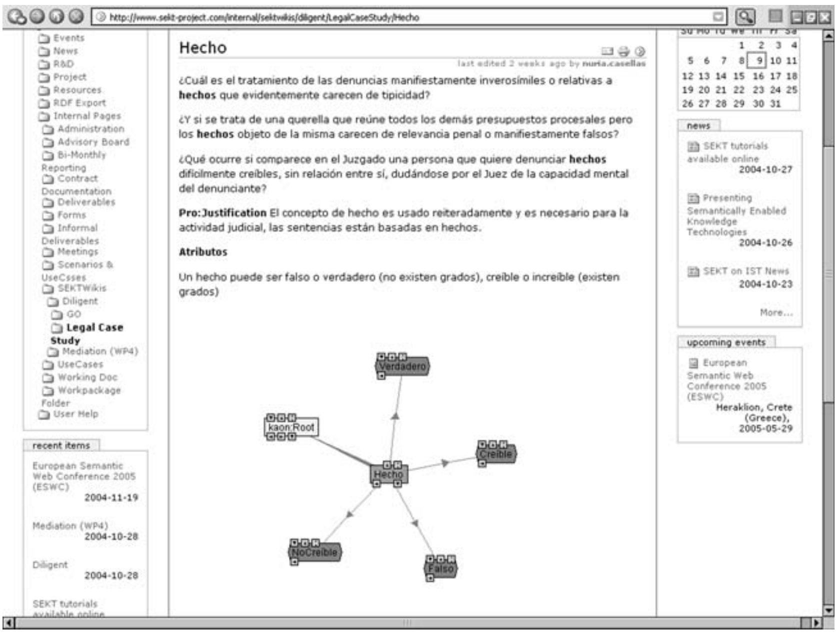

Figure 2. Screenshot of OPJK wiki discussion page.

team, offered a reliable basis for a controlled discussion of the arguments for and against a modeling decision. The introduction of DILIGENT proved the need to rely on guidelines for the decision-making process within the ontology design. The use of DILIGENT sped up the modeling process, as decisions were more easily reached and more concepts were agreed upon.

Besides the argumentation stack, an alternatives stack would be helpful. Arguments, in particular elaboration, evaluation and justification and alternatives, were discussed heavily during the experiments. However, the lack of appropriate evaluation measures made it difficult, at some times, for the contradicting opinions to achieve an agreement. The argumentation should then be focused on the evaluation criteria. The evaluation can take place off-line, or can be based on modeling advices from practical experience. The argumentation stack was captured and tagged after the discussion in order to trace the arguments. As suggested for the discussion process, an accessible web based interface was offered in order to track the discussion. A standard wiki was used which supports seamless discussion and is easy to use. The ontology discussion wiki made all decisions transparent, traceable and available to all members of the team, especially those joining the team at a later stage. However, the tool did not provide several features such as: visualization of the graphical representation of the ontology being built or a system of e-mail notifications when arguments had been added. To solve the requirement of graphical visualization, the ontology modeling team extended the wiki with screenshots from the relevant parts of the ontology build with the KAON OI-Modeler. Later, we considered the addition of a referee (or that one of the members of the team played the role of referee) in order to further speed up the discussions and to keep them on track, as discussions often tent to loose focus.

The wiki was the tool of choice because of the ease of use the technology promises and due to the availability of implementations of the technology. Keeping the argumentation stack up to date and discussing concepts was considered to be very easy with the help of the wiki. The success of projects like the Wikipedia[5] was taken as an indicator towards the successful use of the technology. As we have seen, the wiki technology allowed for a much better tracking of the argumentation than the previous approach. The effectively used engineering system was made up of several tools, used in parallel (thus leading often to work done more than once, due to the lack of interoperability of the tools). These tools were the wiki, used for the tracking of the argumentation, the KAON OI Modeler, used for the visualization of the ontology, and Protégé, used for the formalization of the ontology. A tool that would provide the whole functionality would support the effective use of DILIGENT as described here in other teams as well, without the need of mastering a number of tools. Currently we are working on design studies for such a tool.

4. The current OPJK

The OPJK has, currently, 700 terms, mostly relations and instances as a result of a choice to minimize the concepts at the class level when possible. Some top classes of the domain ontology identified are: CalificaciónJurídica [LegalType], Jurisdicción [Jurisdiction], Sanción [Sanction], Acto [Act], (which includes as subclasses ActoJurídico (LegalAct), Fase [Phase] and Proceso [Process]. These latter classes contain those taxonomies and relations related to the different types of judicial procedures (both, criminal and civil or private) and the different stages that these procedures may have (period of proof, conclusions, appeal, etc.). A necessary reference has to be made to the introduction of the class Rol [Role], which allowed the distinction of situations where an agent might play a part in a process. In the case of OPJK, the class Role contains the concepts and instances of procedural roles [RolProcesal] that an agent might play during a given judicial procedure (Figure 3).

Some of the properties/attributes of concepts and relations between concepts are summarized in the following examples:

- Agente: has_role, is_involved_in_facts
- ActoProcesal: has_document

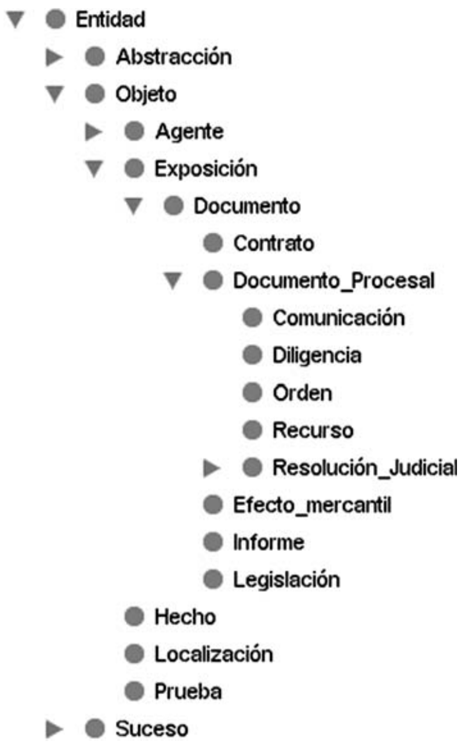

Figure 3. Screenshot of part of the current version of OPJK.

- FaseProcesal: begins_with, ends_with, is_followed_by
- ProcesoJudicial: has_phase
- RolProcesal: is_played_by

Nonetheless, this ontology has been integrated into PROTON[6] (PROTO ONtology), as part of the integration of the SEKT Project technology. PROTON is a domain independent ontology and OPJK modelers thought at first that this integration could require some rearrangements, as the integration implied that OPJK should include the System and Top Modules from PROTON. For that reason, although it was important to keep this two modules in mind, it was essential for the OPJK to model judicial knowledge as perceived by judges and that point of view has to be maintained when possible.

Finally, OPJK has recently been integrated into the System and Top modules of PROTON (Casellas et al. 2005) and, as top layers represent usually the best level to establish alignment to other ontologies, the classes contained in the Top Module Abstract, Happening and Object were straightforwardly incorporated, together with most of their subclasses. Also most of the relations/properties existing between the Top Module classes were inherited. The domain independence of PROTON facilitated the integration of OPJK.

5. Conclusions

This paper has described the ontology development for the second version of the prototype *Iuriservice*. The professional judicial knowledge represented by the OPJK ontology refers to the core of professional work that contains the experience of the daily treatment of cases and is unevenly distributed within individuals as a result of their professional and personal experiences. OPJK modeling affirms that the modeling of professional judicial knowledge demands the description of this type of knowledge as it is perceived by the judge and as it is usually stored in the judicial legal culture that professional judges share among them. This is related to, but clearly different from the legal knowledge contained in normative statutes and regulations.

This paper describes the modeling process and presents the OPJK that has been extracted manually from the selection of relevant terms from the corpus of questions obtained through an extensive and complicated process of professional knowledge acquisition. Above, we have described the main classes, concepts, instances, attributes and relations contained in the current version of the OPJK. This ontology is still under development as the ontology is being, at the moment, integrated into the *Iuriservice* and is being tested for its efficiency in relation to the FAQ retrieval system. That might lead to a refinement process.

This paper also describes the usage of DILIGENT methodology. DILIGENT has been followed as a methodology to facilitate the decision among the terms and relations that had to be included within the ontology. The existence of a methodology and tool support has proved effective to speed up and ease the decision-making process. Nevertheless, specific requirements for tool support and methodology guidance, such as the moderator, have been identified and will be provided and integrated in the near future.

The experiences with this setup lead to the following requirements for a future tool for applying DILIGENT:

- more push-technologies need to be applied. Monitoring changes and the discussions of the ontology must be allowed: now, with the wiki, the user must actively look for changes in her domain of interest, but she cannot ask the system to actively tell her when a change occurs, either by an RSS-feed or by eMail-notification.
- a stronger integration with an ontology engineering environment will become crucial. For now the user had to keep the wiki up to date manually, as well as his formalized ontology in whatever tool he uses, be it Protégé or the KAON OI Modeler. The wiki is oblivious of its content and the relationship between the different pages.
- a visualization is crucial. The users have gone great lengths to provide a visualization manually, even if it meant a lot of manual work. A future tool must include some kind of visualization and connect this to the captured argumentation.
- the data of the discussion is, due to the nature of the wiki, without enough structure. The system that will succeed the wiki must allow for a much stronger structure of the argumentation itself.

Finally, to track the arguments and direct the discussion, DILIGENT suggests the role of moderator in the ontology development team. This role will be introduced in the further development of the and the change will be evaluated.

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Notes

[1] We are producing this kind of statistical and ethnographic data as an ongoing process within a mixed team of magistrates and researchers at the Spanish Judicial School. Some

data are confidential and non available (Ayuso et al. 2003). But other data – related e.g. to users' technological profile – are public (Blázquez et al. 2004; Poblet and Casanovas 2005).

[2] Notions such as 'incremental modeling' and 'cooperative assessment' have been proposed in the current literature to indicate the difficulties of full encoding complex deontic notions (*right*, *liability*, *immunity*, etc.) in the modeling process for conceptual retrieval. Legal reasoning becomes more a normative assessment component than an end in itself. See Winkels et al. (2002), Breuker et al. (2005).

[3] For what it follows and a more extended explanation of the features of PLK and the properties of OPJK, see Casanovas et al. (2005b).

[4] Due to the use of Spanish (a romanesque language) and not English, knowledge discovery on the corpus of questions had to be improved by adding up a lemmatization step before running both applications, TextToOnto and ALCESTE. For more details and a comparative study of results consult Vallbé et al. (2005).

[5] http.//www.wikipedia.org

[6] http://www.ontotext.com

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