

A Systematic Mapping of the Literature on Legal Core Ontologies¹

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***Abstract.** Over the last decades, the field of legal ontologies has seen a sharp increase in the number of published papers. The literature on legal ontologies now covers a wide variety of topics and research approaches. One of these topics is legal core ontologies, which have received significant attention since the 1990s. In order to provide an up-to-date overview of this research area, this article presents a systematic mapping study of published researches on legal core ontologies. The selected papers were analyzed and categorized according to the perspective of their main contribution as well as according to the legal theories used. The study reveals that only a small number of studies use legal theories suitable to address current societal challenges.*

1. Introduction

The importance of understanding the universe of norms has to do with the broad spectrum of roles that norms play in society. As stated in [Bobbio 2001], individuals, from birth to death, live in a world of norms, which direct their actions. It is thus not surprising that many computer applications are concerned with or manipulate information related to norms, in particular legal norms.

Research in Computer and Law has its roots in the 1960s. In 1957, Mehl [*apud* Bing 2007] wrote about automated legal decisions and initiated a new research trend. Since then, the transdisciplinary area of Computer and Law has matured, with different research niches investigating the various aspects of the field. One of the niches that has received special attention in recent decades is that of *Legal Ontologies*. *Legal Ontologies* is a generic term for ontologies developed to address the legal domain and relates to representation of legal concepts, legal knowledge, and common sense, among others. In contrast, *legal core ontologies (LCO)* are legal ontologies that represent, in the domain of law, domain-independent concepts, properties and relations as well. Applying Guarino's classification of ontologies [Guarino 1998] to the legal domain we can establish the following categories of legal ontologies beyond legal core ontologies: legal domain ontologies, legal task ontologies, and legal application ontologies.

In the early years of research in Computer and Law, researchers did not emphasize the difference between kinds of legal ontologies in their works. The term *legal core ontology* was used in 1996 by [Valente and Breuker 1996] when they

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proposed to relate the term *core ontology* used in Van Heijst's thesis (*apud* [Valente and Breuker 1996]) in legal ontology research.

Our investigation of existing "*legal core ontologies*" is motivated by our recent efforts into the construction of a new layer of the Unified Foundational Ontology (UFO) [Guizzardi 2005] in order to represent the legal domain. We started the research based on two pillars to build a consistent legal ontology, as we have defended in [Griffo et al. 2015]: the use of legal theories² and foundational ontologies.

Initially, a non-systematic search showed a significant number of papers modeling fundamental legal concepts, such as *claim*, *duty*, *obligation* and *permission*, based on Hohfeld's classification [Hohfeld 1913], [Hohfeld 1917], one of the most important legal theories in the juridical literature. In addition, this preliminary search showed that a noticeable number of papers proposing LCOs had chosen a positivist legal theory as a basis for the ontology, despite the limitations of this particular theory to deal with current legal cases. Finally, it was possible to observe that few legal core ontologies were grounded in a foundational ontology. With this scenario, it was necessary to delimit a study scope and a systematic research method to understand better this field. The scope was limited to *legal core ontologies* and the chosen method was systematic mapping. The genre *legal ontologies* as a whole is not included in the scope, since our focus is to delimit existing work that could in the future inform the design of a unified legal core ontology.

A systematic mapping is an extensive review of primary studies in a specific subject area that aims to identify the available body of work in the literature in order to answer relevant issues [Kitchenham and Charters 2007]. Two points are identified by mapping a specific field of research: 1) difficulties and limitations found by other researchers; and 2) present and future research niches identified by the researchers.

This paper presents the result of systematic mapping of primary studies on *legal core ontologies*, which aimed to:

- Select published studies on legal core ontologies, which mentioned or used either Hohfeld's classification of legal concepts or expressions such as "legal theory" or "legal concepts";
- Classify the selected studies concerning the category of their main contribution: (1) language; (2) tool; (3) method; and (4) model;
- Identify legal theories used in the building of legal core ontologies;
- Identify foundational ontologies used in the building of legal core ontologies;
- Analyze all selected researches in order to point out important research niches into the area of the legal core ontologies.

This paper is outlined as follows: Section 2 presents how the systematic mapping process was developed. In this section, we advance a list of relevant papers as well as the result of their analysis. Section 3 presents final considerations, pointing out the main conclusions of this study, including a discussion on possible bias and limitations.

² A legal theory is a body of systematically arranged fundamental principles in order to describe, under a perspective, what exists in the domain of enquiry of the *Law*.

2. The Systematic Mapping Process

In the study reported in this paper, we carried out the systematic mapping process described in [Petersen et al. 2008] and [Kitchenham and Charters 2007], which is illustrated in figure 1. In the first phase of the process, the sources of bibliographical material and both criteria of inclusion and exclusion were defined. Each phase produced an outcome that was used as input for the next phase. As pointed out by [Kitchenham and Charters 2007] and [Petersen et al. 2008], the purpose of a systematic mapping is to provide an overview of a research area in a wide and horizontal way and identify the quantity and type of research and results available within it.



Figure 1. The Systematic Mapping Process. Source: [Petersen et al. 2008] (adapted)

2.1 Planning

In this first phase, both universe and sample of the systematic mapping was delimited. We have chosen *legal ontologies* as the **universe** of our study and *legal core ontologies* as the **sample** of this study. The following questions guided this mapping as well the following inclusion and exclusion criteria.

RQ1: What researches exist in the area of *legal core ontologies*? Which research niches have been investigated (*e.g.* language, method, tool, and model)?

RQ2: Which legal theories were used in the selected studies?

RQ3: Which foundational ontologies or core ontologies were used on selected legal ontologies?

Inclusion criteria (IC): Papers and chapters of books on legal core ontologies published from 1995 to 2014:

IC1: studies in Computer Science and concerned exclusively with “Computer and Law”;

IC2: studies that referred to generic legal concepts such as “legal theory” or “legal concepts” (*e.g.* Hohfeld’s classification, legal relation, legal fact).

Exclusion criteria. Exclusion criteria were:

EC1: studies merely available in *abstracts*, slide presentations, technical reports or similar;

EC2: duplicity in studies (including versions of the same study, different sources);

EC3: studies that were not available in English;

EC4: studies about “legal ontologies” only concerned with Law or Philosophy.

Our research source was Google Scholar, which includes papers from different conferences and journals, such as AAI, ICAIL, JURIX, JURISIN, DEON, RELAW, FOIS, ACM, IEEE, and RuleML, JISCI, Int. Journal of Human-Computer Studies.

2.2 Conduct Search

After the planning phase, the second phase started with the delimitation of the search strings as well as its corresponding control group. Firstly, the *search string* was applied on the sources and the result was compared with the control group in order to minimize a possible bias. The search string was modified to converge with the control group and to include a wider number of studies as well. The outcome of this phase was a total of 269 studies. The selected papers are cited in the text as well as referred to in Section 5.

Search String = (“legal core ontology” OR “legal core ontologies” OR “legal top-level ontology” OR “generic ontology for legal concepts” OR “core legal ontology” OR “core legal ontologies” OR “legal upper-level ontology” OR “core ontology for law” OR “core ontology of legal concepts” OR “ontology of legal norms” OR core ontology” OR “generic ontology” OR “principled ontology”) AND ((Hohfeld OR hohfeldian) OR “legal theory” OR “legal concepts”)

2.3 Screening of the Studies

In this phase, the outcome of phase 2 was refined by considering both inclusion and exclusion criteria. In this phase, we have excluded duplicated studies (found in different sources), technical reports, studies for which a paper with a more recent version had already been included, as well as studies not available in English, or not concerned with ontology in Computer Science. The result of this phase produced a list of 128 selected studies.

2.4 Classification Scheme

Firstly, the outcome of phase 3 was organized by year of publication in order to provide an overview of the LCO area from the chronological point of view (figure 2). Despite that, some papers on legal ontologies have been published since the 1990’s; the term *legal core ontology* became more widespread only after the beginning of 2000, peaking in the period of 2005-2009, which sustained attention in the period of 2010-2014.

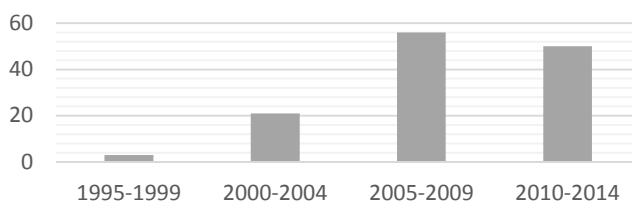


Figure 2. Studies published from 1995 to 2014

A second dimension related to the *contribution perspective* guided the classification of the selected studies in order to identify the major research niches in the area of LCO as well as to identify and analyze three points: 1) the use of legal theories as a theoretical base, 2) the use of foundational ontologies as a base for developing a LCO, and 3) the LCOs encountered in the mapping. For this, we analyzed abstracts, keywords, introduction sections, and references in the selected studies.

2.5 Data Extraction

In this phase, we extracted data from selected papers in order to make a comparative analysis. This analysis consisted of three parts: a) classification and analysis of papers according to their contribution, b) analysis of use of legal theories, and c) analysis of use of foundational ontologies.

Contribution Area. The studies were classified according to their contribution area as shown in figure 3. For this classification, we excluded studies that were either review or opinion papers. The result of this analysis produced a list of 116 studies distributed according to four different contribution areas (see figure 3).

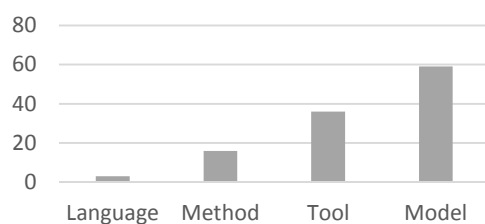


Figure 3. Distribution of researches by contribution perspective

Three among the analyzed papers proposed *languages* in legal ontologies. [Athán et al. 2013] presented the LegalRuleML language in the context of the OASIS project and exemplified it with cases of Italian courts. In addition, the Open Digital Rights Language (ODRL), an open standard for expressing machine-readable licenses for digital objects, has been used with ontologies in studies as [García et al. 2005]. Since the scope of this mapping study has temporal and subject boundaries, some studies did not appear. However, it is relevant to point out the following articles, which are related with legal discourse [McCarty 1989], legal relations [Allen and Saxon 1998], legal knowledge [Hamfelt 1995], [Barklund and Hamfelt 1994], and legal argumentation [Gordon 1994].

Regarding the contribution area of *methods*, the following works have been identified: [Capuano et al. 2014], [Dhouib and Gargouri 2014], [Ceci 2012], [Ceci and Gangemi 2012], [Lenci et al. 2012], [Nguyen and Kaneiwa 2014], [Tiscornia 2010], [Despres and Szulman 2007], [Trojahn et al. 2008], DILIGENT [Casanovas et al. 2005] [Casanovas et al. 2007], TERMINAE [Despres and Szulman 2006] used in [Saravanan et al. 2009] and [Dhouib and Gargouri 2014], Semantic Peer-to-Peer Approach used in EGO ontology [Ortiz-Rodríguez et al. 2006], and Schweighofer's research about legal IR and indexing [Schweighofer 2010].

In the *tools* category, we have included applications, systems, databases, and frameworks related with ontologies. Examples in this line of research include: [Hussami 2009], [Drumond and Girardi 2008], [Schweighofer and Liebwald 2007], [Gil et al. 2005], [Moor and Weigand 1999], [Ceci and Ceci 2013], [Lamparter et al. 2005], [Boonchom, V. S., & Soonthornphisaj 2012], [Ceci and Gordon 2012], the FrameNet repository [Venturi et al. 2009], [Venturi et al. 2012], [Breuker et al. 2000], [Wolff et al. 2005], [Kiškis and Petrauskas 2004]. In addition, eGovernance solutions in [Edelmann et al. 2012]; [Tiscornia and Sagri 2012], [Palmirani et al. 2012], [Casellas 2012]; ontology-based application for music digital licenses in [Baumann and Rosnay 2004], [Poblet 2011], [Engers et al. 2008], [Ryan et al. 2003], [Curtoni et al. 1999], [Biasiotti 2011], [Gangemi et al. 2003], [Markovic et al. 2014], DIRECT [Breuker and Hoekstra

2004a], IURISERVICE [Casellas et al. 2007], the LME Project [Bartalesi Lenzi et al. 2009], the LOIS Project [Peters et al. 2006], and a Vietnamese legal application [Think et al. 2014].

As shown in figure 3, most of the papers identified in our study, propose particular *models* (i.e., *particular ontologies*). We identified some projects within which ontologies have been developed, such as: DALOS [Agnoloni and Tiscornia 2010], LME [Bartalesi Lenzi et al. 2009], ESTRELLA³, JUR-IWN or Jur-Wordnet [Casanovas and Poblet and et al. 2005], LOIS [Curtoni et al. 1999], [Tiscornia 2000], [Peters et al. 2006], among others cited. The following legal domain ontologies were build in a project: Medical Law Ontology [Despres and Delforge 2000], Dutch Tax ontology in the E-POWER Project [Boer and Van Engers 2003], International Copyright Law Ontology [Ikeda 2007], Copyright Ontology [García et al. 2007], Mediation Core Ontology (MCO) [Poblet et al. 2009], LAO ontology [Lu et al. 2012], ALLOT ontology [Barabucci et al. 2012], [Despres and Szulman 2004], Ukraine legal ontology [Getman and Karasiuk 2014].

Legal core ontologies. Among legal ontologies found, were found the following legal core ontologies: FOLaw ontology [Valente and Breuker 1994a], [Valente and Breuker 1996], [Valente and Breuker 1994b], Kralingen’s ontology [Kralingen 1997], CLO ontology [Gangemi 2007], NM-L+ NM-core ontology [Shaheed, Jaspreet, Alexander Yip 2005], LRI-Core [Breuker and Hoekstra 2004b], Legal-RDF Ontology [McClure 2007], PROTON+OPJK, OPLK [Caralt 2008], Ontological Model of Legal Acts [Gostojic and Milosavljevic 2013], LKIF-core ontology [Hoekstra et al. 2007], [Hoekstra et al. 2009], LegalRuleML-core ontology [Athán et al. 2013] and LOTED core ontology [Distinto et al. 2014].

Use of legal theories. Regarding the *legal theories* referred to selected studies, we focused on identifying the legal theories that were referred to as *primary sources* for the selected works. Among the legal theories, the most cited are: (i) Legal Positivism (appearing in “Pure Theory of Law” [Kelsen 2005], “Some Fundamental Legal Conceptions” [Hohfeld 1913]); (ii) Inclusive Positivism (appearing in “The Concept of Law” [Hart. 1994] and “Norms, Institutions and institutional facts” [MacCormick 1998]); (iii) Legal Realism (appearing in “Normative System” [Alchourrón, C. E. and Bulygin 1971], “On norms of competence” [Bulygin 1992]); (iv) Legal Interpretivism (appearing in “Taking Rights Seriously” [Dworkin 1978]); (v) Legal Argumentation (appearing in “A Theory of Legal Argumentation” [Alexy 2001], “A Theory of Constitutional Rights [Alexy 2010]”, “The New Rhetoric: A Treatise on Argumentation [Perelman, C., Olbrechts-Tyteca 1969]”).

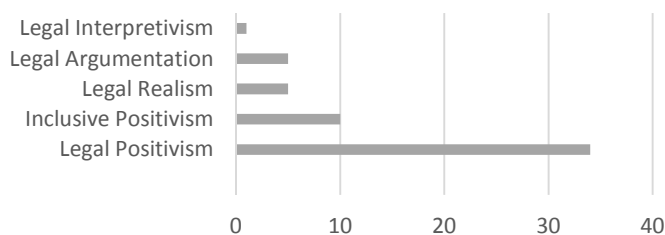


Figure 4. Main legal doctrines referred in the selected studies

³ <http://www.estrellaproject.org/>

The most frequently cited legal doctrines are shown in figure 4. Despite the existence of new legal theories to solve *hard cases*, Legal Positivism is the most frequently used legal theory for legal ontologies. In addition, despite the importance of *legal theory* to legal core ontologies, solely 35 (approx. 27%) of the 128 selected works used primary sources of legal theories; 44 studies (approx. 34%) used indirect sources (e.g. use a LCO based on a legal theory to build a domain ontology); and 49 studies (approx. 38%) did not use any primary source.

Use of foundational ontologies. We emphasize the importance of grounding legal ontologies in foundational ontologies in order to obtain ontological quality, as strongly defended by researchers, such as [Guizzardi 2005] and [Uschold and Gruninger 1996]. We identified 47 studies that propose a kind of ontology. Among these ontologies, 32% do not ground the proposed ontology on a foundational/core ontology. The most applied foundational/core ontologies are LKIF, LKIF-core, LRI-CORE, SUMO, DOLCE, CLO, FOLAW and OPJK. Most of the ontologies were specified using OWL, regardless of the various expressiveness limitations (such as those discussed in [Mossakowski et al. 2012]).

3. Final considerations

This paper presents the results of a systematic mapping study investigating published works on the topic of *legal core ontologies*. The systematic mapping revealed that the niche with more extensive literature was the niche of *models*. Some studies used the generic term “*legal ontology*”, giving the idea of a generic or core ontology. An analysis in these studies showed that most of the proposed ontologies were actually *domain ontologies* addressing specific fragments of the Law. In fact, there are few existing LCO, suggesting a research niche to be explored as future work.

This mapping had the purpose of finding existing proposals of LCO in the literature. This purpose was reflected in the *search strings* that we have employed. For this reason, naturally, most of the studies analyzed were cases of studies in which models (ontologies) were proposed. For a more comprehensive research about *language, tools* or *methods* in LCO, a change in the search string would be required (with the inclusion of these keywords). For example, visual languages for Law (e.g. Nomos [Ingolfo et al. 2013], [Ingolfo et al. 2014]) suggests an interesting future research topic. Other lines of research that received less attention are tools and, specifically, applications. Finally, the line of research related to *methodologies* in LCO could be explored not only with new proposals of methodologies, but also with evaluation research, qualifying the existing methodologies.

Regarding the issue of legal theories, we select two closely related issues to discuss here. The first point concerns Hohfeld’s classification of legal concepts and its meaningful use in the studies of the sample. Exactly 16 studies refer directly to Hohfeld’s classification [Hohfeld 1913], [Hohfeld 1917] and many other studies refer to it indirectly. In fact, Hohfeld’s classification of legal concepts is one the most important work about classification in Law, and many others theories or classifications are built with Hohfeld’s work as a basis. Despite its unquestionable influence in the study of Law *per se*, the popularity of Hohfeld’s classification in LCO can also be attributed to its logic-based nature. In the early 20th century, the use of Logic in Law reflected a desire to bring a touch of authority to the discipline. This search for objectivity/scientificity

also contributed to the broad acceptance of Legal Positivism and its doctrine lines at the time. In this context, considering a logic-based approach to the Law as a basis for an LCO, in particular, and computational approaches to the Law, in general, seems like a natural choice. The problem with using theories based on Legal Positivism (*e.g. Hohfeld, Hart, Kelsen theories*) is that they do not include modern concepts of the Law introduced by the explicit countenance of a *social reality*. This problem is propagated to all LCO and computational approaches built following these theories.

The second point is about the (not so) modern theories of Legal Argumentation and Principles (*e.g. Alexy, Perelman, Ryle-Toulmin, Fisher&Patton theories*). In conducting this study, we have observed in recent years an interesting change in Legal-theoretical scenario. The traditional scenario is one in which the so-called “*Purity of the Law*” is sought after, i.e., a scenario in which the analysis of the Law is considered in isolation from the influences of other disciplines such as Economics, Sociology, Anthropology and Politics. We have observed a tendency towards a scenario in which the importance of these related disciplines is acknowledged and openly discussed.

We would like to acknowledge explicitly the following bias in our study. In light of the fact that our study was designed to investigate existing proposals in “*legal core ontologies*”, in our search strings, we did not use the terms “legal ontologies” or “legal ontology” (which were too broad for the scope of this paper). Nevertheless, we are aware that some studies about LCO did use the term “*legal ontologies*” or “*legal ontology*” rather than “*legal core ontology*” or “*legal core ontologies*”. In addition, other studies did not use any expressions such as “legal theory”, “legal concepts”, but rather synonyms (*e.g. “concept of law”*). Examples include: [Gordon 1994], [Visser and Bench-capon 1998], [Visser and Bench-Capon 1996], [Hage and Verheij 1999], [Trojahn et al. [S.d.]], [Allen and Saxon 1998] and [Wyner and Hoekstra 2012].

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