Ontologies in the Design of Legal Knowledge Systems;
Towards a Library of Legal Domain Ontologies

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Abstract

Legal ontologies are useful in the design of knowledge systems because they are reusable. A library of such ontologies could greatly enhance the development of legal knowledge systems. In this article we address the creation of such a library. In particular, we discuss four legal ontologies and investigate how the ontologies can be indexed and represented in a library.

1. Introduction

What are the building blocks of legal knowledge? Legal philosophers have pondered over this question for a long time. Research in Artificial Intelligence and Law has also run up against this question, albeit from a different angle. Arguably, the creation of a legal knowledge representation requires a conceptualisation of the building blocks of legal knowledge. Eventually, these building blocks will form the basis for operational legal knowledge systems.

An important reason for producing ontologies is that they form reusable building blocks for the design of (legal) knowledge systems. Many development methodologies for knowledge systems, such as CommonKADS (Breuker and Van de Velde, 1994), recognise the role of ontologies. Although literature is showing efforts to create ontology libraries (Farquhar *et al*., 1997) there are no such efforts in the legal domain. In this article we address the creation of libraries of legal (domain) ontologies. Crucial to the success of such a library is that its users are aware of what the library contains. This is less trivial than it seems. For books there are well established methods of classification, typically based on subject, and the physical organisation of the library uses this. Since the title, author and subject of a book provides a reasonably good idea of the contents, users can browse the library on these items. The problems with an legal ontology library are different: while there will be far fewer items in the library, there are no well understood principles of organisation. In this article we suggest some features of, and relations between, ontologies, which could serve as the basis for structuring the contents of a library of legal ontologies.

This article is structured as follows. In section 2 we briefly discuss four legal ontologies which can be used in the method. In section 3 we address the development of a library of legal ontologies and in particular we discuss the indexing mechanisms of the library. In section 4 we draw conclusions.

2. Four Legal Ontologies

Ontologies are reusable building blocks for knowledge system design (Visser *et al.*, 1997). However, AI and Law research so far has not produced very many legal ontologies for this purpose. Only a small number of explicit conceptualisations of the legal domain is available (for an overview on legal ontologies for system design, see Visser and Winkels, 1997). Below, we discuss four well known legal ontologies that could be used in the design of a LKS: (*a*) McCarty's LLD, (*b*) Stamper's NORMA, (*c*) Valente's Functional Ontology of Law and (*d*) the Frame-based Ontology of Van Kralingen and Visser.

(a) LLD

McCarty (1989) has proposed a language for legal discourse (LLD). He considered the language to be a first step towards a general applicable representation language for legal knowledge. Although LLD itself is a representational language and not an ontology it clearly reveals a generic conceptualisation of the legal domain. The basic components of LLD are atomic formulae and rules. *Atomic formulae* are merely predicate relations used to express factual assertions. A distinction is made between *count terms* (to express tangible objects, such as houses, and persons) and *mass terms* (to express intangible objects, such as cash, and stock). *Rules* are formed by connecting atomic formulae with logical connectives. They have a left-hand side which is an atomic formula, and a right-hand side which is a compound expression. The compound expression determines the type of rule involved. There are five types of rules: (1) horn clauses, (2) 'horn clauses' with embedded implications, (3) 'horn clauses' with embedded negations, (4) default rules, and (5) prototype-and-deformations. Together atomic formulae and rules allow the creation first-order expressions. Modalities are stated as second-order expressions. The following modalities are supported: time, events and actions, and deontic expressions (McCarty, 1989). To express temporal statements LLD recognises states. A state essentially is the (temporal) reification of a predicate relation. Predicate relations can be reified both with points of time, as well as with intervals (two points of time). Changes in states are realised by events. Events are either elementary (*viz.* a state-change) or complex (*viz.* elementary events connected by the operations of disjunction, sequential and parallel composition, and universal and existential quantification applied to the elementary events). An action is the relation between an actor and an event. With regards to deontic statements, LLD supports four modal operators: permitted (P), forbidden (F), obligatory (O), and enabled (E). Modalities, such as time and permissions, are stated as second-order expressions. For more details on LLD we refer to McCarty (1989; 1993).

(b) NORMA

Stamper has criticised the use of traditional logics for the representation of (legal) knowledge because they suffer from some important semantic problems (Stamper, 1991). Briefly stated, traditional logics rely on symbolic representations that have only a very weak connection to the real-world concepts

they intend to denote. In particular, symbolic representations rely (according to Stamper - invalid) on notions such as truth, individuality, and identity. Accordingly, expressing legal knowledge in the form of rules is an over simplification of what legal knowledge is about. To overcome these problems Stamper argues that there is need to escape from the frame of reference of classical logic (Stamper, 1991, p.229). Building on his LEGOL work (see Stamper, 1980), he proposed the NORMA formalism (Stamper, 1991). NORMA, which means 'logic of norms and affordances', is based on two main philosophical assumptions: (1) there is no knowledge without a knower, and (2) the knowledge of a knower depends on his behaviour (Stamper, 1996). Using NORMA (henceforth: NOR) the entities in the world are described by their behaviour rather than by assigning them an individuality and truth values. The main ontological concepts are (a) *agents*, (b) *behavioural invariants*, and (c) *realisations*. An agent is an organism standing at the centre of reality. It gains knowledge, regulates, and modifies the world by means of actions. For its actions the agent takes responsibility. The concept of an *agent* (a) can be extended to include groups, teams, companies, social agents or even nation states. A *behavioural invariant* (b) is a description (*e.g.*, using verbs, nouns, or adjectives) of a 'situation' whose features remain invariant. Here, a situation loosely denotes some knowledge of the world, such as an object (*e.g.*, a cup, a piano) or a state of affairs (*e.g.*, walking, paying). The realisation of a situation - a *realisation* (c)- is specified as the combination of (1) an agent and (2) a behavioural invariant, shortly written as *Ax* (the situation, denoted by behavioural invariant *x*, that is realised by agent *A*). An example of a realisation *Ax* is *John walks*. Different kinds of realisations are recognised, for instance, *Ax** (denoting the ability of *A* to realise *x*), *Ax@* (denoting the authority of *A* to realise *x*), *Ax+* (denoting *A* starts to realise *x*), *Ax-* (denoting *A* finishes the realisation of *x*), and *Ax#* (denotes that *x* can be divided into individuals, *cf.* classes and objects). By combining behavioural invariants composite realisations can be made. We here mention the most important composite realisations: *Axy* (denoting that *A* cannot realise *y* without first realising *x*), *A.x.y* (denoting that *x* is a part of *A* and *y* is a part of *x*), *A(x while y)*, *A(x orwhile y)*, *A(x whilenot y)*, *A(x whenever y)* (denotes that *x* is realised whenever *y* is realised); *A(x then y*) (denotes that if *x* is realised then y is be realised), *A "Bx"* (denoting that an agent *A* can tell another agent *B* to bring about *x*, for instance by commanding or suggesting), and *A(a:b:c) → d)* (denoting that *a*, *b*, and *c* are instances of *d*). For a more extensive discussion we refer to Stamper (1991; 1996)[1].

(c) The Functional Ontology of Law

Valente's ontology of law (1995) - LFU - is based on a functional perspective of the legal system. The legal system is considered an instrument to change or influence society in specific directions, determined by social goals. Its main function is reacting to social behaviour. This main function can be decomposed into six primitive functions, each corresponding with a category of primitive legal knowledge in LFU. Accordingly, LFU distinguishes six categories of legal knowledge: (a) normative

[1] A full appreciation of Stamper's theory requires a more extensive discussion than the - necessarily very brief - description presented in this article. We have attempted to compile Stamper's 1991 and his 1996 article although there are some notable differences between both articles. When confusion could arise, we have used his 1996 article.

knowledge, (b) world knowledge, (c) responsibility knowledge, (d) reactive knowledge, (e) meta-legal knowledge, and (f) creative knowledge.

Normative knowledge (a) is characterised as knowledge that defines a standard of social behaviour. It thereby prescribes behaviour of the people in society. The standard is defined by issuing individual norms, expressing what ought to be the case. In LFU *world knowledge* is legal knowledge that describes the world that is being regulated. It delineates the possible behaviour of (people, and institutions) in society, and thereby it provides a framework to define what behaviour ought (and ought not) to be performed. It can be considered to be an interface between the commonsense knowledge of people in society and the normative knowledge. Within the world knowledge Valente distinguishes (b.1) definitional knowledge, and (b.2) causal knowledge. The definitional knowledge is the static part, it consists of definitions of (b.1.1) legal concepts (*e.g.*, agents, objects), (b.1.2) legal relations (*e.g.*, legal qualifications of actions), (b.1.3) a case (*viz*. the problem case under investigation), (b.1.4) circumstances (*viz*. the grounded facts, or, building blocks of a case), (b.1.5) generic cases (*viz*. typical generic legal cases), and (b.1.6) conditions (*viz*. the building blocks of the generic legal cases). Together these constructs provide a vocabulary which can be used to describe the relevant aspects of the world under a specific perspective taken by the legislator. The causal knowledge (b.2) is the dynamic part, describing the behaviour of people in society in terms of the definitional knowledge. *Responsibility knowledge* (c) is legal knowledge that either extends (assigns), or restricts the responsibility of an agent for its behaviour. Its function is to provide the legal means to reject the common idea that someone is only responsible for what one causes. *Reactive knowledge* (d) is legal knowledge that specifies which reaction should be taken (and how) if an agent violates a primary norm. *Meta-legal knowledge* (e) is legal knowledge about legal knowledge, or, legal knowledge that refers to other legal knowledge. There are four sub categories of meta-legal knowledge: (e1) norm data, (e2) ordering norms, (e3) normative default, and (e4) validity knowledge. Norm data (e1) includes information about norms, such as their scope of application, their type, their place in the norm hierarchy, their power origin, their promulgation, and the norm goal. Ordering norms (e2) are norms that determine how to solve conflicts. *Creative knowledge* is legal knowledge that allows the creation of previously non-existent legal entities. For more details on this ontology we refer to Valente (1995).

(d) FBO: Van Kralingen and Visser's Frame-based Ontology

Van Kralingen (1995) and Visser (1995) argue that robust (conceptual and formal) ontologies of the legal domain are necessities for reducing the task-dependency of legal knowledge specifications. Although there are some minor differences between the (conceptual) ontology as defined by Van Kralingen, and the (formal) ontology as defined by Visser, their similarities allow us to treat them as one ontology. The main ontological distinction in FBO concerns the generic legal ontology and the

statute-specific ontology. The distinction is based on the observation that some parts of an ontology are reusable across different legal subdomains.

The *generic legal ontology* (GLO), in contrast to the statute-specific ontology, is the generic and reusable part of the ontology. It divides legal knowledge over three distinct entities: norms, acts and concept descriptions. For each of these entities the ontology defines a template (also referred to as frame structure) that lists all attributes relevant for the entity. *Norms* are the general rules, standards and principles of behaviour that subjects of law are enjoined to comply with. In the ontology a norm comprises the following eight elements: (1) a norm identifier (used as a point of reference for the norm), (2) a norm type (either norm of conduct or norm of competence), (3) a promulgation (the source of the norm), (4) the scope (the range of application of the norm), (5) the conditions of application (the circumstances under which the norm is applicable), (6) the norm subject (the person or persons to whom the norm is addressed), (7) the legal modality (either ought, ought not, may or can), and (8) the act identifier (used as a reference to a separate act description). *Acts* represent the dynamic aspects which effect changes in the state of the world. Within the category of acts two distinctions are made. The first distinction is between *events* and *processes*. Events represent an instantaneous change between two states, while processes have duration. The second distinction is between *institutional acts* and *physical acts*. The former type of acts are considered legal (institutional) versions of the (physical) acts that occur in the real world (more precisely: an institutional act is a legal qualification of a physical act). Note that these two distinctions result in four different types of acts. All acts are assumed to have the following thirteen elements: (1) the act identifier (used as a point of reference for the act), (2) a promulgation (the source of the act description), (3) the scope (the range of application of the act description), (4) the agent (an individual, a set of individuals, an aggregate or a conglomerate), (5) the act type (both basic acts, and acts that have been specified elsewhere can be used), (6) the modality of means (material objects used in the act or sub acts; *e.g.*, a gun), (7) the modality of manner (the way in which objects have been used or sub acts have been performed) (*e.g.*, aggressively), (8) the temporal aspects (an absolute time specification; *e.g.*, on the first of August, on Sundays, at night, etc, but not: during a fire, after the King dies, etc), (9) the spatial aspects (a specification of the location where the act takes place; *e.g.*, in the Netherlands, in Leiden, on a train), (9) the circumstantial aspects (a description of the circumstances under which the act takes place; *e.g.*, during a war), (10) the cause of the action (a specification of the reason(s) to perform the action, *e.g.*, revenge), (11) the aim of the action (the goal visualised by the agent; *e.g.*, with a view to unlawfully appropriate an object), (12) the intentionality of an action (the state of mind of the agent; *e.g.*, voluntary), and (13) the final state (the results and consequences of an action; *e.g.*, the death of the victim). *Concept descriptions* deal with the meanings of the concepts found in the domain. They may be definitions or deeming provisions and can be used to determine definitively the meaning of a notion, either by, as in the case of the former, providing necessary and sufficient conditions, or, as in the case of the latter, establishing a legal fiction. Another type of concept is the factor, which may either establish a sufficient condition, or indicate some contribution to the applicability of the concept, as discussed above. Finally there are meta concepts which are provisions governing the application of other provisions. Concept descriptions comprise the

following seven elements: (1) the concept to be described, (2) the concept type (definition, deeming provision, factor, or meta), (3) the priority (the weight assigned to a factor), (4) the promulgation (the source of the concept description), (5) the scope (the range of application of the concept description), (6) the conditions under which a concept is applicable, and (7) an enumeration of instances of the concept.

The *statute-specific ontology* consists of predicate relations that are used to complement the terminology for norms, acts and concept descriptions. The statute-specific ontology cannot be reused for other legal subdomains, and should always be created for each legal sub domain under consideration. The statute-specific ontology states the vocabulary with which the knowledge base is constructed. A more elaborate discussion of the legal and the statute-specific ontology can be found in Van Kralingen (1995) and Visser (1995), which gives a statute-specific ontology for the Dutch Unemployment Benefits Act (DUBA). An ONTOLINGUA specification of the legal ontology is given by Visser and Bench-Capon (1996).

3. The Ontology Library

The ontologies discussed in the previous section differ substantially in the way they conceptualise the legal domain even though all four ontologies are intended to support the construction of legal knowledge or information systems (LKS). Visser and Bench-Capon (1998) - after a comparison of these ontologies - argue that no ontology is necessarily better than another. Which ontology is most adequate depends on the specific application being developed. The indexing of the ontologies in our library should allow for the selection of the ontology that best suits the intended application. Otherwise stated, the ontology indexing mechanism should reveal the differences between the ontologies. In this section we address the structure and indexing mechanism of the legal ontology library. In section 3.1 we discuss related work on ontology indexing schemes. In section 3.2 we address ontology relations between ontologies in the library. Then, in section 3.3 we propose a set of questions that can be used to index the library.

3.1 Ontology Indexing Schemes: Related Work

Any library indexing mechanism is based on distinguishable features of ontologies. Indexing mechanisms differ in the features that are distinguished and in the way they are expressed. To create a library of legal ontologies, and thus, to determine what ontology features we will distinguish we first make an inventory of related work on this matter. Below, we list the ontology features distinguished in five different research efforts.

Gruber (1995) formulates five design criteria for ontologies in the context of knowledge sharing and interoperation among programs. The ontology features he distinguishes are: (1) *clarity*, (2) *coherence*, (3) *extendibility*, (4) *encoding bias*, and (5) *ontological commitment*.

Visser and Bench-Capon (1998) build on the work of Gruber and others and present a taxonomic structure of ontology-comparison criteria. The ontology features they distinguish are: (1)

epistemological adequacy (1.1 *epistemological clarity*; 1.2 *epistemological intuitiveness*; 1.3 *epistemological relevance*; 1.4 *epistemological completeness*; 1.5 *discriminative power*), (2) *operationality* (2.1 *encoding bias*; 2.2 *coherence*; 2.3 *computationality*), (3) *reusability* (3.1 *task-and-method reusability*; 3.2 *domain reusability*).

Farquhar *et al.* (1997) describe the Ontolingua Ontology Library. They distinguish four type of ontology relations (1) *inclusion*, (2) *restriction*, (3) *polymorphic refinement* and (4) *circularity*. Currently, the indexing of ontologies in the library is done via full text and context-sensitive search facilities. Also, the ontology library has an inclusion lattice which shows the inclusion relations between the different ontologies.

Fridman-Noy and Hafner (1997) have compared 10 large ontology projects. In their survey they used the following (groups of) features to distinguish the ontologies: (1) *general*, (2) *design process*, (3) *taxonomy*, (4) *internal concept structure and relations between concepts*, (5) *axioms*, (6) *inference mechanism*, (7) *applications* and (8) *contributions*.

Van Heijst *et al* (1997) address the issues in creating an ontology library. Ontologies are indexed using dimensions *task / method dependency* and *domain dependency*. These dimensions are used to partition the library into two regions: a *core library* and a *peripheral library*. The former contains ontologies that are generic with respect to task / method and domain, and the latter contains ontologies that are both domain and task / method specific. Other library construction issues are the *language* in which ontologies are stated (inclusive whether it supports *higher-order expressions*), the *modularity* of the ontologies as building reusable blocks, and the option to allow *alternative (and possibly inconsistent) ontologies*.

It should be noted that none of the features mentioned above is currently measurable in a unique way. Scaling the ontologies on ontology features remains a subjective task (Visser and Bench-Capon, 1998). Some of the features are not directly usable for our ontology library. For instance, Gruber's 'minimal ontological commitment' criterion. In the context of a library this criteria is not relevant, as is distinguishing the ontological-commitment feature of ontologies. We note that there seem to be two broad categories of features, namely (1) *intra-ontology features*, and (2) *inter-ontology features*. Gruber, Fridman & Hafner, Van Heijst *et al.*, and Visser and Bench-Capon seem to emphasise the former type of ontology features, Farquhar *et al.* seem to emphasise the latter type of features. Here, we deem both type of features to be useful for our ontology indexing mechanism. Since the intra-ontology features have been addressed extensively in the work mentioned above, in the next section we concentrate on the inter-ontology features.

3.2 Inter-Ontology Features

One approach to find ontologies in the ontology library is to exploit the relations between different ontologies in the library. One ontology might, for instance, be an extension of another ontology in the library (this is the case with the *statute-specific ontology* of Van Kralingen and Visser, which is an

extension of the *generic legal ontology*). In this section we address how ontologies can be characterised by their relation to other ontologies. In particular, we look into the question (I) how component ontologies can be identified and (II) what relations can exist between them[2].

(I) *identify component ontologies*

We assumed that an ontology consists of a set of definitions of classes, relations, instances, functions, and axioms. Identifying component ontologies implies isolating multiple sets of ontology definitions. Below, we list five principles that can be used to define multiple, but related, ontologies.

1. *Domain partitioning*: An obvious way to identify multiple ontologies is to partition the domain itself in logical units, each representing another fragment of the domain. The Ontolingua ontology library, for instance, holds a collection ontologies for sets, numbers, lists, etc. (Farquhar *et al.*, 1997).
2. *Alternative domain views*: Multiple ontologies can be created by allowing different - possibly inconsistent - views of the same fragment of the domain (Van Heijst *et al.*, 1997). This principle covers the *polymorphic refinement* operator as defined by Farquhar *et al.* (1997, p.713).
3. *Abstraction*: Multiple ontologies can be defined by allowing both abstract and detailed ontologies. For instance, one can define generic legal concepts (*e.g.*, norm, modality, definition, act, law) and some statute-specific legal concepts (*e.g.*, definition-of-employee, forbidden, kill, penal-law). A top-level ontology (Sowa, 1995; Guarino, 1997a) is an example of an abstract ontology.
4. *Primary ontologies versus Secondary ontologies*: Multiple ontologies can be defined by allowing both primary ontologies and secondary ontologies. The distinction being that a primary ontology defines the basic concepts and relations in a domain (*e.g.*, apple, pear) and the secondary ontology adds a dimension to the concepts and relations (*e.g.*, rotten, red) by distinguishing additional features (*e.g.*, Borst *et al.*, 1996).
5. *Terminological, Information and Knowledge modelling ontologies*: The difference between these three types of ontologies is defined by 'the amount and type of structure in an ontology' (Van Heijst, 1995; Van Heijst *et al.*, 1997). Terminological ontologies define a lexicon, Information ontologies define record structures of databases, and knowledge modelling ontologies specify knowledge (with a richer internal structure than information ontologies)[3].

(II) *defining ontology relations*

The principles above enable us to define multiple sets of ontology definitions. We have not yet addressed how these ontology definitions are related. Below, we list three kinds of relations that might be defined between component ontologies. The kind of relations that can be defined between component ontologies is greatly influenced by the way these component ontologies are identified.

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[2] This section is based on a similar discussion in Visser (1997).

[3] For a critical review of these distinctions, see Guarino (1997b).

a. *Subset / Superset relation.* Ontology O_1 is a subset of ontology O_2 if all definitions in O_1 are contained in O_2 (O_2 is the superset of O_1). Strictly speaking, this kind of relation cannot occur with any of the above mentioned principles since all principles create ontologies without overlap (a primary and a secondary ontology, for instance, do not overlap). If we relax the definitions of the partitioning principles so as to allow overlap between the ontologies we can use this relation in combination with principles domain partitioning, abstraction, primary versus secondary ontologies, and terminological / information / knowledge modelling ontologies.
b. *Extension Relation.* Ontology O_2 is an extension of ontology O_1 if all definitions in ontology O_1 are available in ontology O_2. The difference with subset /superset relations is that the definitions contained in O1 are themselves not contained in ontology O_2. This kind of relation can be used in combination with domain partitioning, abstraction, primary versus secondary ontologies, and terminological / information / knowledge modelling ontologies.
c. *Restriction.* Ontology O_2 is a restriction of ontology O_1 if all definitions in ontology O_1 are available in ontology O_2 except for those that are redefined (*cf.* Farquhar *et al.* 1997). This kind of relation can be used in combination with alternative domain views, abstraction, primary and secondary ontologies, and terminology / information / knowledge modelling ontologies.
d. *Mapping Relation.* O_1 is mapped onto O_2 if some expression in O_1 is linked to an expression in O_2 where both expressions are (assumed to be) semantically equivalent or similar. This kind of relation can only be used in combination with alternative domain views since equivalent or similar expressions cannot occur using the other partitioning principles.

Both the principles to define multiple ontologies and the ontology relations can be exploited as indexing mechanisms. In the next section we propose a set of questions that can be used to index the ontologies in the library.

3.3 Indexing the Ontologies in the Library

The indexing mechanism of the legal ontology library consists of two groups of features: (I) the intra ontology features, and (II) the inter-ontology features. Below, we present a set of questions for each group.

Intra Ontology Features

- Supply name of the ontology, its author(s), their affiliation, relevant publications, relevant URLs, and the date at which it is designed?
- What tools were used to design the ontology?
- What is the purpose of the ontology?
- Does the ontology make method / task-specific commitments? If so, to what method(s) / task(s).
- Does the ontology make specific commitments towards legal subdomains (is the ontology reusable throughout all legal subdomains)? If so, state the restrictions and commitments?
- Does the ontology make any commitments towards representational formalisms (which)?
- What language is used to specify the ontology?
- What are the most fundamental distinctions in the ontology?

- How many concepts are defined (how many classes, relations, functions, instances and axioms)?
- Has the ontology been used in practical information-system applications (prototype, operational)?
- Sketch the internal structure of the ontology: (a) it is only a set of terms, (b) there is some structure, or (c) it has a high degree of structuring?
- What organisation principle is used (a) none, (b) hierarchy, (c) graph.

Inter Ontology Features

- Does the ontology include all definitions of another ontology in the library (which)?
- Are all definitions in the ontology included in another ontology in the library (which)?
- Does the ontology assume all definitions of another ontology in the library to be known (which)?
- Are all definitions in the ontology assumed to be known in another ontology in the library (which)?
- Does the ontology provide an alternative view on the legal domain than another ontology in the library (which)?
- Is the ontology an specialisation of another ontology in the library (which)?
- Is the ontology an abstraction of another ontology in the library (which)?
- Is the ontology a restriction on another ontology (which)?
- Can the ontology be mapped onto another ontology in the library? If so, what is the nature of this mapping (a) method to domain, (b) domain to method, (c) method to method, (d) domain to domain?

The idea to distinguish inter-ontology features next to the intra-ontology features allows us to build a lattice of ontologies showing how the ontologies relate to one another. If, while browsing through the library, one dislikes the commitments of a particular ontology then the inter-ontology links will lead to similar ontologies in the library which make different commitments. Alternatively, we could depict the ontologies according to method and domain specificity, when the core ontologies will tend to lie towards the origin. This is illustrated in figure 1 (*cf.* Van Heijst *et al.*, 1997).

4. Conclusions

If we try to relate our indexing questions to the four legal ontologies discussed in section 2 the result is at first sight a bit disappointing. Almost all the answers are no; the only exceptions being whether the ontologies give different views of the domain, and, if we include the statute specific ontology for the DUBA as a different ontology from the generic ontology, the former can be seen as an extension of the latter. This is readily explained, however, if we consider Figure 1. From this we can see that all the four ontologies we discussed earlier are intended to be core ontologies. As such, they record rather fundamental decisions about how the domain is to be conceptualised, and represent fundamentally different conceptualisations. If we had, for example, more examples of statute specific ontologies developed from LFU, we would find considerable inter-ontology relations with the statute specific ontology of the DUBA, particularly if they were in similar areas of law, such as equal employment law. Our indexing questions are most appropriate for rather detailed ontologies.

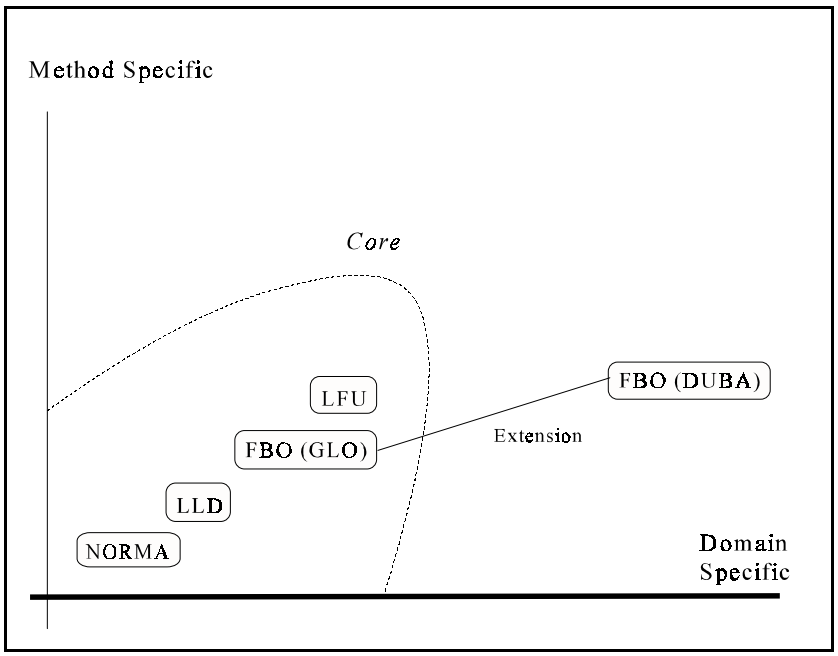

Figure 1: Method and Domain Specificity of Legal Domain Ontologies

At the level of core ontologies, the users of the library will want to select an ontology which embodies the fundamental design choices that they find congenial. This really means that they have to look at the highest level distinctions; for example the norm / concept / event distinction of FBO or the distinction into six kinds of knowledge of LFU. What the users need to do therefore, is to be able to browse and preferably compare, the competing ontologies starting with the top-level concepts. This will at once alert them to the fundamental design choices to be made, and enable them to decide which one is most in accord with their own conceptualisation. Armed with this knowledge, they will then be able to select a more refined ontology which conforms to this conceptualisation, using the other indexing questions. We observe that to construct a software tool to support this activity it is desirable that the language in which the ontologies are stated is formal and standardised.

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