Developing content for LKIF: ontologies and frameworks for legal reasoning

Joost BREUKER, Alexander BOER and Rinke HOEKSTRA and Kasper VAN DEN BERG

a Leibniz Center for Law, Faculty of Law, University of Amsterdam

Abstract. In this article we present the structure and an outline of the content of the LKIF-Core. LKIF is an interchange format for legal knowledge, under development in Estrella, a 6th framework European project. One of the layers of LKIF consists of a combination of the OWL-DL/SWRL knowledge representation languages in which LKIF-Core is written. LKIF-Core contains an ontology that has definitions of basic legal concepts. A number of these concepts are combined in frameworks that represent the use of these concepts (e.g. norms) in legal reasoning. LKIF-Core is intended for re-use in modelling legal knowledge bases and as a semantic basis in translating existing knowledge formats into LKIF.

Introduction

LKIF, the legal knowledge interchange format, is developed in Estrella, a 6th framework European project. Like KIF (Knowledge Interchange Format), LKIF is expected to be a highly expressive logic that enables interchanging the full, known range of knowledge representation and reasoning formalisms developed in industries and (AI & Law) research. However, LKIF is not only intended for translating existing legal knowledge services, but also constructing legal knowledge systems. Both functions do not exclude one another, as in constructing a new knowledge system, one should be able to reuse and incorporate legal knowledge from existing knowledge bases (e.g. by importing ontologies). However, to guarantee tractability of inferences, the expressiveness of the knowledge representation (KR) language needs to be limited. Therefore, LKIF consists of layers of expressiveness, similar to the layers of OWL, the web ontology language. A secondary requirement for LKIF is that it should be build upon XML-based standards for the Semantic Web. For these reasons some combination of OWL-DL and SWRL applies.
pears to be the most likely choice. In this article we will not further discuss the design options for LKIF, but focus on an extra feature of LKIF: it should provide high level, general support in knowledge modeling in the form of a core ontology that contains descriptions of common legal concepts. This core ontology (LKIF-Core) is currently under construction. In the following sections, we explain our design principles and some initial results.

1. Ontologies and Frameworks in LKIF-Core

The LKIF-Core consists of two kinds of structures: a highly abstract ontology of core legal concepts, and a number of frameworks that represent typical dependencies in the use of some of these concepts. We restrict the term ‘ontology’ to generic, terminological knowledge, i.e. intensional definitions of concepts, represented as classes. That means that the “backbone” structure of an ontology consists of class/subclass hierarchies. Although definitions of terms may be further refined using a large variety of other types of relations (properties), this backbone is the hallmark of an ontology. Why do we emphasize this? In defining concepts this class/subclass structure is soon considered background, and “usual” relationships with other concepts become foreground. For instance, when defining ‘restaurant’ we can note that “eating-in-a-restaurant” is one of its major functions. Hence, one may represent ‘in the sideline’ the dependencies between actions of clients and service personnel. This functional rather than ontological perspective becomes the major structure, i.e. as a generic, skeletal plan or script. Similarly we may define a car as consisting of a body, a motor, wheels, etc., where a part-of hierarchy becomes the dominant view. To be sure, the dependency or part-of view belong to the meaning of those concepts, these structures can also be part of an ontology, and indeed often are. However, our point is that such structures provide a specific, contextual view on the concept. We call these elaborate part-of or dependency structures frameworks.[1] Like ontologies, frameworks represent generic knowledge. They differ in that a framework captures common and frequently occurring patterns, while an ontology captures definitions of concepts. Frameworks and ontologies cannot be distinguished sharply and clearly. It makes sense to include in the definition of a car that it has a motor, but a complete inventory of its (generic) parts is only useful for mechanics. In LKIF-Core we develop a core-ontology – to some extent inspired by LRI-Core [4,3] – which constrains the meaning of terms used in frameworks and ultimately in special legal inference services.

2. Identifying and defining ‘clusters’ of legal concepts

In this section we will give an overview of the main concepts that will make up the LKIF-Core ontology. Contrary to more traditional top-down or bottom-up approaches to ontology development, we start out by identifying clusters of closely related concepts. This is analogous to the strategy described by [13], and similar to what [10] dubbed the middle-out approach. These clusters represent interdependencies between concepts defined in the ontology which can be combined using import-statements to form the

---

[1] Synonyms are: generic models, patterns, frames, scripts, etc.
basis for more elaborate framework representations and models. This modular approach
allows for distributed ontology development.

We have identified the following top-level clusters: propositional attitude, norm, pro-
process, action, role, agent, and a number of clusters containing basic notions related to
mereology, topology, time and space. Figure 1a shows the structure of the dependencies
between these clusters (note that the imports relation is transitive).

Figure 1 Clusters

As these clusters grow and become more dense, they will be grouped under a single
top ontology, following the structure of LRI-Core [23]. The intentional nature of the
core concepts for the ontology (see sections [22]) emphasizes the distinction with other
more (meta)physically inclined top ontologies such as SUMO [6], Sowa's upper ontology
[18] and DOLCE [7]), but shows similarities with the distinction between intentional,
design and physical stances described in [6].

At a lower level of abstraction, the clusters are used to specify frameworks for typical
legal actions and roles (see Figure 1b).

Process.owl The process cluster describes concepts related to change. Processes
change objects and use time (duration) and energy as resources. This cluster forms the
basis of definitions of more elaborate dynamic concepts such as actions, tasks, proce-
dures, plans and even causation: processes introduce causal propagation. Although the
default interpretation of ‘process’ is physical; we can distinguish mental processes as
well, e.g. forgetting something. The process cluster does not commit to any view as
to what the propositional content of a situation might be, i.e. we do not attach ‘condi-
tionals’ to the definition of processes. As these conditions are to a large extent ‘system
specific’, they are not an ‘inherent’ part of the description of process.

Action.owl Actions are intended processes, initiated by an agent, i.e. an agent selects
and executes the action whose effect the agent believes matches his/her intention. Pro-
cesses have a causal perspective; actions have an intentional stance. The intention pro-

---

6Suggested Upper Merged Ontology: (http://ontology.teknowledge.com )
7Descriptive Ontology for Linguistic and Cognitive Engineering: (http://www.loa-cnr.it/DOLCE.html)
vides the rationale (motive) for an action (see Agent.owl below). We distinguish physical actions from mental actions such as reasoning. Acts of communication form a special category: they combine physical and mental effects (cf. speech acts). They aim at bringing about a change in the mind of another agent, but need a physical medium (sound, writing). Usually agents do not (re-)act directly, but plan their actions. Plans consist of sequences of actions (possibly intertwined with processes.). A plan has a goal; the intentions associated with each action can be viewed as means to achieve this goal. Actions imply roles of agents: in particular the role of actor is a necessary role in actions. It is the agent who performs the actor role whose intention is viewed in common sense to be the primary cause of actions and basis for assigning responsibility. Another (passive) role that agents may take in actions is the role of recipient or beneficiary (see further under role.owl).

Agent.owl Agents – or 'persons' have a body (a physical object) and a mind (a mental object). The mind is a container of mental objects and mental processes/actions. Mental objects are e.g. beliefs, thoughts, memories, emotions, etc.. A specific kind of mental object is an intention.

In assessing responsibility for illegal actions or damage, the legal system makes assumptions about the working of the mind. As a default, agents are held responsible for their actions, as intentions and the execution of actions happen normally under conscious control. Moreover, the legal system also makes the assumption that not only the effects, but also certain side-effects are foreseeable, for which an agent can also be held responsible. Legal reasoning about responsibility in actions is based on a common sense model of intelligent behavior. It should be noted that in law there is a way to shortcut problems in assessing intention and foreseeability in actions by predefining liabilities [14].

Role.owl Roles are behavioral requirements on role execution and on qualifications of role taking. These requirements are prescriptions, i.e. they are normative. In modern society many roles have formal requirements enforced by law. Legislation addresses actors by the roles they play. If actual behavior deviates from the norms attached to these roles, we violate the law. Violations are based upon the distinction between the prescription (role) and role performance. In court, it is the actor of the role who is made responsible: as a person; not as a role. The notion of role has played an important part in recent discussions on ontology [19][16][15].

Roles can be viewed from two perspectives: as a relation or as a class. For all roles both perspectives hold, but it is dependent on the task context which view is the explicit one. The role of a teacher is e.g. to prepare and deliver instruction. However, roles also imply complementary roles (e.g. teacher-student) which constitutes the basis for a relational view on roles. The complementarity of roles is the consequence of (and results in) mutual expectations on behavior. It is the basis for social predictability and normative control, but also for complementary legal positions.

The predictability of roles makes them the building stones for society. Social organizations are assemblies of roles, and as these assemblies have generally a hierarchical character to simplify control, roles are associated to positions in such hierarchies.

The notion of role is more general than only for de-/pre-scribing social behavior. Roles may be assigned to physical objects, in particular: to artifacts. These roles are

---

8We may want to reserve the term (legal) person for the legal identity of agents or organizations of agents
usually called: *functions*. Roles may also be assigned to mental objects. The best example of mental roles are *epistemological roles*, such as ‘hypothesis’, ‘assumption’, ‘evidence’, ‘data’, ‘conclusion’, etc., i.e. the roles of goal directed problem solving. In argumentation one will find roles as ‘defeaters’, ‘counterarguments’, etc. A special kind of role are *thematic roles*, such as ‘actor’, ‘object’, ‘instrument’, ‘recipient’, etc, i.e. they are roles for agents and non-agent objects.

*Propositional attitude.owl* Propositional attitude are attitudes an agent may have towards some piece of information (viz. [5]). Like roles, attitudes can be viewed as classes and as mental objects. A propositional attitude is a relational mental state connecting a person to a proposition. The relation may be expressed by a qualifier (“this is a nice house”). Many legal concepts – e.g. norms – are defined in terms of propositional attitudes. The term ‘proposition’ stands for some understood content, and is a *reification* of some piece of information. The attitude – as a class – is a qualification about this information.

There are many kinds of propositional attitudes: as many as the perspectives one can have about some information. In law two kinds of qualifiers are of importance: qualifications of cases in terms of violations[^9] and deontic qualifications that qualify a legal norm statement. The assessor of cases is a judge; the assessor/designer of norms is the legislator.

*Norm.owl* The **norm cluster** defines some of the concepts that play a central role in LKIF-Core: *norm, obligation, prohibition, permission, obliged, and violation.*

A norm is a statement combining two performative meanings: it is *deontic*, in the sense that it is a qualification of the (moral or legal) acceptability of some behavior, and it is *directive* in the sense that it commits the speaker to bringing about that the addressee brings about the more acceptable thing (cf. [17]), presumably through a sanction. These meanings do not have to occur together. It is perfectly possible to attach a moral qualification to something without directing anyone, and it is equally possible to issue a directive based on another reason than a moral or legal qualification (e.g. a warning).

Norms are propositional attitudes, expressed in deontic terms; the directive or expectancy attitudes are added by the addressees. These two perspectives (the one from the legislator; the other from the addressee) can both be modelled. In the modal approach obligation, prohibition, and permission are modal operators, which works from the fact that obligation and prohibition are interdefinable, and obligation implies permission. This approach suffers from the lack of distinction between norms as objects and normative statements as logical expressions without object identity. There are also several rule-based approaches that try to capture norms in rules with notions like violation or duty as antecedent or conclusion. The rule itself captures the meaning of the norm, so that the confusion between norm and normative statement is again retained. A last option is to consider the norm as a preference statement (as in [12]), again failing to distinguish the statement and the thing (proposition) one is making the statement about. In summary, a formalism that is in accordance with the ontological view on the relation between a deontic qualification and the mental object (proposition) should ‘jump’ between the two levels of aggregation. Such formalism/algorithm is now under construction in Estrella.

[^9]: Maybe a better term is whether the case is ‘legal’ or ‘illegal’ to indicate that cases in which no violation of law has been assessed should have the same status as cases which have not been assessed.
3. Conclusions

LKIF-Core is expressed in LKIF’s layer that consists of two complementary (and tractable) knowledge representation formalisms: OWL-DL and (a subset of) SWRL. OWL-DL is used to construct an ontology of central, highly abstract concepts that are typical for law; the use of these concepts as practical reasoning components, called frameworks, are expressed as SWRL rules using OWL-DL classes. LKIF-Core gives LKIF a ‘legal’ content that not only supports knowledge acquisition and knowledge interchange in legal domains, but also provides some basic legal inferences by frameworks, such as for reasoning with deontic qualifications over norms. In the middle-out approach in developing LKIF-Core we have identified a number of clusters of basic concepts. These clusters can be further aggregated into two major, bigger clusters. Processes, agents, actions and roles are concepts involved in reasoning about responsibility and causation in law; the notions of norm and propositional attitude reflect reasoning about norms and norm violation. They are in line with the view of the FOLaw framework, developed by [20], that these two clusters of dependencies form the two major paths in legal reasoning.

References


