Formal Aspects of Legislative Meta-Drafting

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Abstract. The paper presents a logic-based approach to legislative meta-drafting. A class of meta-data, corresponding to specific classes of legal provisions, is introduced and discussed. Such meta-data are then formalized using a simple and tractable Description Logic, and the reasoning tasks available in the formalism are described.

Keywords. Meta-drafting, description logic

Introduction

The semantic mark-up of legal texts calls, first of all, for the development of suitable sets of meta-data, supposed to capture the formal structure of the legal text, as opposed to its content. Such meta-data need then to be systematically interconnected, to reveal the semantic structure underlying the mark-up.

Suppose for example we assume the theory of legal concepts set forth in [10] as a basis for a semantic mark-up of a given legal text. If a fragment of text at hand is marked as a duty of the bearer i against the counterpart j to perform/not-perform a certain action α, that same fragment should be consistently marked also as a right of the bearer j against the counterpart i to have α performed/not-performed. In Hohfeld's words:

> [...], if X has a right against Y that he shall stay off the former's land, the correlative (and equivalent), is that Y is under a duty toward X to stay off the place [10, p.32]

The possibility of automatizing this kind of inferences linking semantic meta-data such as "duty" and "right" lies at the core of the development of successful tools for meta-drafting.

The paper is organized as follows. After the Introduction, in Section 1 we sketch our perspective on legislative meta-drafting and in Section 2 we introduce the theory of provisions underlying our analysis of meta-data. In Section 3, we propose a logic which can support the specification of theories of meta-data, and provide at the same time the computational ground for the automatization of reasoning tasks linking different meta-data. The logic at issue is a tractable fragment of the Description Logic $\mathcal{SHIF}(D)$ underlying the Web Ontology Language (OWL).

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1. Perspectives on Legislative Meta-Drafting

We cite from [3]:

> "Legal documents show peculiar features and are quite different from other documents in terms of their fruition. Indeed, it can be argued that the reason underlying a considerable portion of documentary research on law collections is related to the need for identifying rules rather than law texts as such, which are therefore, at the very most, an intermediate target."
> "Legal orders are often perceived as the sets of laws that accumulate within them, through a dynamic process that expresses the becoming of the legal order itself. Legislative archives reflect this type of historical organization of the legal order, in which the documentary unit is thus the law. The lack of a analytical/systematic vision of the whole poses an obstacle to obtaining information about and exercising efficacious control over the contents."
> "The legislative text may be seen as a vehicle that contains and transports rules and the legal order as a set of rules rather than of laws; this approach allows us to see its contents more clearly. This perspective, inspired by analytic legal philosophy, permits us to perceive the rules as the true bricks in the legal system, and the laws as purely temporal events. In the model presented here, the significant pieces are regarded as individual provisions, while their significant and necessary components as their arguments. Although no linear relationship can be found between functional and surface patterns in a text, there is a reassuringly consistent correspondence between textual units (paragraphs) and functional units (provisions). Based on this finding, it can be reasonably argued that this is no casual correspondence: indeed, each provision is, from a general standpoint, the meaning of each elementary textual unit." [2]

2. Meta-data as Provisions

The meta-data needed for legislative meta-drafting can be obtained from suitable theories of provisions, which make explicit the functional structure of the legal text. In this section, we sketch our proposal for such a model.

2.1. Classes of provisions

Provisions in the model are divided into two main families: rules and rules on rules, a peculiar category that includes the provisions related to the dynamics of a legal system. The main family of rules is divided into the two major classes, which are the subject of normative theories, often referred to as constitutive rules and regulatory rules respectively, based on the well-known distinction drawn, among others, in [12]. For space reasons we cannot expose our theory of provisions in detail. The following sections are devoted to sketch a few of its features, and a partial representation of the model is given in Figures 1 and 2, which we hope are self-explanatory.

[2] The provision in Italian texts generally corresponds to a paragraph, but in some cases to an internal partition, or a sentence, or still a part of it. Therefore the identification of rules is based on the various illocutive profiles of underlying speech acts.

Class	Sub-class	Arguments			
definition	term	definiendum	definiens		
	procedure	addressee	counterpart	action	object
creation	establishment	addressee			
	organization	addressee			
attribution	power	addressee	counterpart	activity	object
	liability	addressee	counterpart	activity	object
	status	addressee			object

Figure 1. Constitutive provisions and their arguments

Class	Sub-class	Arguments			
action	right	bearer	counterpart	action	object
	duty	bearer	counterpart	action	object
	prohibition	bearer	counterpart	action	object
	permission	bearer	counterpart	action	object
remedy	redress	bearer	counterpart	effect	action
	violation	bearer	counterpart	penalty	action

Figure 2. Regulative provisions and their arguments

2.1.1. Constitutive provisions

Constitutive provisions lay out the components of relevant pieces of legislation by introducing new types of entities, defining new terms or procedures, creating new institutional bodies, and attributing powers. Essentially, they correspond to the "existence laws" referred to in [11]. They are systematically used by the legislation community and, as such, they have been several times recognized as the most characteristic feature of institutional reality in general [14]. A comprehensive formal analysis of them can be found in [9].

2.1.2. Regulative provisions

Regulative provisions concern deontic concepts. The example used in Introduction illustrates precisely the type of logical connections existing between these concepts. Worth mentioning is the class `remedy`. There we distinguish between the different consequences resulting from the non-compliance w.r.t. a constitutive and, respectively, regulative rules (or norms). To quote Bulygin:

> "If we do not comply with constitutive norms, the result is not a sanction or a punishment, for it is not a breach or violation of any obligation, nor an offence, but nullity" [6, p. 208]

For instance, the violation of a prohibition is typically linked to an ad-hoc penalty (or sanction), while the failure to comply with the necessary conditions for the creation of a legal contract lead to the nullity of the contract itself.

2.1.3. *Modificatory provisions (Meta-rules)*

Modificatory provisions are especially interesting for public administrative agencies as they concern the maintenance of legal systems. For a detailed formal analysis of this type of provisions we refer the reader to [7,8]. They are rules on rules, which manage the dynamics of laws and are divided into modifications and applications (derogations). The derogation is a rule that changes the meaning of a pre-existing rule, but neither abrogates it, nor modifies its text, contributing only to the clarification of the resulting norm.

2.2. *Arguments of provisions*

Arguments are the main focus of the provisions: they are always to be found in a provision, indeed no provision could be regarded as such in the absence of its own arguments. The lawmaker indicates in section/part headings the type of provision and its arguments to inform about the meaning of what follows (meta-textual messages). Arguments may be either explicit or implicit, single or multiple, and appear in the texts in various forms. The provisions model allows to highlight the terms of the dispositions that carry out a particular role, while the information on the general meaning of the term will be derived from dictionaries.

3. A Tractable Logic of Meta-data

The present section is devoted to the exposition of a tractable Description Logic which, we argue, can be successfully used for the formalization of theories of meta-data such as the one sketched in the previous sections. A sketchy introduction to Description Logics is provided.

3.1. *Description logics*

Description logics are a wide spectrum of knowledge-representation languages which handle concept description expressions, which are endowed with model-theoretic semantics, and which typically enjoy attractive computational complexity.

In DL elementary descriptions are atomic concepts (monadic predicates) and atomic roles (dyadic predicates) from which complex concept descriptions such as $\neg\texttt{man} \sqcup \texttt{mortal}$ and $\texttt{man} \sqcup \exists \text{has}.\texttt{mother}$ can be built. As an example we provide here the syntax and semantics of the probably most known DL, i.e., $\mathcal{ALC}$, where $\mathcal{AL}$ stands

Class	Sub-class	Arguments			
`application`	`inclusion`	partition			
	`exclusion`	partition			
`modification`	`abrogation`	partition	position	out	in
	`insertion`	partition	position	out	in
	`substitution`	partition	position	out	in

Figure 3. Meta-rules and their arguments

for Attributive Language and $\mathcal{C}$ for complement, indicating that negation of arbitrary concepts, and not only of atomic ones, is allowed. Given a set $\mathbf{A}$ of atomic concepts A and a set $\mathbf{R}$ of atomic roles R, the set Γ of $\mathcal{ALC}$ concept descriptions γ is defined by the following BNF:

$$\gamma ::= A \mid \bot \mid \top \mid \neg\gamma \mid \gamma_1 \sqcap \gamma_2 \mid \forall R.\gamma.$$

The operator $\forall$ is the dual of the terminological logic cropping operator $\exists$. In DL they are called, respectively, universal and existential restriction operators. Expressions $\forall R.\gamma$ denote the set of elements d such that all elements d' that are in a relation R with them are instances of γ.

An $\mathcal{ALC}$ model is a structure $m = \langle \Delta_m, \mathcal{I}_m \rangle$ where:

- Δ_m is the non-empty domain of the model;
- $\mathcal{I}_m$ is a function $\mathcal{I}_m : \mathbf{A} \cup \mathbf{R} \longrightarrow \mathcal{P}(\Delta_m) \cup \mathcal{P}(\Delta_m \times \Delta_m)$, such that to every element of $\mathbf{A}$ and $\mathbf{R}$ an element of $\mathcal{P}(\Delta_m)$ and, respectively, of $\mathcal{P}(\Delta_m \times \Delta_m)$ is associated. This interpretation of atomic concepts and roles of $\mathcal{L}_i$ on Δ_m is then inductively extended as follows:

$$\begin{aligned}
\mathcal{I}_m(\top) &= \Delta_m \\
\mathcal{I}_m(\bot) &= \emptyset \\
\mathcal{I}_m(\neg\gamma) &= \Delta_m \setminus \mathcal{I}_m(\gamma) \\
\mathcal{I}_m(\gamma_1 \sqcap \gamma_2) &= \mathcal{I}_m(\gamma_1) \cap \mathcal{I}_m(\gamma_2) \\
\mathcal{I}_m(\exists R.\gamma) &= \{d \in \Delta_m \mid \exists d', (d, d') \in I_m(R) \Rightarrow d' \in I_m(\gamma)\} \\
\mathcal{I}_m(\forall R.\gamma) &= \{d \in \Delta_m \mid \forall d', (d, d') \in I_m(R) \Rightarrow d' \in I_m(\gamma)\}
\end{aligned}$$

We denote the interpretation and its inductively defined extension both with $\mathcal{I}_m$. An $\mathcal{ALC}$ model m assigns a denotation to each atomic concept (for instance the set of elements of Δ_m that instantiate the concept `man`) and to each atomic role (for instance the set of pairs on Δ_m which are in a relation such that the first element is said to "have" the second element of the pair). Accordingly, meaning is given to each complex concept (e.g., $\neg$`man` $\sqcup$ `mortal` or $\exists$has.`mother`).

A model m is then said to be a model of a concept inclusion statement $\gamma_1 \sqsubseteq \gamma_2$ iff $\mathcal{I}_m(\gamma_1) \subseteq \mathcal{I}_m(\gamma_2)$. A concept definition $\gamma_1 \equiv \gamma_2$ corresponds in the obvious way to the two assertions $\gamma_1 \sqsubseteq \gamma_2$ and $\gamma_2 \sqsubseteq \gamma_1$.

Inclusion statements and definitions are, in a way, all what DLs are about since they express logical relationships between concept descriptions. A set of inclusion statements is usually called a *taxonomical box* (TBox) or *terminology*. In fact, DLs have been developed in Artificial Intelligence for the representation of terminologies or ontologies, i.e., sets of properties which are held as invariant on a domain (see [2]). And this is exactly the feature of the "universal criteria" stated by normative systems. Universal criteria are represented as subsumption statements, and sets of such criteria as terminologies.

It might be worth reminding that, from a logical point of view, many DLs can be viewed as notational variants of modal logics, or of computationally attractive fragments of first-order logic. DL $\mathcal{ALC}$ corresponds to the multi-modal system $\mathbf{K}_n$ [13] or, equivalently, to the binary fragment of first order logic admitting equality and fomulae with only one free variable [5].

Name	Syntax	Semantics
Top	$\top$	Δ_m
Bottom	$\bot$	$\emptyset$
Conjunction	$\gamma_1 \sqcap \gamma_2$	$\mathcal{I}_m(\gamma_1) \cap \mathcal{I}_m(\gamma_2)$
Existential restriction	$\exists R.\gamma$	$\{d \in \Delta_m \mid \exists d', (d, d') \in I_m(R) \ \&\ d' \in I_m(\gamma)\}$
General concept inclusion	$\gamma_1 \sqsubseteq \gamma_2$	$\mathcal{I}_m(\gamma_1) \subseteq \mathcal{I}_m(\gamma_2)$

Figure 4. Syntax and semantics of $\mathcal{EL}^{\bot}$

$$\texttt{action} \sqsubseteq \texttt{regulative}$$

$$\texttt{remedy} \sqsubseteq \texttt{regulative}$$

$$\texttt{action} \sqcap \texttt{remedy} \sqsubseteq \bot$$

$$\texttt{action} \sqsubseteq \exists \text{bearer}.\top \sqcap \exists \text{counterpart}.\top \sqcap \exists \text{action}.\top \sqcap \exists \text{object}.\top$$

Figure 5. Fragment of a TBox of regulative provisions.

3.2. DL $\mathcal{EL}^{\bot}$

Logic $\mathcal{ALC}$ is a rather expressive logic for our purposes. Besides, its subsumption problem is PSpace-complete. We will therefore make use of a fragment of $\mathcal{ALC}$ which enables enough expressivity for representing basic logical relationships between meta-data, and which, on the other hand, has a tractable, i.e., polynomial-time computable, subsumption problem.

Syntax and semantics of this fragments, which we call $\mathcal{EL}^{\bot}$, are exposed in Figure 4. Notice that, with respect to $\mathcal{ALC}$, concept disjunction and negation, and universal restriction are no more admitted in the syntax. Logic $\mathcal{EL}^{\bot}$ extends the small DL $\mathcal{EL}$ with the bottom concept $\bot$ and with general inclusion axioms. On the other hand, it is a fragment of the well-investigated description logic $\mathcal{EL}^{++}$ whose subsumption problem have been shown, in [1], to be computable in polynomial time. In the next section we show how $\mathcal{EL}^{\bot}$ can be used to formalize provisions as classes of meta-data.

4. $\mathcal{EL}^{\bot}$ at work

The choice of Description Logics as underlying framework for the formal specification of meta-data guarantees a high level of modularity in the formal representation of the desired theory of provisions. In fact, TBoxes can easily be strengthened or weakened by adding or removing terminological axioms. The present section provides some simple examples of the use of $\mathcal{EL}^{\bot}$ as specification tool for systems of meta-data.

4.1. Examples

The TBox in Figure 5 states that `action` and `remedy` are two disjoint types of provisions which are both subtypes of the type `regulative` of regulative provisions (first three subsumptions). Furthermore, it is stated that the provisions of type `remedy` has always 4 arguments, namely: an addressee (the bearer of the provision), a counterpart (the beneficiary of the provision), a content (the action of concern for the provision), and an object (the object concerning the action). Another example along the same lines, taken from the classification of constitutive provisions, is given in Figure 6.

It is easy to see that Figures 5 and 6 are formalizations of part of the content of Table 2 and, respectively, 1. Formalizations of this kind, based on $\mathcal{EL}^{\perp}$, provide a systematic representation of the tables of meta-data introduced in the previous sections as TBoxes, enabling them with a simple set-theoretic semantics that can be consistently used to perform automatic reasoning. It is worth stressing that this type of simple formalization lies at the ground of the methodology for grounding meta-drafting which we set forth in this paper. In a nutshell, such methodology consists in: first, isolating the relevant classes of meta-data and their arguments; second, proceed to their formalization in a tractable logic.

4.2. Relations between classes of provisions

Once the theory of meta-data is formalized, it becomes possible to perform automated reasoning on it. The present section shows what kind of reasoning can be effectively performed within $\mathcal{EL}^{\perp}$.

By motivating the research question of the paper, in the Introduction , we gave the example taken from [10] of two provisions which are considered to be, according to Hohfeld, equivalent. Such equivalences can easily be expressed in $\mathcal{EL}^{\perp}$ in the form of equivalence axioms such as:

$$
\begin{aligned}
\texttt{definition} &\sqsubseteq \texttt{constitutive} \\
\texttt{creation} &\sqsubseteq \texttt{constitutive} \\
\texttt{attribution} &\sqsubseteq \texttt{constitutive} \\
\texttt{term} &\sqsubseteq \texttt{definition} \\
\texttt{procedure} &\sqsubseteq \texttt{definition} \\
\texttt{definition} \sqcap \texttt{creation} \sqcap \texttt{attribution} &\sqsubseteq \perp \\
\texttt{term} \sqcap \texttt{procedure} &\sqsubseteq \perp \\
\texttt{term} &\sqsubseteq \exists \text{definiendum}.\top \sqcap \exists \text{definiens}.\top \\
\texttt{procedure} &\sqsubseteq \exists \text{addressee}.\top \sqcap \exists \text{counterpart}.\top \\
&\quad \sqcap \exists \text{action}.\top \sqcap \exists \text{object}.\top
\end{aligned}
$$

Figure 6. Fragment of a TBox of constitutive provisions.

$$\texttt{duty} \equiv \texttt{right}$$

In meta-drafting terms, this means that if a piece of legislation is marked as an obligation, then it could be appropriately marked also as a claim, and vice-versa. A second typical type of axioms are the disjunction axioms such as:

$$\texttt{action} \sqcap \texttt{remedy} \sqsubseteq \bot$$

in Figure 5. These axioms just state that if a piece of legal text is marked as a regulative provision of type action, then it cannot consistently be marked as a regulative disposition of type reparation.

Now, given a set of such axioms and a formalization of the meta-data such as the one in Figure 5, it becomes thus possible to perform simple automatic reasoning. This is guaranteed by the fact that the subsumption problem in $\mathcal{EL}^{\bot}$ is tractable, that is, solvable in polynomial time [1]. Let us first recall that the standard TBox reasoning tasks in DL are essentially two [2]: satisfiability and subsumption. The satisfiability problem amounts to check whether a state description γ is satisfiable w.r.t. a given TBox $\mathfrak{T}$, i.e., to check if there exists a model $m = \langle S, \mathcal{I} \rangle$ of $\mathfrak{T}$ such that $\emptyset \subset \mathcal{I}(\gamma)$. The subsumption problem amounts instead to check whether a given subsumption relation $\gamma_1 \sqsubseteq \gamma_2$ is modeled by all models of a given a TBox $\mathfrak{T}$, i.e., if it logically follows from $\mathfrak{T}$. In our setting, the typical reasoning task will concern concept subsumption (i.e., subsumption between meta-data), such as, for instance: "$\texttt{duty} \sqsubseteq \texttt{remedy}$?", which assuming $\texttt{duty} \sqsubseteq \texttt{action}$ and the TBox in Figure 5, is obviously false[3].

Equivalence and disjunction axioms for meta-data state, in a way, forms of logical relations between provisions, that is to say, relations between provisions which follow from the common semantics of those terms. In fact, such axioms state essentially set-theoretic relationships between meta-data. However, meta-data can be linked in a slightly more subtle way, which is also amenable to formalization in $\mathcal{EL}^{\bot}$. The typical example is the link between provisions of type `action` and `remedy`, which, as we have seen above, are actually logically disjunct. Such link exists, for instance, between the provisions specifying sanctions (the matadata `violation`) and the provisions specifying the obligations (the meta-data `duty`) to which the sanctions are attached by the legislator. In this case we say that provisions of type `violation` are *complementary provisions* of the provisions of type `duty`.

By making use of a special role compl, it is possible to formalize, within $\mathcal{EL}^{\bot}$, such complementarity relation by means of axioms of the following form:

$$\texttt{violation} \sqsubseteq \exists \text{compl}.\texttt{action}$$

This axiom states that the provisions of type `violation` are all related via the complementarity link—or, to use the DL terminology, role—compl to provisions of type `reg_ action`. To put it otherwise, it states that all reparatory regulative provisions of type `violation` are all complementary provisions of at least one provision which is regulative of action. Again, assuming the TBox in Figure 5 we can infer, by reasoning in $\mathcal{EL}^{\bot}$, that $\texttt{violation} \sqsubseteq \exists \text{compl}.\texttt{regulative}$.

[3]However, in $\mathcal{EL}^{\bot}$, the two reasoning tasks of subsumption and satisfiability have been proven equivalent [1].

To put it in a nutshell, what equivalence and disjunction axioms do is to provide a specification of what a rational mark up is, in terms of a given theory of meta-data. Hence, a mark-up which does not satisfy such a specification would be a mark-up which is inconsistent with the relevant theory of disposition.

4.3. Models of meta-data vs. formal models of normative concepts

The formal theory we presented is a terminology (in the technical sense of description logic) for classifying fragments of legal texts. The domain of discourse is the set of textual fragments, that is to say, the formalization "talks about" textual fragments and it considers them as instances of meta-data, i.e., the dispositions structured in the terminology. The terminology of dispositions presented here can be seen, therefore, as a theory of a possible set of meta-data that can be used for the mark-up of legal texts. Meta-data are isolated a priori and the logical relations holding between them are imposed axiomatically (by the statements of a TBox). As such, the terminology of disposition presented cannot be properly considered a theory of normative concepts.

A theory of normative concepts would be concerned with a formal analysis of the *meaning* (a formal semantics) of textual fragments: what does it meant to have a right? what does it mean to constitute an entity or a power? etc. The domain of discourse of a formal theory of normative concepts is not the set of textual fragments, but the set of entities legal texts talk about: persons, actions, situations, etc. Via such an analysis the logical relations connecting the different normative concepts would emerge from the formal semantics without the need for imposing them axiomatically. This is obviously a far more demanding endeavor which would really constitute a formal foundation of meta-drafting. However, no comprehensive formal theory of normative concepts, in the sense just exposed, has so far ever been proposed, though fragments of such a theory could be found, for instance, in the literature on Deontic Logic.

The two perspectives (terminology of dispositions and theory of normative concepts) can nevertheless meet at a certain point. In fact, a fully fledged theory of normative concepts would directly provide a ready-made set of meta-data for a semantic mark-up of legal texts based on the formal analysis of the meaning itself of textual fragments: a given fragment would be identified as conveying a specific meaning corresponding to a specific normative concepts. As we have noticed above, a terminology of meta-data skips the step of the semantic analysis of what textual fragments via directly marking them via an exogenous set of labels (the meta-data). However, the chosen meta-data and their logical relations could be eventually shown to correspond to the formal meanings (and their logical relations) which would emerge from a theory of normative concepts. On the other hand, more or less developed parts of a formal theory of normative concepts could drive the choice of appropriate meta-data and clarify their logical dependencies.

5. Conclusions

From the point view of information, provisions and concepts models can be used to enhance the accessibility of legal sources, giving users advanced semantic search and retrieval facilities. LMEmetaSearch [4] allows to find provisions in legislative sources and to perform reasonings on relations between provisions and/or domain concepts. From the point of view of maintaining legal order, the model of provisions can be used to tackle legislation with different purposes, as consolidation of texts and diagnosis on features and relations of provisions. From the point of view of law making, the XML editor LMEmetaEdit supports the drafting process and the semantic mark-up, according to the provisions model and domain conceptual dictionaries.

The rules model presented has been mainly conceived to be used as guideline in the drafting process, allowing the planning and construction of a new bill starting directly from the definition of its semantics. The LMEmetaPlan project aims at reversing the traditional drafting process, providing facilities to express first the semantics of a legislative project in terms of its functional profile. The body and the final structure of the text will be automatically generated from the organization of the semantics.

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