An Ontology Reference Model for Normative Acts

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Abstract. *Normative Acts are important legislative and regulatory documents made by different governmental organs. Every year, a huge amount of information is provided in Normative Acts by these organs without control, i.e., there is no effective way to verify redundancies, inconsistencies, cross-impact and ambiguities. In this paper, we propose a domain ontology for Normative Acts based on official documents (the Brazilian Constitution and the Redaction Manual of the Presidency of the Republic) as a reference model that can be used to improve communication, interoperation and automation of Normative Acts. The reference model is built with a highly expressive well-founded language within a methodology that ensures its quality.*

1. Introduction

Among the various duties of the Brazilian powers, one of its main activities is the publication of Normative Acts (NAs) to establish standards and to inform decisions and other information to society. The main types of Brazilian NAs can be found in Article 59 of the 1988 Constitution of the Federative Republic of Brazil. NAs are central to legislative power, where these acts are daily created in the form of laws. They are also important to the executive power, where they are mainly created in form of executive decrees. In addition, they are essential to the national regulatory agencies, where they are created in the form of resolutions.

The activities done by these organs to elaborate, edit, and publish NAs are complex and involve several organizational units and a large number of human resources. Different people, with different cultural and technical knowledge and with different interests are involved with the creation of NAs. Thus, these people must share a common comprehension about the terms and concepts related to NAs, in order to improve the resultant document. Due to the legislative and regulatory importance of NAs, miscomprehension of concepts during the planning and elaboration of NAs can range from a simple structure error (resulting in a difficulty to automatically read the generated document with an computational application) to a huge interpretation problem, generating social and financial losses to society and companies. Moreover, to be published, the NAs text must be clear and unambiguous, as society and other public and private organs have to comprehend and share (textually or computationally) its contents.

In order to produce the desired impact to society, the NAs must be carefully planned in their elaboration stage, involving studies and researches of previous related NAs. Today, these studies and researches are done manually, without intelligence provided by computational applications – to research a NA, an editor must use a non-specialized research tool, just like any layman would. Moreover, once published, its content must be easily accessible and researchable by society and other stakeholders. In fact, in Brazil, a federal law ensures that every public organ or entity must publish, in detail, the formats used to structure their information. It is widely known that, although a reference document exists for the NAs writing, this document is not always used by the legislative houses and regulatory agencies, thus resulting in the above cited problems.

The official reference document which deals with the NAs' writing is the Presidency Writing Manual (in Portuguese, *Manual de Redação da Presidência da República* – available at http://www.planalto.gov.br/ccivil_03/manual/). The Writing Manual is divided into two parts: the first, among other topics, presents the official communications and standardizes the layout of expedients. The second part deals with the elaboration and wording of NAs and presents examples of the Normative Acts and the legislative procedure.

This second part of the document, in particular, describes the textual elements that a NA may have and their inter-relationships, making it a valuable reference and a natural candidate for the development of an Ontology Reference Model for this domain. Even though the description contained in the Presidency Writing Manual is available only in natural language (Portuguese), which does not guarantee absence of ambiguities, the use of an ontologically well-founded language can identify and correct these possible deficiencies. Such type of language differs from other commonly used languages to represent data or knowledge in information systems (like databases schemas) as they are built accordingly to a foundational ontology, i.e., a meta-ontology that describes a set of real-world categories that can be used to talk about reality [Guizzardi 2007]. A framework for ontological evaluation is presented in [Guizzardi 2005], and an example of an application of this kind of evaluation in a network language, also described in natural language, can be seen in [Barcelos et al. 2011].

Our objective in this paper is to present a domain ontology developed to be a reference model for NAs. Reference Models are essential artifacts when dealing with information of a given domain, as they formalize concepts and their relations in a clear and unambiguous way, improving communication and information exchange and interoperation. In fact, the main objective of a reference model is to assist humans in tasks such as meaning negotiation and consensus establishment. This goal can be achieved by using highly expressive languages, within a formal ontology engineering methodology, to create a strongly axiomatized ontology that approximates as well as possible to the domain conceptualization. The focus on these languages is on representation adequacy, instead of computational representation [Guizzardi 2007]. The Normative Acts ontology reference model is formalized with OntoUML, an ontologically well-founded profile of the Unified Modeling Language (UML). The ontology engineering methodology used guarantees the validity and correctness of the modeled information through syntactical and semantic validations.

In brief, the main contribution of this paper is to provide an ontology reference model for the NAs domain, formalized with OntoUML within an ontology engineering methodology. A secondary contribution is the presentation of this ontology`s capabilities to be used as basis for computational implementation.

The work described here is placed in the context of the Information and Knowledge Management Model Project ("Modelo de Gestão da Informação e do Conhecimento", MGIC, in Portuguese), a cooperation project between the Federal Fluminense University and the National Agency of Terrestrial Transportation (ANTT). The MGIC aims to improve efficiency in ANTT's decision-making. To achieve this goal, the information modeling work is performed on four different fronts. The ontology modeling, one of these fronts, aims to create conceptual reference model ontologies for structuring the agency's information.

This paper is structured as follows: in section 2, we compare this work with others that are related to NAs; section 3 presents the ontology engineering methodology used to create and guarantee the quality of the proposed NAs ontology; in section 4, we describe the ontology reference model for NAs in details; section 5 presents possibilities of practical use of the NAs ontology as a conceptual model and as basis for computational implementation; section 6 presents the main conclusions as well as future works.

2. Related Works

As the legislative process involves several public entities in various spheres and as it generates a large amount of information, a huge number of works are published involving the creation of ontologies used for communication and automation in this domain. In fact, some of these works are the results of large projects, like the LexML Project [Lima 2010], and the International Ontojuris Project [Clara et al. 2010].

Legal ontology projects differentiate from each other in scope, objective and in which kind of ontology they are based. As an example, the Brazilian LexML project uses as basis an ontology called FRBROO, an ontology in the domain of cultural heritage; while the Ontojuris Project uses a lightweight ontology (almost a dictionary), similarly to other initiatives, such as the LTS (Legal Taxonomy Syllabus) [Ajani et al. 2009], in Europe.

The Power project, in its turn, uses shared conceptual models to facilitate the legislation process [Engers and Glassée 2001]. [Visser and Bench-Capon 1996] also proposed a Legal Ontology specification, while [Boer et al. 2003] proposed an ontology for comparing and harmonizing legislation. Other works aim to provide foundations for concepts of law, like [Breuker and Hoekstra 2004]. These works and the ontology proposed in this paper, however, do not share the same scope, as the foundations are provided to models representing legislative process concepts, not the internal elements and relations of Normative Acts.

Even though there is a vast number of works about ontologies in the legislative area, it appears, however, that no work involves the creation of a well-founded ontology reference model for the representation of the Normative Acts' internal structure.

3. Ontology Engineering Methodology

In order to create an ontology reference model that correctly reflects the intended domain and that is able to be used by different agents (people, groups of people and other, like machines) to interoperate, an ontology engineering methodology must be used. This section presents our methodology, partially based on the Ontological Approach to Domain Engineering presented in [Falbo et al. 2002]. In our methodology, shown in Figure 1, we use the steps of the Ontological Approach to Domain Engineering with different level of rigor, abstracting non-essential elements to our case.

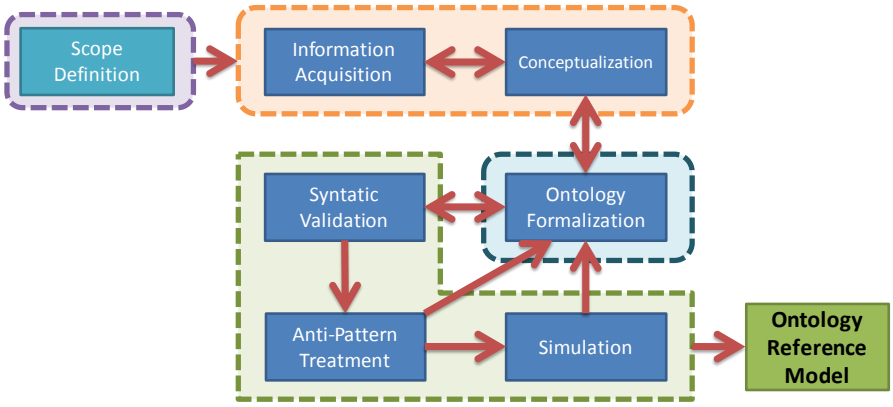

Figure 1 – The used Ontology Engineering Methodology

Scope definition is the first step of the iterative methodology. Our ontology uses a reference document, the Presidency Writing Manual, written in natural language (Portuguese in our case), as the modeling scope.

The second step of the methodology is the *ontology capture*, were the sub activities of Information Acquisition and Conceptualization are realized. In order to acquire information, a domain study is necessary for the modeler to learn about the subject to be modeled. We used the Presidency Writing Manual and the Brazilian Constitution as main source of information. Conceptualizations are immaterial entities that only exist in the mind of the user or a community of users of a language. In order to be documented, they must be captured in terms of some concrete artifact. This implies that a language is necessary for representing them in a concise, complete and unambiguous way [Guizzardi 2007].

The *ontology formalization* step consists in the formalization, through diagrams, of the domain model. In order to correctly represent a domain, an expressive language must be used. This language should be able to represent information despite of implementation technologies or limitations. In this work, we use OntoUML, an ontologically well-founded UML profile [Guizzardi 2005]. As graphical languages are not always capable of correctly representing the domain, some Object Constraint Language (OCL) rules are also necessary for restrictions and derivations rules.

As we intend to create a reference model for Normative Acts (NAs), it is important to ensure that the diagrams allow only instantiation as desired, that is, that the user can only create instances that are possible in the real world. To do this, we focus on the *validation* of information modeled at the diagrams. In this stage, we have two main types of validation: (1) the syntactic one, which guarantees that the OntoUML models

created are syntactically correct, that is, that the entities created are according to the languages meta-model; and (2) the semantic validation, where we want to avoid syntactically correct diagrams that can be instantiated to generate undesired world of affairs.

The OntoUML Lightweight Editor (OLED) (https://code.google.com/p/ontouml-lightweight-editor/) provides the *syntactical validation*. The Semantic Validation does not ensure that there is no impossible state of affairs allowed by the ontology, it does, in fact, ensure that its occurrences are reduced. The semantic validation is done in two steps, within an OLED's module, called MOVE (OntoUML Model Validation Environment): the first step is an *anti-patterns identification* and treatment and the second step is a *simulation* using Alloy.

As stated in [Sales et al. 2012], an anti-pattern is a recurrent decision for a specific scenario that usually results in more negative consequences than positives ones. The MOVE tool provides a model verification to check occurrences of anti-patterns. Simulation can help the modeler to find inconsistencies and unwanted worlds of affairs allowed by the model. The MOVE tool can translate the model to Alloy [Jackson 2002]. Alloy is a model-checking language that can be used to simulate possible worlds based on the formalization provided. This kind of validation guarantees the validity of modeled information inside an specific context, thus its usage significantly improves model quality as the user can make assertions and check if these are valid or not.

3.1. The use of OntoUML

OntoUML provides a well-founded UML profile. The classes in OntoUML are based on some important ontological meta-properties that allow the creation of consistent ontologies [Guizzardi 2005].

Examples of meta-properties are *identity principle* and *rigidity*. *Identity principle* is related to the nature of an object. For example, a Student is a Person, as they have the same identity principle, but they can never be a Car, as they have different identity principle. The *rigidity* principle is the capacity of an entity to be part of a class maintaining its existence. For example: John is an individual of the class Student but, in a given world, it can cease to be a Student and still exists as a Person. However, in any world John cannot cease to be a Person without ceasing to exist. Thus, Student is an example of an anti-rigid class while Person is an example of a rigid class.

Table 1 – OntoUML Class Stereotypes present in the Normative Acts Ontology

Stereotype	Main Characteristics	Example
Kind	Rigid types which provide an identity principle	Person, TV
Subkind	Relationally independent rigid specializations of kinds, collectives, or other subkinds	Man, LED TV
Category	Aggregate rigid elements with different identity principles	Animal, Electronic
Collective	Elements whose instances are collectives, i.e., they are collections of elements that have a uniform structure	A forest, a group of people

The OntoUML stereotypes present in the Normative Acts Ontology are summarized in Table 1 above. For an in depth presentation, formal characterization and empirical evidence for a number of the ontological categories underlying OntoUML, the reader is referred to [Guizzardi 2005].

4. The Domain Ontology for Brazilian Normative Acts

The domain ontology presented here is based on official documents: the Presidency Writing Manual (hereafter, for short, called PWM) and on the Brazilian Federal Constitution. Although the Normative Acts (NAs) Ontology created to the National Agency of Terrestrial Transportation involves three aspects of the Normative Process - Structural Elements, Management Issues and Regulatory Marks – the Reference Model presented here considers just the Structural Elements of NAs, considering NAs compositions, aggregations, its internal elements, and all relations between these.

The ontology reference model presented in detail in this section is divided in three subdomains and modeled using OntoUML diagrams. For highlight, the first occurrences of an ontology terms are presented with the Courier New font. It is important to mention that the ontology reference model is fully available for download at: http://www.nemo.inf.ufes.br/en/courses/ontologyengineering.

4.1. Normative Acts and Articles Subdomain

The model related to this subdomain states the different existing types of `Normative Acts` in Brazil and their internal structure.

Due to space limitations, the diagram that differentiates the NAs is not presented in image. This diagram's information was extracted from the 59th Brazilian Federal Constitution article, where it states that the legislative process involves the creation of: `Constitution Amendments`, `Complementary Laws`, `Ordinary Laws`, `Delegated Laws`, `Provisional Measures`, `Legislative Decrees` and `Resolutions`. `Decree`, `Ordinance` and `Handout` were extracted from the PWM. All of these NAs are disjoint from each other, i.e., no NA can be of two different types at the same time. NAs are defined by its composition by different subkinds of Articles and by its preliminary elements.

At the adopted conceptualization, the `Article` performs the most important function in NAs as it contains the statements defining the rules and information that the NA is about. In the ontology reference model every concept has a (direct or indirect) relation with Articles. It can be seen in Figure 2 that every article has an identifier number. An OCL rule formalizes that Articles in the same NA have unique natural numbers.

Figure 2 also represents the different types of Articles. Articles can be `Ordinary Articles` (regular Articles, the ones that states new communication), `Revocation Clauses` (Articles that revokes other Articles) or `Duration Clauses` (Articles that asserts a validation time). Every NA must be composed of at least one Ordinary Article, but it is not necessary for it to be composed of Revocation Clauses or Duration Clauses.

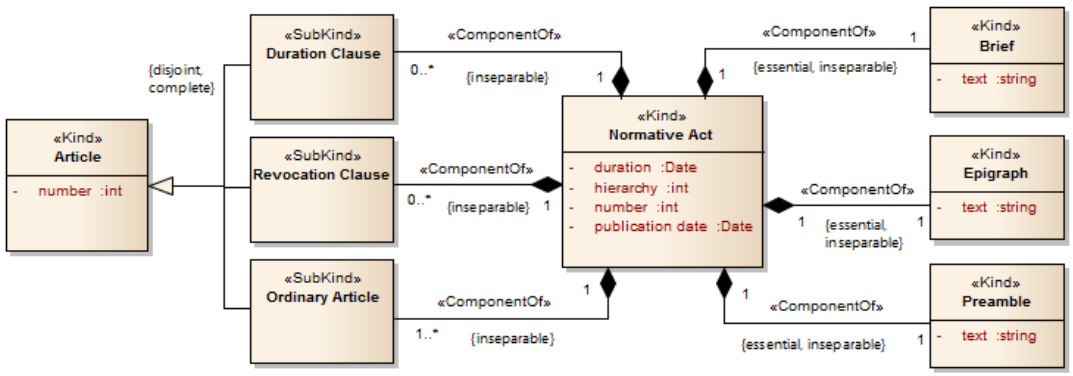

Figure 2. Compositions of Normative Acts

`Preamble`, `Epigraph` and `Brief` (in Portuguese: *Preâmbulo*, *Epígrafe*, and *Ementa*, respectively) are obligatory preliminary elements in every NA. These preliminary elements cannot be modified (vetoed, revoked or altered) – these properties are stated in the Ontology Reference Model by the composition meta-properties of essential and inseparable [Guizzardi 2005].

4.2. Discrimination of Normative Acts' Elements Subdomain

Grouping and Discrimination Elements are important part of NAs as they provide to their author the desired abstraction granularity. The `Discrimination Elements` are used to describe in more detail the information being normalized in a NA.

The different types of Discrimination Elements are: `Paragraph`, `Item`, `Letter` (in Portuguese: *Parágrafo*, *Inciso*, and *Alínea*, respectively) and `Letter Discriminator`. Every Discrimination Element is a part of a Normative Act because the Articles that are discriminated by these elements are part of the Normative Act.

Articles can be of two types: `Simple Article` or `Composed Article`. While the former consists only of a text, the latter consists of its introductory text, named `Caput`, and of at least one Item or Paragraph. Both types are represented in Figure 3.

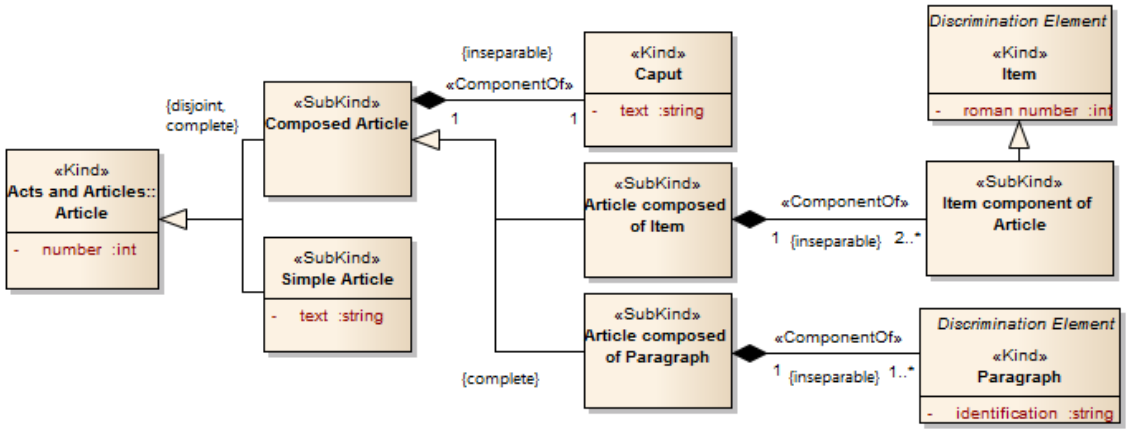

Figure 3. Compositions of Articles

If there is just one Paragraph composing an Article, its identification string must be *Unique Paragraph*. OCL rules ensure these restrictions.

Articles and Paragraphs can be decomposed in `Items` (see Figure 3), identified by roman numbers. Items, represented in Figure 4, can be `Simple Items` (when undivided) or composed by Letters. Letters can also be undivided (`Simple Letters`) or they can be divided in Letter Discriminators. The PWM states at its section 10.2.2.3 that "*Letters can be discriminated with cardinal numbers, followed by periods*". As no name is given to these discrimination elements, we named them Letter Discriminators.

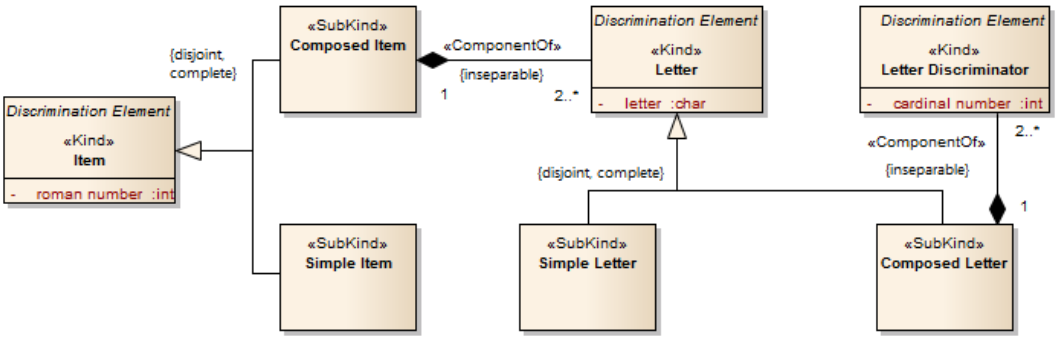

Figure 4 - Items, Letters and Letter Discriminators

4.3 Grouping of Normative Acts' Elements Subdomain

The `Grouping Elements` are used to easily aggregate related information in a NA. They are the `Parts`, `Books`, `Charters`, `Chapters` and `Sections` (in Portuguese: *Parte*, *Livro*, *Título*, *Capítulo*, and *Seção*, respectively). Every Grouping Element is part of the NA that is composed of the Articles that are grouped by these Grouping Elements.

As represented in Figure 5, related Articles can be grouped in Sections or Chapters. Sections can be of two types: `Simple Sections`, i.e., Sections that are not composed by other Sections, and `Composed Sections`, that are Sections composed by other Sections or `Subsections`: a specific type of Section that just occurs composing a Composed Section.

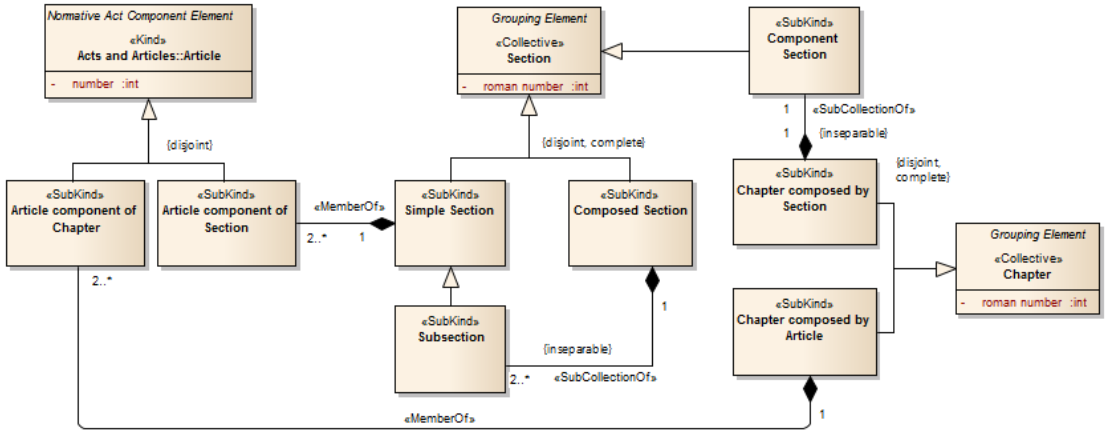

Figure 5. Grouping of Articles in Sections and Chapters

The grouping of Chapters by Charters, of Charters by Books, and of Books by Parts can be seen in Figure 6.

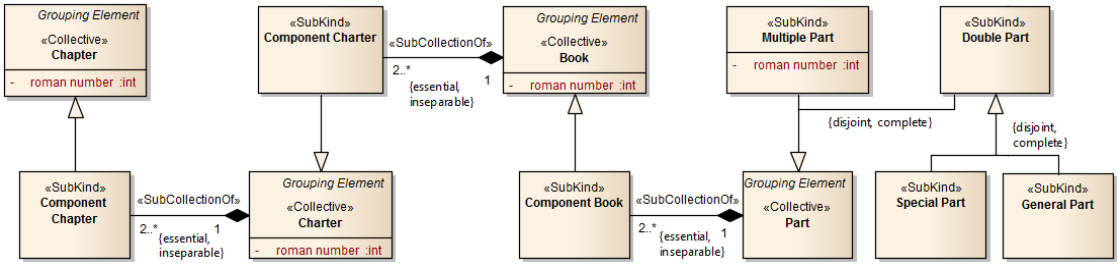

Figure 6 - Chapters, Charters, Books and Parts

Parts can be of types `Double Part` or `Multiple Part`. OCL rules were created to state that every NA that is composed by a Multiple Part always have at least three of these and to state that if the NA is composed of a Double Part it must have exactly only one instance of a `General Part` and a `Special Part`.

5. Practical Applications

As stated by [Guizzardi 2007], there is a clear distinction between (a) Conceptual Modeling, (b) Design and (c) Implementation. The ontology reference model presented here is a result of the Conceptual Modeling stage, as it aims to make a clear and precise description of the Normative Acts (NA) domain elements for the purposes of communication, learning and problem solving, independent of implementation platform or technology. Considering a Model Driven Architecture approach [Miller and Mukerji 2003], the Reference Model can be seen as the *Computational Independent Model* (CIM), its design products as *Platform Independent Models* (PIMs) and its implementation products as *Platform Specific Models* (PSMs). In the Design and Implementation phase, this conceptual specification is transformed by taking into consideration a number of issues ranging from architectural styles, non-functional quality criteria to be maximized, target implementation environment, etc. The same conceptual specification can potentially be used to produce a number of different artifacts in different implementation languages – ranging from relational databases to semantic web languages, like the Web Ontology Language (OWL).

In Brazil, according to the Federal Information Access Law (Brazilian Federal Law number 12,527, from November 18th 2011. Available just in Portuguese at http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2011/lei/l12527.htm), every public organ or entity must use the Internet to publish, in detail, the formats used to structure their information. The ontology presented here, as a well-founded formalization of a domain conceptualization, is the best option to accomplish this requirement. This same law also states that the public organ or entity must enable automated access by external systems to the information in open, structured and machine-readable formats. Thus, an ontology implementation in the Resource Description Framework (RDF) or OWL can entirely satisfy the law. In fact, the federal government with the World Wide Web Consortium (W3C), cite OWL as a desirable practice for Open Data [Comitê Gestor da Internet no Brasil 2011].

A computational implementation of the proposed ontology reference model can also be used in applications to assist different stages of the regulatory and legislative process, like the NA edition. The usage of automation software can significantly improve the time spent with the huge amount of NAs that are created daily in a public entity. This automation can make processes more effective as it reduces the domain specialists' writing and research time and it gives them more time to think and reason about the subject of the documents.

In the edition phase, ontology-based software can eliminate from the writer the need to know each concepts from the PWM, as the software can automatically create these concepts for him. Another great improvement is the restriction to create documents that are not in accordance with the PWM. As an example, every time a writer creates an Article, if he wants to create a subtopic of this Article, he can just press the TAB key and two options appears to him: an Item or a Paragraph. So, it is not possible to create, for example, a Letter discriminating directly an Article. Another possible usage of this software would be to evaluate Normative Acts already created.

The ontology-based software for the NA process can be significantly improved by using other Ontology Models. The usage of an ontology model about NAs' revocation or modifications can add the ability to control the impact of a newly published NA in others already published. That is, there will be no need to manually state that an NA is repealed; it can be done automatically by software – thus, eliminating human errors.

Also, adding ontology reference models to the domain that the NAs are about, we can create a semantic annotation feature [Oren et al. 2006], where the writer can mark (tag) the concepts improving their semantics in accordance with the conceptual model. Please consider a reference model about highways, where a highway is composed by lanes and where it has a relation with other highways (for example "crosses"). If the NA editor is writing, for example, about BR-101 (a Brazilian highway), it can mark it as an instance of highway so, even if it is not explicit in the text that the BR-101 has lanes and that it can cross other highways, this information can be inferred. Semantic annotation is widely studied and used, even for large-scale scenarios [Dill et al. 2003].

With the usage of semantic annotation, the search on documents is improved, as there is no need to lexically match all search terms. A search using the word "highway" can return documents that use the term highway, and documents that deal with highways but do no explicitly use this concept, for example, a document that contains information about the BR-101. An improved search is vital to guarantee that new NAs do not conflicts with older NAs.

Already existent ontology-based tools for the legislative process can be found in [Valente and Breuker 1995] and [Gangemi et al. 2003]. The base ontologies used in these works, however, do not share the same scope of the ontology here presented and some of them are not formalized using a well-founded ontology language such as OntoUML.

6. Conclusions

This work presented an Ontology Reference Model for the domain of Normative Acts, built over information extracted from the Brazilian Constitution and the Presidency Writing Manual. The proposed ontology is formalized using an ontologically well-founded highly expressive language and it was developed following the ontology engineering methodology presented here. This ontology can be used as basis for automation and interoperation of information about this domain.

The Ontology Reference Model is presented considering three subdomains:

(a) Normative Acts and Articles, where different existing types of Brazilian Normative Acts are presented as well as their internal structure, representing their composition by articles and preliminary elements;

(b) Discrimination of Normative Acts' Elements, related to elements that are used to describe in detail the information being normalized in a Normative Act;

(c) Grouping of Normative Acts' Elements, that formalizes elements that are used to easily aggregate related information.

As a reference model, this ontology aims to make a clear and precise description of the domain elements for the purposes of communication, learning and problem solving. As an implementation, the model is able to solve problems related to the redaction and edition of Normative Acts, like reference finding, and cross-impact analysis. The ontology, in its conceptual or computational form, can be used to adequate public organs to the Federal Information Access Law, as every public organ or entity must use the Internet to publish, in detail, the formats used to structure their information.

Future work involves the expansion of the ontology to represent other aspects of Normative Acts, like temporal ones (e.g. an NA is valid from a beginning date and can have an end date). Another important future work is the creation of the computational ontology in semantic web languages, like OWL.

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