

LawV: Towards an Ontology-based Visual Modeling Language in the Legal Domain

Cristine Griffo¹, Maria das Graças da Silva Teixeira², João Paulo A. Almeida²,
Frederik Gailly³, Giancarlo Guizzardi^{1,2}

¹ Conceptual and Cognitive Modeling Research Group (CORE)
Free University of Bozen-Bolzano
Piazza Domenicani, 3, 39100, Bolzano, Italy

²NEMO Conceptual Modeling & Ontologies Research Group
Federal University of Espírito Santo (UFES)
Av. Fernando Ferrari, 514, 29075-910, Vitória, Brazil

³Faculty of Economics and Business Administration. Ghent University
Campus Tweekerken. Tweekerkenstraat 2. 9000 Ghent. Belgium

{cristine.griffo,giancarlo.guizzardi}@unibz.it, maria.teixeira@ufes.br,
jpalmeida@ieee.org, frederik.gailly@ugent.be

Abstract. *There has been an increase use of Domain-Specific Visual Modeling Language (DSVML) as a means of improving models' comprehensibility and, consequently, stakeholders' productivity. Combining the benefits of DSVMLs and of an ontological approach for designing and evaluating DSVMLs, we present, in this paper, the first-steps towards an ontology-based DSVML in the legal domain called LawV. The main purpose of LawV is to provide for a visual symbolic representation for legal statements. LawV has been built by applying an ontology-based language engineering method called PoNTO-S and UFO-L, a legal core ontology. To evaluate LawV, we instantiate a judicial case selected from the database of Appeal Court of the Espírito Santo State in Brazil.*

1. Introduction

In Conceptual Modeling, Visual Modeling Languages (VMLs) are important instruments for improving communication among stakeholders. In particular, studies reveal that the use of Domain-Specific Visual Modeling Languages (DSVML) increases productivity in Software Engineering by 5 to 10 times when compared to general-purpose languages (*e.g.* UML) [Kärnä et al. 2009]. Also, it significantly increases the quality of the generated model, the level of reuse, and the modelers' perceived ease of use [Kärnä et al. 2009].

Combining the DSVMLs benefits with an ontological approach, [Guizzardi 2013] proposed an ontology-based method to design and evaluate DSVMLs. The method focuses on the properties of *comprehensibility appropriateness* and *domain appropriateness* as quality criteria for DSVMLs. In this view, the language's real-world semantics should be clear, unambiguous, and semantically sound - in the sense that it should define a precise ontological mapping to all the language constructs. Moreover, it should be expressive enough to represent all the relevant domains concepts.

Despite the benefits of using ontology-based DSVMLs and design ontological guidance, most languages for legal domain do not hold these aspects concomitantly: These include LegalRuleML [Athan et al. 2013], Business Contract Language (BCL) [Governatori and Milosevic 2006], Formal Language for Writing Contracts (FCL) [Farmer and Hu 2017], Contract Language (CL) [Prisacariu and Schneider 2012], and Visual Law [Haapio and Passera 2013]. Research in Visual Law often propose visual notation for the no-reading contract problem, building symbols or drawings without a categorization system nor ontological guidelines [Haapio and Passera 2013]. *Nòmos* [Ingolfo et al. 2013] benefits from ontological foundations and the visual approach, but does not apply guidelines for the construction of symbols. LegalRuleML or FCL do not use either a visual-approach or explicit ontological foundations/guidelines to represent the concepts from a real-world conceptualization. As result, all these languages exemplify problems such as *construct redundancy*, *construct overload*, lack of proper interpretation (*unsoundness*), or lack of expressivity (*incompleteness*) in the sense of [Guizzardi 2013].

As a contribution to this area of visual representation of normative systems, we present here, the first design steps of an ontology-based DSVML called *Law Visual Language (LawV)*. Our approach applies the ontology-based method proposed in [Guizzardi 2013] that was expanded as a design approach in [da Silva Teixeira 2017]. This extended approach is named *PoNTO-S (Physics of Notation Ontologized and Systematized)* [da Silva Teixeira 2017]¹. PoNTO-S is a methodological framework for supporting the systematic design of visual concrete syntax of modeling languages in a way that is sensitive to the ontological aspects of the domain being represented. The design method is composed of four macro-steps: 1) Building (or reusing) a legal core ontology on which the DSVML at hand will be based; 2) Defining the DSVML’s abstract syntax; 3) Applying a set of ontological guidelines to build the DSVML’s concrete visual syntax for the DSVML’s abstract symbols; and 4) Evaluating the DSVML.

For the design of the DSVML proposed here, we reuse the legal core ontology UFO-L [Griffo 2018] as base for steps 1 and 2. UFO-L is based on a relational legal theory and grounded on Unified Foundational Ontology (UFO) [Guizzardi 2005a]. UFO-L was built specializing categories from UFO-A, UFO-B, and UFO-C. We selected UFO-L due to the fact that it has been successfully applied to a number of cases for the conceptual modeling of legal relations [Griffo et al. 2019, Griffo et al. 2018]. Also, it has the benefit of being easily harmonizable with PONTOS, given that the latter is based on UFO-A. Since UFO-L is a *Core Ontology*, the resulting DSVML proposed here and based on it is a language for representing *Domain Ontologies*². To evaluate the proposed language, we built a legal-domain ontology of *mandamus*³ based on UFO-L. We then

¹PoNTO-S means “dots” in Portuguese. The idea is that the approach helps the language engineer by “connecting the dots” from concrete visual syntax to real-world (i.e., ontological) semantics. See [da Silva Teixeira 2017], for an in depth discussion on how the design of ontology-based languages can be developed and how PoNTO-S can be applied

²See [de Almeida Falbo et al. 2013], for an in depth discussion on the relation between Core and Domain Ontologies.

³A *mandamus* or “writ of security” is a constitutional remedy prescribed in Brazilian Constitution as a type of judicial action used to protect either individual or collective rights against abuse of power or illegality of either a public authority, or the representative of a legal entity in charge of public attributions. It is a very similar instrument to the “writ of mandamus” in the common law existing in the United States of America legal system. For the the whole ontology, the reader is referred to [Griffo 2018].

conduct an instantiation of this *mandamus* ontology using LawV. The selected instance is a judicial case of *mandamus* selected from the database of Court of Appeals of Espírito Santo State. This paper is an updated and refined version of the initial ideas described in [da Silva Teixeira 2017] and [Griffo et al. 2018].

The remainder of this paper is structured as follows: Section 2 presents our baseline, briefly elaborating on UFO and UFO-L, as well as on PoNTO-S. Section 3 describes the steps in the design of LawV emphasizing method, evaluation, and results. Section 5 presents final considerations, including a discussion on future works.

2. Background

2.1. Conceptual Foundations: UFO and UFO-L

The relationship between language and a conceptualization of the real world (reality, domain) goes beyond the concept of reality representation, a concept that still inspires debate and it is a question not yet settled by scholars [Recker and Niehaves 2008]. A real world conceptualization is defined as a set of concepts and their relations towards a dimension of reality that exists in the mind of an individual or group of individuals [Guizzardi 2005b]. The explicit and formal representation of a conceptualization shared through an artifact with the use of a language is defined as an *ontology*. A domain-independent ontology that can serve as support for building ontologies in different domains is termed a *foundational ontology*. Unified Foundational Ontology (UFO) [Guizzardi 2005b] is an example of a foundational ontology.

UFO has been built on results from Formal Ontology, Cognitive Psychology, Linguistic, Philosophical Logic. It also embeds significant empirical and theoretical results from the Conceptual Modeling literature. UFO is organized in three layers: (i) UFO-A is an ontology of Endurants [Guizzardi 2005a], thus, dealing with structural aspects of reality (e.g., objects, qualities, relators, endurant types and roles); (ii) UFO-B is an ontology of Perdurants, which addresses temporal aspects of reality (e.g., events, situations, and temporal relations) [Botti Benevides et al. 2019]; (iii) UFO-C is an ontology of social aspects, grounded on UFO-A and UFO-B, which represents the social reality by means of categories such as Social Agent, Normative Description [Guizzardi et al. 2008]. Over the years, a number of core ontologies based on UFO have been developed. These include, for example, UFO-S [Nardi 2014], a reference ontology of services, and UFO-L [Griffo et al. 2018], which is a legal core ontology. For a full presentation, ontological justification, and formal characterization of UFO, the reader should refer to [Guizzardi 2005a, Guizzardi et al. 2008, Botti Benevides et al. 2019].

UFO-L [Griffo 2018], [Griffo et al. 2019], is a core ontology that has been developed based on legal theories, in particular, on Alexy's Theory of Constitutional Rights [Alexy 2009]. Here, we employed UFO-L in the building of LawV, stressing a relational perspective of the Law.

In the legal domain, semantic problems were studied by several legal theorists. The jurist W.N. Hohfeld [Hohfeld 1913, Hohfeld 1917] proposed a set of legal concepts pairs to clarify their meaning in different contexts. He observed that key legal terms such as *right* were often misunderstood due to their frequent semantic overload. For instance, in the expression "Service Users' right of choice" the term *right* means *liberty*. However,

in the expression “right of driving” it takes on the meaning of *permission*, and in the expression “right to charge taxes” it takes on the meaning of *power*.

Decades later, the jurist and legal philosopher Robert Alexy proposed an extension of Hohfeld’s theory [Hohfeld 1913] in his *Theory of Constitutional Rights* [Alexy 2009]. In his work, he clarified the meaning of every existing element from the original system, proposed new legal positions, and advocated a triadic representation for each legal position. Because of this approach, Alexy’s theory is effective to represent subjective legal relations and to explain judicial cases where there is no legal norm established *a priori*.

As an ontology with a relational perspective, UFO-L focuses on legal relations. A legal relation is defined as a bond between subjects who play roles and hold relevant positions for the Law. Each legal relation is reified by means of a *Legal Relator*, which mediates entities that stand in correlate positions (e.g., if agent A has a right to action X against agent B then B has a duty to action X towards A). This is represented by a triadic structure captured in a *Legal Relator* pattern as proposed in [Griffo et al. 2018]. In that pattern, a *Legal Relator* mediates *Legal Agents* who play *Legal Roles* and bear *Externally Dependent Legal Moments* (e.g. *right, duty, power, subject*) towards each other. For a full discussion on UFO-L, we suggest [Griffo 2018, Griffo et al. 2018, Griffo et al. 2019].

2.2. PoNTO-S: Physics of Notation Ontologized and Systematized

A seminal work for the analysis and (re)design of visual aspects of modeling languages is the *Physics of Notation (PoN)* [Moody 2009]. PoN defines a set of principles useful for analyzing and designing the quality of visual concrete syntaxes.

Although PoN has been so far applied in the development of several VMLs, its application presents some difficulties, as discussed by several authors (e.g., [van der Linden et al. 2016] and [da Silva Teixeira et al. 2016]). In particular, in [da Silva Teixeira et al. 2016], the authors claim that when a VML designer is applying PoN, they need design guidance. To solve this issue, they proposed a systematized approach for applying PoN in the design of VMLs’ concrete syntax, called *PoN-S (PoN Systematized)*. PoN-S defines a way of grouping the PoN principles, some basic design questions that should be answered by a language designer, and a structured set of design activities.

Another manner for improving the quality of VMLs is the application of ontological guidance in their design. In that spirit, [Guizzardi 2013] elaborates on the connection between some PoN principles and a number of ontological guidelines based on UFO. In [da Silva Teixeira 2017], the author extend the proposal of [Guizzardi 2013], resulting in the proposal of Physics of Notations Ontologized and Systematized (PoNTO-S), an extension of PoN-S that adds details to some PoN-S activities, by leveraging on ontological guidelines. Figure 1⁴ identifies a fragment of PoNTO-S, containing some design tasks, the desirable incomes and outcomes, the applied PoN principles and the corresponding ontological guidelines. This fragment is related to the step 3 cited in the Introduction.

The adequacy of PoNTO-S for the project undertaken here is justified in two ways. Firstly, since our intention is to propose an ontology-based DSVML, by using PoNTO-S,

⁴The process is represented through an UML activity diagram, in which guidelines symbols (ellipses) were added. These are characterized by color - orange for guidelines originated directly from PoN and pink for those created in PoNTO-S.

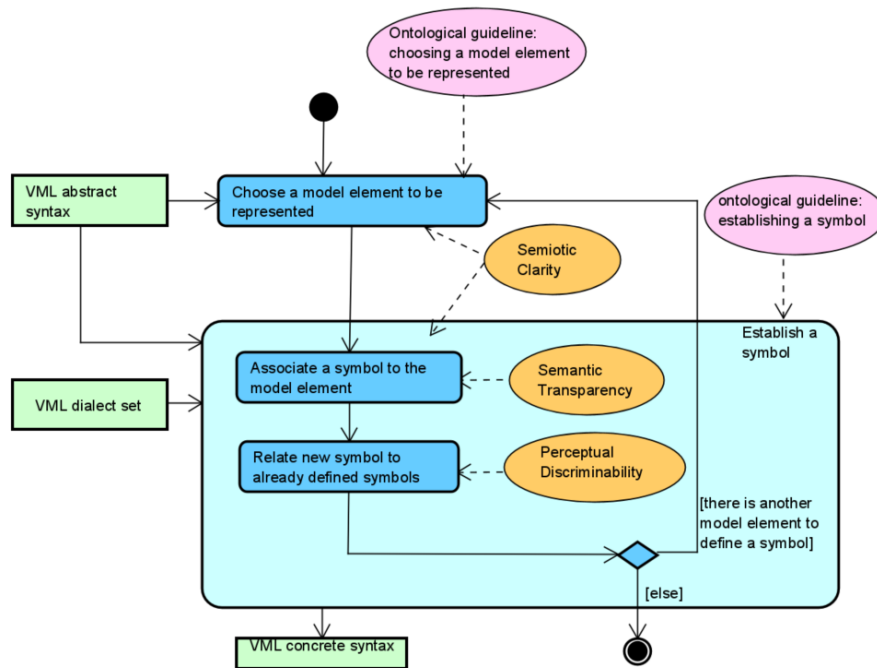


Figure 1. A fragment of PoNTO-S Approach [da Silva Teixeira 2017]

we could leverage on the aspects of the core ontology adopted, as well as on the ontological guidelines of the method to design the proposed language (considering aspects of real-world semantics, as well as abstract and concrete syntax). Secondly, as already mentioned, the fact that both the underlying core ontology and the method in this case agree on their foundational ontology facilitates the entire process.

3. LawV: An Ontology-based Visual Modeling Language for Legal Domain

In the sequel, we describe the construction of LawV following the steps of the PoNTO-S methodology as discussed in the previous section.

FIRST STEP: Build (or reuse) a legal core ontology to serve as a foundation for the DSVML.

UFO-L is a core ontology, i.e., an ontology that can be used to build domain ontologies that are strongly related, thus, forming a domain [de Almeida Falbo et al. 2013]. For example, UFO-S [Nardi et al. 2013] as a core ontology of services, can be used to build more specific ontologies of health services and telecommunication services [Falbo et al. 2016]. Since LawV is based on UFO-L, it should be regarded as a language for modeling more specific domain ontologies in the general domain of legal relations. In this context, the diagrams of LawV can be of two types representing either: (1) domain ontologies and, thus, type-level diagrams; (2) or instances of a domain ontology that should be based on UFO-L, thus, dealing with data representation, i.e., instance-level diagrams. In the current work, we concentrate on the second type. The former type of representation will be explored in a companion publication.

SECOND STEP: Build the language's abstract syntax.

Following PoNTO-S, each UFO-L's element is mapped directly onto an element

of LawV's abstract syntax. Among the main concepts adopted in UFO-L to develop LawV, we highlight: (i) *Legal Agents* play *legal roles* in a legal relation. Legal roles are specializations of *social roles* and, therefore, they are sortals, anti-rigid and relational dependent types [Guizzardi 2005a, Griffo et al. 2018]. Legal roles played by entities of different kinds are abstracted into what is termed a *Legal rolemixin*. For example, in a consumer relation model, legal agents play the legal role mixins of buyer and seller in the buying and selling relation; particular agents such as an individual person and an individual organization then play the legal roles of Personal Buyer (Personal Seller) and Corporate Buyer (Corporate Seller), respectively⁵; (ii) Legal relations are reified by *legal relators*, i.e., relational moments existentially dependent on *legal agents*. These agents then play *legal roles (mixins)* in these scope of these legal relators; (iii) A legal relator is composed of correlate *legal positions* (e.g., rights, duties, powers, subjections). Legal positions are externally dependent legal moments inhering in a *legal agent* and externally dependent on another legal agent. For example, a particular type of *legal relator* type is the *right-duty legal relator* type. "A right-duty legal relator uses the legal relation right-duty to bind right holder and duty holder. A right holder is someone who has a right to something (an action or an omission) against a duty holder. A duty holder is someone who has the duty to materialize the right of a right holder" [Griffo et al. 2015];

THIRD STEP: Build the language's concrete syntax.

Tables 1 and 2 present a subset of LawV symbols representing the corresponding subset of ontological categories in UFO-L.

In order to apply PoNTO-S (Figure 1) to develop LawV, we take here a more liberal interpretation of some of its initial guidelines. This is necessary because the proposed guidelines are only explicit about object *kinds*. However, in this and other application domains, we also need to represent kinds whose instances are not objects, such as, for example, modes [Guizzardi et al. 2018]. Mode kinds play the same role as object kinds in the sense that they also provide principles of identity, individuation, and persistence for their instances. For this reason, we apply here the ontological guidelines proposed for object kinds also for mode kind, i.e., like the former, the latter should also be represented by a shape percept in the phase of visual construct mapping. However, the fact that modes are existentially dependent entities (i.e., which necessarily inhere in some bearer), should also be made explicit in the designed visual syntax. In this case, we choose to represent the *inherence* relation as: a position variable (a visual variable), i.e., the mode at hand should be positioned near its bearer (the proximity of the symbols presupposes the connection between them); size variable, i.e., the mode should be represented in a smaller size than its bearer (in this way turning easier to identify who is the bearer and what is mode). Moreover, in the case of externally dependent modes that are part of a relator, the representation of that mode should be contained in the representation of that corresponding legal relator; the representation of that mode should be positioned relatively far (in reference to the representation of that relator) from the representation of the individual it is existentially dependent on.

According to PoNTO-S guidelines, we proposed the following mappings: the representation of *Singular Legal Agents* can be done by the person symbol plus a label;

⁵For a fuller discussion on the relation between roles and role mixins, one should refer to [Guizzardi 2005b]).

Table 1. Concrete syntax of LawV: Some Entity Types















Concept	Construct (following PoNTO-S guidelines)	Symbol
Right to an Action	Mode	
Duty to Act	Mode	
Power	Mode	
Subjection	Mode	
Bundle of legal relations	*** aggregation of relators ***	
Legal Relator	Relator	
Singular Legal Agent	Kind	 <Label>
Agentive Legal Institution	Kind	 <Label>
Legal Role	Role	
Legal Normative Description	Substantial	
Legal Norm	Substantial	
Legal Norm_Rule	Substantial	
Legal Norm_Principle	Substantial	
Legal Event	Event	

Table 2. Concrete syntax of LawV: Some Relation Types

Concept	Construct	Symbol
Correlates	Formal	-----
Has a legal relation with	Material	Indirectly represented through the representation of relator + roles + mediation relation.
Inheres_in	Characterization	Position - the mode representation should be placed close to the role represented which it is inherent.
Externally_dependent_on	Characterization	Position - the mode representation should be placed distant to the role represented which it is correlate.
Association in general	Association	-----▶ with color differentiation

Agentive Legal Institution, by a familiar neoclassic house icon plus a label; *Legal Roles* by the mask symbol in a small size, within the rectangle that represents *Legal Relator*, and in the same color of the rectangle; *Legal Relators* by the proper rectangles; *inherence* associations, by the position next to the respective; the *correlates* association, by the dotted line connecting to the representation of the corresponding *Externally Legal Moments*; and the *externally-depends-on* associations by proximity to the correlative *Legal Role* within the same *Legal Relator*.

FOURTH STEP: Evaluate the DSVML.

Here, this step is divided into sub-steps: 4.1: Build a legal domain ontology based on UFO-L; 4.2: Using LawV, instantiate the legal domain ontology built in 4.1 by using a real judicial case taken from a legal database.

In order to evaluate LawV, we built a legal domain ontology of *mandamus* (On-

toMandamus) and applied LawV to instantiate it. We also proposed a glossary with every element of OntoMandamus. In the *mandamus* represented here, the clear and perfect right (see below) that was harmed is personal and only the holder of this right has the legitimacy to file the individual *mandamus* [Pereira 2001]. The following terms are considered in the proposed ontology:

(1) *Illegal act* is any public act (action or omission) performed by a public agent in the exercise of a public function that, put under judicial analysis is declared illegal by the judge. The judge's statement that the act is illegal (i.e., it is an act violates the law) grounds the judge's decision of granting the *writ of mandamus*;

(2) *Clear and perfect right* is the right proved by unequivocal documentation (the right arising from facts that can be proven by documents that do not need subsequent evidence). For instance, the right to life is prescribed in the Brazilian Constitution and does not need to be proven. The simple invocation of the law in the petition is sufficient enough;

(3) *Aggrieved Social Subject* is the holder of the clear and perfect right. It is the subject whose right was harmed or threatened. Active subjects can be: the universalities or depersonalized entities, the private legal person, the natural person and depersonalized public bodies, if endowed with procedural capacity. It is possible that one or several aggrieved social subjects fill a *mandamus*, playing the role of *plaintiff*. For example: an act that challenged the enrollment of 100 students may be attacked by several *mandamus*, i.e., each person can file a *mandamus* to protect her/his right. Also, it is possible that all victims (or a proper part thereof) join and file a single petition.

(4) *Injurer Public Agent* is the coercive authority that performs, threatens to perform or orders the execution of an illegal act that harms the clear and perfect right of the active subject or, furthermore, orders the non-execution of a legal act. Passive subjects can be: components of the Direct Public Administration (powers of the Federation, State and Municipality) and Indirect Public Administration (municipalities, foundations, public companies and joint enterprises providers of public services and private individuals or legal entities with delegation of public authorities). An Injurer Public Agent will play the *defendant's* role in the judicial process of a *mandamus*.

The petition for a *mandamus* will be analyzed by its objective criteria (preliminary statements of the action) and its merit. In the absence of any objective criteria, the petition is not going to be received and judged by the State-Judge, i.e., the judge will not analyze whether or not there has been injury or threat to the right of the plaintiff. On the other hand, once the petition is received, the Judge will analyze the merit, the alleged injury or violation of law by act of public authority. In this case, it may: (i) partially approve or totally approve the request(s) made by the plaintiff and order the public authority to do or to abstain from doing something, in order to correct the illegal act; or (ii) the judge may reject the request if s/he considers that the act is not an illegal act.

The perspective modeled on OntoMandamus is that of the objective right that can be turned into subjective right by relations between the roles of Aggrieved Social Subject and Injurer Public Agent in the context of a *mandamus*. Figure 2⁶ shows the fragment of

⁶The corresponding UFO-L supertype of each type represented therein here can be identified on Tables 3 and 4. According to PoNTO-S not all types of the ontology should be mapped to a symbol in the DSVML's

OntoMandamus that represents the domain related to **granting of the *mandamus***, that is, the act performed by the authority is declared illegal by the judge.

When a *mandamus* to act is granted by the judge, the defendant will be in a position of duty to act before the plaintiff, who will be in a position of right to an action. This action will correct the injury to plaintiff's right. On the other hand, when a *mandamus* to an abstention is granted by the judge, the defendant will be in a position of duty not to take action in relation to the plaintiff, while the plaintiff will be in a position of having the right that the defendant shall not practice the act that can injury the right. In both cases, the illegal act is the event that will ground the legal relations built with the decision to grant the *mandamus*.

In OntoMandamus, the subjective part of a judicial process of *mandamus* is formed by Plaintiff and Defendant and both are in a position of subjection to the decision made by the judge, who holds the power to decide the judicial process, granting the *mandamus* or not.

The power to grant the *mandamus* will create a new legal relation between the Aggrieved Social Subject, who suffered the illegal act, and the Injurer Public Agent, who practiced the illegal act. In a *mandamus to act*, the former holds the legal position of right to an action while the latter holds a legal position of duty to act.

Tables 3⁷ and 4 relate each entity identified in OntoMandamus and categorizes them based on UFO-L. These tables also show the LawVs symbols used to represent instances of OntoMandamus.

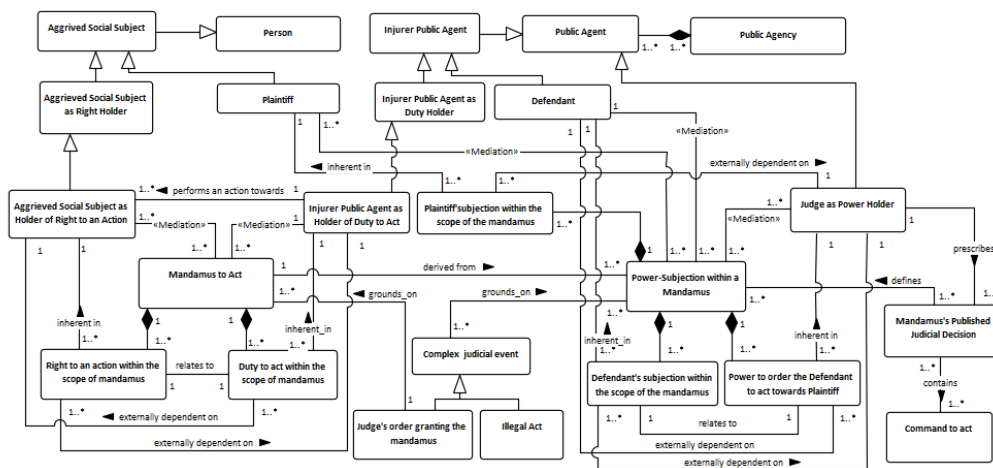


Figure 2. A fragment of OntoMandamus

Instantiation: *Dedier's case*. *Dedier*, a civil police officer, public servant in probationary stage, required a leave of absence for dealing with private affairs (LDPA), more specifically, a leave from his work so that he could attend a clerk training course at the National Academy of Federal Police. This position as a trainee at the National Academy

concrete syntax, only the concrete ones. For this reason, abstract types such as *Categories* and *RoleMixins* are indirectly represented in LawV by their corresponding concrete subtypes.

⁷The symbols that appear to be equal in these tables are differentiated upon instantiation by their different connections.

Table 3. LawV symbols used to represent OntoMandamus





















OntoMandamus Concepts	UFO-L Categories	Symbol
Mandamus to Act	Legal Relator	<Label>
Power-Subjection within a Mandamus	Legal Relator	<Label>
Person	Singular Legal Agent	 <Label>
Public Agent	Singular Legal Agent	 <Label>
Public Agency	Agentive Legal Institution	 <Label>
Aggrieved Social Subject as Holder of Right to an Action	Legal Role	
Plaintiff	Legal Role	
Injurer Public Agent as Holder of Duty to Act	Legal Role	
Defendant	Legal Role	
Judge as Power Holder	Legal Role	
Illegal Act	Legal Event	
Judge's order granting the mandamus	Legal Event	
Right to an Action within the scope of the mandamus	Right to an Action	
Duty to Act within the scope of the mandamus	Duty to Act	
Power to order the Defendant to act towards Plaintiff	Power	
Plaintiff's subjection within the scope of the mandamus	Subjection	
Defendant's subjection within the scope of the mandamus	Subjection	
Mandamus's Published Judicial Decision	Legal Normative Description	
Command to act	Legal Norm_Rule	

Table 4. LawV symbols used to represent OntoMandamus - relations

OntoMandamus Relations	UFO-L Categories	Symbol
Grounds on	Association	
Practices	Association	
Derived from	Association	
Relates to	Correlates	
Defines	Association	
Prescribes	Association	
Contains	Association	

is considered a Public Position in itself. However, the Civil Police Chief of the State of Espírito Santo (PC-ES) denied his leave request based on State law that does not allow the granting of LDPA for public servants in probationary period. Dissatisfied with this decision, Dedier filed a mandamus with a summary judgement injunction invoking the Brazilian constitutional principle of access to public positions prescribed in the Brazilian Constitution and the right to LDPA. The judge of the first instance denied summary judgement because he understood that, prima facie, the right to leave would not apply for servants on probationary period. Once more, discontent with the judge's decision, Dedier filed an appeal before the Court of Appeals of the State of Espírito Santo (TJES) (process number AG24079009809ES). The Appeal Court's judge partially overhauled the first in-

stance judge’s decision, based on constitutional principles. Figure 3 shows a fragment of Dedier’s case using LawV (OntoMandamus instantiation).

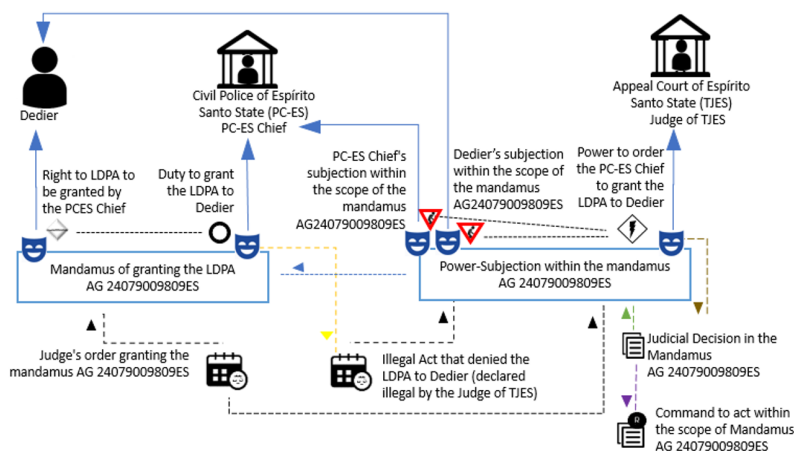


Figure 3. A fragment of the OntoMandamus instantiation in LawV

Interpreting Figure 3: The judge of TJES declared illegal the act practiced by the PC-ES Chief that denied the LDPA to Dedier. This event grounds the power-subjection legal relation. The judge’s order to grant the *mandamus* in the process n.AG 24079009809ES is an event that grounds both the legal relations of power-subjection and right-duty. In the first legal relation, the judge holds the power position to decide the case, and both the plaintiff and the defendant are in the position of subjection to that power. In the second legal relation, the PC-ES Chief holds the duty position of granting the LDPA to Dedier while Dedier holds the position of right to this action. Additionally, the decision prescribed by the judge contains a concrete legal rule (a *Legal Normative Description*) and its physical support (i.e., a means by which it is materialized, e.g., a paper document).

Results. We claim that LawV was properly constructed following the presented method. In the evaluation phase, a model was instantiated by applying LawV (Figure 3) to verify that it is able to represent a real case. We realized that it not only represents the real case, but it also solves a recurrent problem observed in the empirical study described in [Griffo 2018], [Griffo et al. 2018], namely, the excess and crossing of lines as an undifferentiated representation of multiple relationships. We claim that LawV facilitated the representation and the interpretation of the case (the reader can compare the case textual description and the graphical representation, as well as compare figures 2 and 3). The results are promising. However, for a more complete evaluation, an empirical study is necessary to verify the quality of the language, in particular, w.r.t. ease-to-use and comprehensibility issues.

4. Final Considerations

The study described here presents LawV, an ontology-based DSVML. We applied a method to develop and evaluate LawV, considering UFO-L and PoNTO-S. The evaluation of LawV was carried out by building an ontology of mandamus (OntoMandamus) and instantiating a judicial case (Dedier’s case). The purpose of LawV is: 1) to support law professionals in analyzing and identifying requirements in legal scenarios; 2) to assist magistrates in the construction of case scenarios, so they can have a better understanding

of the scenarios involved in legal cases, as well as to verify the objective and subjective requirements involved in a case; and 3) provide a tool to support the teaching Constitutional Law by means of a visual language.

Several legal domain ontologies have been proposed over the last decades. For example: Dutch Tax Ontology [Boer and van Engers 2003], International Copyright Law Ontology [Lu and Ikeda 2007], Mediation Core Ontology [Poblet et al. 2009]. All these ontologies represent sub-domains of Law: Medical law, which regulates the relations between health professionals and patients; Intellectual Property law, which regulates the relations between artifacts creators, blueprints, software, and society. Since LawV is a language for representing domain ontologies, it could in principle be used to address these sub-domains. Testing the language in different case studies in these domains is something we intend to do as part of our future work. This could be a first step in developing DSVMLs in these sub-domains. To facilitate the application of LawV in multiple situations, we also intend to develop a visual editor for this language.

We emphasize that we could not find in the literature DSVMLs based on the aforementioned ontologies. As an example of a language used for legal visual modeling, we highlight the language *Nòmos* ([Siena 2010], [Ingolfo et al. 2013], [Ingolfo et al. 2014]). This language was contrasted with a representation based on UFO-L in the experiment described in [Griffo et al. 2018].

We agree with the claim “Law can be made more comprehensible if it is made more visual” [OPEN LAW LAB]. As highlighted by [Rossi and Palmirani 2015], there is still a gap for a comprehensive framework for visual interpretation of legal texts. The research reported here is a contribution towards this goal.

References

- Alexy, R. (2009). *A Theory of Constitutional Rights*. Oxford Univ. Press, Oxford.
- Athan, T., Boley, H., Governatori, G., Palmirani, M., Paschke, A., and Wyner, A. (2013). Oasis LegalRuleML. In *Proc. 14th Int. Conf. on AI and Law*, pages 3–12.
- Boer, A. and van Engers, T. (2003). A Knowledge Engineering Approach to Comparing Legislation. In *Proc. Conf. Knowl. Manag. Gov.*
- Botti Benevides, A., Bourguet, J.-R., Guizzardi, G., Peñaloza, R., and Almeida, J. P. A. (2019). Representing a reference foundational ontology of events in sroiq. *Applied Ontology*, 14(3):293–334.
- da Silva Teixeira, M. d. G. (2017). *An ontology-based process for domain-specific visual language design*. PhD thesis, Federal University of Espirito Santo, Brazil/Ghent University, Belgium (Double Degree).
- da Silva Teixeira, M. d. G., Quirino, G. K., Gailly, F., de Almeida Falbo, R., Guizzardi, G., and Barcellos, M. P. (2016). PoN-S: a systematic approach for applying the physics of notation (PoN). In *Enterprise, Business-Process and Information Systems Modeling*, pages 432–447. Springer.
- de Almeida Falbo, R., Barcellos, M. P., Nardi, J. C., and Guizzardi, G. (2013). Organizing ontology design patterns as ontology pattern languages. In *Extended Semantic Web Conference*, pages 61–75. Springer.

- Falbo, R. A., Quirino, G. K., Nardi, J. C., Barcellos, M. P., Guizzardi, G., Guarino, N., Longo, A., and Livieri, B. (2016). An ontology pattern language for service modeling. In *Proceedings of the 31st Annual ACM Symposium on Applied Computing*, pages 321–326.
- Farmer, W. M. and Hu, Q. (2017). FCL : A Formal Language for Writing Contracts. *Inf. Reuse Integr. (IRI), IEEE 17th Int. Conf.*, (January):134–141.
- Governatori, G. and Milosevic, Z. (2006). A Formal Analysis of a Business Contract Language. *Int. J. Coop. Inf. Syst.*, 6(7):1–26.
- Griffo, C. (2018). *UFO-L: Uma Ontologia Núcleo de Aspectos Jurídicos Construída sob a Perspectiva das Relações Jurídicas*. Phd thesis, Ufes.
- Griffo, C., Almeida, J., and Guizzardi, G. (2018). Conceptual Modeling of Legal Relations. In *Int. Conf. Concept. Model.*, pages 169–183, Xi’an, China. Springer.
- Griffo, C., Almeida, J., Guizzardi, G., and Nardi, J. (2019). Service contract modeling in enterprise architecture: An ontology-based approach. *Information Systems*, <https://doi.org/10.1016/j.is.2019.101454>.
- Guizzardi, G. (2005a). Agent Roles, Qua Individuals and The Counting Problem. In *Int. Work. Softw. Eng. Large-Scale Multi-agent Syst.*, pages 143–160.
- Guizzardi, G. (2005b). *Ontological foundations for structural conceptual models*. PhD thesis, CTIT PhD thesis series, Amsterdam.
- Guizzardi, G. (2013). Ontology-based evaluation and design of visual conceptual modeling languages. In *Domain engineering*, pages 317–347. Springer.
- Guizzardi, G., Fonseca, C. M., Benevides, A. B., Almeida, J. P. A., Porello, D., and Sales, T. P. (2018). Endurant types in ontology-driven conceptual modeling: Towards ontouml 2.0. In *International Conference on Conceptual Modeling*, pages 136–150. Springer.
- Guizzardi, R. S. S., Falbo, G., and Guizzardi, R. S. S. (2008). A importancia de Ontologias de Fundamentacao para a Engenharia de Ontologias de Dominio: o caso do dominio de Processos de Software. *IEEE Lat. Am. Trans.*, 6:244–251.
- Haapio, H. and Passera, S. (2013). Visual law: What lawyers need to learn from information designers. *Legal Information Institute, VoxPopuLII Blog*, 15.
- Hohfeld, W. N. (1913). Some fundamental legal conceptions as applied in judicial reasoning. *Yale Lj*, 23:16.
- Hohfeld, W. N. (1917). Fundamental Legal Conceptions as Applied in Judicial Reasoning. *Fac. Sch. Ser.*, 23(1):710–770.
- Ingolfo, S., Siena, A., and Mylopoulos, J. (2014). Goals and Compliance in Nòmos 3. In *CAiSE 2014 Proc.*, pages 1–6.
- Ingolfo, S., Siena, A., Susi, A., Perini, A., and Mylopoulos, J. (2013). Modeling laws with Nòmos 2. *2013 6th Int. Work. Requir. Eng. Law*, pages 69–71.
- Kärnä, J., Tolvanen, J.-P., and Kelly, S. (2009). Evaluating the use of domain-specific modeling in practice. In *Proceedings of the 9th OOPSLA workshop on Domain-Specific Modeling*.

- Lu, W. and Ikeda, M. (2007). Capturing a Conceptual Model for Intercultural Collaboration in Copyright Management. *IWIC 2007, LNCS 4568*, pages 61–75.
- Moody, D. L. (2009). The "Physics" of Notations: Toward a Scientific Basis for Constructing Visual Notations in Software Engineering. *IEEE Trans. Softw. Eng.*, 35(6):756–779.
- Nardi, J. C. (2014). *A Commitment-Based Reference Ontology for Service: Harmonizing Service Perspectives*. Ph.d. thesis, Federal University of Espírito Santo, Vitória.
- Nardi, J. C., Falbo, R. A., and Almeida, J. P. A. (2013). A Panorama of the Semantic EAI Initiatives and the Adoption of Ontologies by these Initiatives. *Lect. Notes Bus. Inf. Process.*, 144 LNBIP:198–211.
- OPEN LAW LAB. Visual law. <https://aws.amazon.com/service-terms/>. accessed in: 22 jul. 2020.
- Pereira, C. M. d. S. (2001). *Instituições de Direito Civil, vol. I*. Ed. Forense, Rio de Janeiro, 19 edition.
- Poblet, M., Casellas, N., Torralba, S., and Casanovas, P. (2009). Modeling Expert Knowledge in the Mediation Domain: A Middle-out Approach to Design ODR Ontologies. In *LOAIT 2009 Proc.*, volume 465.
- Prisacariu, C. and Schneider, G. (2012). A dynamic Deontic Logic for Complex Contracts. *J. Log. Algebr. Program.*, 81(4):458–490.
- Recker, J. and Niehaves, B. (2008). Epistemological Perspectives on Ontology-based Theories for Conceptual Modeling. *Appl. Ontol.*, 3(1-2):111–130.
- Rossi, A. and Palmirani, M. (2015). From words to images through legal visualization. In *AI Approaches to the Complexity of Legal Systems*, pages 72–85. Springer.
- Siena, A. (2010). *Engineering Law-Compliant Requirements The Nòmos Framework*. PhD thesis, DISI-University of Trento.
- van der Linden, D., Zamansky, A., and Hadar, I. (2016). How cognitively effective is a visual notation? on the inherent difficulty of operationalizing the physics of notations. In *Enterprise, Business-Process and Information Systems Modeling*, pages 448–462. Springer.