SismaDL: an ontology to represent post-disaster regulation *

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Abstract. The emergency caused by a natural disaster must be tackled promptly by public institutions. In this situation, Governments enact specific laws (i.e., decrees) to handle the emergency and the reconstruction of destroyed areas. As it happened in 2009 and 2016 when the Italian Government issued several, very different, decrees to face respectively the earthquakes of *L'Aquila* and *Centro Italia*.
In this work, we propose SismaDL, a LKIF based ontology, that models the laws in the domain of natural disasters. SismaDL has been used to model the aforementioned laws to build a knowledge base useful to reason about why one regulation is less effective and efficient than the other. SismaDL is the first step of a wider project whose aims are: i) compare laws in the domain of natural disaster; ii) integrate such laws in the Semantic Web; iii) evaluate the effectiveness of a post-disaster reconstruction law; iv) identify good practices to build a reference normative model of the natural disaster regulation. This project is a founding step towards the development of accurate and timely IT systems for efficient and high quality disaster management and reconstruction services to support Governments and local institutions in case of natural disasters.

Keywords: Ontology · Regulation and law · Reasoning · Analysis of laws · Semantic Web · LKIF

1 Introduction

Natural disasters have a big impact on human beings. The arisen emergency must be tackled promptly by local and national institutions. Even if the emergency management has been already planned, at both operative and normative levels, governments must promptly provide the details needed to manage the specificity of the event.

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One of the tools used by Governments could be to enact specific laws to handle the emergency and the reconstruction of involved places, as in the Italian Government case, which manages post-disaster and reconstruction by issuing a series of normative acts, namely law-decrees (*"decreti-legge"* in Italian). It is worth noting that the Italian Government can be, " reasons of necessity and urgency", exceptionally authorized to exercise the legislative power through the executive one. As it happened in 2009 and 2016 when the Italian Government issued several decrees to face respectively the earthquakes of *L'Aquila* and *Centro Italia* ([1], and [2] are respectively the principal ones). Those decrees aim to regulate: *i) repair interventions; ii) reconstruction; iii) assistance to the population; iv) economic recovery.*

If we consider the socio-economic context and the natural disaster type, the two events are comparable. But analyzing the related reports[3] and data[4], it is possible to notice that the reconstruction related to the 2016 event proceeds at a speed different than the one of 2009. As an example, the percentage of private buildings reconstructed after 42 months from the event (2009 and 2016) are 25% and 3%, respectively[3].

Another unexpected difference, as noticed by Caroccia (co-author and law professor), was that the two main decrees differ deeply in their structure and content: the number of articles present is very different and the 2016's decree details the functions that each authority must perform.

Even if the reconstruction speed difference can be precisely analyzed quantitatively, it is needed to carry out a semantic analysis to understand the hidden causes.

The depicted scenario poses the basis to investigate which is the impact of a law on the effectiveness of its actuation. Furthermore, we recognized a lack of knowledge and good practice in the specific domain of the legal aspects of natural disasters. Considering the highlighted necessities, we drafted a long term project which wants to provide support for the following activities: *i)* to compare laws in the natural disaster domain; *ii)* to integrate the domain of natural disaster-related laws in the Semantic Web; *iii)* to evaluate the effectiveness of a post-disaster reconstruction law; *iv)* to identify good practices to produce effective reconstructions' laws; *v)* to build a normative conceptual model for natural disaster emergencies.

This long term project will provide governments and local institutions of accurate and timely information supply for efficient and high quality disaster management and reconstruction processes and services that are customized on the specific context represented by the damaged area together with its social, economical and environmental infrastructure. Moreover, using technology to map and understand disaster-related laws can be useful to help law-scholars to understand inferences, to identify conflicting statutes and to infer hidden causes of such conflicts.

[3] The percentages are obtained by considering the number of reconstructed buildings on the total number of buildings, normalized to involved area.

As a grounded step, in this paper, we present an ontology (namely SismaDL) based on LKIF [8], a dedicated legal ontology. We extend LKIF to model the semantic content of the decrees. To define SismaDL ontology, we employed a top-down approach where we specialized the emergency concepts, specific of the considered domain, on the LKIF abstract ones.

We chose to adopt the ontology formalism since it offers: *i)* to structure the laws providing a clear representation of them to promote the dissemination of knowledge according to the basis of the semantic web; *ii)* to capture and highlight the differences of existing decree-laws, by using queries and inference tools.

The ontology can be used to map and clarify disaster-related laws. The ontological representation of a decree should be done with the support of legal experts and should be published with the decree itself.

The paper proceeds as follows: in Section 2 we report the related work, Section 3 provides details about the SismaDL ontology. Section 4 describes the analysis that has been made on the modeled decrees. Finally, in Section 5, we discuss final remarks and future works.

2 Related Work

The related work is organised into three sections which discuss the following aspects: *i)* Legal Foundation Ontology, Classification and comparison; *ii)* Domain-Specific Regulation; *iii)* Ontology Specification Process.

Legal Foundation Ontology, Classification and Comparison. In [8], a legal domain ontology, namely LKIF, is presented. LKIF characterizes the elements of the legal domain in a very detailed way. Figure 1 describes the modules and the relations defined in LKIF to model legal concepts. *Top* and *Mereology* modules describe fundamentals elements like `Abstract` and `Physical Entities`, `Atom`, `Part`, `Whole` etc. *Time* and *Place* modules extend the previous ones defining space (`Place`) and time concepts like `Temporal Occurrence`. *Process*, *Role* and *Action* modules are useful to describe dynamic processes, like causal changes, introducing the concepts of `Change`, `Organization`, `Person`, `Process` and so on. *Legal Role* extends the *Role* module introducing more specific legal roles and finally the *Expression* and *Norm* modules introduce concepts useful to describe the mental process of an actor while doing an action, and to describe legal sources, respectively. In this paper we extended LKIF to define SismaDL ontology. Since our domain is particular, we decided to include only a few classes from the last two modules as the others may result misleading in our context. For example, the *Expression* module starts from the definition of the `Proposition` and `Propositional Attitude` concepts, useful to describe the purpose of an action performed by an agent. Since in our contest the purpose of the actions (described by the measures in the decrees) is always to deal with the emergency, in SismaDL we decided to not include `Proposition` and `Propositional Attitude` concepts.

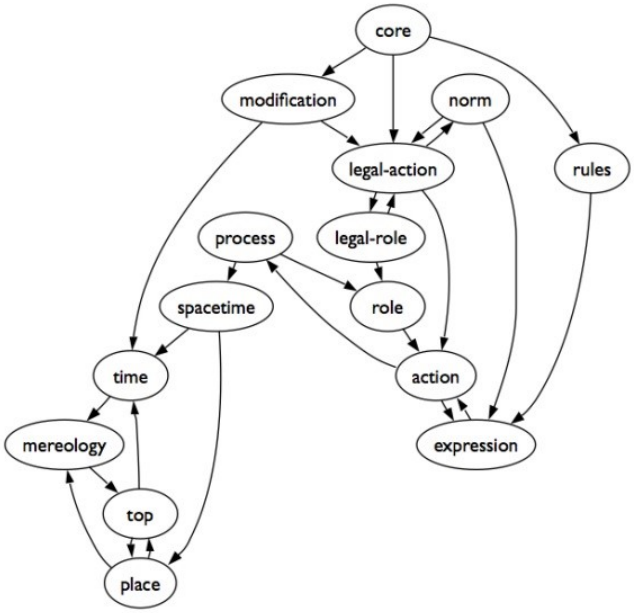


Fig. 1: LKIF modules relations

The work presented in [12] and [13] deal with the *comparison and classification of ontologies in the legal domain*. [12] provides an overview of the legal domain ontologies by making a distinction between *i)* semantically oriented approaches that focus on the semantic interpretation of a representation of elements, *ii)* epistemically oriented approaches that focus on knowledge in a domain, and *iii)* ontologically oriented approaches that emphasize the entities and relationships constituting a domain. [12] presents many examples of ontologies that, as our one, are based on a top-down approach starting from very abstract concepts and trying to apply them on concrete domains. It also discusses ontology's applications to several domains helping us to determine the purpose of SismaDL ontology. [13] analyzes legal ontologies by conceptualising the basic characterizing elements. It illustrates an analysis and comparison between conceptualizations useful to represent the legal domain (such as McCarty's language [11], and Van Kralingen's ontology [10]). Moreover, it implicitly exposes critical issues related to the representation of the concepts expressed in natural language.

Domain Specific Regulation. In literature, there exist ontologies dealing with Privacy and Protection Regulation and Emergency Management Regulation. For what concern *Privacy and Protection Regulation*, [5,7] deal with the GDPR issue and the approach to this problem through IT ontologies. [5] presents IPROnto, an ontology for GDPR, using the Semantic Web approach. The discussion illustrates the structure of ontology by going into the details of the description of

some key elements and describing some scenarios. It also discusses a correlation between ontology and its applications. [7] presents the ontology for the processing of personal data and privacy. It aims to support organizations in solving personal data processing and privacy, providing a knowledge base on ontology-based data protection. It highlights the interdependence between GDPR and information security. Then it illustrates a methodology, similar to that applied for SismaDL, which starts from the study of the legal field, then proceeds to study the issued regulation, identifying the requirements and representing the main concepts. For what concern the *Emergency Management Regulation*, two relevant papers [6,9] are discussed. In [6], preliminary work is done to create an ontology for emergency management. This paper assumes that the realization of an ontology for emergencies includes the representation of any information useful for representing an emergency, and should be based on an information ontology capable of acquiring different types of data from different types of sources. It also highlights the problems related to the cataloguing and representation of reality within the ontology showing the example of the words used in emergency cases and illustrating the ambiguity of natural language for this type of representation. It puts the base of any ontology concerning emergencies the need for a shared basic vocabulary. Finally, [9] offers an overview of the construction of an ontology for emergencies and uses the AFM methodology for the construction of an ontology for avian influenza. The AFM methodology presented is described through these 5 steps: *1.* Select one emergency document and divide them into knowledge pieces; *2.* Verify relevant main topics of the knowledge pieces; *3.* Extract relevant concepts from the knowledge pieces; *4.* Extract relations among these concepts; *5.* Extract restrictions from these relations. The scope of [9] is to provide support to decision-makers in case of emergencies occur.

Ontology Specification Methodology. One of the works that have most inspired this work is reported in [14] where the Superior Court case of Popov v. Hayashi is modelled. The aforementioned work provides a cue on a possible representation's methodology. It highlights the motivations and choices that led to creating an ontology focused on a representation useful for the fruition and dissemination of information. The parallelism between that research and SismaDL concerns in addition to the choice in the use of the Protégé software to have a support tool in the implementation of ontology.

3 SismaDL Ontology

This section reports on the SismaDL Ontology specification. We recall that the main elements that must be defined into an ontology are:

- *Concepts:* provide general information about the objects of the domain described by the ontology. They are identified as sets of individuals and are modelled by Classes which are the key elements characterizing the domain.
- *Individuals:* are the smallest units of information that describe specific objects of the real world. They are instances of the classes.

– *Properties:* express links between individuals. They specify whether an individual belongs to a class or connects an individual to a type of information.

Starting from the regulatory context definition (Section 3.1), we move to illustrate the ontology conceptual model (in terms of classes and properties) (Section 3.2) and finally to show some individuals (Section 3.3). In defining SismaDL ontology, we used a top-down approach, starting from abstract concepts and applying them to the emergency concrete domain. Moreover, We integrate LKIF ontology [8] in SismaDL.

3.1 Regulatory Context Definition

The first step to build a legal ontology is the definition of the regulatory context in which the research shall be carried out.

The Italian regulation has a hierarchical structure of laws. This means that different legal bases may be situated at a different hierarchical level. This hierarchical background allowing to derive one law from the others. Creating an ordered chain of priority which allows determining which rules must prevail according to the *lex superior derogat inferiori* (also referred to as kelsenian model). Considering the strict hierarchy allows solving conflicts and deciding which law is the most appropriate one to apply among several. Considering such a model, the Italian Constitution expressly establishes that *"in extraordinary situations of necessity and emergency"* the government could adopt under its own responsibility *"provisional measures having the force of law"*, named Decreti-Legge (law-decrees, art. 77 It. Const.). The law-decrees are normative acts having the force of law but issued by the executive power. The earthquake (or natural disaster) typically allows the governments to enact law-decrees. Thus, in 2009 and 2016, the Italian Government approved law decrees (earthquake of L'Aquila, DL 28/04/2009, n. 39; the earthquake of *Centro Italia*, DL 17/10/2016, n. 189) containing urgent provisions and interventions in favour of the areas affected by seismic events. These normative acts were converted with (minimal) changes into law (respectively, L. 24/06/2009, n. 77 and L. 15/12/2016, n. 229). Thus, within the hierarchy of Italian legal sources, law-decrees are situated at the same level as laws, after the Constitution and before secondary sources (regulations etc.).

SismaDL ontology conceptual model embeds the regulatory context and the hierarchy of the Italian legal sources.

3.2 SismaDL Conceptual Model

Figure 2 reports the ontology's logical schema, where ovals represent classes and arrows represent properties. An exception is made by the arrows labelled with the prefix *rdfs* which indicates sub-classes. The blue colour depicts entities and relations of LKIF (such as `Agent` class that `play` a `Role` class), while in yellow are drafted the new proposed classes and relationships (such as, `Measure` class is `described in` `DecreeLaw` class). Many of the entities in our ontology are defined

by LKIF [8]. SismaDL extends those entities to fit better the domain of interest (examples are `Task` and `Measure` that specialize `Action`). Figure 3 highlights this concept by showing the most important SismaDL entities' hierarchy, also in relation to LKIF. As before, the blue rectangles represent LKIF classes, while yellow rectangles depict SismaDL classes. The leaves are the entities used in the final ontology. As seen from the picture, all of our custom entities derive from one or more LKIF classes.

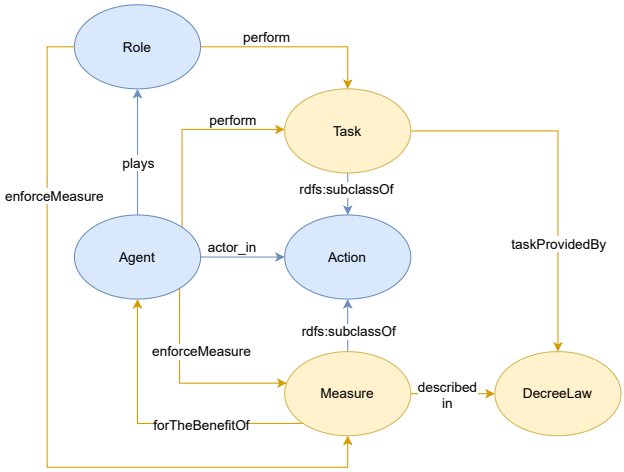


Fig. 2: SismaDL logical schema.

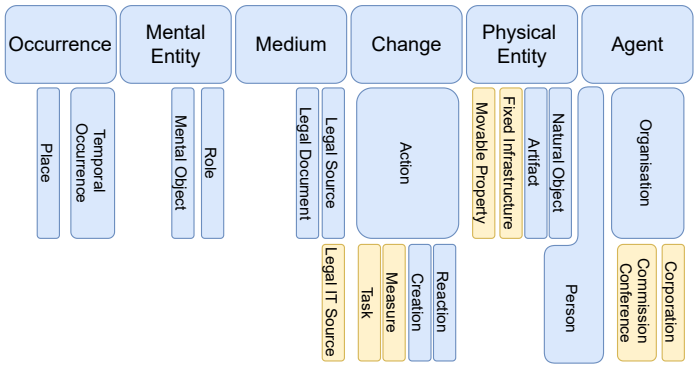


Fig. 3: Entity hierarchy

One of the central classes in SismaDL is the `Agent` class, which is defined as the set of individuals that can play a `Role` and have an `actor_in` relation

with the Action class, meaning that they are part of an action, both in performing or receiving it. Figure 4a shows the hierarchy of the Agent class: first of all, we have decided to keep as in LKIF the distinction between Person and Organization. An Organization is defined as an individual that has at least a member which is in relation with an instance of Person. We introduced two classes under Organization to better modelling the considered domain: Corporation and, its subclass CommissionConference. The first contains all the agents identified from the decrees as companies, foundations, associations, committees and organizations. CommissionConference, instead, contains the individuals representing committees appointed by the decrees to carry out actions as part of the measures issued to deal with the emergency (e.g. Special Offices). Agents take part to actions, as specified by actor_in relationship in Figure 2. Figure 4b shows the specialization of the Action entity. An Action - defined as a sub-class of the Process class which is in turn a sub-class of the Change class - is modelled as a change brought about by a single agent playing a specific role. Different kinds of actions are specified: Reaction and Creation are native of LKIF while Task and Measure are classes introduced to model the specific domain. A Task is defined as an action provided by a decree-law and performed by an agent which plays a particular role. Instead, a Measure is an action directly described in a decree-law and enforced by an agent. The semantic difference between Measure and Task is that while a measure is a particular action, which can be classified as *Administrative*, *Economic*, *Infrastructural* or *Social*, directly described in the decree, a task is a duty given to an agent by a decree in function of his role. To emphasize this difference, we have introduced two object properties enforceMeasure and perform which respectively relates an agent or a role to a measure and a task. To clarify better this distinction, the individual *ConcessioneGratuitaDiGaranzieSuFinanziamentiBancari* (in English: Free Granting Of Guarantees On Bank Loans) is an example of a SocialMeasure i.e. a specific action described in the *Art10Comma1L'Aquila* (Article 10 paragraph 1 L'Aquila) and effected by the *MinisteroDelloSviluppoEconomico* (Ministry of Economic Development) for the benefit of small and medium-sized enterprises. Instead, *AssegnazioneAlloggi* (Housing Assignment) is an example of a Task i.e. a duty assigned by *Art43Comma2Amatrice* (Article 43 Paragraph 2 Amatrice) to people with the role of Major. Figure 4c shows the hierarchy of the Role entity. A Role is defined as a specification of default behaviour and accompanying expectations of the thing 'playing' the role. Inside this class and his sub-classes, we included some individuals defined as *Passive Subjects* or *Active Subjects* in the decrees. It is worth noting that a Function is defined as a particular kind of Role, meaning the purpose of some object as used in some context. As stated in section 3.1, a central point in building a legal ontology is the definition of the regulatory context. Figure 4d shows the hierarchy of Italian legal sources. This class has been modeled as a child of the Medium class, which contains all the individuals that are bearer of expressions. Legal_Sources_IT is specified by five subclasses: CommunityLaw, Constitution, Statute BookLaw, Regulations and OtherMeasure, all disjoint between each other. Within the

StatuteBookLaw there are `DecreeLaw`, `DecreeSection` (articles, defined as child of `DecreeSection`), `RegionalLaw` and `StateLaw` sub-classes. This representation fully reflects the law theory on the sources hierarchy. Sometimes in a `DecreeSection`, the issuance of an `OtherMeasure` is regulated. `OtherMeasure` is a `LegalSource` having the property `articleProvidesOther Measure`. Finally figure 4e describes the structure of physical entities and in particular of physical objects. Among the physical objects we distinguish `Artifacts`, which are objects created as a consequence of an action and have a specific `Function` (i.e. `Role`) and `Person` as a sub-class of `Natural_Object`. `FixedInfrastructure` and `MovableProperty` are instead two classed that we introduced to better characterize objects mentioned in the decrees.

3.3 SismaDL individuals

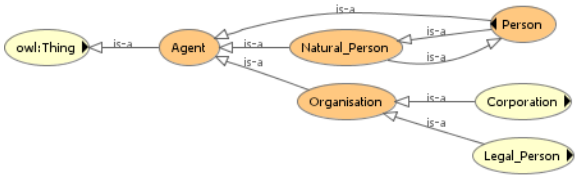
We use SismaDL to model the two considered decrees-laws and then we insert the individuals of ontology.

As an example of individual insertion, we describe the individual *progettazioneERealizzazioneModuliAbitativiEOpereUrbanizzazione* (in English: Design And Construction Of Housing Modules And Urbanisation Works). This individual is considered as belonging to the InfrastructuralMeasure class. It is described by *Art2Comma1LAquila* (Article 1 paragraph 2 L'Aquila), which shows in the description of the full text of the related paragraph of the decree-law. It has a relationship with individuals belonging to the FixedInfrastructure class *moduliAbitativi* (in English: housing modules) and with individuals belonging to the Plan (a sub-class of Mental Entity) class *OpereDiUrbanizzazione* (in English: Urbanization works). It is effected by some actors having a specific Legal Role, and therefore, it has a relationship with this class, particularly with *CommissarioDelegato* (in English: Delegate Commissioner). Furthermore, it is connected with the class of the Person Role since the measure has as beneficiaries the Individuals *PersoneFisicheResidenti* (in English: Resident Physical Persons) and *DimorantiInAbitazioniInagibili* (in English: people in uninhabitable dwellings). In the future, we will expand the SismaDL ontology and its individuals by considering other decrees or other legal sources referred from the text of the decrees.

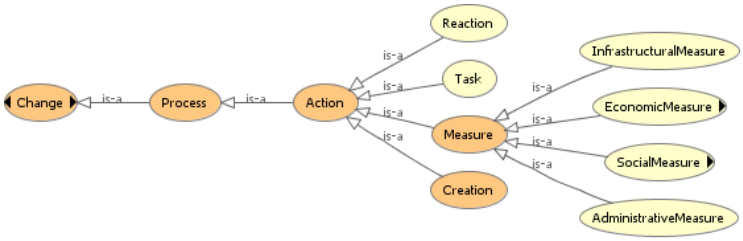
3.4 SismaDL implementation

SismaDL has been encoded with the OWL Web Ontology Language (OWL) through the Protégé tool[4]. OWL is a markup language used to represent knowledge like ontologies and essentially is a declaration of *1)* entities, object properties, individuals and annotations; *2)* axioms describing sub-classes, equivalent classes, equivalent object properties and sub-object properties; *3)* class assertions relating a class to an individual; *4)* object property assertions relating an object property to one or more individuals; *5)* object properties characteristics such as specific properties, domain, range and so on.

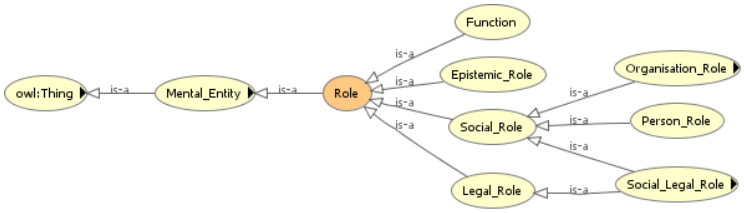
[4] https://protege.stanford.edu/



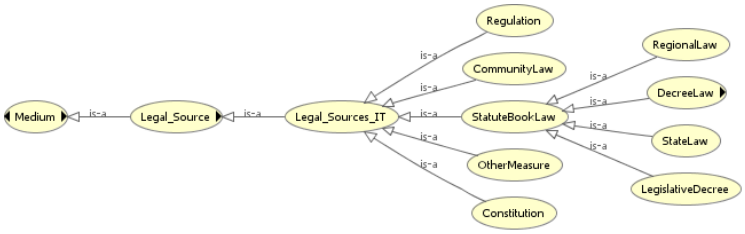
(a) Hierarchy of agents



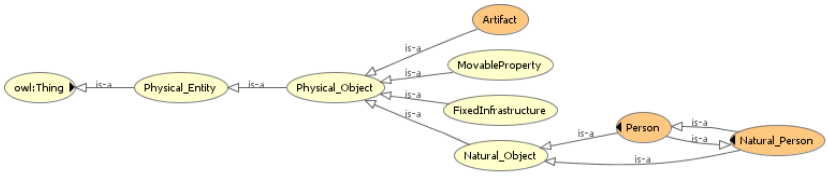
(b) Action hierarchy



(c) Role hierarchy



(d) Hierarchy of legal sources



(e) Hierarchy of physical entities

Fig. 4: Hierarchies of entities. Orange circles represent *definite* classes while yellow circles are *primitive* classes.

The SismaDL OWL's version can be downloaded at the following link: https://doi.org/10.6084/m9.figshare.13853468.v2

4 Analysis and experimental results

The decree-laws articles included in the ontology have been subject to a preliminary analysis to formalize the differences expressed in the two regulations. The variations detected concern the regulatory model, the social measures, and the financing mechanism. To verify the SismaDL expressiveness with respect to our preliminary analysis, we query the ontology using *SPARQL* query language[5]. In the following we report on the queries we implement that highlight the most interesting differences among the two considered decrees: the type of measures issued, the subject of the functions assigned to the active subjects, and the financing mechanism adopted to deal with the financial costs arising from the reconstruction. For the sake of space, we omit the full results of the queries and show only the query that extracts social measure for L'Aquila decree-law, since all the other queries follow the same structure.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX SismaDL: <http://www.semanticweb.org/damiano/ontologies/2020/0/SismaDL#>

SELECT   ?Measure ?DecreeSection  ?TypeofMeasure WHERE {

 ?TypeofMeasure rdfs:subClassOf SismaDL:SocialMeasure .
 ?Measure rdf:type ?TypeofMeasure .
 ?Measure SismaDL:measureDescribedInTheArticle ?DecreeSection .
 ?DecreeSection SismaDL:isContainedIn SismaDL:DL27-06-2009 .
}
```

Fig. 5: Query to extract `SocialMeasure`.

The first analysis concerns the used modalities to reconstruct the social fabric and aims to compare all the social measures described in the two considered decrees. To this purpose, we defined two queries, one for the 2009 decree-law and the other for the 2016 decree-law. Figure 5 shows the query specification that allows extracting `SocialMeasures` for L'Aquila. The first three lines, characterized by *PREFIX*, contain abbreviations useful to avoid reporting the entire URIs to refer to elements present in RDF and RDFS concerning the structure of the ontology, and to elements defined within SismaDL. The second part of the query refers to the selection. The *SELECT* keyword indicates the elements resulting from the query. In this case, there are three variables: `?Measure ?DecreeSection ?TypeofMeasure` which respectively represent the measure, the item (decree section) describing the measure and the type of the measure. In this way, we can extract measures for social purposes and the classification regarding the direct or indirect government intervention. The third

[5] https://www.w3.org/TR/rdf-sparql-query/

part, indicated by the keyword *WHERE*, is used to express the Query Pattern that creates a subgraph of the ontology and assigns a meaning to the variables object of the selection, that is SocialMeasures (both direct and indirect ones) for the Aquila decree (SismaDL:DL27-06-2009) . The results of the social measures queries (i.e., the ones for earthquake 2009 and 2016) are organized in columns according to the *SELECT* section. As it is observed during the analysis phase, one of the important differences between the decrees concerns the direct or non-direct involvement of the State in interventions in favor of the population: as we have seen from the results of the queries, in the case of the earthquake in L'Aquila, no direct social measures have been defined. This means that the intervention of the State to promote the welfare of the affected population, the workers, and in general the resumption of social activity was always exercised through other types of intervention such as, for example, the granting of funds. Instead, for what concerns the management of the *Centro Italia* emergency, the social impact has been taken much more into account and regulated through direct and indirect measures and articles entirely dedicated to this purpose. Another difference that has been observed is that in the *Centro Italia* decree, there are definitions of functions whose purpose is still largely addressed to the social sphere, while they are completely missing in the *L'Aquila* decree. As an example, there are functions for public and cultural works (namely *InterventiAlleOperePubblicheEBeniCulturali*) or to assign temporary accommodations (*AssegnazioneAlloggi*). The functions play an important role in the definition of the rehabilitation strategy of the post-earthquake emergency, therefore the absence of functions in the decree for L'Aquila offers us further information about the overall plan of interventions: both decrees provide for flooding interventions, but then, for the understanding of the management model, it would be necessary to represent in the ontology every normative act that appeared in the decrees. It is possible, however, to infer, in the measure for *Centro Italia*, greater clarity of the general design implemented and described through measures and functions represented in the ontology. As a last analysis, we have studied the economic measures grouped by Law decrees. The query results highlight differences in the financing mechanism of the funds allocated. While bank credit institutions and *Fintecna S.p.a.* appear in the measures for L'Aquila, they are not for the one for *Centro Italia*, where all the charges are owned by the State. The mechanism designed for L'Aquila afforded for loans from banks and credit institutions to guarantee immediate liquidity, but they needed to be guaranteed in turn by the *Cassa Depositi e Prestiti*, hence, the State. In this way, it was possible to find the funds needed to finance the interventions, and *Fintecna S.p.a.* was also involved to support the loan procedures and the identification of the beneficiaries of the loans. The financing mechanism for *Centro Italia* was concerned only with the intervention of the state and the establishment of donations to the solidarity number 45500. Table 1 summarizes the differences between L'Aquila and *Centro Italia* decrees, founded running the SPARQL queries on SismaDL ontology.

Finally, comparing our ontology to the related works described in section 2, we can position SismaDL among the second and the third category defined by

	17/10/2016 n.189 Amatrice	27/06/2009 n.77 L'Aquila
Legal Model	Defined, Legal Function	Flood Model
Social Measure	Direct and Indirect	Only Indirect
Financing Mechanism	Ordinary means	FINTECNA

Table 1: Differences in the decrees resulting from the analysis.

[12]. Differently from [12,13], our work does not discuss ontology classification or comparison criteria, but instead focuses on aspects relevant to the specific domain and identify key elements like the ontologies presented in [5,7]. In particular, a parallelism can be found with [6,9], since, as for SismaDL, the cited approaches starts from the regulations issued to deal with emergencies, as *"...According to the experiences in practice, we found that most of such knowledge and information is written in emergency documentation dispersedly."* (quoted by [9]).

5 Conclusion and Future Work

This paper presented SismaDL, a novel ontology that allows representing decrees issued for an emergency caused by natural disasters. To this aim, we analyzed two law decrees which face the post-disaster reconstruction of earthquakes. SismaDL has been crafted with a top-down methodology, integrating the abstract legal concepts of LKIF with a set of more concrete ones. Those specific concepts were identified through the study of real decrees. We modeled the two decrees using SismaDL in a way that they can be available for future semantic analysis. As future work, we plan to analyze further the modeled decrees using reasoning tools other than SPARQL.

The ontology aim is to provide reasoning support to legal questions. In the future, we plan to create an answering tool that determines entailment between different legal laws. The proposed system does not address the range of NLP challenging issues as polysemy, legal named entity recognition, and implicit information in the legal text. Nevertheless, the ontology could be a handy tool for jurists. The research outcome was primarily focused on giving legal interpreters and lawmakers an instrument to help them understand better the conditions that make a law more effective.

Until now we did not fully address a range of issues as the legal automated reasoning and the linking, and the representation to the referenced legal texts. We plan to address them in future development.

SismaDL ontology, currently, allows reasoning on qualitative aspects, i.e. reasoning on the normative differences of two or more decrees. In the future, we will include the modeling of quantitative aspects to reason on the efficiency and effectiveness of the decrees in the ontology. The ontology will be populated with other decrees to favor comparisons between several instances. Moreover, we will insert the data related to the normative texts referred to within the decrees studied to reach a higher detail level.

Through the extension of SismaDL, we aim to identify a functional scheme for legal regulation and specify guidelines for an efficient regulation for emergencies.

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