Checking Compliance in European Tender Documents through Ontologies and Rules

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Abstract. In this paper we present an overview of the PhD thesis, which aims to show the feasibility of a legal knowledge modeling based on the definitions included into legal texts using Semantic Web techniques in order to check compliance of tender documents to EU Directives. We show a hybrid approach, i.e. a theory and a system that combine the use of Akoma-Ntoso standard to describe legal texts, OWL 2.0 for modeling legal concepts and the emerging LegalRuleML standard for providing a rule-based extension of legal knowledge representation on the top of ontologies.

1 Introduction

The world of public procurements is a field of great significance for many reasons. It is one of the main economic activities of Governments, since through procurements are acquired services and goods for functioning of the *res publica* and for meeting needs of citizens' communities. This activity represents also a significant business opportunity for economic operators because public procurement in the EU accounts for 17% of EU GDP. In this scenario, the regular conduct of tendering processes plays a key role, in terms of transparency and fairness in bidding competitions, reduction of litigation-related costs, but also corruption fighting strategies.
A tender situation can be considered as a complex case, in which agents, documents and processes play an interactive role. Norms on public procurements contracts regulate either the content of documents and the conduct of processes. Through the representation of knowledge contained in normative texts it is possible to define the abstract, lawfully type of those documents or processes. Each single document or applied procedure is an instance of the abstract type defined by normative provisions.
With respect to documents involved in processes related to European public procurements, both the abstract type and the actual token can be represented with languages of Semantic Web, in order to describe all the layers perspective of this kind of texts: structure (as organization of the texts), metadata (as any information that was not approved by the authority in the document), ontology (as any legal concept called from text that need a modeling), and finally legal knowledge representation (as modeling of rules). Through this articulate definition of legal knowledge, as showed in [16], it is possible to bridge the gap between legal text description of procurement documents and legal knowledge representation that on these same texts start.

This structured knowledge base can be exploited by a system that, making use of an inference engine, may enable automated reasoning useful to check compliance of tender documents and processes involved (ABox) with legal concepts and rules, as norm expressions (TBox).
We define *compliance* the conformity of a legal document and/or of a relevant behavior with the normative prescriptions regulating them. The difference between the prescription stated in legal texts and its actual application is a *compliance failure*. Through *compliance check* is possible to detect this failure.
The ultimate goal of the research is to produce a set of pilot cases in order to show the feasibility of such kind of system that would facilitate the monitoring by the administrations on the regular conduct of procedures for the award of public contracts.

2 Background and approaches

XML-based standards are widely adopted by Governments of several countries for structuring legal documents. Some Legal XML standard (such as Akoma-Ntoso standard [22]) envisages the connection of structured legal texts with ontologies. Upon this connection, ontologies can be intended as a common vocabulary for shared understanding of terms and a powerful tool to express the legal concepts in a formal and unambiguous way. In that way it is possible to have a link between legal language or terms and legal concept-based representation, as defined by the same text.
We distinguish between two types of legal knowledge, which can be represented through languages of Semantic Web [1]. The first is static knowledge, namely any concept that is used in legal domain as mean of classification of facts (or ontological instances), by applying certain rules. We think that the role of ontologies is to model all static and definitional aspects of these rules-contained knowledge components. Indeed, legal systems are built upon concepts, whose semantics is defined by the same text in which they are invoked and through which are enabled inferences, broadly coincident with teleological purposes of norms. These kinds of knowledge components are also called “intermediate legal concepts” [20], since through them are represented preconditions and legal consequences, in the same way of rules, or as “inferential links” [18].
The second type of legal knowledge is the dynamic one. The ontological level is used to classify instances (facts) into ontological classes (abstract types). Such classified facts are then subject to certain provisions. This is the point where ontologies and rules meet. Indeed, even if in many cases rules applied to classified instances may be represented through first order logic (necessary condition), in many others cases monotonic reasoning based on Open World Assumptions (OWA) is not suitable for reasoning with knowledge-base inconsistencies or conflicts among rules. In legal domain, accordingly to a set of information an argument can be considered true, but if the set under consideration is enriched, maybe the truth of the argument has to be revised. This type of situation is well known as defeasibility and typically is required non-monotonic logic with Closed World Assumptions (CWA) to represent it. So, our hypothesis is based on the assumption that it is possible to recognize rules that define

ontologically legal concepts (in terms of proof-of-concepts) and rules that are applied to legal concepts.

Over the last decades, many rules interchange languages has been produced. The most relevant are undoubtedly RuleML [3], SVBR [15], SWRL [13], RIF [14] and LKIF [6, 7]. As noted in [10], these languages are not suited to represent rules of legal domain. Both SWRL and RIF are not able to meet the requirements of legal knowledge representation, such as the isomorphism and the defeasibility, which can not be represented with a series of chained implications in first-order logic. It's also necessary to emphasize that the same type of rules can be implemented in ontologies through the additional features (Property Chain Inclusion) of OWL 2.0. Also SVBR suffer the same kind of limitation. Instead, LKIF, although designed specifically for modeling legal knowledge, is based on the ISO Common Logic standard that does not look as a candidate standard to be widely adopted within the World Wide Web community. RuleML has been designed to become the markup language for the Semantic Web Rules: it is based on XML, is suitable to integrate inferences from Web ontologies, is extensible since it is built with a modularity approach. However, it lacks of extensions required by the legal knowledge. Thus, the extension of RuleML with key features of rules extracted from legal knowledge is now the goal of LegalRuleML [17] emerging standard. This last language, indeed, allows to meet the requirements of isomorphism (i.e. the one-to-one correspondence between the atomic rule and the fragment of natural language text in which the rule is expressed), the specification of normative effects (such as deontic, qualificatory or potestative, just to name a few), the dynamic feature of norm and normative effects and the reification (namely the fact that rules are like objects with relevant properties, such as jurisdiction, authority and temporal constraints). For these reasons, we chose to represent rules in LegalRuleML.

3 Related works

Compliance checking is a field that is typically related to business domain. There is a vast literature on various techniques developed for supporting compliance checking of business processes to regulations. Just to name a few, Governatori et al. have been proposed approaches based on multi-modal logic [12] and on a specialized logic, namely Formal Contract Language (FCL) [11] to formalize contracts' rules in order to manage the compliance of contractual relationships in business processes. Many other works are based on the formal representation of business contracts and their performance [5, 8]. An approach based on the use of an ontology of compliance requirements for service processes is described in [21]: however this work represent an exception in field of business process compliance checking.

About the legal domain, under the NEURONA project, has been developed a legal ontology for the representation of data protection knowledge for reasoning about the correctness of the information regarding personal data files and the correctness of the measures of protection applied to these data files [4]. Some studies has been conducted on the complexity and limitations of reasoning on EU Directives with OWL [9].

4 Pilot Case Scenario

A pilot case scenario is used for explaining the described methodology. It is based on the modeling of a complex norm extracted from the European Directive 2004/18 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts, namely the Art. 17. With this example, we intend to show what are both the limits and the role of ontologies versus rules and also that LegalRuleML allows to model articulated types of rules, which may be encountered in modeling of legal knowledge.
The article 17 of Directive 2004/18 states: "*Without prejudice to the application of Article 3, this Directive shall not apply to service concessions as defined in Article 1(4)*". In this norm are contained: a reference to a the legal concept of *service concession* as defined by the same directive (in Art. 1 (4)); an exception to the application of the Directive ("*shall not applied*") and an exception of exception about this rule in all the cases covered by the Art. 3 recalled by the Art. 17 ("*Without prejudice to the application of Article 3*"). In legal domain this mechanism (to recall another rule) is called *meta-rule*, since it is a rule about (the activation of) another rule, namely the Art. 3. This article states that if a contracting authority grants special or exclusive rights to carry out a public service activity to an entity other than such a contracting authority, the act by which that right is granted shall provide that, in respect of the supply contracts which it awards to third parties as part of its activities, the entity concerned must comply with the principle of non-discrimination on the basis of nationality[1]. Section 4.1 describes our proposal about modeling of legal concepts (static knowledge); Section 4.2 describes how it is possible to model complex metadata on the top of legal concepts with a syntax *look-like* LegalRuleML[2].

4.1 Proof of legal concepts as basis of proof of legal compliance

As outlined in Section 1, legal concepts are basically identified by terms incorporating inferential links between preconditions and legal consequences, in the same way of rules. So, the role to express this kind of rules can be delegated to ontologies and in that way the proof of legal concepts can serve as basis of proof of legal compliance, since every individual belonging to a class of a specific legal concept have to comply with the restrictions on this class. For the purpose of the presented pilot case, we've developed an ontology[3] for describing particularly the class of `Service Concession` as defined in the Art. 1 (4) of the Directive

[1] Article 3. *Granting of special or exclusive rights: non-discrimination clause - Where a contracting authority grants special or exclusive rights to carry out a public service activity to an entity other than such a contracting authority, the act by which that right is granted shall provide that, in respect of the supply contracts which it awards to third parties as part of its activities, the entity concerned must comply with the principle of non-discrimination on the basis of nationality.*

[2] Documents of the OASIS LegalRuleML TC are available at https://www.oasis-open.org/committees/documents.php?wg_abbrev=legalruleml. The mailing list describing the work in progress can be browsed at https://lists.oasis-open.org/archives/legalruleml/.

[3] Available at http://codexml.cirsfid.unibo.it

2004/18/ec and the class of `Act of grant to entities others than authority` as defined in the Art. 3 of the Directive 2004/18/ec. The main commitments of this ontology are to check if an individual of type `Public Procurement Contract` is also of type `Service Concession`, and which individual belongs to the class of `Service Concession`, but is also of type `Act of grant to entities others than authority`. In that way the rules are applied upon the materializations made by the ontology on legal concepts.
According to the definition of Art. 1 (4) of the Directive 2004/18/ec the Class of `Service Concession` is modeled as `SubClassOf` a Public procurement contract, which has its object the right to exploitation the service or both the right to exploitation the service and the payment:

```
<EquivalentClasses>
        <Class IRI="#ServiceConcession"/>
        <ObjectIntersectionOf>
            <Class IRI="#PublicProcurementContract"/>
            <ObjectSomeValuesFrom>
                <ObjectProperty IRI="#hasObjectOfContract"/>
                <ObjectUnionOf>
                    <Class IRI="#RightOfExploitationTheService"/>
                    <ObjectIntersectionOf>
                        <Class IRI="#Payment"/>
                        <Class IRI="#RightOfExploitationTheService"/>
                    </ObjectIntersectionOf>
                </ObjectUnionOf>
            </ObjectSomeValuesFrom>
        </ObjectIntersectionOf>
    </EquivalentClasses>
```

According to the definition of Art. 3 of the Directive 2004/18/ec the Class of `Act of grant to entities others than authority` is modeled as `SubClassOf` a LegalDocument, by which is granted a right (special or exclusive) to a legal person that is not a Contracting authority:

```
<EquivalentClasses>
        <Class IRI="#ActOfGrantToEntityOtherThanAuthority"/>
        <ObjectIntersectionOf>
            <Class IRI="#LegalDocument"/>
            <ObjectSomeValuesFrom>
                <ObjectProperty IRI="#byWhichIsGrantedRightTo"/>
                <ObjectIntersectionOf>
                    <Class IRI="#LegalPerson"/>
                    <ObjectComplementOf>
                        <Class IRI="#ContractingAuthority"/>
                    </ObjectComplementOf>
                </ObjectIntersectionOf>
            </ObjectSomeValuesFrom>
        </ObjectIntersectionOf>
    </EquivalentClasses>
```

4.2 Rules in LegalRuleML

We have modelled three rules[4] using a very preliminary syntax of LegalRuleML[5] for testing the emerging standard and providing useful feedback to the OASIS TC:

- the `rule1` is a defeasible rule and involves this fragment of the Art. 17:

"*this Directive shall not apply to service concessions as defined in Article 1(4)*."

The formalization of this text is the following:

```
if
     X is a member of the OWL class public-procurement-contract
     X is a member of the OWL class called service-concession
     X enters in the definition of the Article 1(4)
then
     the Directive2004/18/EC shall not apply
```

- the `rule2` has strength defeater and is also a meta-rule, since it activates the `rule3`:

"*Without prejudice to the application of Article 3*"

```
if
    X is a member of the OWL class public-procurement-contract
    X is a member of the OWL class called service-concession
then
    the Directive2004/18/EC shall apply
    the rule3 is activated
```

- the rule3 is related to the content of Article 3;

```
if
    X is a member of the OWL class called service-concession
    X is a member of the OWL class act-of-grant-to-entity-other-
than-authority
then
    X shall respect the principle of
    Non-discriminationClauseOnTheBasisOfNationality
    X shall respect of supply contracts which it awards to third
parties as part of its activities
```

We concentrate our attention on the connection between `rule2` and `rule3` using `lrml:typeRule=&legalRuleML;metaRule` as attribute in the `rule2` and the `<Ind iri="#rule3">rule3</Ind>`:

```
<Rule material="no" id="rule2" lrml:typeRule="&legalRuleML;metaRule">
  <!-- Art.17 Without prejudice to the application of Article 3 -->
  <if id="rule2-body">
     <And>
      <Atom id="rule2-atom1">
        <Rel iri="&lkif;#member_of">is a member of the public-
procurement-contract</Rel>
        <Var type="&lkif;#public-procurement-contract">X</Var>
      </Atom>
      <Atom id="rule2-atom2">
        <Rel iri="&lkif;#member_of">is a member of class service-
concession</Rel>
        <Var type="&lkif;#service-concession">X</Var>
```

[4] "Article 17 Service concessions - Without prejudice to the application of Article 3, this Directive shall not apply to service concessions as defined in Article 1(4)."

[5] We take in consideration the version available at the date of the paper submission: http://www.oasis-open.org/apps/org/workgroup/legalruleml/download.php/45888/2.1defeasibility.002.002.doc

```
      </Atom>
    </And>
  </if>
  <then id="rule2-head">
    <And>
      <Atom id="rule2-atom2">
        <Rel iri="&lkif;#shallApply">shall apply</Rel>
        <Ind iri="&DIRECTIVE2004_18_ec">Directive2004_18_</Ind>
      </Atom>
      <Atom id="rule2-atom2">
        <Rel iri="&lkif;#shallApply">shall apply</Rel>
        <Ind iri="#rule3">rule3</Ind>
      </Atom>
    </And>
  </then>
</Rule>
```

5 Ongoing and future perspectives

In this paper we have shown how with an hybrid approach that integrates ontologies in OWL 2.0 (for contents related to legal concepts) and rules in a preliminary syntax of LegalRuleML (for the dynamic legal knowledge), it is possible to express in a computable formalism also complex norms, maintaining the isomorphic [2] relation with the text and with a clear distinction between roles of ontologies and rules.

Up to now, an ontology of European public procurement notices has been developed from scratch in OWL 2.0, in order to represent concepts related to these types of tender documents and processes involved. The ontology is based on both a top-down and a bottom-up approach. Indeed it represents concepts extracted form authoritative sources (Directive 2004/17/EC; Directive 2004/18/EC; etc.) compared with natural language patterns derived from standard forms in use for these tender documents[6]. The ontology is based on a modular approach and allows, for example, inferences for classifying a contract notice as contract notice with European relevance (i.e. upon EU threshold) or not. Another module of the ontology has the main commitment to classify contract notices covered by the Government Procurement Agreement: through this information it is possible to find out whether a call is open to the participation of economic operators from countries that are not EU members.

RDFa assertions in the XML enable the connection between the structural part of legal texts and the classes of the ontology so developed. Finally upon the ontological level, are represented rules applied to defined ontological classes as well as to materializations inferred through reasoners such as Hermit or Pellet.

We think that future perspectives on this work are strictly related to the investigation of the topic of legal ontology evolution, in order to met the need to automatically detect changes in legal concepts and allow for a sustainable evolutionary system approach.

[6] These forms are available at http://simap.europa.eu/buyer/forms-standard/index_en.htm

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