On the Road to Regulatory Ontologies

Interpreting Regulations with SBVR

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Abstract. Regulatory compliance has proved to be difficult and time consuming across business domains. In Financial Services, the wide and complex spectrum of regulations calls for machine assistance in making sense of, and in consuming, the regulatory text. Semantic technologies, and Ontologies in particular, bring new solutions to the challenges in consuming financial services regulations that traditional technologies fell short in addressing. Current state-of-the-art related work is silent on the role of Legal/ Regulatory Subject-Matter-Experts in building these ontologies. This paper presents an on-going study on creating regulatory ontologies. It describes a Subject-Matter-Expert-centric approach to collaborative development of regulatory ontologies using structured natural language, Semantics of Business Vocabulary and business Rules (SBVR) in particular.

Keywords: Regulatory Ontology, Structured Natural Language, SBVR, Financial Industry, Regulations, Semantic Technologies, Subject Matter Experts, Common Vocabulary, Complex Regulations.

1 Introduction

The global financial regulatory environment is growing in complexity and scope in response to the financial crisis in 2008 [1]. The growth and complexity of national and international 'hard' and 'soft' regulation [2] is causing problems for organisations in the financial industry [3], with the "deep distributional implications of rule making in a world of competitive and globally integrated financial markets" little understood or appreciated [4]. Take, for example, that the "Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 increases the power of financial regulatory agencies, reduces regulatory gaps, develops better crisis management tools, and consolidates the regulation of systemically important institutions" [5]. It will do this using an estimated 1,500 provisions and 398 rules, which will be drafted by relevant regulatory agencies—approximately 40% of these rules are in force in 2013 at the time of writing.[1] The resultant rules can be extremely complex; take, for example, the Volker Rule, which was originally 10 pages, had "swelled to 298 pages and was accompanied

[1] http://www.usatoday.com/story/money/business/2013/06/03/dodd-frank-financial-reform-progress/2377603/

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by more than 1,300 questions about 400 topics" and was claimed by financial organisations as being "too complex to understand and too costly to adopt"[2]. The international reach of the Dodd-Frank Act is also significant, as non-U.S. banks will only be exempt from the Volker Rule's prohibitions if their activities have no link with the U.S. market—a truly rare scenario [6]. The problems are created by 'hard' regulations, such as Dodd-Frank, with 'soft' regulations based typically on standards and which focus on particular regulatory domains, such as capital adequacy or disclosure obligations. Nevertheless, these 'soft' regulations have been 'hardened' through their adoption by the EU and governments globally. All this presents significant problems for the regulators drafting the regulations and rules, legal practitioners who interpret them, and financial services practitioners who apply them.

There is significant interest in the concept of semantic technologies and legal ontologies to capture procedural legal knowledge [7-9], to deal with the flood of legal information [10] and to provide legal knowledge management services [27]. Section 2 focuses on this body of literature. While it is generally agreed that semantic technologies can help stem this flood, there is a paucity of research on semantic technologies to address the regulatory flood that faces the financial industry. Research on the use of semantic technologies in financial services is emergent [11], and focuses on the business domain [12]. At the Demystifying Financial Services Semantics Conference in New York, 2012, Wall Street executives and U.S. regulators call for the development of a 'common vocabulary' for the industry that would be human and machine readable. The need for such a vocabulary is indicated by [13] who calls for a taxonomy of global securities and for common definitions. However, [14] echoes each of the points made above by arguing that the "looming train wreck" for regulatory compliance in the financial industry requires regulatory ontologies such as that described herein.

The remainder of this paper is structured as follows: section 2 describes the state of the art in Legal Ontologies. Section 3 explains the challenges faced when consuming a regulatory document for the purpose of knowledge representation. Section 4 describes the suggested approach to use SBVR to express regulations in structured natural language as means to bridge the gap between Subject Matter Experts and Ontology Engineers. Section 5 concludes and draws next steps.

2 Related Work

The typology of legal ontologies developed to date is diverse as a result of the purpose and focus of the ontology, the degree of formality, the various methodologies used, and the application of the ontology. Some of the relevant legal ontologies are briefly discussed here in terms of their completeness, reusability and availability, subject-matter and purpose.

Many of the early ontologies can be described as core ontologies. These were concerned with modelling knowledge that is common across various legal domains with the focus on jurisprudence and legal doctrine that didn't reflect the true nature of the

[2] http://www.nytimes.com/2011/10/22/business/volcker-rule-grows-from-simple-to-complex.html?_r=0

law in practice. The focus was on legal norms, legal actors and legal concepts. Some of these early core ontologies such as FBO [15], DOLCE, and FOLaw [16] are either legal ontologies or contain legal terms. The high-level nature of these ontologies dealing with legal theory has meant they have been reused in very limited circumstances due to the small number of legal concepts contained therein. This was highlighted in the Estrella project (European project for Standardized Transparent Representation in order to Extend Legal Accessibility) that produced LKIF (Legal Knowledge Interchange Format) comprising the LKIF core ontology and the LKIF rules language. The LKIF core ontology was created by reusing concepts from LRI-Core and gathering and reviewing the top legal terms from consortium partners. LKIF is likely the most reusable of the core ontologies because of its legal coverage.

Domain specific legal ontologies are also an active area of development. These focus on a particular area of law such as consumer complaints in the CContology, European VAT fraud in FFPOIROT (Financial Fraud Prevention Oriented Information Resources using Ontology Technology), ship classification in the CLIME (Computerized Legal Information Management and Explanation) ontology, and intellectual property rights and copyright in IPROnto. While these legal ontologies have application in the specific domain of law chosen, relevance beyond this is impracticable because of the subject-matter it is modelling, for example, an ontology on contracts cannot be readily applied to procedural case law. Domain specific legal ontologies are not without value, some have been applied rather than remaining at prototype stage. FFPOIROT developed the Topical Ontology of Fraud, and the Topical Ontology of VAT based on European Law and preventive practices to deal with financial fraud. Trials were conducted with CONSOB (Commissione Nazionale per la Societá e la Borsa – The Italian Securities Market Commission) that generated good results. However, very little was published due to the confidentiality of the real cases used [17]. An ontology on Dutch Immigration law was developed by *Be Informed* specifically for the Dutch Immigration and Naturalisation Service. It proved to be highly effective but is proprietary and therefore inaccessible.

The development of legal ontologies has many approaches but one noticeable trait is the lack of involvement of legal experts. The majority of legal ontologies are developed using text-extraction later reviewed by legal experts [7], if at all. The limited involvement of legal experts can compromise the correctness, application and acceptance of the ontology within the legal arena.

There is also a need to look at the work undertaken on semantic standards particularly for legislative drafting. This allows for legal documents to be displayed in both human and machine readable forms. Metalex resulted from the E-POWER (European Program for an Ontology based Working Environment for Regulations and Legislation) project. It provided a generic and easily extensible framework for the coding of the structure and contents of legal documents. It was redesigned taking account of Norme in Rete [18] and Akoma Ntoso[3].

[3] `http://www.akomantoso.org/`. Akoma Ntoso was developed as part of a UNDESA project to set standards for e-Parliament services in a Pan-African context. See Palmirani & Vitali, 2011. It is also being adopted in Switzerland, the State of California, The European Parliament amongst others.

Akoma Ntoso 'is a technology-neutral XML machine-readable descriptions of parliamentary, legislative and judiciary documents…that enable addition of descriptive structure (markup) to the content of parliamentary and legislative documents' [19]. It allows management of legislative change for legal documents. Akoma Ntoso has been adopted in several jurisdictions worldwide as the XML standard for parliamentary and legislative documents.

RuleML[4] is a standard for rules knowledge representation across all industries. LegalRuleML extends RuleML in order to capture in an expressive XML language, legal norms, rules and legal knowledge to allow it to be used for legal reasoning and for semantic information of legal documents to be shared [20].

There is recognition that while all the research to date is contributing to a rich landscape of semantic solutions for the legal domain, new approaches are needed to represent regulations through the development of a regulatory ontology.

3 Challenges in Consuming Regulations

Understanding regulations has proven to be a complex task to both, non-trained human agents, and to machines. This section describes a set of challenges or difficulties in understanding a regulatory text. It categorizes them in five types based on the nature of the difficulty. It provides examples extracted from the US Code of Federal Regulations, Title 31 Chapter X - Financial Crimes Enforcement Network, Department of the Treasury, which deals with Anti Money Laundering.

3.1 References to Follow and Flesh Out

Typically, in a regulatory text the sentences aren't self-contained, they refer to content in other sections or even in other documents. This content is needed to ensure correct understanding. For example in 31 CFR 1022.210(d)(1)(iii), shown below, one needs to read/consume the content of §1022.380(a)(2) in order to understand when a *person* is considered *a money services business*.

> *A person that is a money services business solely because it is an agent for another money services business as set forth in §1022.380(a)(2), and the money services business for which it serves as agent […]*

Following these references can prove to be tedious, especially when one is faced with a chain of references. In the previous example, §1022.210(d)(1)(iii) redirects to §1022.380(a)(2) to understand when a *person* is considered *a money services business*. In turn, §1022.380(a)(2), as shown below, redirects to §1010.100(ff) to complete the definition of an *agent for money services business.*

> *A person that is a money services business solely because that person serves as an agent of another money services business, see § 1010.100(ff) of this chapter, is not required to […]*

[4] http://ruleml.org/

In this example, §1010.100(ff) is a ten-paragraph section which the reader/consumer of the regulation should process to identify when *a person is a money services business solely because that person serves as an agent of another money services business* to ensure that her understanding of the sentence she started with, in 31 CFR 1022.210(d)(1)(iii), is accurate.

3.2 Definitions to Identify, Delimit and Disambiguate

Usually legal documents contain sections dedicated to define/redefine the terms and the concepts used in these documents. Naturally, regulatory documents follow this rationale. For example in the US Code of Federal Regulations, Title 31 Chapter X contains §1010.100 which is a list of *General definitions*. However, other definitions could be embedded in the body of the regulatory text. These definitions are usually made explicit by using connectors such as "means", "as set forth in", "includes", etc. But sometimes they aren't explicitly stated as such and locating them becomes a harder task.

Definitions of regulatory terms tend to be highly context-related, thus rendering the reuse of existing vocabularies, without adapting them and validating them, practically impossible. For example, a reader/consumer of 31 CFR Chapter X might be well familiar with a definition of Financial Institutions not containing telegraph companies. Conversely, in the context of prepaid access for money services businesses, telegraph companies are considered as financial institutions as stated in §1010.100(t).

When trying to delimit the coverage of a concept in a regulatory document, definitions taken from the original regulatory text are key. However, these definitions often contain terms whose definition, scope and coverage aren't necessarily clear. The reader/consumer of the regulation is then faced with a recursive search-and-understand process. For example, §1010.100(mm) defines the entity *Person* as a list of other entities considered as *Person*s for the purpose of 31 CFR Chapter X such as the entity *Indian Tribe*. If the reader/consumer of the regulation isn't clear on what is considered an *Indian Tribe* in the "spirit of this regulation", it is up to her to refer to the Indian Gaming Regulatory Act and place the definition in context.

3.3 Complex Sentences to Make Sense Of

The complexity of legalese is no secret [21] and regulations do not escape this complexity. For example, §1022.320(a)(4) on the reporting of suspicious transactions as shown below, starts with an obligation (*to identify*) followed by two imbricated assumptions (*provided that* and *so long as*) and finishes with a related possibility (*of liability depending on the nature of some relationship*).

> *(4) The* ***obligation to identify*** *and properly and timely to report a suspicious transaction rests with each money services business involved in the transaction,* ***provided that*** *no more than one report is required to be filed by the money services businesses involved in a particular transaction* ***(so long as*** *the report filed contains all relevant facts).* ***Whether, in addition to any liability on*** *its own for failure to report, a money services business […]* ***may be liable for*** *the failure of another money services business involved in the transaction to report that transaction* ***depends upon the nature*** *of the contractual or other* ***relationship*** *between the businesses […]*

3.4 Ambiguities to Clarify

The potential ambiguity of natural language sentences is widely recognized. A regulatory text written in natural language is certainly no exception. For example, in §1022.380(a)(2) shown below, it is not clear what *location* refers to. It could be the business of the agent, the agent's home address or the location where the registration form has to be filed.

> *Each foreign-located person doing business, whether or not on a regular basis or as an organized or licensed business concern, in the United States as a money services business shall designate the name and address of a person who resides in the United States and is authorized, and has agreed, to be an agent to accept service of legal process with respect to compliance with this chapter, and shall* ***identify the address of the location within the United States for records*** *pertaining to paragraph (b)(1)(iii) of this section.*

Moreover, in regulations some sentences deliberately introduce ambiguity around the meaning or the scope of certain concepts. For example, the usage of sentences such as: *unless the context otherwise requires*, *matter of "Facts and Circumstances"*, *or any other similar items*, etc. introduces a deliberate opening for possibilities not captured in the text.

3.5 Exceptions to Take into Account

Whether in a concept definition or in a list of requirements, most regulations contain exceptions. Take for example, §1022.380 on registration of money services businesses. This section starts by listing the exceptions before listing the requirements. Furthermore, the difficulty in understanding listed exceptions increases when these exceptions are hidden in the body of a referenced text, as illustrated by the sentence hereafter from §1022.380.

> *Except as provided in paragraph (a)(2) of this section, relating to agents, each money services business […]*

To address this challenge type, a reader/consumer of the regulation needs to rely on her subject matter expertise to put these exceptions in context and ensure a correct understanding of them.

To overcome challenges when facing a regulatory text, such as the ones previously described, it is clear that Subject Matter Experts (SMEs) play an important role in consolidating and making sense of the text. We believe that this step is a key requirement preceding formal Knowledge Representation. To the best of our knowledge, state of the art approaches (as described in section 2) proposing legal ontologies are silent on the SMEs role. The remainder of this paper suggests an alternative way to creating regulatory ontologies that is characterized by the introduction of an intermediate step while going from regulation to formal ontologies. This step involves the consolidation, the disambiguation and the interpretation of regulatory text by subject matter experts using Structured Natural Language (SNL) which is SME-friendly and which has precise semantics (grounded in formal logic).

4 Interpreting Regulations with SBVR

The suggested approach relies on subject matter expertise in disambiguating and interpreting the regulatory text for the purpose of formal knowledge representation. This section describes the structured natural language used to bridge the gap between Subject Matter Experts (SMEs) and Semantic Technologies Experts (STEs) and a methodology for collaborative development of regulatory vocabulary and regulatory guidance.

4.1 Semantics of Business Vocabulary and Business Rules

Semantics of Business Vocabulary and business Rules (SBVR) [22] is an Object Management Group (OMG) specification for Business Natural Language that is grounded in ISO Common Logic. SBVR structures natural text around elements from the SBVR metamodel. The frequently used elements are:

- *Noun Concepts*, which are things in the domain of interest. For example, regulator, regulation, financial institution, etc. *Individual Noun Concepts* are a particular type of *Noun Concepts* representing actual entities or individuals. For example, Securities and Exchange Commission, RegulationW, Wells Fargo Bank, etc.
- *Verb Concepts*, which capture the relationships between Noun Concepts. For example, the *Verb Concept* "money services business submits suspicious activity report" captures the submission relationship between a money services business and a suspicious activity report.

It is also common for SBVR users to look in the text for *Keywords*, which are linguistic symbols listed in the OMG-specification. For example, the natural language representation of logical quantifiers, logical operators and modal operators are identified as *keywords* in SBVR Structured English.

Typically an SBVR document has two parts: a Vocabulary and a Rulebook. An SBVR Vocabulary is a Terminological Dictionary where entries are *Noun Concepts* and *Verb Concepts.* It also contains *definitional rules* - which constrain, in the form of alethic modalities (it is necessary that), the relationships represented by verb concepts - and related *advices of possibility.* An SBVR rulebook is a set of guidance statements containing *behavioral rules* in the form of deontic modalities (it is obligatory that) and *advices of permission/ prohibition*. An SBVR vocabulary & rulebook should be complete and consistent [23]. This is determined by three basic principles: (1) noun concepts should be explicitly defined from the text, from other authoritative sources or recognized as implicitly-understood by the SMEs; (2) only defined/recognized noun concepts may play roles in verb concepts; (3) definitional rules and behavioral rules may only be built using defined verb concepts.

SBVR does not have a normative syntax but the OMG specification describes SBVR Structured English (SBVR SE) which is a simplified version of natural English. SBVR SE relies on text styles to visually identify elements from the SBVR metamodel. In the following we adopt a similar style to express examples in SBVR. Noun concepts are underlined with a single line. Individual noun concepts are doubled underlined. **Keywords** are in a bold font face. The ***verb part*** of a verb concept is in italic-bold font face.

To illustrate the usage of SBVR in the context of financial regulations, take for example the definitions of currency from 31 CFR Chapter X § 1010.100(m):

> *The coin and paper money of the United States or of any other country that is designated as legal tender and that circulates and is customarily used and accepted as a medium of exchange in the country of issuance. Currency includes U.S. silver certificates, U.S. notes and Federal Reserve notes. Currency also includes official foreign bank notes that are customarily used and accepted as a medium of exchange in a foreign country.*

The related SBVR entry is

Definition: coin **and** paper money ***of*** **a** country **that** ***is designated as legal tender in*** **the** country **and that** ***circulates and is customarily used and accepted as a medium of exchange in*** **the** country
Concept Type: general noun concept
General Concept: legal tender
Source: 31 CFR Chapter X § 1010.100(m)
Example: the coin and paper money ***of*** the United States
Example: U.S. silver certificates, U.S. notes and Federal Reserve notes

4.2 Disambiguation and Interpretation Approach

The objective of this approach is to rely on subject matter expertise to overcome the challenges described in section 3. SMEs produce, in SBVR, a regulatory vocabulary capturing definitions of the concepts underlying the studied regulation. The vocabulary also contains descriptions of the relationships between these concepts and constraints over these relationships. The SMEs also produce, in SBVR, regulatory guidance capturing a list of obligations and a list of prohibitions expressing the regulatory imperatives. These lists are constructed using the aforementioned vocabulary.

Figure 1 recalls the circle of understanding to illustrate the iterative disambiguation and interpretation process to which it adds the stylizing in SBVR SE activity.

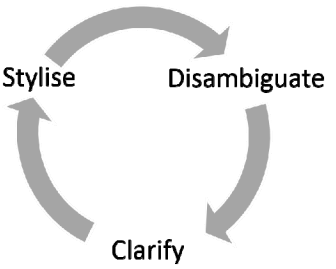

Fig. 1. Iterative Interpretation of Regulations with SBVR

The stylizing activity consists of indicating which element in the SBVR metamodel a term (or set of terms) corresponds to. This is done by applying the appropriate SBVR SE font styles. The disambiguation activity consists of consolidating and understanding the text. It can require any combination of the following activities:

- Consolidate references, which implicates following reference chains and integrating required parts to produce self-contained sentences.
- Define terms/ concepts from the text itself or find appropriate definitions, which implicates delimiting concepts coverage, clarifying "confusing" terms and identifying parent concepts.
- Define unclear terms in the definitions themselves, which implicates repeating the previous activity for terms and concepts in the produced definitions (imbricated levels of disambiguation).
- Identify relationships between things represented by the terms, which requires capturing the roles played by previously defined concepts. Each relationship is captured in a verb concept wording.
- Identify constraints on these relationships, which are represented in SBVR SE by necessity-formulations.
- Identify modalities and the action(s) on which these modalities lie, which implicates navigating the list of previously defined verb concepts and identifying the ones that are modified by regulatory imperatives (obligations, prohibitions).

The clarification activity consists of relying on Subject Matter Expertise to formulate guidance when the regulatory intent is not clear (after each of the disambiguation activities).

4.3 Experimental Work

Multiple experiments to test and evaluate the relevance of this approach to compliance practitioners and ontology engineers are carried out as part of the research program of the Governance, Risk and Compliance Technology Centre (GRCTC) in University College Cork, Ireland. The following describes a completed experiment on the US Bank Secrecy Act (US BSA) and its implementing regulation Chapter X of Title 31 of the Code of Federal Regulations (31 CFR Chapter X). The scope of this experiment was limited to sections of 31 CFR Chapter X that are modified by the following Federal Register final rule: 76 FR 45403 Bank Secrecy Act Regulations - Definitions and Other Regulations Relating to Prepaid Access.

The experimental setting and supporting software environment were described and discussed in [23]. Four legal SMEs participated in the disambiguation/interpretation process. They were tasked with producing a vocabulary and a rulebook built on this vocabulary as described in the previous section. The following is a selection of excerpts from the produced SBVR interpretation of 76 FR 45403 explaining how SBVR brings regulatory knowledge closer to formal representation while being SME-friendly.

- On reference chains and producing self-contained sentences:

The regulation defines transaction accounts as "[…] transaction accounts includes accounts described in 12 U.S.C. 461(b)(1)(C) […]". After consolidation and interpretation in SBVR, the definition of transaction accounts becomes a list as follows:

deposit accounts ***on which*** **the** depositor **or the** account holder ***can make withdrawals by*** transferable instrument, payment orders of withdrawal, telephone transfers […]

- On definitions and levels of disambiguation:

A seller of prepaid access has to abide by a list of obligations. For example, **It is obligatory that a** seller of prepaid access ***sells*** prepaid access ***offered under*** **a** prepaid program ***provided that*** **the** prepaid access ***can be used before*** verification of customer identification […]. It is clear that the noun concept verification of customer identification needs to be precisely defined. To this purpose, a related SBVR vocabulary entry is created:

Verification of customer identification
Definition: ***is*** **the** collection ***of*** information ***about*** **the** customer ***including*** name, date of birth, address, **and** identification number.
Source: § 1022.210(d)(1)(iv).

- On identifying, describing and constraining relationships:

A person can structure a transaction. This is captured in the following verb concept entry: a person ***structures*** a transaction **if** that person, […] ***for*** the purpose ***of evading*** reporting requirements. Like the previous example, capturing this verb concept definition isn't sufficient, one needs, for example, to flesh out the definition of reporting requirements to ensure complete understanding of transaction structuring cases. Typical examples of constrained relationships consist of qualifying the noun concepts playing roles in a verb concept, for example: agreement ***designates*** **only one** person ***to register*** money services business.

- On capturing regulatory requirements:

The regulation imposes on providers of prepaid access to maintain access to a history of transactional records for five years. The verb concept provider of prepaid access ***maintains access to*** transactional records is modified as follows:
It is obligatory that each provider of prepaid access ***maintains access to*** transactional records ***for*** **a** period ***of*** five years.

5 Discussion

This work aims at bringing regulatory knowledge closer to formal representation in a subject-matter-expert-friendly way. The role of subject matter experts is central to the presented approach. Their active participation guarantees a correct and accurate representation of domain knowledge.

The on-going experimental work, described in section 4.3, highlighted the advantages of applying SBVR using the described approach and confirmed some expected shortcomings. For instance, the SBVR specification doesn't provide a technique to directly represent an exception to a rule. However, a subject matter expert drafting guidance in SBVR SE could represent an exception to an obligation as a permission related to the rulebook entry describing the aforementioned obligation. The possibility of transforming such from SBVR SE to a formal representation depends highly on the logical expressiveness of the selected machine-readable representation language.

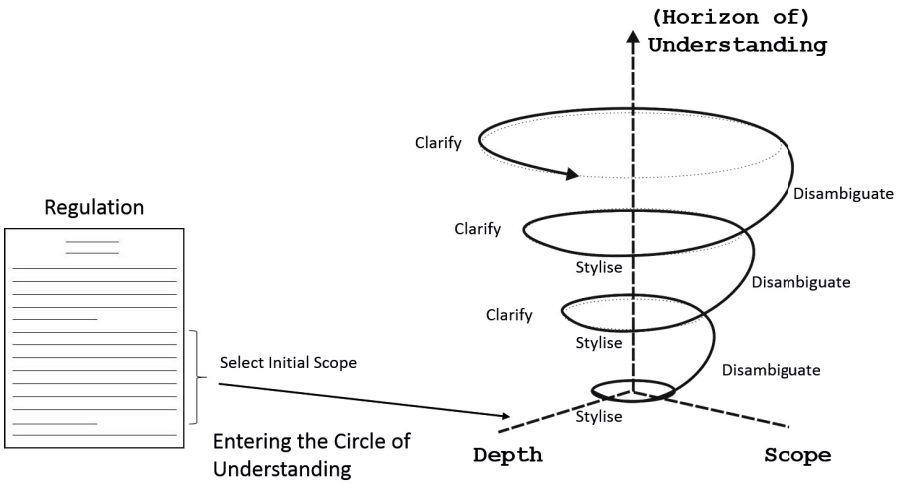

Fig. 2. Increasing Understanding of Regulations Using the Described Approach

On the formal semantics underpinning SBVR, Gordon *et al.* [26] identified two major areas where future versions of the SBVR specification could evolve. First, the under-specification of the semantics of SBVR deontic modalities, which hinders an accurate modeling of legal norms. And second, the inherited shortcomings of classical first order logic such as the lack of support to defeasibility, which precludes the formal representation of conflicts (conflictual statements). These limitations related to formal semantics have an impact on automated reasoning.

However, in the experiments described here, automated legal reasoning is not the primary intended application. We intend to highlight the need for a step preceding a "complete" formal representation of regulatory knowledge. This step consists of subject matter experts capturing regulatory intent in clearer and more accessible representations than the challenging ones provided by regulators, as described in section 3. For instance, these SBVR-based representations would provide financial services compliance officers, who don't necessarily have complete legal training, with support to make more informed decisions which are traceable back to the regulations. As illustrated in Figure 2, the usage of SBVR Structured English in the iterative manner detailed in section 4.2 and within a technical environment such as the one presented in [23], guarantees a deeper understanding of the regulations and a broader comprehension of the context while preserving clear provenance of underlying concepts.

6 Conclusion and Future Work

This paper built on the need for regulatory ontologies in the financial industry to describe an approach to represent knowledge from financial services regulatory documents in structured natural language as a step towards representing a subset of this knowledge using Semantic Web technologies. It identified a list of challenges that

require human subject matter expertise in understanding regulatory text. To overcome these challenges, the paper suggests relying on subject matter experts to interpret and represent regulations using Semantics of Business Vocabulary and business Rules. The described approach was supported by a series of examples in SBVR from a completed experiment on a piece of regulation from the US Bank Secrecy Act.

This approach overcomes uncertainty and imprecision in regulations by combining Subject Matter Expertise and SBVR precision in representing domain knowledge. It is targeted at removing complexity and ambiguity from regulations and resulting policies and rules. With the underlying formal logic of SBVR guaranteeing a certain level of accuracy in knowledge representation, immediate understanding is expected to increase and communications are meant to improve. Clear provenance of the vocabulary entries and the guidance rules renders possible tracing back to the original text regulatory concepts and constraints described in resulting ontologies making the whole knowledge model auditable.

The developed vocabulary answers the need for a common and shared language as described in section 1 whereas guidance rules can be used in policies and procedures to build controls. The ultimate potential of this approach is achieved when SBVR vocabularies and rules are transformed into fully machine understandable models using for example the semantic web representation languages or more expressive/ more adequate representation languages.

Next steps will focus on transforming the vocabulary part of an SBVR SE document to formal ontologies and specifically OWL ontologies to enable several applications such as knowledge management, regulatory change management, etc. To the best of our knowledge, and to date, there is a lack of methods/tools supporting automated transformation of SBVR vocabularies to OWL. Current work is focusing on developing such methods and stressing on maximizing their automation. Due to the natural language characteristics of SBVR, full automation is not expected but a high degree of automated support is sought. Promising results were described by Kendall and Linehan in [24]. Future work will focus on leveraging Natural Language Processing techniques to assist the subject matter experts in the interpretation process as discussed in [25].

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