LegalRuleML Core Specification Version 1.0

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Additional artifacts:

This prose specification is one component of a Work Product that also includes:

- XSD schemas: http://docs.oasis-open.org/legalruleml/legalruleml-core-spec/v1.0/csprd01/xsd-schema/
- RelaxNG schemas: http://docs.oasis-open.org/legalruleml/legalruleml-core-spec/v1.0/csprd01/relaxng/
- XSLT transformations: http://docs.oasis-open.org/legalruleml/legalruleml-core-spec/v1.0/csprd01/xslt/
- XSD-conversion drivers: http://docs.oasis-open.org/legalruleml/legalruleml-core-spec/v1.0/csprd01/generation/

- RDFS metamodel: http://docs.oasis-open.org/legalruleml/legalruleml-core-spec/v1.0/csprd01/rdfs/
- Metamodel diagrams: http://docs.oasis-open.org/legalruleml/legalruleml-core-spec/v1.0/csprd01/diagrams/
- Examples: http://docs.oasis-open.org/legalruleml/legalruleml-core-spec/v1.0/csprd01/examples/

Declared XML namespaces:

- http://docs.oasis-open.org/legalruleml/ns/v1.0/
- http://docs.oasis-open.org/legalruleml/ns/mm/v1.0/

Abstract:

The objective of this document is to extend RuleML with formal features specific to legal norms, guidelines, policies and reasoning. It defines a specification (expressed with XML-schema and Relax NG) that is able to represent the particularities of the legal normative rules with a rich, articulated, and meaningful markup language.

Status:

This document was last revised or approved by the OASIS LegalRuleML TC on the above date. The level of approval is also listed above. Check the “Latest version” location noted above for possible later revisions of this document. Any other numbered Versions and other technical work produced by the Technical Committee (TC) are listed at https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=legalruleml#technical.

TC members should send comments on this specification to the TC’s email list. Others should send comments to the TC’s public comment list, after subscribing to it by following the instructions at the “Send A Comment” button on the TC’s web page at https://www.oasis-open.org/committees/legalruleml/.

For information on whether any patents have been disclosed that may be essential to implementing this specification, and any offers of patent licensing terms, please refer to the Intellectual Property Rights section of the TC’s web page (https://www.oasis-open.org/committees/legalruleml/ipr.php).

Note that any machine-readable content (aka Computer Language Definitions) declared Normative for this Work Product is provided in separate plain text files. In the event of a discrepancy between any such plain text file and display content in the Work Product's prose narrative document(s), the content in the separate plain text file prevails.

Citation format:

When referencing this specification the following citation format should be used:

[LegalRuleML-Core-v1.0]

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Notices

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1 Introduction

1.1 Terminology

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in **[RFC2119]**.

1.2 Normative References

[RFC2119]	S. Bradner, *Key words for use in RFCs to Indicate Requirement Levels*, http://www.ietf.org/rfc/rfc2119.txt, IETF RFC 2119, March 1997.
[RDF]	RDF 1.1 Primer, W3C Working Group Note 25 February 2014 http://www.w3.org/TR/2014/NOTE-rdf11-primer-20140225/
[RDFS]	RDF Schema 1.1, W3C Recommendation 25 February 2014 http://www.w3.org/TR/rdf-schema/
[RelaxNG]	http://relaxng.org/
[XSD]	XML Schema Part 0: Primer Second Edition, W3C Recommendation 28 October 2004 http://www.w3.org/TR/xmlschema-0/
[XML]	Extensible Markup Language (XML) 1.0 (Fifth Edition), W3C Recommendation 26 November 2008 http://www.w3.org/TR/2008/REC-xml-20081126/
[RFC3987]	https://tools.ietf.org/html/rfc3987
[CURI]	http://www.w3.org/TR/rdfa-syntax/#s_curies
[FRBR]	http://www.ifla.org/publications/functional-requirements-for-bibliographic-records

1.3 Non-Normative References

[ConsumerRuleML] Consumer RuleML Specification 1.02.
http://wiki.ruleml.org/index.php/Specification_of_Consumer_RuleML_1.02

1.4 Typographical Conventions

Preformatted type, e.g. Agent, is used for the names of XML components (elements and attributes) and IRIs.

Prefixes used in this document for qualified names in XML and for abbreviating IRIs are the following:

- `lrml` for `http://docs.oasis-open.org/legalruleml/ns/v1.0/`
- `lmrlmm` for `http://docs.oasis-open.org/legalruleml/ns/mm/v1.0/`
- `ruleml` for `http://ruleml.org/spec`
- `xsi` for `http://www.w3.org/2001/XMLSchema-instance`
- `xs` for `http://www.w3.org/2001/XMLSchema`
- `xml` for `http://www.w3.org/XML/1998/namespace`.

The following formatting conventions are used to distinguish the occurrence of LegalRuleML terms within the document:

1. When an occurrence of a term refers to an element or attribute, the term appears in preformatted type, with no spaces and XML markup (e.g. `<lrml:ConstitutiveStatement>` and `@hasMemberType`).

2. When it refers to a concept, it appears with spaces (if appropriate) and no preformatted type (e.g. Constitutive Statement, Deontic Specification).

3. When both readings are possible, it appears with no spaces, no preformatted type, and no XML markup (e.g. ConstitutiveStatement).

Capitalization is used to distinguish certain terms and names. UpperCamelCase is used for:

a) Node elements e.g. `<lrml:ConstitutiveStatement>;`
b) their associated concepts, e.g. Constitutive Statement, and;
c) their type, as a metamodel IRI, e.g. lrmlmm:ConstitutiveStatement.

Similarly, lowerCamelCase is used for:

d) edge elements and attributes e.g., `<lrml:hasStatement>`, `@memberType`;
e) and their associated role, as a metamodel IRI, e.g. `lrmlmm:hasStatement`, `lrmlmm:memberType`.

Italic is used in the angle bracket for distinguishing the annotation to the XML syntax when it is necessary to underline the presence of a generic XML element.

In examples in the presentation syntax, we use a particular annotation:

- variables are prefixed with $ (e.g., $income);
- constants are prefixed with % (e.g., %employer).

2 Background, Motivation, Principles

2.1 Motivation

Legal texts, e.g. legislation, regulations, contracts, and case law, are the source of norms, guidelines, and rules. As text, it is difficult to exchange specific information content contained in the texts between parties, to search for and extract structured the content from the texts, or to automatically process it further. Legislators, legal practitioners, and business managers are, therefore, impeded from comparing, contrasting, integrating, and reusing the contents of the texts, since any such activities are manual. In the current web-enabled context, where innovative eGovernment and eCommerce applications are increasingly deployed, it has become essential to provide machine-readable forms (generally in XML) of the contents of the text. In providing such forms, the general norms and specific procedural rules in legislative documents, the conditions of services and business rules in contracts, and the information about arguments and interpretation of norms in the judgments for case-law would be amenable to such applications.

The ability to have proper and expressive conceptual, machine-readable models of the various and multifaceted aspects of norms, guidelines, and general legal knowledge is a key factor for the development and deployment of successful applications. The LegalRuleML TC, set up inside of OASIS (www.oasis-open.org), aims to produce a rule interchange language for the legal domain. Using the representation tools, the contents of the legal texts can be structured in a machine-readable format, which then feeds further processes of interchange, comparison, evaluation, and reasoning. The Artificial Intelligence (AI) and Law communities have converged in the last twenty years on modeling legal norms and guidelines using logic and other formal techniques [6]. Existing methods begin with the analysis of a legal text by a Legal Knowledge Engineer, who scopes the analysis, extracts the norms and guidelines, applies models and a theory within a logical framework, and finally represents the norms using a particular formalism. In the last decade, several Legal XML standards have been proposed to represent legal texts [30] with XML-based rules (RuleML, SWRL, RIF, LKIF, etc.) [16, 18]. At the same time, the Semantic Web, in particular Legal Ontology research combined with semantic norm extraction based on Natural Language Processing (NLP) [15], has given a strong impetus to the modeling of legal concepts [8, 10, 11]. Based on this, the work of the LegalRuleML Technical Committee will focus on three specific needs:

1 To close the gap between legal texts, which are expressed in natural language, and semantic norm modeling. This is necessary in order to provide integrated and self-contained representations of legal resources that can be made available on the Web as XML representations [32] and so foster Semantic Web technologies such as: NLP, Information Retrieval and Extraction (IR/IE), graphical representation, as well as Web ontologies and rules.

2 To provide an expressive XML standard for modeling normative rules that satisfies legal domain requirements. This will enable use of a legal reasoning layer on top of the ontological layer, aligning with the W3C envisioned Semantic Web stack.

3 To apply the Linked Open Data [9] approach to model raw data in the law (acts, contracts, court files, judgments, etc.) and to extend it to legal concepts and rules along with their functionality and usage. Without rules that apply to legal concepts, legal concepts constitute just a taxonomy [36].

2.2 Objective

The objective of the LegalRuleML TC is to extend RuleML with formal features specific to legal norms, guidelines, policies and reasoning; that is, the TC defines a standard (expressed with XML-schema and Relax NG) that is able to represent the particularities of the legal normative rules with a rich, articulated, and meaningful markup language.

LegalRuleML models:

- defeasibility of rules and defeasible logic;

- deontic operators (e.g., obligations, permissions, prohibitions, rights);

- semantic management of negation;

- temporal management of rules and temporality in rules;

- classification of norms (i.e., constitutive, prescriptive);

- jurisdiction of norms;

- isomorphism between rules and natural language normative provisions;

- identification of parts of the norms (e.g. bearer, conditions);

- authorial tracking of rules.

Some matters are out of the scope of the TC and LegalRuleML such as specifications of core or domain legal ontologies.

2.3 Main Principles

The main principles of LegalRuleML are as follows.

Multiple Semantic Annotations: A legal rule may have multiple semantic annotations, where these annotations represent different legal interpretations. Each such annotation appears in a separate annotation block as internal or external metadata. Interpretations are provided with parameters that indicate provenance, applicable jurisdiction, logical interpretation of the rule, and others.

Tracking the LegalRuleML Creators: As part of the provenance information, a LegalRuleML document or any of its fragments can be associated with its creators. This is important to establish the authority and trust of the knowledge base and annotations. The creators of the document can be the authors of the text, knowledge base, and annotations, as well as the publisher of the document.

Linking Rules and Provisions: LegalRuleML includes a mechanism, based on IRI, that allows many to many (N:M) relationships among the rules and the textual provisions: multiple rules are embedded in the same provision, several provisions contribute to the same rule. This mechanism may be managed in the metadata block, permitting extensible management, avoiding redundancy in the IRI definition, and avoiding errors in the associations.

Temporal Management: LegalRuleML's universe of discourse contains a variety of entities: provisions, rules, applications of rules, references to text, and references to physical entities. All of these entities exist and change in time; their histories interact in complicated ways. LegalRuleML represents these temporal issues in an unambiguous fashion. In particular, a rule has parameters that can vary over time, such as its status (e.g. strict, defeasible, defeater), its validity (e.g. repealed, annulled, suspended), and its jurisdiction (e.g. only in the EU, only in the US). In addition, a rule has temporal aspects such as internal constituency of the action, the time of assertion of the rule, the efficacy, enforcement, and so on.

Formal Ontology Reference: LegalRuleML is independent from any legal ontology and logic framework. However, it includes a mechanism, based on IRIs, for pointing to reusable classes of a specified external ontology or framework.

LegalRuleML is based on RuleML: LegalRuleML reuses and extends the concepts and syntax of RuleML wherever possible, and it also adds novel annotations. RuleML includes Reaction RuleML.

Mapping: LegalRuleML is mappable to RDF triples for Linked Data reuse.

2.4 Criteria of Good Language Design

The syntax design should follow from semantic intuitions from the subject matter domain - labeling entities, properties, and relations as well as some of the type constraints amongst them that guide how the labels are combined and used.

Criteria of Good Language Design are:

- Minimality, which requires that the language provides only a small set of needed language constructs, i.e., the same meaning cannot be expressed by different language constructs.
- Referential transparency, which means that the same language construct always expresses the same semantics regardless of the context in which it is used.
- Orthogonality, which means that language constructs are independent of each other, thus permitting their systematic combination.

LegalRuleML follows pattern-based design, where design patterns are a distillation of common wisdom in organizing the structural parts, the grammar and the constraints of a language. Some of them are listed in [11] and as XML Patterns[1]. Inside of LegalRuleML we introduce five design patterns.

LegalRuleML was designed based on the above principles. In particular, its vocabulary is inspired by terms from the legal domain, which then facilitates their use by users familiar with that domain. Also, the LegalRuleML meta-model captures the common meaning of such terms as understood in the legal field. In what follows we illustrate the connections among the various concepts and their representation in the language.

1 http://www.xmlpatterns.com/

3 Vocabulary

3.1 Scope of the vocabulary (non-normative)

This chapter defines the terminology for the internal documentation of LegalRuleML XML-schema and connected modules as well as general concepts used in the narrative about LegalRuleML. Those terms that are embedded in the XML-schema appear under Node Elements, while those used as well in the narrative are indicated with +. Terminology that is being defined appears on the left, while terminology that has been defined elsewhere appears with an initial capital letter.

These definitions are duplicated in the Relax NG and XSD schemas and the RDFS metamodel. In the case of discrepancy, the definition in the Vocabulary section takes precedence.

3.2 General Concepts (non-normative)

Actor: an Agent or a Figure.

Deontic Specification: An indication of what states are legal or illegal. Deontic Specifications include Obligation, Permission, Prohibition, SuborderList, etc., or a Boolean combination of Deontic Specifications other than SuborderLists (at any depth).

Internal Identifier: a local unique identifier of a node in a LegalRuleML document.

Isomorphism: a relationship between a set of Legal Rules with a set of Legal Sources such that the origin of the Legal Rules is tied to the Legal Sources.

Legal Norm: a binding directive from a Legal Authority to addressees (i.e. Bearers or Auxiliary Parties).

Legal Rule: a formal representation of a Legal Norm.

LegalRuleML Specification: an XML schema, Relax NG schema, metamodel, glossary, license, or any other technical normative specification that is an approved outcome of this OASIS TC.

LegalRuleML Schema: one of the following

- Basic Dialect XSD schema: xsd-schema/basic/lrml-basic.xsd).
- Compact LegalRuleML XSD schema: xsd-schema/compact/lrml-compact.xsd) OR
- Compact LegalRuleML RelaxNG schema relaxng/lrml-compact.rnc
- Normalized LegalRuleML XSD xsd-schema/normal/lrml-normal.xsd
- Normalized LegalRuleML RelaxNG schema relaxng/lrml-normal.rnc

Legal Statement: a LegalRuleML expression of a Legal Rule or a part of a Legal Rule.

Legal Status: a standing that can apply to a Legal Norm at a Time, e.g., "is applicable", "is in force", "has efficacy", "is valid".Status Development: a kind of event (e.g., start, end) that changes the Legal Status of a Legal Norm, e.g. making a Legal Norm come into force.

LegalRuleML Profile of Consumer RuleML 1.02: it means the derivative work of Consumer RuleML 1.02 for the purpose of LegalRuleML Specification.

3.3 Namespaces (normative)

The LegalRuleML namespace is `http://docs.oasis-open.org/legalruleml/ns/v1.0/`.

The LegalRuleML metamodel namespace is `http://docs.oasis-open.org/legalruleml/ns/mm/v1.0/`

Other namespaces used in LegalRuleML documents are:

- The RuleML namespace `http://ruleml.org/spec`
- The XML namespace `http://www.w3.org/XML/1998/namespace`

- The XML Schema namespaces http://www.w3.org/2001/XMLSchema-instance and http://www.w3.org/2001/XMLSchema

3.4 Node Elements (normative)

Agent(s)+: an entity that acts or has the capability to act.

Alternatives +: a mutually exclusive collection where every member is a LegalRuleML rendering of one or more Legal Norms.

Association(s): a partial description of the extension of some relations where each non-target entity is paired with every target entity.

Authority(ies) +: a person or organization with the power to create, endorse, or enforce Legal Norms.

AuxiliaryParty +: a role in a Deontic Specification to which the Deontic Specification is related.

Bearer +: a role in a Deontic Specification to which the Deontic Specification is primarily directed.

Comment: a comment, which has no semantic effect.

Compliance +: an indication that an Obligation has been fulfilled or a Prohibition has not been violated.

ConstitutiveStatement +: a Legal Statement that defines concepts and does not prescribe behaviors.

Context +: an application of Associations to their target entities within a Scope.

DefeasibleStrength +: an indication that, in the absence of information to the contrary and where the antecedent of a Legal Rule holds, the conclusion of the Legal Rule holds.

Defeater +: an indication that, in the absence of information to the contrary and where the antecedent of a Legal Rule holds, the opposite of the conclusion of the Legal Rule does not hold.

FactualStatement +: an expression of fact.

Figure(s) +: an instantiation of a function by an Actor.

Jurisdiction(s) +: a geographic area or subject-matter over which an Authority applies its legal power.

LegalRuleML: a formal representation of one or more LegalSources using the LegalRuleML Specifications.

LegalSource(s) +: a source of one or more Legal Norms formulated in any format and endorsed by an Authority.

Obligation +: a Deontic Specification for a state, an act, or a course of action to which a Bearer is legally bound, and which, if it is not achieved or performed, results in a Violation.

Override +: an indication that a Legal Rule takes precedence over another Legal Rule. The ordered pair of Legal Rules is an instance in a defeasible priority relation.

OverrideStatement +: a Legal Statement of an Override.

Paraphrase +: a natural language rendering of a Legal Rule or fragment of it that is an alternative to its Legal Source(s).

PenaltyStatement +: a Legal Statement of a sanction (e.g. a punishment or a correction).

Permission (see also Right) +: a Deontic Specification for a state, an act, or a course of action where the Bearer has no Obligation or Prohibition to the contrary. A weak Permission is the absence of the Obligation or Prohibition to the contrary; a strong Permission is an exception or derogation of the Obligation or Prohibition to the contrary.

Prefix +: a prefix declaration in a LegalRuleML document.

PrescriptiveStatement +: a Legal Statement which prescribes behaviors, e.g. with Permissions, Obligations, or Prohibitions on states, actions, or courses of actions.

Prohibition +: a Deontic Specification for a state, an act, or a course of action to which a Bearer is legally bound, and which, if it is achieved or performed, results in a Violation.

Reference(s) +: a pair consisting of an internal ID and an enriched non-IRI identifier, where the non-IRI is paired with some additional information that is sufficient to disambiguate the non-IRI to a unique LegalSource.

Reparation +: an indication that a PenaltyStatement is linked with a PrescriptiveStatement. It indicates that a sanction may apply where the PrescriptiveStatement entails a Deontic Specification and when there is a Violation of the Deontic Specification.

ReparationStatement: a Legal Statement of a Reparation.

Right (see also Permission) +: a Deontic Specification that gives a Permission to a party (the Bearer) and implies there are Obligations or Prohibitions on other parties (the AuxiliaryParty) such that the Bearer can (eventually) exercise the Right.

Role(s) +: a function of or part played by an Actor relative to a LegalRuleML expression.

Source(s)+: a source of information formulated in any format.

Statements +: a collection where every member is a Legal Statement or a FactualStatement.

Strength: the quality of a Legal Rule to resist or not to resist a rebuttal.

StrictStrength +: an indication that where the antecedent of a Legal Rule is indisputable, the conclusion of the Legal Rule is indisputable.

SuborderList: A Deontic Specification consisting of a sequence of Deontic Specifications other than SuborderLists (at any depth). When a SuborderList holds, a Deontic Specification in the SuborderList holds if all Deontic Specifications that precede it in the SuborderList have been violated.

TemporalCharacteristic(s) +: a pair of Time with a qualification, which consists of a Legal Status and a Status Development, such that the qualification holds at the Time.

Time(s) +: a collection where each member is a Time.

Violation +: an indication that an Obligation or Prohibition has been violated.

3.5 RuleML Node Elements (normative)

`ruleml:Rule`:

a) a RuleML Rule encoding a Constitutive Statement.

b) a RuleML Rule encoding a Prescriptive Statement.

`ruleml:Time` +: a neutral temporal entity.

For nodes with the plural, i.e., `<Node>`(s) the node `<Nodes>` is defined as a collection where every member is a `<Node>`. The plural form is not a General Concept.

3.6 Edge elements (normative)

`applies`*`<Node>`* : a *`<Node>`* applied by the `Context` or `Association` (e.g. `appliesAuthority` – an `Authority` applied by the `Context` or `Association`).

`appliesAlternatives`: a collection of Alternatives applied by the `Context`.

`appliesAssociations`: a collection of Associations applied by the `Context`.

`appliesAssociation`: an `Association` applied by the `Context`.

`appliesAuthority`: an `Authority` applied by the `Context` or `Association`.

`appliesJurisdiction`: a `Jurisdiction` applied by the `Context` or `Association`.

`appliesStrength`: a `Strength` applied by the `Context` or `Association`.

`appliesTemporalCharacteristics`: a collection of `TemporalCharacteristics` applied by the `Context` or `Association`.

`appliesTemporalCharacteristic`: a `TemporalCharacteristic` applied by the `Context` or `Association`.

`appliesModality`: the deontic mode that applies to a Deontic Specification in a `Context` or `Association`.

`appliesPenalty`: the `PenaltyStatement` that is linked to a LegalRule in a `Reparation`.

appliesSource: a LegalSource or Reference applied by the Context or Association.

atTime: the Time of the qualification of a TemporalCharacteristic.

filledBy: an Actor that fills the Role.

forExpression: a LegalRuleML expression for which the Role is responsible (e.g., the expression was created or endorsed by the role).

forStatus: the Legal Status of the qualification in a TemporalCharacteristic.

fromLegalSources: the LegalSources from which the Alternatives are derived.

has<*Node*>*:* a <Node> in the collection (e.g. hasAgent – an Agent in the collection).

- hasAlternative: an Alternative in the collection.
- hasAgent: an Agent in the collection.
- hasAssociation: an Association in the collection.
- hasAuthority: an Authority in the collection.
- hasFigure: a Figure in the collection.
- hasJurisdiction: a Jurisdiction in the collection.
- hasLegalSource: a LegalSource in the collection.
- hasReference: a Reference in the collection.
- hasRole: a Role in the collection.
- hasStatement: a Legal Statement in the collection.
- hasTemporalCharacteristic: a TemporalCharacteristic in the collection.
- hasTime: a Time in the collection.

has<Node>s: a collection of <node>s (e.g. hasAgents – a collection of Agents).

- hasAgents: a collection of Agents.
- hasAlternatives: a collection of Alternatives.
- hasAssociations: a collection of Associations.
- hasAuthorities: a collection of Authorities.
- hasFigures: a collection of Figures.
- hasJurisdictions: a collection of Jurisdictions.
- hasLegalSources: a collection of LegalSources.
- hasReferences: a collection of References.
- hasRoles: a collection of Roles.
- hasStatements: a collection of Legal Statements.
- hasTemporalCharacteristics: a collection of TemporalCharacteristics.
- hasTimes: a collection of Times.

hasActor: an Actor that has the responsibility to fulfill the function of a Figure.

hasContext: a Context described in the LegalRuleML document.

hasComment: a Comment on the parent Node Element.

hasFunction: the function of a Figure.

hasParaphrase: a Paraphrase of the parent Node Element (e.g. a Legal Rule).

hasPrefix: a Prefix declared in the LegalRuleML document.

hasQualification: a qualification (e.g. an Override) of the Statements.

hasStatusDevelopment: the Status Development of the qualification in a TemporalCharacteristic.

hasStrength: the Strength of the Legal Rule.

hasTemplate: the template of a Legal Statement.

inScope: the Statement or (collection of) Statements that the Context is applied to.

hasMemberType: the type or class of members of the collection.

toPrescriptiveStatement: the PrescriptiveStatement that is linked to a PenaltyStatement in a Reparation.

toTarget: the target to which properties are applied by the Association.

hasType: the type or class of the parent Node Element.

3.7 Attributes on LegalRuleML elements, unqualified (normative)

@hasCreationDate: the creation date of the Context or LegalRuleML document.

@iri: an IRI providing details regarding the parent Node Element.

@key: a Node Element label.

@keyref: a Node Element reference.

@memberType: the type or class of members of the collection.

@over: the Legal Rule with higher priority.

@pre: the prefix in a Prefix declaration, following CURIE conventions.

@refersTo: the internal ID of the Reference.

@refID: the external ID of the Reference.

@refIDSystemName: the name of the ID system of the Reference (or of References contained by the References collection).

@refIDSystemSource: the IRI source of the ID system of the Reference (or of References contained by the References collection).

@refType: the conceptual type of the Reference (or of references contained by the References collection).

@sameAs: an IRI that denotes the same thing as the parent Node Element.

@strength: the (defeasible) Strength of the Legal Rule.

@type: the type or class of the parent Node Element.

@under: the Legal Rule with lower priority.

3.8 Non-skippable Edges (normative)

In the LegalRuleML normalized serialization, the children of Node elements can only be edge elements. An edge element MAY be empty (called a leaf element) or it MAY contain one Node element. Together, these requirements give rise to a "striped" syntax.

In the LegalRuleML compact serialization, the only edge elements in the LegalRuleML namespace that are allowed are leaf edge elements. To obtain the compact serialization from a normalized serialization of a LegalRuleML document, first delete the tags for any LegalRuleML edge elements that have children.

Further, in the LegalRuleML compact serialization, the elements in the RuleML namespace MUST also be "compactified". To accomplish this, delete the tags of the following skippable edge elements in the RuleML namespace:
ruleml:arg

```
ruleml:op
ruleml:torso
ruleml:left
ruleml:right
ruleml:formula
ruleml:declare
ruleml:weak
ruleml:strong
```

3.9 LegalRuleML Metamodel (normative)

The LegalRuleML metamodel captures the common meaning of domain terms as understood in the legal field, formalizes the connections among the various concepts and their representation in the language, and provides an RDF-based abstract syntax. RDFS (see Annex C) is used to define the LegalRuleML metamodel, and graphs of the RDFS schemas accompany the following discussions about the domain concepts. http://wiki.ruleml.org/index.php/Metamodel

The LegalRuleML metamodel uses placeholder IRIs to stand in for components of the RuleML metamodel [RuleMLMetamodel], which is under development at the time of publication of this document.

4 LegalRuleML Functional Requirements (non-normative)

4.1 Functionalities

Specifically, LegalRuleML facilitates the following functionalities.

- R1) Supports modeling different types of rules. There are constitutive rules, which define concepts or institutional actions that are recognized as such by virtue of the defining rules (e.g. the legal definition of “transfer property ownership”) and there are prescriptive rules, which regulated actions or the outcome of actions by making them obligatory, permitted, or prohibited.
- R2) Represents normative effects. There are many normative effects that follow from applying rules, such as obligations, permissions, prohibitions, and more articulated effects. Rules are also required to regulate methods for detecting violations of the law and to determine the normative effects triggered by norm violations, such as reparative obligations, which are meant to repair or compensate violations. These constructions can give rise to very complex rule dependencies, because the violation of a single rule can activate other (reparative) rules, which in turn, in case of their violation, refer to other rules, and so forth.
- R3) Implements defeasibility [17, 33, 37]. In the law, where the antecedent of a rule is satisfied by the facts of a case (or via other rules), the conclusion of the rule presumably, but not necessarily, holds. The defeasibility of legal rules consists of the means to identify exceptions and conflicts along with mechanisms to resolve conflicts.
- R4) Implements isomorphism [7]. To ease validation and maintenance, there should be a one-to-one correspondence between collections of rules in the formal model and the units of (controlled) natural language text that express the rules in the original legal sources, such as sections of legislation.
- R5) Represents alternatives. Often legal documents are left ambiguous on purpose to capture open ended aspects of the domain they are intended to regulate. At the same time legal documents are meant to be interpreted by end users. This means that there are cases where multiple (and incompatible) interpretations of the same textual source are possible. LegalRuleML offers mechanisms to specify such interpretations and to select one of them based on the relevant context.
- R6) Manages rule reification [17]. Rules are objects with properties, such as Jurisdiction, Authority, Temporal attributes [26, 32]. These elements are necessary to enable effective legal reasoning.

4.2 Modeling Legal Norms

According to scholars of legal theory [36], norms can be represented by rules with the form

```
if A_1, ... , A_n then C
```

where `A_1,...,A_n` are the pre-conditions of the norm, `C` is the effect of the norm, and `if ... then ...` is a normative conditional, which are generally defeasible and do not correspond to the if-then material implication of propositional logic. Norms are meant to provide general principles, but at the same time they can express exceptions to the principle. It is well understood in Legal Theory [18, 37] that, typically, there are different types of “normative conditionals”, but in general normative conditionals are defeasible. Defeasibility is the property that a conclusion is open in principle to revision in case more evidence to the contrary is provided. Defeasible reasoning is in contrast to monotonic reasoning of propositional logic, where no revision is possible. In addition, defeasible reasoning allows reasoning in the face of contradictions, which gives rise to *ex false quodlibet* in propositional logic. One application of defeasible reasoning is the ability to model exceptions in a simple and natural way.

4.2.1 Defeasibility

The first use of defeasible rules is to capture conflicting rules/norms without making the resulting set of rules inconsistent. Given that `-expression` means the negation of expression, the following two rules conclude with the negation of each other

```
body_1 => head
body_2 => -head
```

Without defeasibile rules, rules with conclusions that are negations of each other could give rise, should body 1 and body 2 both hold, to a contradiction, i.e., `head` and `-head`, and consequently *ex falso quodlibet*. Instead, defeasible reasoning is sceptical; that is, in case of a conflict such as the above, it refrains from taking any of the two conclusions, unless there are mechanisms to solve the conflict (see the discussion below on the superiority relation). We can apply this to model exceptions. Exceptions limit the applicability of basic norms/rules, for example:

```
body => head
body, exception_condition => -head
```

In this case, the second rule is more specific than the first, and thus it forms an exception to the first, i.e., a case where the rule has extra conditions that encode the exception, blocking the conclusion of the first rule. Often, exceptions in defeasible reasoning can be simply encoded as

```
body => head
exception_condition => -head
```

In the definition of rules as normative conditionals made up of preconditions and effect, we can see a rule as a binary relationship between the set of pre-conditions (or body or antecedent) of the rule, and the (legal) effect (head or conclusion) of the rule. Formally, a rule can be defined by the following signature:

```
body x head
```

We can then investigate the nature of such a relationship. Given two sets, we have the following seven possible relationships describing the “strength” of the connections between the body and the head of a rule:

```
body always head
body sometimes head
body not complement head
body no relationship head
body always complement head
body sometimes complement head
body not head
```

In defeasible logic we can represent the relationships using the following formalisation of rules (rule types):

```
body -> head
body => head
body ~> head
body -> -head
body => -head
body ~> -head
```

The seventh case is when there are no rules between the body and the head. The following table summarizes the relationships, the notation used for them, and the strength of the relationship.[2]

body always head	body -> head	Strict rule
body sometimes head	body => head	Defeasible rule
body not complement head	body ~> head	Defeater

[2] The syntax presented here is based on Defeasible Logic, see [3, 30].

`body no relationship head`		
`body always complement head`	`body -> -head`	`Strict rule`
`body sometimes complement head`	`body => -head`	`Defeasible rule`
`body not head`	`body ~> -head`	`Defeater`

The meaning of the different types of rules is as follows:

For a *strict rule* `body -> head` the interpretation is that every time the body holds then the head holds.

For a *defeasible rule* `body => head` the reading is when the body holds, then, typically, the head holds. Alternatively, we can say that the head holds when the body does unless there are reasons to assert that the head does not hold. This captures that it is possible to have exceptions to the rule/norm, and it is possible to have prescriptions for the opposite conclusion.

For a *defeaters* `body` ~> `head` the intuition is as follows: defeaters are rules that cannot establish that the head holds. Instead they can be used to specify that the opposite conclusion does not hold. In argumentation two types of defeaters are recognized: defeaters used when an argument attacks the preconditions of another argument (or rule); other defeaters used when there is no relationship between the premises of an argument (preconditions of a rule or body) and the conclusion of the argument (effect of the rule or head).

It is possible to have conflicting rules, i.e., rules with opposite or contradictory heads, for example

```
body1 => head
body2 => -head
```

Systems for defeasible reasoning include mechanisms to solve such conflicts. Different methods to solve conflicts have been proposed: *specificity*, *salience*, and *preference relation*. According to specificity, in case of a conflict between two rules, the most specific rule prevails over the less specific one, where a rule is more specific if its body subsumes the body of the other rule. For salience, each rule has an attached salience or weight, where in case of a conflict between two rules, the one with the greatest salience or weight prevails over the other. Finally, a preference relation (also known as superiority relation) defines a binary relation over rules, where an element of the relation states the relative strength between two rules. Thus, in case of a conflict between two rules, if the preference relation is defined order such rules, the strongest of the two rules wins over the other.

Various researchers have taken different views on such methods. Specificity corresponds to the well know legal principle of *lex specialis*. Prakken and Sartor [34] argue that specificity is not always appropriate for legal reasoning and that there are other well understood legal principles such as *lex superior* and *lex posterior* apply instead. Prakken and Sartor [34] cite cases in which the *lex specialis* principle might not be the one used to solve the conflict, for example, a more specific article from a local council regulation might not override a less specific constitutional norm. Prakken and Sartor [34] propose a dynamic preference relation to handle conflicting rules. The preference relation is dynamic in the sense that it is possible to argue about which instances of the relation hold and under which circumstances. Antoniou [2] proposes that instances of the superiority relation appear in the head of rules, namely:

```
body => superiority
```

where *superiority* is a statement with the form

```
r1 > r2
```

where `r1` and `r2` are rule identifiers.

Gordon et al. [19] propose Carneades as a rule-based argumentation system suitable for legal reasoning, where they use weights attached to the arguments (rules) to solve conflicts and to define proof standards. Governatori [21] shows how to use the weights to generate an equivalent preference relation, and, consequently, how to capture the proposed proof standards. In addition, Governatori [21] shows that there are situations where a preference relation cannot be captured by using weights on the rules.

To handle defeasibility, LegalRuleML has to capture the superiority relation and the strength of rules. For the superiority relation, LegalRuleML offers the element `<lrml:Override>`, which defines a relationship of superiority where `cs2` overrides `cs1`, where `cs2` and `cs1` are Legal Statement (see the glossary definition) identifiers. These elements are included in `<lrml:hasTemplate>` element in the Normal form (all the Normal form examples are collected in the Annex F) and in the <lrml:OverrideStatement> element in the Compact form. Example 1 (compact form)[3]:

```
<lrml:OverrideStatement>
   <lrml:Override over="#cs2" under="#cs1"/>
</lrml:OverrideStatement>
```

For the representation of the strength of rules, LegalRuleML has two options. The first is to include it in a <lrml:Context> block, where a <lrml:Context> specifies a context in which the rule is applied.

Example 2 (compact form)[4]:

```
<lrml:Prefix pre="defvo" refID="http://example.org/defeasible/vocab#"/>

<lrml:Context key="ruleInfo2">
   <lrml:appliesStrength iri="defvo:defeasibleType2"/>
   <lrml:inScopekey ref="#cs1"/>
</lrml:Context>
```

The second (and optional) way to express the qualification of the rule is directly inside of the rule with an <lrml:hasStrength> block. The difference is that <lrml:Context> localizes the strength of a rule, while the <lrml:hasStrength> block in effect relates the strength to the rule in all contexts.

Example 3 (compact form)[5]:

```
<ruleml:Rule key=":ruletemplate3" keyref=":ruletemplate2">
   <lrml:hasStrength>
          <lrml:Defeater key="str4"/>
   </lrml:hasStrength>
</ruleml:Rule>
```

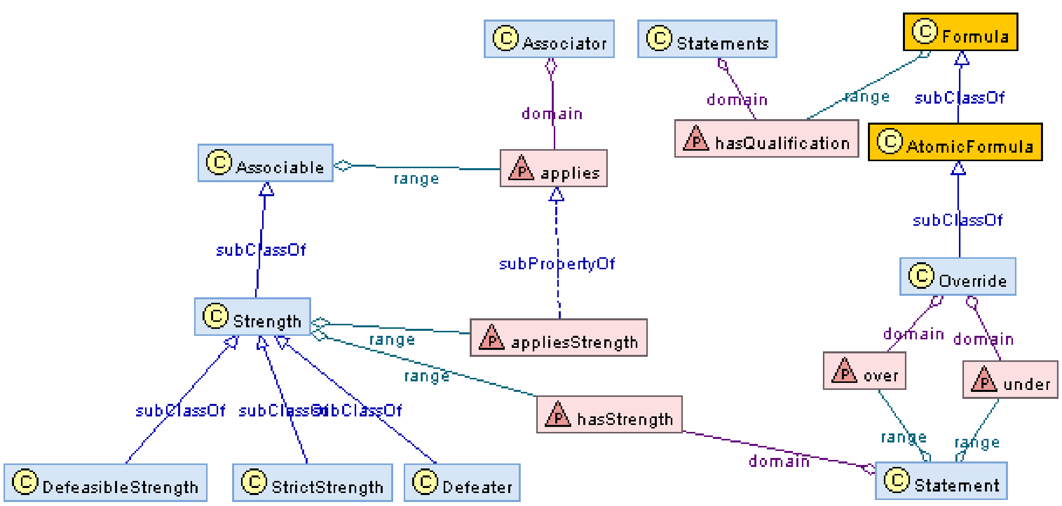

Fig. 1. Partial Metamodel for Defeasible Concepts. LegalRuleML classes are shown with blue fill,

[3] examples/compactified/ex8-defeasible-compact.lrml

[4] examples/compactified/ex8-defeasible-compact.lrml

[5] examples/compactified/ex8-defeasible-compact.lrml

LegalRuleML properties with pink fill, RuleML classes with orange fill.

4.2.2 Constitutive and Prescriptive Norms

As we have discussed, a Legal Rule can be seen as a binary relationship between its antecedent (a set of formulas, encoding the pre-conditions of a norm, represented in LegalRuleML by a formula, where multiple pre-conditions are joined by some logical connective) and its conclusion (the effect of the norm, represented by a formula). It is possible to have different types of relations. In the previous section, we examined one such aspect: the strength of the link between the antecedent and the conclusion. Similarly, we can explore a second aspect, namely what type of effect follows from the pre-condition of a norm. In Legal Theory norms are classified mostly in two main categories: *constitutive norms* and *prescriptive norms*, which will be then represented as *constitutive rules* (also known as *counts-as rules*) and *prescriptive rules*.[6]

The function of constitutive norms is to define and create so called *institutional facts* [39], where an institutional fact is how a particular concept is understood in a specific institution. Thus, constitutive rules provide definitions of the terms and concepts used in a jurisdiction. On the other hand, prescriptive rules dictate the obligations, prohibitions, permissions, etc. of a legal system, along with the conditions under which the obligations, prohibitions, permissions, etc. hold. LegalRuleML uses deontic operators to capture such notions (see Section 4.2.3). Deontic operators are meant to qualify formulas. A Deontic operator takes as its argument a formula and returns a formula. For example, given the (atomic) formula `PayInvoice(guido)`, meaning 'Guido pays the invoice', and the deontic operator `[OBL]` (for obligation), the application of the deontic operator to the formula generates the new formula `[OBL]PayInvoice(guido)`, meaning that "it is obligatory that Guido pays the invoice".

The following is the LegalRuleML format for prescriptive rules. Notice, that in LegalRuleML Legal rules are captured by the broader class of Statements.

Example 4 (compact form)[7]:

```
<lrml:Statements>
   <lrml:PrescriptiveStatement key="ps1">
         <ruleml:Rule key="ex:key1">
                <lrml:hasStrength>
                <lrml:StrictStrength key="str3"
iri="http://www.w3.org/2001/XMLSchema#strict1"/>
                </lrml:hasStrength>
                <ruleml:if>
                       <ruleml:Atom key=":atom1">
                       </ruleml:Atom>
         set of deontic formulas and formulas
                </ruleml:if>
                <ruleml:then>
                       <lrml:SuborderList>
                       list of deontic formulas
                       </lrml:SuborderList>
                </ruleml:then>
         </ruleml:Rule>
   </lrml:PrescriptiveStatement>
</lrml:Statements>
```

6 Gordon et al. [18] identify more types of norms/rules. However, most of them can be reduced to the two types described here insofar as the distinction is not on the structure of the rules but depends on the meaning of the content (specific effect) of the rules, while keeping the same logical format.

7 examples/compactified/ex8-defeasible-compact.lrml

The difference between constitutive rules and prescriptive rules is in the content of the head, where the head of a prescriptive rule is list of deontic operators, i.e., `[D1]formula1,...,[Dn]formulan` which is called a *suborder list* (see Section 4.2.3.2 below), and represented in LegalRuleML by the `<lrml:SuborderList>` block. Prescriptive and constitutive rules can have deontic formulas as their preconditions (body). The conclusion (head) of a constitutive rule cannot be a deontic formula.

Example 5 (compact form)[8]:

```
<lrml:Statements>
   <lrml:ConstitutiveStatement key="ps1">
                <ruleml:Rule key="ruleml:key1">
                     <lrml:hasStrength>
                          <lrml:DefeasibleStrength key="str1"
iri="http://www.w3.org/2001/XMLSchema#defeasible1"/>
                     </lrml:hasStrength>
                     <ruleml:if>
                          <ruleml:Atom key=":atom1">
                          </ruleml:Atom>
           set of deontic formulas and formulas
                     </ruleml:if>
                     <ruleml:then>
                          <ruleml:Atom key=":atom1">
                          </ruleml:Atom>
           set of deontic formulas and formulas
                     </ruleml:then>
                </ruleml:Rule>
   </lrml:ConstitutiveStatement>
</lrml:Statements>
```

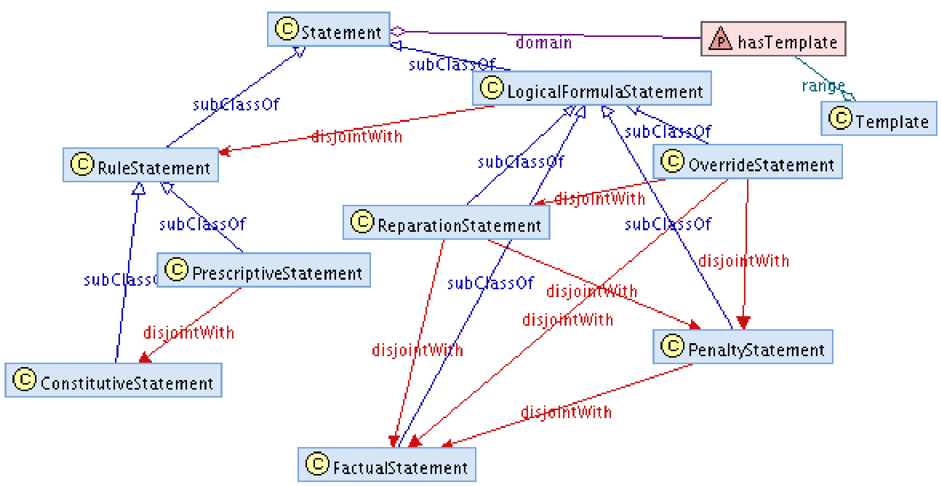

Fig. 2. Partial Metamodel for Statement Subclasses.

The partial meta-model for Statement Subclasses is depicted in Figure 2.

4.2.3 Deontic

One of the functions of norms is to regulate the behavior of their subjects by imposing constraints on what the subjects can or cannot do, what situations are deemed legal, and which ones are considered to be illegal. There is an important difference between the constraints imposed by norms and other types of constraints. Typically, a constraint means that the situation described by the constraint cannot occur. For

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example, the constraint A means that if -A (the negation of A, that is, the opposite of A) occurs, then we have a contradiction, or in other terms, we have an impossible situation. Norms, on the other hand, can be violated. Namely, given a norm that imposes the constraint A, yet we have a situation where -A, we do not have a contradiction, but rather a Violation (see also the glossary), or in other terms we have a situation that is classified as "illegal". From a logical point of view, we cannot represent the constraint imposed by a norm simply by A, since the conjunction of A and -A is a contradiction. Thus we need a mechanism to identify the constraints imposed by norms. This mechanism is provided by modal (deontic) operators.

4.2.3.1 Modal and Deontic Operators

Modal logic is an extension of classical logic with modal operators. A modal operator applies to a proposition to create a new proposition. The meaning of a modal operator is to "qualify" the truth of the proposition that the operator applies to. The basic modal operators are those of *necessity* and *possibility*. Accordingly, given a proposition p expressing, for example that "the snow is white" and the necessity modal operator [NEC], [NEC]p is the proposition expressing that "necessarily the snow is white". Typically, the necessity and possibility operators are the dual of each other, namely:

```
[NEC]p equiv -[POS]-p
[POS]p equiv -[NEC]-p
```

The modal operators have received different interpretations: for example, necessity can be understood as logical necessity, physical necessity, epistemic necessity (knowledge), doxastic necessity (belief), temporal necessity (e.g., always in the future), deontic necessity (obligatory), and many more.

In the context of normative reasoning and representation of norms the focus is on the concepts of deontic necessity and deontic possibility. These two correspond to the notions of Obligation (see also the glossary) and Permission (see also the glossary). In addition, we consider the notion of Prohibition (see also the glossary), which corresponds to the operator of deontic impossibility. For something to be "deontically necessary" means that it holds in all situations deemed legal; similarly, something is "deontically possible" if there is at least one legal state where it holds. Finally, "deontically impossible" indicates that something does not hold in any legal state.

We will use [OBL] for the modal/deontic operator of Obligation, [PER] for Permission, and [FOR] for Prohibition (or Forbidden).

Standard deontic logic assumes the following relationships between the operators:

```
[OBL]p equiv -[PER]-p
```

If p is obligatory, then its opposite, -p, is not permitted.

```
[FOR]p equiv [OBL]-p
```

If p is forbidden, then its opposite is Obligatory. Alternatively, a Prohibition can be understood as Obligation of the negation.

Accordingly, the following is an example of mathematical statement of a Prescriptive Rule (see also the glossary):

```
p_1_, ..., p_n_, [DEON_1_]p_n+1_, ..., [DEON_m_]p_n+m_ =>[DEON] q
```

The antecedent, p_1_, ..., p_n_, [DEON_1_]p_n+1_, ..., [DEON_m_]p_n+m_, conditions the applicability of the norm in the consequent [DEON] q; that is, when the antecedent conditions are met, then the consequent is the *deontic* effect of them. Thus, given the antecedent, the rule implies [DEON] q.

The operators of Obligation, Prohibition and Permission are typically considered the basic ones, but further refinements are possible, for example, two types of permissions have been discussed in the literature on deontic logic: *weak permission* (or *negative permission*) and *strong permission* (or *positive permission*). Weak permission corresponds to the idea that some A is permitted if -A is not provable as mandatory. In other words, something is allowed by a code only when it is not prohibited by that code

[41]. The concept of strong permission is more complicated, as it amounts to the idea that some `A` is permitted by a code if and only if such a code explicitly states that `A` is permitted, typically as an exception to the prohibition of `A` or the obligation of its contrary, i.e., `–A`. It follows that a strong permission is not derived from the absence of a prohibition, but is explicitly formulated in a permissive (prescriptive) norm [1]. For example, an explicit permissive norm is a sign "U-turn permitted" at a traffic light, which derogates the (general) prohibition on U-turns at traffic lights.

Refinements of the concept of obligation have been proposed as well. For example it possible to distinguish between *achievement* and *maintenance* obligations, where an *achievement* obligation is an obligation that is fulfilled if what the obligation prescribes holds at least once in the period when the obligation holds, while a *maintenance* obligation must be obeyed for all the instants when it holds (see [19] for a classification of obligations).

LegalRuleML is neutral about the different subclasses of the deontic operators; to this end, LegalRuleML is equipped with two mechanisms to point to the semantics of various Deontic Specifications (see also the glossary) in a document. The first mechanism is provided by the `iri` attribute of a Deontic Specification, for example.

Example 6 (compact form):

```
<lrml:Obligation
    key="oblig1"
    iri="ex:achievementObligation">
    ...
</lrml:Obligation>
```

The second mechanism is to use an Association to link a Deontic Specification to its meaning using the `<lrml:applyModality>` element, namely:

Example 7 (compact form)[9]:

```
<lrml:Association>
    <lrml:appliesModality
       iri="ex:maintenanaceObligation"/>
    <lrml:toTarget keyref="#obl101"/>
</lrml:Association>
```

Furthermore, Obligations, Prohibitions and Permissions in LegalRuleML are directed operators[28], thus they have parties (e.g. Bearer - see also the glossary), specifying, for example, who is the subject of an Obligation or who is the beneficiary of a Permission.

Example 8 (compact form)[10]:

```
<lrml:Obligation iri="ex:obl1”>
  <ruleml:slot>
    <lrml:Bearer iri="ex:oblBearer"/>
    <ruleml:Ind>Y</ruleml:Ind>
  </ruleml:slot>
  <ruleml:Atom key="ex:atom2">
    <ruleml:Rel iri="ex:rel2"/>
```

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```
    <ruleml:Ind>X</ruleml:Ind>
  </ruleml:Atom>
</lrml:Obligation>
```

4.2.3.2 Violation, Suborder, Penalty and Reparation

Obligations can be violated; according to some legal scholars, the possibility of being violated can be used to define an obligation. A violation means that the content of the obligation has not been met. It is important to notice that a violation does not result in an inconsistency. A violation is, basically, a situation where we have

```
([OBL]p) and -p:
```

One of the characteristics of norms is that having violated them, a penalty can be introduced to compensate for the violation, where a penalty is understood to also be a deontic formula. To model this feature of norms and legal reasoning, Governatori and Rotolo [25] introduced what is called here a suborder list, and Governatori [22] showed how to combine them with defeasible reasoning for the modeling of (business) contracts. As we have seen above, a suborder list (SuborderList in the glossary) is a list of deontic formulas, i.e., formulas of the form `[D]A`, where `[D]` is one of `[OBL]` (Obligation), `[FOR]` (Prohibition, or forbidden), `[PER]` (Permission) and `[RIGHT]` (Right). To illustrate the meaning of suborder lists, consider the following example:

```
[OBL]A, [OBL]B, [FOR]C, [PER]D
```

The expression means that `A` is obligatory, but if it is violated, i.e., where we have its opposite `–A`, then the obligation comes into force to compensate for the violation of `[OBL]A` with `[OBL]B`. If the Obligation with respect to `B` is violated, then we have `[FOR]C`, the Prohibition of `C`. At this stage, if we have a Violation of such a Prohibition, i.e., we have `C`, then the Permission of `D` kicks in. Obligations and Prohibitions should not be preceded by Permissions and Rights in a suborder list, for the semantics of Suborder lists is such that an element holds in the list only if all the elements that precede it in the list have been violated. It is not possible to have a Violation of a Permission, so it cannot serve a purpose in the Suborder list. Accordingly, an element following a Permission in a suborder list would never hold. For a full discussion on the issue of permissions and suborder lists, see [24].

Governatori and Rotolo [25], Governatori [22] also discuss mechanisms to combine the suborder lists from different rules. For example, given the rules

```
body => [OBL]A
-A => [OBL]B
```

Here the body of the second rule is the negation of the content of the obligation in the head of the first rule. It is possible to merge the two rules above in the following rule

```
body => [OBL]A, [OBL]B
```

stating that one compensates for the violation of the obligation of A with the obligation of B. This suggests that suborder lists provide a simple and convenient mechanism to model penalties.

It is not uncommon for a legal text (e.g., a contract) to include sections about penalties, where one Penalty (see also the glossary) is provided as compensation for many norms. To model this and to maintain the isomorphism between a source and its formalization, LegalRuleML includes a `<lrml:Penalty>` element, the scope of which is to represent a penalty as a suborder list (including the trivial non-empty list of a single element).

Example 9 (compact form)[11]:

---

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```
<lrml:Statements>
        <lrml:PenaltyStatement key="pen1">
                <lrml:SuborderList> list of deontic formulas
                </lrml:SuborderList>
        </lrml:PenaltyStatement>
</lrml:Statements>
```

Notice that the `<lrml:SuborderList>` node might be skipped in case of a trivial non empty list of a single element.

LegalRuleML not only models penalties, but aims to connect the penalty with the correspondent Reparation (see also the glossary).

Example 10 (compact form)[12]:

```
<lrml:Statements>
        <lrml:ReparationStatement>
                <lrml:Reparation key="rep1">
                        <lrml:appliesPenalty keyref="#pen1"/>
                        <lrml:toPrescriptiveStatement keyref="#ps1"/>
                </lrml:Reparation>
        </lrml:ReparationStatement>
</lrml:Statements>
```

With the temporal model of LegalRuleML (see Section 4.3.5), we can model a unique deontic rule (e.g., a prohibition) and several penalties that are updated over time according to the modifications of the law. Dynamically, the legal reasoner can point out the correct penalty according to the time of the crime (e.g., statutory damage 500$ in 2000, 750$ in 2006, 1000$ in 2010).

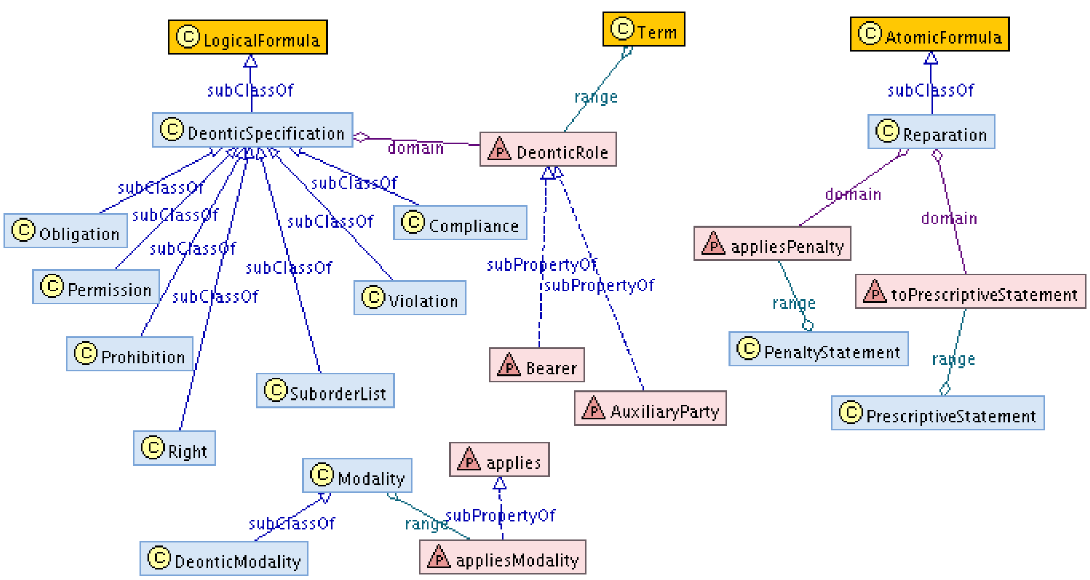

Fig. 3. Partial Metamodel for Deontic Concepts.

The partial meta-model for Deontic Concepts is depicted in Figure 3.

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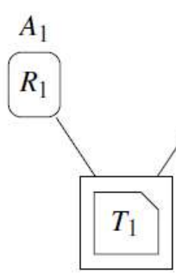
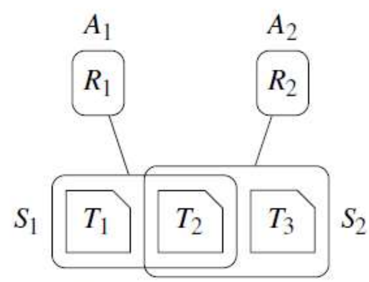
4.2.4 Alternatives

Judges interpret norms in order to apply them to concrete cases [40]. However, there may be a variety of interpretations of the law, some of which conflict and diverge from each other [14, 27, 35]. In addition, interpretations may vary for different reasons such as geographical jurisdiction (e.g., national and regional levels) or legal jurisdiction (e.g., civil or criminal court). The practice of law over time has developed its own catalogue of hermeneutical principles, a range of techniques to interpret the law, such as catalogued and discussed in [38]. In addition, in Linguistics, issues about interpretation have long been of central concern (see among others [13, 29]), where the need for interpretation arises given that the meanings (broadly construed) of "linguistic signs", (e.g., words, sentences, and discourses), can vary depending on participants, context, purpose, and other parameters. Interpretation is, then, giving the meaning of the linguistic signs for a given set of parameters.

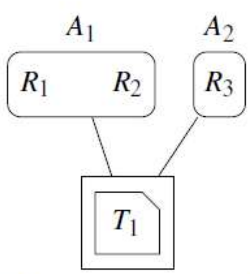
LegalRuleML endeavours not to account for how different interpretations arise, but to provide a mechanism to record and represent them as Alternatives (indicated with A's) containing rules (indicated with Rs). We have four different templates:



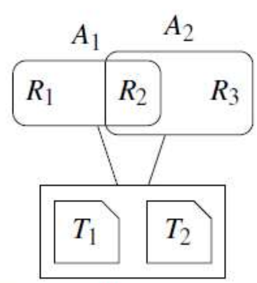
Case 1: Same legal provision(s), T_1, and different alternatives (A_1 and A_2).



Case 2: Different alternatives (A_1 and A_2) that share one or more pieces of text, T_2, but others are not shared (T_1 and T_3).



Case 3: Different alternatives (A_1 and A_2) sharing the same legal provision(s) (T_1), but embedding different rules (R_1 and R_2 for A_1 and R_3 for A_1).



Case 4: Different alternatives that share the same legal provision(s), but one or more rules are in common (e.g., R_2).

With the element `<lrml:Alternatives>`, we can express all these interpretation templates. The following LegalRuleML fragments illustrate how to represent the four cases above (the first case shows the normalized serialization, while the rest show the compact serialization).

Example 11 (compact form)[13]:

```
<lrml:Alternatives key="alt1">
  <lrml:fromLegalSources keyref="#t1"/>
  <lrml:hasAlternative keyref="#rule1"/>
  <lrml:hasAlternative keyref="#rule2"/>
```

[13] examples/compactified/ex9-alternatives-compact.lrml


```
  </lrml:Alternatives>
```

* CURIE annotation http://www.w3.org/TR/2009/CR-curie-20090116/

Example 12 (compact form)[14]:

```
   <lrml:Associations key="s1">
          <lrml:Association>
                 <lrml:appliesSource keyref="#ref1"/>
                 <lrml:appliesSource keyref="#ref2"/>
                 <lrml:toTarget keyref="#rule1"/>
          </lrml:Association>
   </lrml:Associations>
   <lrml:Associations key="s2">
          <lrml:Association>
                 <lrml:appliesSource keyref="#ref3"/>
                 <lrml:appliesSource keyref="#ref2"/>
                 <lrml:toTarget keyref="#rule2"/>
          </lrml:Association>
   </lrml:Associations>

<lrml:Alternatives key="alt1">
          <lrml:hasAlternative keyref="#s1"/>
          <lrml:hasAlternative keyref="#s2"/>
   </lrml:Alternatives>
```

Example 13 (compact form)[15]:

```
   <lrml:Alternatives key="alt3">
          <lrml:fromLegalSources keyref="#ref1"/>
          <lrml:hasAlternative keyref="#ss1"/>
          <lrml:hasAlternative keyref="#ss2"/>
   </lrml:Alternatives>

<lrml:Statements key="ss1">
   <lrml:ConstitutiveStatement keyref="#ps1"/>
   <lrml:ConstitutiveStatement keyref="#ps2"/>
</lrml:Statements>

<lrml:Statements key="ss2">
   <lrml:ConstitutiveStatement keyref="#ps3"/>
</lrml:Statements>
```

Example 14 (compact form)[16]:

```
   <lrml:Associations key="s1">
          <lrml:Association>
                 <lrml:appliesSource keyref="#ref1"/>
                 <lrml:appliesSource keyref="#ref2"/>
```

14 examples/compactified/ex11-maternity_alternatives-compact.lrml

15 examples/compactified/ex9-alternatives-compact.lrml

16 examples/compactified/ex11-maternity_alternatives-compact.lrml


```
                <lrml:toTarget keyref="#rule1"/>
                <lrml:toTarget keyref="#rule2"/>
        </lrml:Association>
</lrml:Associations>
<lrml:Associations key="s2">
        <lrml:Association>
                <lrml:appliesSource keyref="#ref1"/>
                <lrml:appliesSource keyref="#ref2"/>
                <lrml:toTarget keyref="#rule2"/>
                <lrml:toTarget keyref="#rule3"/>
        </lrml:Association>
</lrml:Associations>

<lrml:Alternatives key="alt4">
        <lrml:hasAlternative keyref="#s1"/>
        <lrml:hasAlternative keyref="#s2"/>
</lrml:Alternatives>
```

The LegalRuleML mechanism for alternatives can be used to model the (different, disputed) interpretations of a piece of legislation by the parties involved in the dispute; a comprehensive illustration of this is provided in [5].

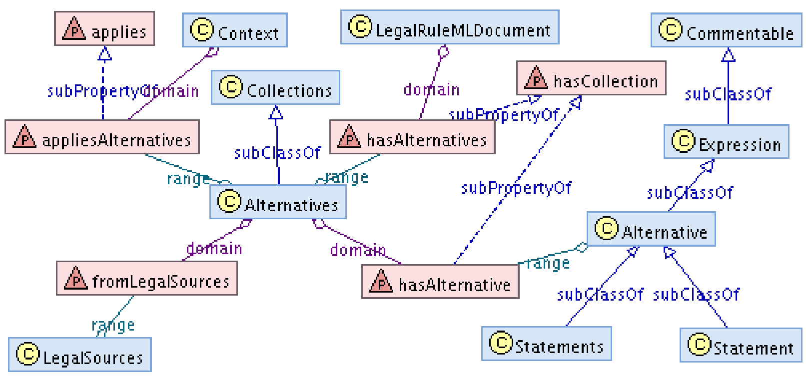


Fig. 4. Partial Metamodel for Alternatives Concepts.

The partial meta-model for Alternatives Concepts is depicted in Figure 4.

4.3 Metadata of the LegalRuleML Specifications

4.3.1 Sources and Isomorphism

For legal rule modeling, it is important for several reasons to maintain the connection between the formal norms and the legally binding textual statements that express the norms. Legal knowledge engineers and end users should know and be able to track the textual source of the formal representation. Furthermore, because the legal text is the only legally binding element, the connection between text and the rule(s) (or fragment of rule) guarantees the provenance, authoritativeness, and authenticity of the rules modelled by the legal knowledge engineer. In addition, legal experts (judges, lawyers, legal operators) request a mechanism to connect text and rules for legibility and validation of the rules. Finally, because the legal sources of rules change over time, the formal rules need to be updated according to the textual changes; as there is usually no automatic mechanism to correlate and track modifications to rules, the connection between text and rules helps to do so. For these reasons LegalRuleML includes a mechanism for managing this connection, which is called "isomorphism" in the AI & Law community.

The mechanism must support a fine granularity (rules, fragments of rules, atoms, fragments of atoms connected with provisions, fragments of provisions, letters, numbers, paragraphs, sentences, and word) as well as represent temporal modifications.

LegalRuleML dedicates two elements (`<lrml:References>`, `<lrml:LegalSources>`) to annotate the original legal sources and to connect them to rules, so permitting an N:M relationship (e.g. many rules in relation to one textual provision; many textual provisions for one rule). There are blocks for sources and blocks that associate sources with rules, assuming references to rules such as rule1.

<lrml:References> is the element dedicated to record non-IRI based identifier sources, and the attribute refIDSystemName is able to annotate the naming convention used. In the following example, the identifier /au/2012-05/30/C628:2012/eng@/main#sec2.2 represents the section 2.2 of the Australian code C628 using the naming convention “AkomaNtoso2.0-2011-10” and an example.

Example 15 (compact form)[17]:

```
    <lrml:LegalReferences xmlns:appex="http://docs.oasis-
open.org/legalruleml/examples/compactified/"
refType="http://example.legalruleml.org/lrml#LegalSource">
        <lrml:LegalReference refersTo="ref1" refID="/au/2012-05-
30/C628:2012/eng@/main#sec2.2" refIDSystemName="AkomaNtoso3.0-2016-03"/>
        <lrml:LegalReference refersTo="ref6" refID="ECLI:EU:C:2015:650"
refIDSystemName="European Case Law Identifier"
refIDSystemSource="OJ:C:2011:127:0001:0007:EN:PDF"/>
    </lrml:LegalReferences>
```

<lrml:LegalSources> is the element dedicated to record the IRI-based identifier sources. The following example defines the source of the U.S. Code, section 504, paragraph 1, title 17 published in the Cornell University portal http://www.law.cornell.edu/

Example 16 (compact form)[18]:

```
<lrml:LegalSources>
   <lrml:LegalSource key="ref2"
sameAs="http://www.law.cornell.edu/uscode/text/17/504#psection-1"/>
</lrml:LegalSources>
```

In addition to these two blocks, there is another element <lrml:Sources> that can be used to connect a source of legal information to other external, non-legal sources, which are important for modeling laws in LegalRuleML. Usually this element is used to document the IRI to the external LegalRuleML rules modelled in another knowledge base (e.g., another XML file).

<lrml:Sources> is the element dedicated to record the IRI based identifier sources that are not legal text but that are important for the LegalRuleML modeling. The following example illustrates the definition of an external source.

Example 17 (compact form)[19]:

```
  <lrml:Sources>
    <lrml:Source key="ex-rule_1b" sameAs="http://example.com/ex2.1.1-
references-b#rule_1b"/>
    <lrml:Source key="oasis-rule_1b" sameAs="http://docs.oasis-
open.org/legalruleml/examples/approved/ex2.1.1-references-b#rule_1b"/>
  </lrml:Sources>
```

17 examples/compactified/ex2-references-compact.lrml

18 examples/compactified/ex2-references-compact.lrml

19 examples/compactified/ex2-references-compact.lrml

The list of the resources connected with the legal rules that are modeled in a LegalRuleML document are defined once in the first part of the XML file. This minimizes redundant definitions of the resources and avoids errors.

As we see later, using the attribute value specified in `@key`, rules (or fragments of a rule) can be connected to References or Legal Sources.

The element `<lrml:Association>` links Legal Sources and References with rules (or a fragment of a rule), thus implementing the N:M relationship. For one source (`ref1`) to many rules (`rule1` and `rule2`), we have.

Example 18 (compact form):

```
<lrml:Association>
   <lrml:appliesSource keyref="#ref1"/>
   <lrml:toTarget keyref="#rule1"/>
   <lrml:toTarget keyref="#rule2"/>
</lrml:Association>
```

For one rule with multiple sources, we have the following, where `rule1` is connected to `ref1` (above) and to `ref2` (below).

Example 19 (compact form):

```
         <lrml:Association>
                <lrml:appliesSource keyref="#ref1"/>
                <lrml:appliesSource keyref="#ref2"/>
                <lrml:toTarget keyref="#rule1"/>
         </lrml:Association>
```

Combining `<lrml:References>/<lrml:LegalSources>`/`<lrml:Sources>` and `<lrml:Association>,` we can implement the principle of isomorphism.

ps

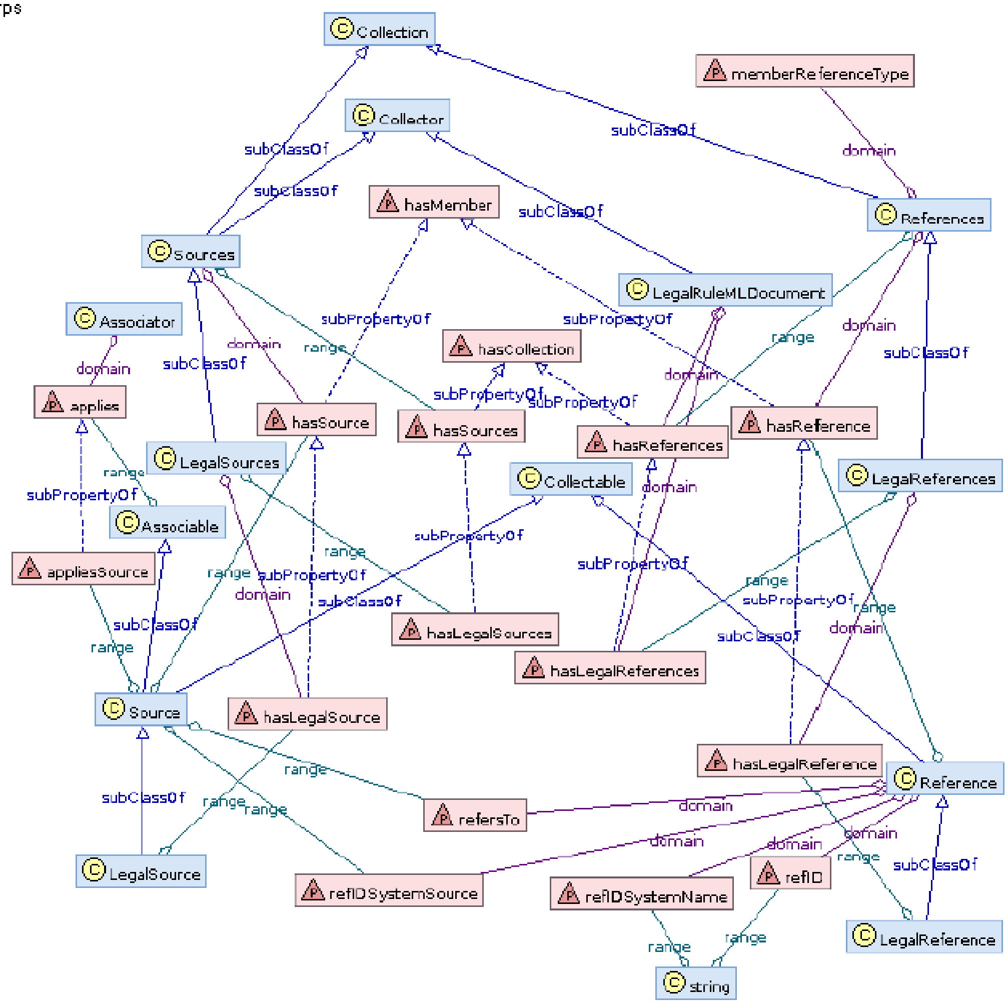


Fig. 5. Metamodel for LegalSource Concepts.

The partial meta-model for LegalSource Concepts is depicted in Figure 5.

4.3.2 Agent, Figure, Role

An Agent is an entity that acts or has the capability to act. An Agent could be a physical person, a database, or a bot; for this reason we have the sub-element `<lrml:hasType>` that expresses the category of agent.

Example 20 (compact form)[20]:

```
<lrml:Agents>
  <lrml:Agent key="mp" sameAs="http:example.org/agents#MonicaPalmirani">
         <lrml:hasType iri="http://example.org/types#Person"/>
  </lrml:Agent>
  <lrml:Agent key="ta" sameAs="http://example.org/agents#TaraAthan"/>
</lrml:Agents>
```

20 examples/compactified/ex4-meta-compact.lrml

The Agent usually is the author of the rule model and he/she/it can act in a particular function (e.g., as senator). A Figure in LegalRuleML is an instantiation of a function by an Actor, where an Actor could be an Agent or a Figure.

Example 21 (compact form)[21]:

```
<lrml:Figures>
   <lrml:hasMemberType iri="http://example.org/figure-types#LegislativeFigure"/>
   <lrml:Figure key="fs">
         <lrml:hasFunction iri="http://example.org/functions#Senator"/>
         <lrml:hasActor keyref="#ta"/>
   </lrml:Figure>
</lrml:Figures>
```

In the end we associate the Actor that fills a Role (using `<lrml:filledBy>`) for a particular rule.

Example 22 (compact form)[22]:

```
<lrml:Roles>
   <lrml:Role key="role1" iri="http://example.org/roles#author">
         <lrml:filledBy keyref="#mp"/>
         <lrml:filledBy keyref="#ta"/>
         <lrml:forExpression keyref="#rule1a"/>
   </lrml:Role>

   <lrml:Role key="role2" iri="http://example.org/roles#author">
         <lrml:filledBy keyref="#mp"/>
         <lrml:forExpression keyref="#atom2a"/>
         <lrml:forExpression keyref="#atom2b"/>
   </lrml:Role>
</lrml:Roles>
```

Using this mechanism, we can filter all the rules modelled by a particular Actor when he/she/it acts as a particular figure; for instance, we can filter for all the rules modelled by President Obama when he is acting as chief executive and not as the commander-in-chief of the United States Armed Forces.

21 examples/compactified/ex4-meta-compact.lrml

22 examples/compactified/ex4-meta-compact.lrml

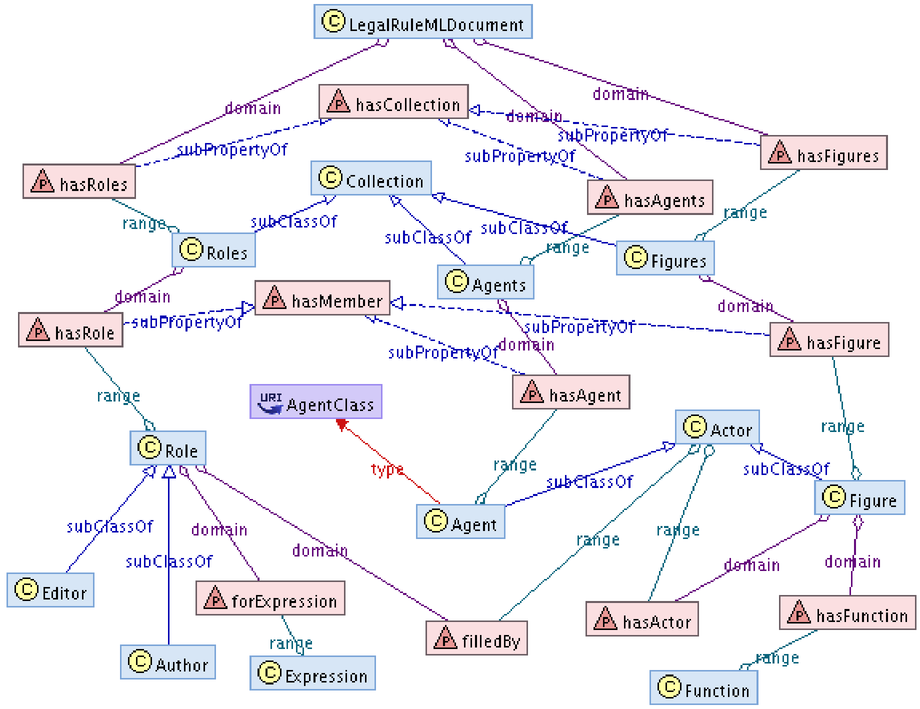


Fig. 6. Partial Metamodel for Agent, Figure and Role Metadata Concepts.

The partial meta-model for Agent, Figure and Role Metadata Concepts is depicted in Figure 6.

4.3.3 Jurisdiction

The Jurisdiction element is a geographic area or subject-matter over which an Authority applies its legal power. It annotates the legal rules that are applicable to a given area or subject-matter (e.g. the rules applicable only in Scotland respect the all UK legal rules).

Example 23 (compact form)[23]:

```
  <lrml:Jurisdictions>
    <lrml:Jurisdiction key="us"
sameAs="http://example.org/jurisdiction#unitedStatesOfAmerica"/>
  </lrml:Jurisdictions>
```

We can use `<lrml:Jurisdiction>` also to specify a limited subject-matter, for instance, legal rules which are applicable only to the executive departments (e.g., an Executive Order in the USA is addressed only to the executive departments or agencies).

Example 24 (compact form):

```
  <lrml:Jurisdictions>
    <lrml:Jurisdiction key="exd"
sameAs="http://example.org/jurisdiction#executiveDepartments"/>
  </lrml:Jurisdictions>
```

23 examples/compactified/ex4-meta-compact.lrml

4.3.4 Authority

Similarly to the jurisdiction, authority qualifies the rules with respect to the authenticity of the provenance of the formal model. Authority is a person or organization with the power to create, endorse, or enforce Legal Norms.

Example 25 (compact form)[24]:

```
  <lrml:Authorities>
        <lrml:Authority key="house"
sameAs="http://example.org/authority#house-of-representatives"/>
  </lrml:Authorities>
```

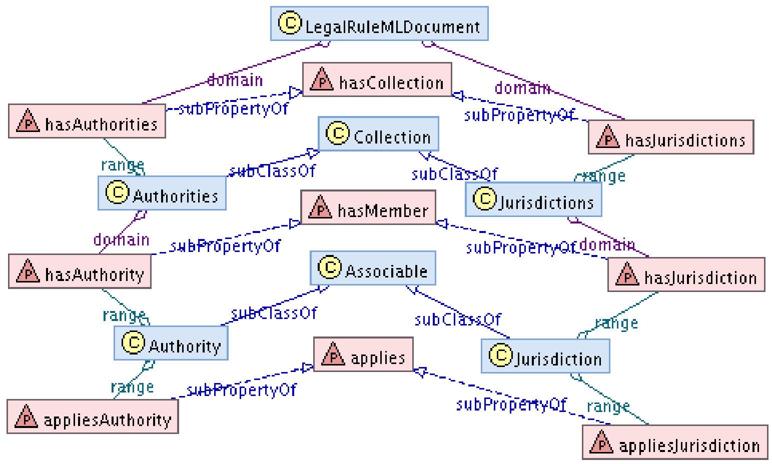


Fig. 7. Metamodel for Authority and Jurisdiction Metadata Concepts.

The partial meta-model for Authority and Jurisdiction Metadata Concepts is depicted in Figure 7.

4.3.4.1 Time and Events

Legal texts are often amended as a society or judicial system evolves. Norms and rules are valid in a particular interval of time and with respect to three main legal axes: when they come into force (entry), when they effect the intended or desired result (efficacy), and when they apply (applicability). In this section, we model the external temporal dimensions of the norms (e.g., when the norm is valid) and not the temporal dimensions of the complex events that are the content of the textual provision (e.g., when a person is to present a tax application). Therefore, we only model the intervals and temporal parameters that define the period of validity of the rules. Moreover, in keeping with the sources, it is important to link the temporal parameters to any part of a rule (e.g. `atom`, `rel`, `ind`, `if`, `then`, etc.) with a very fine granularity.

The following fragment shows the definition of the instant time using the `<ruleml:time>` element wrapped by the `<lrml:Time>` element:

Example 26 (compact form)[25]:

```
 <lrml:Times>
  <ruleml:Time key=":t1">
```

24 examples/compactified/ex4-meta-compact.lrml

25 examples/compactified/ex6-temporal-compact.lrml

```
        <ruleml:Data xsi:type="xs:dateTime">1978-01-01T00:00:00</ruleml:Data>
   </ruleml:Time>
</lrml:Times>
```

Legally-relevant times delimit intervals according to the legal temporal situation that is modelled, e.g. enforceability, efficacy, applicability (see Temporal Characteristic in vocabulary).

Example 27 (compact form)[26]:

```
<lrml:TemporalCharacteristics key="tblock1">
    <lrml:TemporalCharacteristic key="nev1">
      <lrml:forStatus iri="http://docs.oasis-
open.org/legalruleml/ns/v1.0/vocab#Efficacious"/>
      <lrml:hasStatusDevelopment iri="http://docs.oasis-
open.org/legalruleml/ns/v1.0/vocab#Starts"/>
      <lrml:atTime keyref="#t1"/>
    </lrml:TemporalCharacteristic>
    <lrml:TemporalCharacteristic key="nev2">
      <lrml:forStatus iri="http://docs.oasis-
open.org/legalruleml/ns/v1.0/vocab#InForce"/>
      <lrml:hasStatusDevelopment iri="http://docs.oasis-
open.org/legalruleml/ns/v1.0/vocab#Starts"/>
      <lrml:atTime keyref="#t2"/>
    </lrml:TemporalCharacteristic>
  </lrml:TemporalCharacteristics>
```

In the following fragment, we associate `ref1`, which is a legal source, with the appropriate temporal parameters defined using the TemporalCharacteristic `nev1` and `nev2`.

Example 28 (compact form)[27]:

```
  <lrml:Associations>
    <lrml:Association>
      <lrml:appliesSource keyref="#ref1"/>
      <lrml:toTarget keyref="#nev1"/>
      <lrml:toTarget keyref="#nev2"/>
    </lrml:Association>
  </lrml:Associations>
```

In the `<lrml:Context>` block (see the next section), the block `tblock1` uses the `<lrml:Associations>` mechanism to associate Temporal Characteristics with any part of the rule formalization, avoiding redundancy in the definition of a legal situation.

Example 29 (compact form)[28]:

```
  <lrml:Associations key="ascs1">
    <lrml:Association>
      <lrml:appliesTemporalCharacteristics keyref="#tblock1"/>
      <lrml:toTarget keyref="#rule1"/>
      <lrml:toTarget keyref="#atom1"/>
      <lrml:toTarget keyref="#body1"/>
    </lrml:Association>
   </lrml:Associations>
```

---

26 examples/compactified/ex6-temporal-compact.lrml

27 examples/compactified/ex6-temporal-compact.lrml

28 examples/compactified/ex7-temporal-data-compact.lrml


```
<lrml:Context key="ruleContext1">
  <lrml:appliesAssociations keyref="#ascs1"/>
  <lrml:inScope keyref="#stmt1"/>
</lrml:Context>
```

The (partial) meta-model of the Temporal Metadata Concepts presented in this section is depicted in Figure 8.

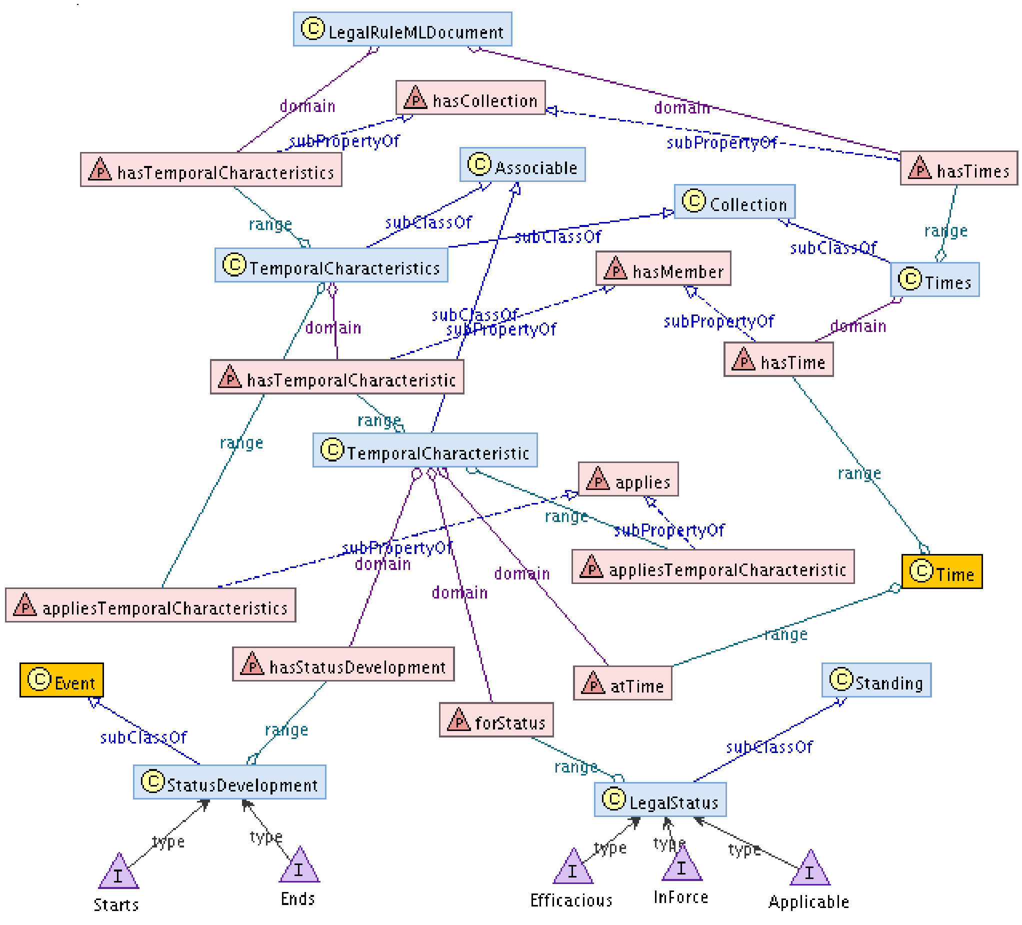


Fig. 8. Partial Metamodel for Temporal Metadata Concepts.

4.4 Associations and Context

4.4.1 Associations

To avoid redundancy, we have the element `<lrml:Association>`, which can be used to group meta information referred to several rules or portions of them. In the following example, we have two associations inside of the element `<lrml:Associations>`. The first `<lrml:Association>` applies the temporal parameters of `tblock1` to the prescriptive statements `ps1` and `ps2`. In the second one authority and jurisdiction properties are applied to prescriptive statements `ps1` and `ps3`:

Example 30 (compact form)[29]:

```
<lrml:Associations key="sourceBlock1">
   <lrml:Association>
         <lrml:appliesTemporalCharacteristics keyref="#tblock1"/>
         <lrml:toTarget keyref="#ps1"/>
         <lrml:toTarget keyref="#ps2"/>
   </lrml:Association>
   <lrml:Association>
         <lrml:appliesAuthority keyref="#congress"/>
         <lrml:appliesJurisdiction keyref="#us"/>
         <lrml:toTarget keyref="#ps1"/>
         <lrml:toTarget keyref="#ps3"/>
   </lrml:Association>
</lrml:Associations>
```

This LegalRuleML language construct introduces information flexibly and without redundancy, maintaining an XML representation that is neat, clean, compact, and with fewer opportunities for errors. The parameters that we can associate are.

Example 31 (compact form)[30]:

```
<lrml:appliesModality iri="/ontology/deontic/"/>
```

For expressing modality.

Example 32 (compact form)[31]:

```
<lrml:appliesSource keyref="#sec504-clsc-pnt1"/>
```

For connecting LegalSources or References.

Example 33 (compact form)[32]:

```
<lrml:appliesTemporalCharacteristics keyref="#tblock1"/>
```

For connecting temporal parameters.

Example 34 (compact form)[33]:

```
<lrml:appliesStrength iri="/ontology/defeasible"/>
```

For qualifying the strength of a rule according to the defeasibility categorization.

Example 35 (compact form)[34]:

---

[29] examples/compactified/Ex12-USC_17_504_context-compact.lrml

[30] examples/compactified/Ex12-USC_17_504_context-compact.lrml

[31] examples/compactified/Ex12-USC_17_504_context-compact.lrml

[32] examples/compactified/Ex12-USC_17_504_context-compact.lrml

[33] examples/compactified/Ex12-USC_17_504_context-compact.lrml

[34] examples/compactified/Ex12-USC_17_504_context-compact.lrml


```
<lrml:appliesAuthority keyref="#congress"/>
```

For assigning the authority of the editor of the rule.

Example 36 (compact form)[35]:

```
<lrml:appliesJurisdiction keyref="#us"/>
```

For assigning the jurisdiction to a rule.

4.4.2 Context

A rule may be differently interpreted according to a variety of parameters associated with a particular situation. For instance, sometimes an alternative interpretation of a textual source of a rule (and its associated formalisation) is associated with a jurisdiction, e.g., regional, national, or international levels, meaning that in one jurisdiction, the rule is interpreted one way, while in another jurisdiction, it is interpreted in another way. Similarly, temporal parameters (e.g., efficacy, enforceability) can change over time due to the normative modifications, and these changes can also affect the strength of the norms.

To represent such parameters, we introduce the `<lrml:Context>` element, which permits the description of all the characteristics that are linked to a particular rule (e.g., `rule1`) using the operator `<lrml:applies*>`, substituting the * with different relationships. In addition to the previous relationships, we also have the following.

Example 37 (compact form)[36]:

```
  <lrml:Context key="Context1">
        …
        <lrml:appliesAssociations keyref="#assoc1"/>
        <lrml:appliesAlternatives keyref="#alt2"/>
        <lrml:inScope keyref="#ps1"/>
  </lrml:Context>
```

The mechanism combines the relationships and the target rules, and it acts as a bridge between metadata and rules or fragments of them. The following example shows rules `rule1` and `rule3` connected with a LegalSource section 504, point 2, under the authority of Congress, valid in the jurisdiction of the USA, associated with the block `#assoc1` and connected to the alternatives represented in `#alt2`.

Example 38 (compact form)[37]:

```
<lrml:Context key="ruleInfo4" hasCreationDate="#t1">
  <lrml:appliesSource keyref="#sec504-clsc-pnt2"/>
  <lrml:appliesTemporalCharacteristics keyref="#tblock1"/>
  <lrml:appliesStrength iri="/ontology/defeater"/>
  <lrml:appliesAuthority keyref="#congress"/>
  <lrml:appliesJurisdiction keyref="#us"/>
  <lrml:appliesAssociations keyref="#assoc1"/>
  <lrml:appliesAlternatives keyref="#alt2"/>
  <lrml:inScope keyref="#rule1"/>
```

35 examples/compactified/Ex12-USC_17_504_context-compact.lrml

36 examples/compactified/Ex12-USC_17_504_context-compact.lrml

37 examples/compactified/Ex12-USC_17_504_context-compact.lrml


```
   <lrml:inScope keyref="#rule4"/>
</lrml:Context>
```

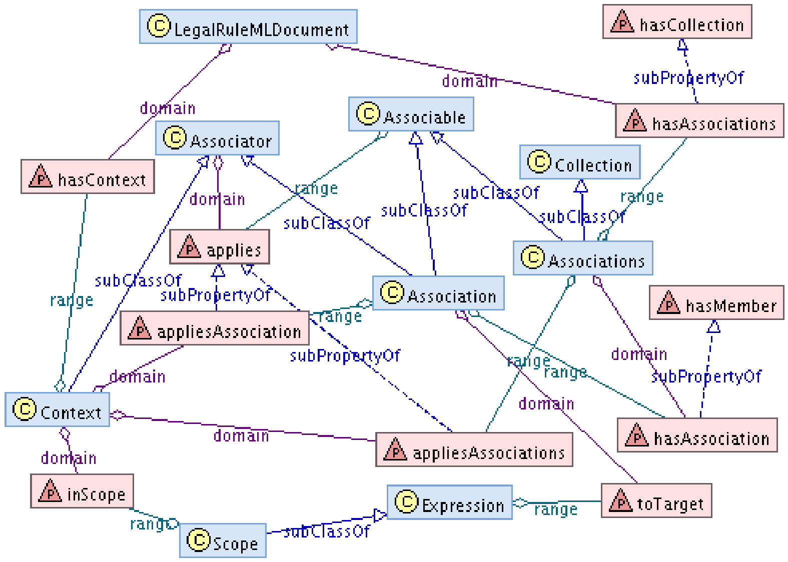


Fig. 9. Partial Metamodel for Context Concepts.

The partial meta-model for Metamodel for Context Concepts is depicted in Figure 9.

5 LegalRuleML XML Design Principles (non-normative)

5.1 Design Principles

The concrete XML-based syntax for LegalRuleML was designed based on the principles in Section 2.3, as well as certain design principles that are specific to XML-based syntaxes (see Section 5.2) and additional design principles (see Sections 5.3-5.9) that are domain-specific. In particular, many of the XML conventions developed in RuleML are adopted in LegalRuleML, providing common principles for the merged language hierarchy. All statements herein about the RuleML syntax are in reference to the elements in the RuleML namespace that are allowed to be embedded within LegalRuleML documents; as such, these are restrictions from the more general RuleML syntax as well as extensions of the content models of RuleML element in that certain child elements in the LegalRuleML namespace may be allowed within some RuleML elements.

5.2 XML Elements vs. Attributes

A common design decision for XML-based languages is whether to use an XML element or an attribute to represent a particular abstract syntactic feature. General guidelines are:

– If the information in question could be itself marked up with elements, put it in an element, because attributes cannot contain such complex content;
– If the information is suitable for attribute form (i.e., not complex), but could end up as multiple attributes of the same name on the same element, use child elements instead, avoiding list datatypes for attributes;
– If the information is required to be in a standard XML schema attribute type such as `xsd:ID`, `xsd:IDREF, xsd:ENTITY`, `xsd:KEYREF`, use an attribute;
– If the information should not be normalized for white space, use elements (XML processors normalize attributes in ways that can change the raw text of the attribute value).

5.3 LegalRuleML Syntactic Requirements

The following syntactic characteristics were deemed mandatory for the LegalRuleML syntax:

1. An abstract syntax for LegalRuleML must be described by an RDFS metamodel.
2. Two equivalent XML-based concrete serializations of the abstract syntax must be specified: the normalized serialization and the compact serialization. Each constraint of the specification must be in one of the following formats: Relax NG grammar, XSD 1.0 schema, or natural language statement.
3. Parsing from either LegalRuleML concrete serialization to the LegalRuleML abstract syntax in RDF/XML format must be specified by a composition of XSLT transformations.
4. A pair of abstract-syntax preserving XSLT transformations, called the compactifier and the normalizer, must convert LegalRuleML documents between compact and normalized serializations.
5. The conformance level of a document must be preserved by the compactification and normalization transformations. I.e., an XSD-conformant document must still be XSD-conformant after transformation, and similarly for Relax NG-conformance.

5.4 Syntactic Objectives

The following syntactic characteristics were deemed desirable for the LegalRuleML syntax, though they could not all be simultaneously satisfied. The LegalRuleML syntax was designed to optimize over these characteristics to the extent possible:

1. maximize correspondence to the RDF-based abstract syntax representation in the normalized serialization.
2. minimize verbosity, especially in the compact serialization.

3. minimize redundancy of expression, avoiding multiple ways to express the same thing.
4. minimize the difference between the syntax defined by the Relax NG and XSD schemas.
5. minimize the additional constraints not expressible in either Relax NG or XSD schemas.
6. minimize the additional constraints (from #5) not expressible through abstract-syntax preserving validating XSLT transformation.
7. (related to 5 and 6) minimize discrepancies after round-trip transformation between the compact and normalized serializations of instances that validate against Relax NG and XSD schemas.
8. minimize the modifications to imported RuleML schemas.
9. minimize the set of schema-conformant instances that do not satisfy a round trip law between serializations after projection by the abstract-syntax preserving validating transformations.
10. minimize the modifications that are necessary in the projections (as described in #9) to instances that satisfy the round-trip laws.

5.5 Node and Edge Element Dichotomy

In order to satisfy objective 5.3.1, LegalRuleML adopted, for its normalized serialization (see Section 5.7.1 Normalized Serialization), where Node elements alternate with edge elements, a form of striped syntax, where Node elements alternate with edge elements, forming a bipartite pattern, similar to the striped syntax of RDF/XML. The striped syntax of normalized LegalRuleML is also compatible with the normalized striped syntax of RuleML, although it differs in a few particulars.

The LegalRuleML schemas specify two groups of elements: Node (also called type in RuleML) elements and edge (also called role in RuleML) elements, the element name of the former starting with an upper case letter, and the latter with a lower case letter. The one exception to this pattern in RuleML is the `<ruleml:slot>` element, which is neither a Node or edge element.

Node elements correspond to classes of the metamodel while edge elements represent relationships between members of these classes. Edge elements correspond, in most cases, to properties in the metamodel. In a few cases, edge elements correspond to compositions of such properties.

In some cases, the metamodel is sufficiently restrictive so that the edge element provides no additional information, allowing for a lossless conversion from the normalized serialization to an XML representation that is less verbose by simply deleting the start and end edge tags. The LegalRuleML compact serialization is defined in this way (see Section 5.7.2 Compact Serialization).

In the XML document tree of a LegalRuleML document, elements that have no children are called branch elements, otherwise they are called leaf elements. Element types may be classified according to whether their instances are all leaf elements (Leaf type), all branch elements (Branch type) or either (Leaf/Branch type).

5.5.1 Node Elements

The naming convention for Node elements is UpperCamelCase local names.

The qualified name of a Node element corresponds to the type of the syntactic construct defined by the Node element, i.e., an `rdf:type` relationship in the RDF-based abstract-syntax representation (http://wiki.ruleml.org/index.php/Metamodel). The IRI of the metamodel class is constructed by concatenating the local name of the Node element with the appropriate IRI prefix:

* `http://docs.oasis-open.org/legalruleml/ns/v1.0/metamodel#` for Node elements in the LegalRuleML namespace

* `http://docs.oasis-open.org/legalruleml/ns/v1.0/rule-metamodel#` for Node elements in the RuleML namespace

We use the prefixes `lrmlmm` and `rulemm`, resp., to abbreviate the metamodel IRIs. At the time this document was published, the RuleML specification did not provide a metamodel, but a RuleML metamodel is under development [http://wiki.ruleml.org/index.php/Metamodel].

5.5.1.1 Classification of Node Elements

Collection Node element: In general, a Collection Node element is a Node element that defines a syntactic construct that is a collection. In LegalRuleML's RDF-based metamodel, these constructs are of type `rdf:List` and have a metamodel type arising from the type of the members of the collection. The naming convention of Collection Nodes in LegalRuleML uses the plural of the type of the members of the collection. For example, a collection for constructs of type `lrmlmm:Authority` is specified with an `<lrml:Authorities>` element. The specialized metamodel types of collection Node elements use the suffix `Collection`; e.g. `lrmlmm:AuthorityCollection`. RuleML has no Collection Nodes.

Document Node element: In general, a Document Node element is a Node element that can serve as the root node of an instance document. In LegalRuleML, the element `<lrml:LegalRuleML>` is the only Document Node element, and it has type `lrmlmm:LegalRuleMLDocument`.

Annotation Node element: In general, an Annotation Node element contains mixed content and is intended to hold marked-up text. In LegalRuleML, the Annotation Nodes are the Node elements `<lrml:Comment>` and `<lrml:Paraphrase>`. RuleML has no Annotation Nodes.

In general, Node elements may have Leaf (see section 5.10.2), Branch (see section 5.10.3), or Leaf/Branch (see section 5.10.4) types. In the LegalRuleML namespace, all Nodes types are Leaf/Branch type, while in the RuleML namespace, Nodes types are mostly Leaf or Branch types, with a few exceptional Leaf/Branch types.

Commentable Node element: The Node elements (in the LegalRuleML and RuleML namespaces) that may contain a comment belong to the class of Commentable Node elements, which is the union of LegalRuleML Node elements and RuleML Branch or Leaf/Branch Node elements.

Expression Node element: LegalRuleML Expression Node elements are Node elements in the LegalRuleML and RuleML namespaces that render one or more Legal Norms or a fragment of a Legal Norm. This Node class is the union of RuleML Branch or Leaf/Branch Node elements, together with the LegalRuleML Override and Reparation Nodes. Node elements in the LegalRuleML Expression class may contain a paraphrase. The types of RuleML Branch or Leaf/Branch Node element have been extended in the LegalRuleML syntax so that RuleML elements within a LegalRuleML document may optionally have a child element that attaches a paraphrase to it, specified in an `<lrml:Paraphrase>` element (see Section 5.14 Annotations - Comment and Paraphraser).

Additional Node classes are Associator, Associable, Alternative, Actor, and Collector:

- Associator Nodes are Node elements that can define associations - these are `<lrml:Context>` and `<lrml:Association>`.
- Associable Nodes are Node elements that can participate in associations - these are `<lrml:Association>`, `<lrml:Strength>`, `<lrml:Temporal Characteristic(s)>`, `<lrml:Authority>`, `<lrml:Jurisdiction>`, `<lrml:Source>`,`<lrml:LegalSource>`.
- Alternative Nodes are Node elements that can belong to an Alternatives collection - these are `<lrml:Statement>` or `<lrml:Statements>`.
- Actor Nodes are Node elements that can fill a Role - these are `<lrml:Agent>` and `<lrml:Figure>`.
- Collector Nodes are Node elements that can contain a collection - these are `<lrml:LegalRuleML>`, the root element, `<lrml:(Legal)Sources>`, and `<lrml:Statements>`.

Attributes of Node Elements for most LegalRuleML Node elements (called in the schemas commonLRMLNodeInit.attlist) are the following:

* `@key`

* `@keyref`

* `@type`

with the exception of <lrml:Reference> and <lrml:LegalReference>, which are not allowed to have these attributes. See Sections 5.11 and 5.12 for details of the usage of @key and @keyref attributes, and see Section 5.13 for details of the usage of @type.

Common optional attributes for most RuleML Node elements within LegalRuleML documents are

* @key

* @keyref

* @xml:id

The @key and @keyref attributes in RuleML elements have a different content model than the corresponding attribute in LegalRuleML elements (see Section 5.11). The usage of the @xml:id attribute is described in Section 5.15.

The root element of every LegalRuleML document is a Document Node element (in particular, <lrml:LegalRuleML>). This root element may optionally have the following attributes:

* @xml:base

* @hasCreationDate

* @xsi:schemaLocation

in addition to the common optional Node attributes. The semantics of @xml:base and @xsi:schemaLocation are defined by the https://www.w3.org/TR/xmlschema-1/ , respectively. The @hasCreationDate attribute has semantics related to Dublin Core's http://dublincore.org/documents/dcmi-terms/#terms-created, except that the Dublin Core property takes a literal value, while @hasCreationDate takes a local identifier reference to a <ruleml:Time> entity.

Specialized attributes may be optional or required for a subset of Node elements, as follows:

* @pre, on <lrml:Prefix>

* @refID, on <lrml:Prefix>, <lrml:Reference> or <lrml:LegalReference>

* @sameAs on <lrml:Source>, <lrml:LegalSource>, <lrml:Agent>, <lrml:Authority>, <lrml:Jurisdiction>

* @iri on Annotation Nodes, Role Nodes, LegalRuleML Deontic Nodes and Deontic Key Nodes (see Section 5.15)

* @refersTo (on <lrml:Reference> and <lrml:LegalReference>)

* @refType, @refIDSystemName, @refIDSystemSource (on <lrml:Reference>, <lrml:References>, <lrml:LegalReference>, <lrml:LegalReferences>)

* @memberType (on Collection Node elements)

* @hasCreationDate (on <lrml:LegalRuleML> and <lrml:Context>)

* @strength (on <ruleml:Rule>)

* @over, @under (on <lrml:Override>)

Additionally, @xml:base is allowed on <ruleml:Data> elements with an explicit datatype of xsd:anyURI.

5.5.2 Edge Elements

The naming convention for Edge elements is lowerCamelCase local names.

5.5.2.1 Classifications of Edge Elements

Collection Membership Edge: In the LegalRuleML namespace, collection membership edges are the children of Collection Nodes (i.e. elements of type lrmlmm:Collection) that define the membership of the collection. The local names of these edges begin with 'has', followed by the name of the collection member type. For example, the collection membership edge for a <lrml:Authorities> collection is

<lrml:hasAuthority> - the parent of an <lrml:hasAuthority> element is always <lrml:Authorities>, and its child is always <lrml:Authority>. English grammar conventions are followed when relating the plural form used in the name of the collection with the singular form used in the collection edge. Note that not all edges whose local name begins with 'has' are collection edges. In the RuleML namespace, an edge is a collection edge if and only if it has an @index attribute. The local names of RuleML collection edges are <ruleml:arg>, <ruleml:content> and <ruleml:formula>. The first two are always collection edges, while <ruleml:formula> is only a collection edge when its parent is <ruleml:And>, <ruleml:Or>, <ruleml:Operation>, or <lrml:SuborderList>.

Document Edge: In LegalRuleML, document edges are the edges whose parent Node element is the Document Node element, the root of the XML document. The local names of these edges begin with 'has', followed by the name of the (unique) child element; e.g. <lrml:hasReferences>

Annotation Edge: In LegalRuleML, annotation edges contain an Annotation Node element. The local names of these edges begin with 'has', followed by the name of the (unique) child element; e.g. <lrml:hasComment>.

The types of edge elements may be classified by syntactic type as Leaf (see Section 5.10.2), Branch (see Section 5.10.3), or Leaf/Branch (see Section 5.10.4) types. RuleML edge elements have only Branch types, while LegalRuleML edge elements have mostly Leaf or Branch type with a few exceptional Leaf/Branch types.

The qualified name of an edge element corresponds, in most cases, to a property of the syntactic construct defined by its parent Node element, i.e., the property of a triple in the RDF-based abstract-syntax representation see Section 3.9). The IRI of the metamodel property is constructed by concatenating the local name of the edge element with the appropriate IRI prefix:

* http://docs.oasis-open.org/legalruleml/ns/v1.0/metamodel# for Node elements in the LegalRuleML namespace

* http://docs.oasis-open.org/legalruleml/ns/v1.0/rule-metamodel# for Node elements in the RuleML namespace

with the exception of collection edges. The order in the collection is specified by the order of the sibling collection edges in the LegalRuleML document.(new sentence from Tara also about index attribute collection edges for putting the order – new version)

Edge elements may be classified as skippable or non-skippable, relative to the syntax. In the LegalRuleML namespace, it is exactly the Branch-type edge elements that are skippable, while Leaf-type and Leaf/Branch-type elements are non-skippable. Branch-type edges are the following:

* collection edges

* document edges

* annotation edges

* the edges <lrml:hasTemplate>, except within <lrml:FactualStatement>

The RuleML edge elements that are considered skippable within LegalRuleML documents are the following:

* <ruleml:arg>

* <ruleml:op>

* <ruleml:formula>

* <ruleml:declare>

* <ruleml:strong>

* <ruleml:weak>

* <ruleml:left>

* <ruleml:right>

* <ruleml:torso>

Attributes of Edge Elements for non-skippable LegalRuleML edge elements (called in the schemas commonLRMLEdgeInit.attlist) are defined and contain only the following:

* `@xml:id`

The value of this attribute provides an identifier for the corresponding triple in the RDF-based abstract syntax representation.

Leaf-type edge elements have a required attribute, which points to the object of the relationship they define. If the object is required to have a local identifier, then `@keyref` is the required attribute, otherwise it is `@iri`. Note that the Source, LegalSource, Reference, and LegalReference constructs are provided so that external resources can be aliased with a local identifier that may then be used as the value of an `@keyref` attribute.

5.6 Generic Node elements

A generic element is a main element whose syntax and/or semantics is underspecified unless an attached attribute or header element provides a predefined value or an IRI pointer to a user-defined specification

For example, `<ruleml:Operation>` represents the application of a generic operator, which may be used for modal operators or logical connectives such as exclusive disjunction. Generic elements provide extension points for user-defined syntactic and semantic variation. The following table provides a listing of Generic Node elements and the attributes or header elements that may be used to specialize them.

`<ruleml:Operation>`	`@type @style`
`<ruleml:Negation>`	`@type @style`
`<ruleml:Rule>`	`@strength @style @hasStrength`

5.7 Serializations

Two equivalent normative serializations are defined in the Relax NG and XSD schemas – a normalized serialization and a compact serialization.

5.7.1 Normalized Serialization

In many cases, edge elements are redundant because they could be reconstructed based on the type or position of the parent and child node elements. In the RuleML syntax, such edges are skippable. LegalRuleML syntax allows the two extreme cases - either no edge tags are skipped in the document (the normalized serialization) or the tags of all skippable edges in the document are omitted (the compact serialization). The normalized serialization may be reconstructed from a document in compact serialization by applying the normalizer XSLT transformation (xslt/lrml-xml/normalizer/lrml_normalizer.xslt), which reconstructs the skipped edge tags.

5.7.2 Compact Serialization

The compact serialization of LegalRuleML reduces verbosity without loss of information.

The compact serialization may be derived from the normalized serialization by removing the start and end tags of skippable edge elements.

The compact serialization may be obtained from a document in normalized serialization by applying the compactifier XSLT transformation (xslt/lrml-xml/compactifier/lrml_compactifier.xslt).

Note that RuleML has a relaxed serialization that allows edges to be optionally skipped and also allows a (mostly) arbitrary ordering of child elements. RuleML in the relaxed serialization is not allowed to be embedded within LegalRuleML – the embedded RuleML must be in either normalized or compact serialization, consistent with the serialization of the parent LegalRuleML.

5.8 Basic Dialect

In order to provide a simple path for checking the conformance, a basic dialect of the compact serialization was introduced. The basic dialect is a proper sublanguage of the compact serialization that does not allow

* the use of the CURIE abbreviation for IRIs

* the `<ruleml:content>` edge.

With these restrictions, it is possible to confirm conformance as a Basic Dialect XML file through only XSD validation.

5.9 General Design Patterns

5.8.1 LegalRuleML Design Pattern Overview

Inside of LegalRuleML, we employ four well-known design patterns:

1. container, which is a structure of elements having independent existence (e.g., `<lrml:Context>` can include several `<lrml:Association>` sub-elements);
2. collection, a subpattern of container that is in the form of a list of elements of the same type (e.g., `<lrml:Roles>` that is a sequence of `<lrml:Role>` elements);
3. recursive element (e.g., `<lrml:Obligation>` can have descendants that are other `<lrml:Obligation>` elements);
4. marker, an element that uses attribute `@sameAs` for identifying a source, e.g., `<lrml:LegalSource key="sec504-clsa-pnt1" sameAs="&USCode;#title17-chp5-sec504-clsa-lst1-pnt1"/>`.

5.9.1 Collection Design Pattern

LegalRuleML uses a collection design pattern for efficiently organizing, representing and referring to metadata, e.g. metamodel class `lrmlmm:AuthorityCollection` and corresponding Node `<lrml:Authorities>`. The `lrmlmm:Collection` class in the LegalRuleML metamodel is the superclass for the collection syntactic constructs, which is in turn a subclass of `rdf:List`. The `lrmlmm:hasMember` property is the superproperty for the properties of collections indicated by edges such as `<hasAuthority>`. The name of the collection element indicates the type of its members. Properties may be assigned to all members using an attribute on or header child element within the Collection element. For example, the member type for a particular collection may be specialized using the attribute `@memberType` or a child element `<lrml:hasMemberType>`. Metadata collections must occur in a prescribed order in a LegalRuleML document (see 5.16).

Like other Node elements, collections may be labeled with an `@key` attribute, which is referenced with `@keyref` for distributed definition of collections. The semantics of LegalRuleML collections is that of sets, i.e. unordered and without duplication.

5.9.2 Recursive Element Pattern

The RuleML syntax uses recursive elements, i.e. elements that may have descendants of the same name, to represent the inherently recursive nature of logical connectives and functional expressions. LegalRuleML introduces some specialized logical connectives which are similarly recursive, as follows:

* `<lrml:Obligation>`

* `<lrml:Permission>`

* `<lrml:Prohibition>`

* `<lrml:Right>`

In order to reduce redundancy through modularization, some of the collections elements are recursive, as follows:

* <lrml:Sources>

* <lrml:LegalSources>

Similarly, the element that is used to efficiently construct contextual relationships is recursive to facilitate modularization:

* <lrml:Association>

5.9.3 Marker Interface Pattern

The marker interface pattern is used in programming to annotate entities. In LegalRuleML, external entities are in many cases required to be aliased with a local identifier, which may then be referenced as the subject or object of annotations. The syntax that implements the marker interface pattern in LegalRuleML consists of the following attributes:

* @key

* @keyref

* @sameAs

* @refersTo

* @refID

5.10 Specialized Design Patterns

5.10.1 Ordered-Children Design Pattern

There are three different cases for addressing order, or lack thereof, in child XML elements within RuleML and LegalRuleML documents:

1. *The order of children has semantic significance.*
   In the normalized serialization, when the order of some children is significant to the semantics of the parent Node element, an index attribute is required on the edges so that the order is made explicit. In the compact serialization, the edge elements that would have an index attribute are skipped, so that the order of occurrence of children in the XML document is significant as it is the only indication of the order. Examples of this design pattern include <lrml:SuborderList> and the positional (<ruleml:arg>) children of <ruleml:Atom> and <ruleml:Expr>.
2. *The order of children has no semantic significance, but a canonical order of element types is prescribed by the schema.*
   This case applies for most LegalRuleML elements, e.g. the document root <lrml:LegalRuleML> as well as in the normalized and compact serializations of RuleML.
3. *The order of children has no semantic significance, and a canonical order is not prescribed by the schema.*
   This case applies in the relaxed or mixed serializations of RuleML, and within certain LegalRuleML elements, e.g. <lrml:Sources>, which allows nested <lrml:Sources> collections as well as collection member <lrml:Source>, and <lrml:Association>.

5.10.2 Leaf Edges

LegalRuleML introduces a syntactic pattern that is not present in RuleML – the leaf edge element. The purpose of this pattern is decreased verbosity of the XML documents. A Leaf edge element is an edge element that is necessarily empty. I.e., its type, as defined in the Relax NG or XSD schemas, does not allow content, only attributes. These elements are required to have at least one attribute, typically @keyref.

5.10.3 Branch Edges

In the previous section, we defined a Leaf edge element. A Branch edge element is defined similarly; it is an edge element that is necessarily non-empty. I.e., its type, as defined in the Relax NG or XSD schemas, does not allow the absence of content.

5.10.4 Leaf/Branch Edges

A Leaf/Branch edge element is an edge element that is not necessarily empty or non-empty. I.e., its type, as defined in the Relax NG or XSD schemas, has optional content. Like the Leaf edge, this pattern is not used in RuleML.

5.10.5 Slot Design Pattern

In RuleML, the slot design pattern is used in atomic formulas and functional expressions for labeled arguments. The label is called the “slot key” while the argument is the “slot filler”. Multiple occurrences of the same slot key within an atom or functional expression allowed. LegalRuleML adopts the slot design pattern as implemented in RuleML for expressing properties of deontic formulas. This design pattern comes from frame language and serves to store information about a frame as a "property-value" pair (e.g. `<lrml:Bearer>`).

5.11 CURIES, Relative IRIs and the xsd:ID Datatype

LegalRuleML employs a variety of syntactic forms for labeling components with identifiers and for referring to these or other identifiers. In this section, we discuss the syntactic forms that are based on the IRI system, and compare to the corresponding forms employed in RuleML. In RuleML 1.02 elements, attribute values that are intended to be IRIs may be expressed without abbreviation or may be abbreviated using the CURIE syntax (https://www.w3.org/TR/rdfa-syntax/). LegalRuleML has adopted the RuleML 1.02 approach to expressing IRIs, and modifies it as follows:

* CURIE prefixes are defined (only) by `<lrml:Prefix>` elements

* `@key` values are expressed (only) with datatype `xsd:ID`, the same type of values as `@xml:id`

* `@keyref` values are expressed (only) with "same-document" relative IRIs, starting with '#'

5.12 Distributed Syntax

The `@key` and `@keyref` attributes are used to enable the distributed definition of syntactic constructs in both RuleML and LegalRuleML namespaces. The `@key` attribute supplies a local identifier for the syntactic construct. In particular, the value of the `@key` attribute, of datatype `xs:ID`, is concatenated with the base IRI of the LegalRuleML document (as specified by the `xml:base` attribute on the root, if present, and otherwise determined according to https://www.ietf.org/rfc/rfc3986.txt) to construct the IRI of the syntactic construct defined by the parent Node element of the `@key` attribute.

The `@keyref` attribute is used to reference the local identifiers defined by `@key` attributes. It is a syntactic error for a `@keyref` attribute to have a value that does not correspond to a local identifier in the same document.

When `@keyref` occurs on an element with no attributes or content, then it is a reference to the syntactic construct having that local identifier. When `@keyref` occurs on a parent element that has attributes and/or content, it refers to a new syntactic construct that is based on the referenced construct, modified by the attributes and/or content of the parent. Such elements are translated into the abstract syntax using the `lrmlmm:mergerOf` property.

Taking into account the simultaneous occurrence of `@key` and `@keyref` attributes on the same element, these references form a directed graph which must be acyclic; it is a syntactic error if this graph is not acyclic.

5.13 Metamodel Refinement

The @type attribute is used to refine the semantics of LegalRuleML elements by reference to external resources. An @type attribute on any element is translated into the abstract syntax as an RDF triple with property rdf:type. From this, it may be inferred that the resource is an rdf:Class, and the syntactic construct defined by the element on which it occurred is an instance of that class as well as an instance of the class of the LegalRuleML metamodel corresponding to the element's name. Note that the @type attribute has quite different semantics on RuleML elements (see http://wiki.ruleml.org/index.php/Glossary_of_Consumer_RuleML_1.02#.40type).

5.14 Annotations - Comment and Paraphrase

The Annotation Node elements <lrml:Comment> and <lrml:Paraphrase> may contain arbitrary well-formed XML. Both are semantically neutral - their absence, presence or content have no semantic effect on their parent element. All Branch Node elements, in the LegalRuleML and RuleML namespaces, may optionally have one <lrml:Comment> child (compact serialization) or <lrml:hasComment> child (normalized serialization). The <lrml:Paraphrase> element is restricted to the content of LegalRuleML Expressions

5.15 Identifiers - @xml:id and @iri

The @xml:id attribute is optionally allowed on most non-skippable edge elements in the LegalRuleML namespace and all elements in the RuleML namespace. The value of this attribute provides a syntactic label that has no semantic effect. Therefore, it is ignored when translating to the abstract syntax.

A number of elements in the LegalRuleML and RuleML namespaces may contain an @iri attribute, whose value may be an IRI (not a relative IRI reference) or a CURIE that expands to an IRI upon application of the Prefix mapping. An @iri attribute on a Node element corresponds to an owl:sameAs relationship in the abstract syntax.

5.16 Order of Elements within a LegalRuleML Document

The elements of LegalRuleML XML serialization follow a precise prescriptive order. The following list shows this order. The list uses the regular-expression-like syntax convention adopted by Relax NG, where an asterisk (*) means 'zero or more' elements; ? means 'zero or one' element:

```
lrml:Prefix*,
lrml:Comment?,
lrml:LegalReferences*,
lrml:LegalSources*,
lrml:References*,
lrml:Sources*,
lrml:Times*,
lrml:TemporalCharacteristics*,
lrml:Agents*,
lrml:Figures*,
lrml:Roles*,
lrml:Authorities*,
lrml:Jurisdictions*,
lrml:Associations*,
lrml:Alternatives*,
lrml:Context*,
```



```
lrml:Statements*
```

5.17 Relax NG Schema Design

5.17.1 Modules

The normative definition of the LegalRuleML syntax is provided by modular Relax NG schemas in the Relax NG Compact (RNC) syntax.

The Relax NG schema modules are written in the “chameleon” style (see http://books.xmlschemata.org/relaxng/relax-CHP-11-SECT-5.html), without specifying a target namespace, to maximize the potential for re-use.

The LegalRuleML modules follow the monotonic design pattern [4] developed for the RuleML 1.0 Relax NG schemas and again employed in RuleML Version 1.01 and 1.02, for best compatibility with the included RuleML modules.

This design pattern is based on restricting the Relax NG syntax in a manner that guarantees monotonicity when schema modules are mixed together. That is, a language defined by a subset of the modules of another language will be a sublanguage of it.

5.17.2 Suites and Drivers

The fine-grained Relax NG modules are assembled into driver schemas through re-usable module "suites", as follows.

5.17.2.1 Core Suites

LegalRuleML core suites define the essential features of a LegalRuleML schema, aside from RuleML modules. There are two module suites considered to be at the "core" level, as follows:

* "relaxng/suites/core.rnc", the main core suite,

* "relaxng/suites/core-basic.rnc", the basic core suite.

The basic core suite is a subset of the module in the main core suite, excluding only the prefix module.

5.17.2.2 Basic, Compact, and Normal Suites

There are three module suites that expand on the core suites to include serialization aspects:

* "relaxng/suites/basic.rnc", the basic suite, expands the basic core suite to include the stripe-skipping module.

* "relaxng/suites/compact.rnc", the compact serialization suite, expands the main core suite to include the "stripe_skipping" module.

* "relaxng/suites/normal.rnc", the normalized serialization suite, expands the main core suite to include the "stripe_optional" modules.

5.17.2.3 LegalRuleML Drivers

The Relax NG schemas that are used directly for validation or generation of other artifacts are called "drivers". There are three groups of drivers, according to their purposes, as follows:

* Validation drivers are intended to be used directly for validation of LegalRuleML instances.

** "relaxng/lrml-basic.rnc" may be used to validate LegalRuleML instances in the basic dialect. This driver expands the basic suite with serialization modules and the Relax NG schema module for a basic version of the RuleML grammar.

** "relaxng/lrml-compact.rnc" may be used to validate LegalRuleML instances in the compact serialization

** "relaxng/lrml-normal.rnc” may be used to validate LegalRuleML instances in the normalized serialization

* XSD-conversion drivers are intended to be used only for generation of the corresponding XSD schemas, as described in Section 5.18 XSD Schema Derivation.

** "generation/lrml4xsd-basic.rnc" is the source used to generate the XSD basic dialect schema, "xsd-schema/basic/lrml-basic.xsd" as well as its companion schema "xsd-schema/basic/ruleml.xsd" for the RuleML namespace

** "generation/lrml4xsd-compact.rnc" is the source used to generate the XSD compact serialization schema, "xsd-schema/compact/lrml-compact.xsd" as well as its companion schema "xsd-schema/compact/ruleml.xsd" for the RuleML namespace

** "generation/lrml4xsd-normal.rnc" is the source used to generate the XSD normalized serialization schema, lrml-normal.xsd as well as its companion schema "xsd-schema/normal/ruleml.xsd" for the RuleML namespace

** "generation/lrml4xsd-normal.rnc" is the source used to generate the basic dialect simplified schema, "simplified/lrml-basic4simp.rnc"

** "generation/drivers4simp/lrml-compact4simp.rnc" is the source used to generate the compact serialization simplified schema, "simplified/lrml-compact4simp.rnc"

** "generation/drivers4simp/lrml-normal4simp.rnc"is the source used to generate the normalized serialization simplified schema, "simplified/lrml-normal4simp.rnc"

5.18 XSD Schema Derivation

5.18.1 XSD-Conversion Drivers

To accomplish the automated conversion from Relax NG to XSD, XSD-conversion drivers were constructed (generation/lrml4xsd-basic.rnc, generation/lrml4xsd-compact.rnc, and generation/lrml4xsd-normal.rnc). These schemas differ from the normative Relax NG schemas only in the following ways:

* inclusion of a different module (generation/modules/time4xsd_module.rnc) defining the type of the content of `<ruleml:Data>` within `<ruleml:Time>` to be `xsd:dateTime`, `xsd:date`, or `xsd:duration`, omitting the explicit implementation of the `@xsi:type` attribute because it is inherently implemented in XSD schemas.

* inclusion of a different module (generation/modules/stripe_required_4xsd_module.rnc) defining the Leaf/Branch-type edge elements by a lenient pattern that is exactly expressible in XSD

* inclusion of a modified RuleML schema suitable for conversion to XSD.

5.18.2 Conversion using Trang

The Trang software (https://code.google.com/p/jing-trang/downloads/detail?name=trang-20091111.zip) was used to convert the Relax NG schemas into XSD, selecting the options to disable abstract elements and perform lax processing of elements of type `xs:anyType`.

5.18.3 Post-processing with XSLT

Due to differences in the expressivity of the Relax NG and XSD schema languages, and the particularities of the Trang software used to make the conversion, some post-processing of the generated XSD was necessary to obtain a valid XSD schema that appropriately approximates the original Relax NG schemas. The post-processing was accomplished with XSLT transformations generation/xslt-xsd/basic-rnc2xsd.xslt, generation/xslt-xsd/compact-rnc2xsd.xslt and generation/xslt-xsd/normal-rnc2xsd.xslt, as appropriate. These XSLT transformations eliminate duplicate include statements and unused definitions, fix the definitions of elements with wildcard content to have `xs:anyType` in the XSD (`<ruleml:Data>`, `<lrml:Comment>`, `<lrml:Paraphrase>`), fix the definitions of elements with required `@index` attribute, sets the datatype of the `@key` and `@refersTo` attributes to `xs:ID`.

5.19 Differences between Relax NG and XSD Schemas

5.19.1 @xsi:type

XSD schemas do not have the capability to constrain the appearance of the @xsi:type attribute (as in http://www.w3.org/TR/xmlschema-1/#no-xsi), nor may they alter the definition from the definition built into XSD schemas (https://www.w3.org/2001/XMLSchema.xsd). As a consequence, to be XSD valid, the value of any @xsi:type attribute must correspond to some predefined type (e.g. xsd:string) or a user-defined type in the schema, such as the RuleML complex types, e.g. ruleml:integer that permits attributes (e.g. @key) on the <ruleml:Data> element while still constraining the content to be of type xsd:integer. Further, XSD validation requires that the attributes and content of the element on which the @xsi:type attribute appears must conform to that specified type definition.

Relax NG intentionally treat @xsi:type attributes just like any other attribute, so it must be explicitly implemented. It is not possible to implement the @xsi:type attribute in Relax NG in a way that is equivalent to its nature in XSD schemas.

RuleML uses the @xsi:type attribute on the <ruleml:Data> element to manage the datatype. The RuleML Relax NG schemas implement a limited form of the @xsi:type attribute on <ruleml:Data>, such that only certain types are allowed. In particular, the XSD datatypes are allowed, and user-defined datatypes in the RuleML namespace are implemented which allow attributes on the <ruleml:Data> element in addition to simple content according to a particular XSD datatype. Otherwise, RuleML does not permit the use of @xsi:type on elements in the RuleML namespace, a constraint enforced by the normative Relax NG schemas.

LegalRuleML introduces no additional elements where the use of @xsi:type is appropriate and does allow embedded <ruleML:Data> with @xsi:type attributes to be validated by the LegalRuleML Relax NG schemas, through importing the corresponding Relax NG schema module. In addition, LegalRuleML derives a restricted <ruleml:Data> element for use in temporal characteristics. This use of @xsi:type is fully supported in the XSD schemas by default, but the XSD schemas are not able to express the constraint against other uses of @xsi:type attributes, and thus are lenient in this regard, relative to the Relax NG schemas.

5.19.2 @xsi:schemaLocation

Like other attributes in the xsi namespace, XSD schemas may not constrain the occurrence of the @xsi:schemaLocation attribute or alter the definition from the definition built into XSD schemas https://www.w3.org/2001/XMLSchema.xsd).

Relax NG treats @xsi:schemaLocation just like any other attribute. RuleML implements the @xsi:schemaLocation attribute in the Relax NG schemas, and allows it to appear on any element.

For LegalRuleML, the occurrence of the @xsi:schemaLocation attribute on a skippable edge causes problems in regard to objective #7, due to inability to reconstruct the attribute because it is deleted along with the edge tags during compactification. Because there does not appear to be any usecase for the @xsi:schemaLocation attribute on any element other than the root element of the LegalRuleML document, the @xsi:schemaLocation attribute is implemented in the LegalRuleML Relax NG schemas in this restricted fashion, and the RuleML module that implements the @xsi:schemaLocation attribute on elements in the RuleML namespace is not included into the LegalRuleML Relax NG drivers. This is a sacrifice of objective #4 in favor of objective #7.

Therefore, the Relax NG schemas are more restrictive than the XSD schemas in this regard.

5.19.3 @xsi:nil and @xsi:noNamespaceSchemaLocation

Again, XSD schemas allow the @xsi:nil and @xsi:noNamespaceSchemaLocation attributes to occur anywhere. In both LegalRuleML and RuleML, these attributes are not defined in the Relax NG schemas, and so are not permitted anywhere in instances that meet the Relax NG conformance criterion. Again, the Relax NG schemas are more restrictive than the XSD schemas in this regard.

5.19.4 @xml:base

Attributes in the `xml` namespace do not have built-in definitions in either XSD or Relax NG schemas, and so must be explicitly defined if their use is desired.

In RuleML, the `@xml:base` attribute may appear only on the `<ruleml:Data>` element, where it may be used in the resolution of a data value that is a relative IRI.

In LegalRuleML, the `@xml:base` attribute is additionally permitted on the document root `<lrml:LegalRuleML>` element.

Relax NG and XSD schemas express this equivalently.

5.19.5 @xml:id

In the original RuleML grammar, the `@xml:id` attribute is allowed on any element, although there is a compatibility requirement with an `@xsi:type` attribute if both appear on a `<ruleml:Data>` element. This causes problems in regard to objective #7 if `@xml:id` appears on a skippable edge, since the information is lost upon compactification.

In LegalRuleML, `@xml:id`, or any other attribute, is not allowed on skippable edges in the `lrml` namespace through the LegalRuleML Relax NG schemas.

In order to satisfy objective #7 as fully as possible, while somewhat sacrificing #8, the `@xml:id` attribute is disallowed on skippable RuleML edges that are embedded in LegalRuleML documents. This is accomplished in both Relax NG and XSD schemas through redefining the imported RuleML Relax NG modules prior to conversion to XSD.

A separate issue is in regard to enforcing the uniqueness of `@xml:id` values within a document. This is partially accomplished by the XSD schemas. It is not possible to enforce this at all in the RELAX NG schemas due to some interference from wild card patterns, a known issue (https://github.com/relaxng/jing-trang/issues/178). This means the XSD schemas are necessarily more restrictive than the RELAX NG schemas in this regard.

5.19.6 @key/@keyref

In the original RuleML grammar, the key and keyref attributes are allowed on all elements, including skippable edges. Since `@key` has an IRI (or CURIE) datatype rather than an `@xsd:ID` datatype, it is not incompatible with the `@xml:id` attribute, and so both are allowed to occur on the same element. Like `@xml:id` discussed above, this causes problems in regard to objective #7. This is only an issue on skippable edges in the RuleML namespace. In RuleML, what is "skippable" varies somewhat depending on the expressivity. In some languages, `<ruleml:if>` and `<ruleml:then>` edges are skippable, and in others they are not. In LegalRuleML, `<ruleml:if>` and `<ruleml:then>` edges, within either `<ruleml:Rule>` or `<ruleml:Implies>` elements, are not skippable.

In order to satisfy objective #7 as fully as possible, while somewhat sacrificing #8, the `@key` attribute is disallowed on skippable RuleML edges that are embedded in LegalRuleML documents. This is accomplished in both RELAX NG and XSD schemas through redefining the imported RuleML RELAX NG modules prior to conversion to XSD.

As mentioned in item 5.16.5, the `xsd:ID` datatype for `@key` on LegalRuleML elements is enforced by the XSD but not the RELAX NG schemas. This imposes a uniqueness requirement on the `@key` attribute but only relative to other attributes with `xsd:ID` datatype, which does not include `@key` on RuleML elements, but does include `@xml:id` attributes.

5.19.7 Document Root Element

The LegalRuleML RELAX NG schemas enforce the requirement that the root element is lrml:LegalRuleML. This requirement is not enforced in the XSD schemas, although it could be done with a refactoring of the definitions. The challenge is that any element defined at the global level in an XSD schema is allowed to be the root element. To restrict the XSD schema so that only LegalRuleML elements may be the root, all element definitions would have to be contained within the definition of the LegalRuleML element. For enhanced readability of the XSD schemas, this requirement is thus only enforced by the RELAX NG schemas.

5.19.8 Leaf/Branch Type Edges

Edges of this type, which only occur in the LegalRuleML namespace, may optionally have a child element and optionally may have attributes. When there is a child, the attributes on the edge are typically meaningless, except for `@xml:id` which serves simply to label the edge. When the conversion is made to the RDF-based representation of the abstract syntax, the `@key` and `@keyref` attributes are ignored, while an `@xml:id` attribute is honored. Thus if a document is parsed into the abstract syntax through the XSLT to RDF, and then serialized back into the XML syntax, the (meaningless) `@key` and `@keyref` attributes are lost. The ideal solution would be to disallow the `@key` and `@keyref` attributes on this type of edge element.

Unfortunately, it is not possible to construct an XSD 1.0 schema that allows attributes on an element only when it does not have a child. However this is possible with RELAX NG, and with Schematron or XSD 1.1. Also, the removal of such (meaningless) attributes is easily accomplished with XSLT, so a validating XSLT transformation can be constructed for this constraint.

The RELAX NG schema main drivers (relaxng/lrml-compact.rnc and relaxng/lrml-normal.rnc) implement the choice (exclusive or) between attributes and content on edges of Leaf/Branch type. This favors objective #3, as well as clarity, at the expense of an additional deviation between Relax NG and XSD schemas. The Relax NG schema drivers that are used for the conversion to XSD (generation/lrml4xsd-compact.rnc and generation/lrml4xsd-normal.rnc) implement the attributes and content of Leaf/Branch-type edges as an “inclusive or”, so that the converter does not need to approximate.

There is a validator XSLT (xslt/lrml-xml/validator/lrml_validator-leaf-branch.xslt) that strips these attributes away from a LegalRuleML document, and also uses the `xsl:message` capability to inform the user when such attributes were present in the input.

5.20 Prefix Mapping XSLT Transformation

A number of RuleML and LegalRuleML attributes have values which should be treated as CURIEs. That is, they should be evaluated to IRIs according to a prefix mapping, which is defined by the `<lrml:Prefix>` element.

The XSLT at xslt/lrml-xml/normalizer/lrml_normal_canonicalizer.xslt performs CURIE evaluation, in addition to some other modifications, as preparation for applying the parsing XSLT that produces RDF (xslt/lrml-rdf/triplifyMerger-ids.xsl)

This evaluation also applies to the values of `@refID` within `<lrml:Reference>` and `<lrml:LegalReference>`, which are not constrained to be IRIs or CURIEs. The choice of `xs:string` for the datatype of the prefix mapping (also called `@refID`) enables this usage, allowing CURIE-like abbreviation to be used within `<lrml:Reference>` and `<lrml:LegalReference>`, as illustrated in examples/compactified/ex1-curies-compact.lrml for identifiers of Akoma Ntoso.

5.21 Validating XSLT Transformations

Conformance to the additional constraint Section 5.18 point 1 may be checked by applying the XSLT transformation xslt/lrml-xml/normalizer/lrml_prefix_evaluation.xslt, and validating the output. This transformation is abstract-syntax preserving. Conformance to the additional constraint Section 5.18 point 2 may be checked through the XLST transformation xslt/lrml-xml/validator/lrml_validator-sequential-indexing.xslt.

This transformation is abstract-syntax preserving when applied following the xslt/lrml-xml/validator/lrml_validator-sequential-indexing.xslt transformation.

6 Comprehensive Examples

6.1 Section 29 of the Australian “National Consumer Credit Protection Act 2009” (Act No. 134 of 2009).

In this section we illustrate the use of LegalRuleML by modeling a fragment of Section 29 of the Australian “National Consumer Credit Protection Act 2009” (Act No. 134 of 2009). The fragment, entitled “Prohibition on engaging in credit activities without a licence”, states:

> *A person must not engage in a credit activity if the person does not hold a licence authorising the person to engage in the credit activity. Civil penalty: 2,000 penalty units. [. . .] Criminal penalty: 200 penalty units, or 2 years imprisonment, or both.*

In the norm, we see that the penalties are stated as separate statements. Accordingly the best way to capture the structure is to use `<Penalty>` elements for them. There is a general statement of a prohibition in '...must not...' along with an implied statement of a permission under certain circumstances. A preference order is implied, the general statement over the particular circumstances. We paraphrase the statements as:

> *A person is prohibited from engaging in credit activity.*
>
> *A person is permitted to engage in a credit activity if the person holds a licence.*

Based on the observation and paraphrases above we can model the norm with the following rules (and auxiliary statements).

```
ps1: Person(x) => [FORB]EngageCreditActivity(x)
ps2: HasLicence(x) => [PERM]EngageCreditActivity(x)
ps2 > ps1
pen1: [OBL] PayCivilUnits(x,2000)
pen2:
   [OBL] PayCriminalUnits(x,200)
   [OBL] Imprisonment(x,2m),
   [OBL] PayPenaltyUnitsPlusImprisonment(x,200,2m)
rep1: [Violation]ps1, pen1
rep2: [Violation]ps1, pen2
```

This norm can be represented in LegalRuleML as follows[38]:

```
<lrml:LegalSources>
   <lrml:LegalSource key="ls1"
   sameAs="http://www.comlaw.gov.au/Details/C2009A00134/Html/Text#param43"/>
</lrml:LegalSources>
```

the block above is for declaring the source of the legal provisions and to give it a key to refer to it. An Associations block links legal provisions with the rules (and other statements) that model them

```
<lrml:Context key="psInfo1">
   <lrml:appliesAssociations>
         <lrml:Associations>
               <lrml:Association>
                     <lrml:appliesSource keyref="#ls1/>
```

[38] examples/compactified/ex5-section29new-compact.lrml


```
                        <lrml:toTarget keyref="#ps1"/>
                        <lrml:toTarget keyref="#ps2"/>
                        <lrml:toTarget keyref="#pen1"/>
                        <lrml:toTarget keyref="#pen2"/>
                 </lrml:Association>
          </lrml:Associations>
   </lrml:appliesAssociations>
</lrml:Context>
```

In this case, the norm referred to by the key ls1 is modelled by a set of statements, namely `ps1`, `ps2`, `pen1`, `pen2`, `rep1`, and `rep2`. The LegalRuleML statements for representing the statements `ps1`, `pen2`, `rep1`, and `rep2` are given in the code below.

```
<lrml:Statements key="textblock1">
   <lrml:hasQualification>
     <lrml:Override over="#ps2" under="#ps1"/>
  </lrml:hasQualification>
  <lrml:PrescriptiveStatement key="ps1">
      <ruleml:Rule key=":rule1" closure="universal">
        <lrml:hasStrength>
          <lrml:DefeasibleStrength key="str1" iri="&defeasible-
ontology;#defeasible1"/>
        </lrml:hasStrength>
        <ruleml:if>
          <ruleml:Atom>
            <ruleml:Rel iri=":person"/>
            <ruleml:Var>X</ruleml:Var>
          </ruleml:Atom>
        </ruleml:if>
        <ruleml:then>
          <lrml:SuborderList>
            <lrml:Prohibition>
              <ruleml:Atom>
                <ruleml:Rel iri=":engageCreditActivity"/>
                <ruleml:Var>X</ruleml:Var>
              </ruleml:Atom>
            </lrml:Prohibition>
          </lrml:SuborderList>
        </ruleml:then>
      </ruleml:Rule>
    </lrml:PrescriptiveStatement>

    <lrml:PenaltyStatement key="pen2">
      <lrml:SuborderList>
        <lrml:Obligation>
          <ruleml:Atom>
            <ruleml:Rel iri=":payPenalUnits"/>
            <ruleml:Var>X</ruleml:Var>
            <ruleml:Ind>200</ruleml:Ind>
          </ruleml:Atom>
        </lrml:Obligation>
        <lrml:Obligation>
          <ruleml:Atom>
            <ruleml:Rel iri=":imprisonment"/>
            <ruleml:Var>X</ruleml:Var>
            <ruleml:Ind>2 months</ruleml:Ind>
          </ruleml:Atom>
        </lrml:Obligation>
        <lrml:Obligation>
          <ruleml:Atom>
            <ruleml:Rel iri=":payPenalUnitPlusImprisonment"/>
            <ruleml:Var>X</ruleml:Var>
```



```
            <ruleml:Ind>200</ruleml:Ind>
            <ruleml:Ind>2 months</ruleml:Ind>
          </ruleml:Atom>
        </lrml:Obligation>
      </lrml:SuborderList>
    </lrml:PenaltyStatement>

    <lrml:ReparationStatement key="rep1">
      <lrml:Reparation key="assoc1">
        <lrml:appliesPenalty keyref="#pen1"/>
        <lrml:toPrescriptiveStatement keyref="#ps1"/>
      </lrml:Reparation>
    </lrml:ReparationStatement>
    <lrml:ReparationStatement key="rep2">
      <lrml:Reparation keyref="#assoc1">
        <lrml:appliesPenalty keyref="#pen2"/>
        <lrml:toPrescriptiveStatement keyref="#ps1"/>
      </lrml:Reparation>
    </lrml:ReparationStatement>
</lrml:Statements>
```

6.2 Case 18/96, Bologna Tribunal, Imola Section

In this section, we examine a case (taken from the Italian legal system and jurisprudence, originally discussed in [23]), where there are multiple (alternative) interpretations of a norm. We show possible formalisations of the case and the interpretations using LegalRuleML. The case is based on a dispute of Art. 1, Comma 2, Law 379/1990. The article recites:

> *The benefit referred to in comma 1 shall be paid in an amount equal 80 per cent of five-twelfths of the income earned and reported for tax purposes by the freelancer in the second year preceding the year of application.*

The case 18/96, Bologna Tribunal, Imola Section, concerns the interpretation of the conjunction in phrase "...the income earned *and* reported for tax purposes...".

A fundamental and indisputable fact of the law is its close connection with natural language; in particular, the interpretation of a textual provision should be the ordinary meaning conveyed by the text of the provision taking into account its context in the act in which it appears and the purpose or object underlying the act. For example, in the Italian legal systems, this connection is prescribed by Article 12 of the Preleggi, Italian Civil Code, stating:

> *In applying a statute, the interpreter should not attribute to it a meaning different from that made evident by the proper meaning of the words and by their connection, as well as by the intention of the law maker.*

Accordingly, the literal interpretation of the above norm of Art. 1, Comma 2, Law 379/1990 is given by the following rule:

```
        (earned ($income, $year-2) ∧ reported ($income, $year-2))=>[OBL
auxiliary=%freelancer, bearer=%employer] paybenefit (f($income),$year)     (1)
```

The arguments of the predicates earned and reported are the income `$income` earned/reported by the freelancer in the year in the second argument `(year-2)`. Similarly for `paybenefit`, where the function `f` encodes the computation of the value of the benefit based on the value of the income.

However, according to the Italian taxation legislation in force at the time of the dispute the income received in one year is reported for tax purposes the year *after* the year in which it has been earned. Thus, for example, the income earned in 1995 is reported in 1996. This principle can be formulated as follows:

```
        earned($income, $year) -> reported($income, $year + 1)      (2)
```



```
reported($income, $year) -> earned($income, $year - 1)     (3)
```

Consider now the *Amount* constant obtained by applying Russell’s definite description operator (ι) on the conjunction in the left-hand side of (1).

```
Amount = ιx(earned($income, $year) ∧ reported($income, $year))    (4)
```

The problem is that the constant `Amount` does not have a denotation, though the interpretation of `Amount` does; that is, there is no income “entity” that is earned and reported in one and the same year. Hence, the left hand side of the rule in (1) never holds, and the rule never fires, against the intentions of the legislator.

Based on the textual provision, two possible interpretations are possible: in the first interpretation the temporal expression “in the second year preceding the year of application” refers to the income earned in the second year preceding the application; in the second interpretation the temporal expression refers to the income reported for tax purposes in the second year preceding the application. For example, for an application in year 1998, the first interpretation bases the computation on the income earned in 1996 (and reported in 1997), while for the second interpretation, the value of the benefit is computed starting from the income reported in 1996 (and earned in 1995).

Accordingly, the first interpretation, proposed by the freelancer in the case, can be formalized by the rule

```
earned($income, $year -2) =>[OBL auxiliary=%freelancer, bearer=%employer]
                   paybenefit (f($income),$year)     (5)
```

In contrast, the second interpretation, the interpretation proposed by the employer, can be represented by the rule

The task of the Judge was to decide which of the two interpretations has to be used for the application of the norm. In the case the Judge argued in favour of the interpretation advanced by the freelancer.We have presented three possible interpretations of the norm: the literal interpretation (example 1), the interpretation of the freelancer (example 5), and the interpretation of the employer (example 6). Each interpretation is formalized in LegalRuleML fragments. The formalisations of these three statements can be represented as prescriptive rules which are encoded by `<lrml:PrescriptiveStatement>` blocks in LegalRuleML, each containing one `<ruleml:Rule>` Template. Since LegalRuleML is built on top of RuleML we can reuse all RuleML facilities, in particular we can use `<ruleml:Expr>` and `<ruleml:Fun>` to encode the computation of the benefit to be paid to the freelancer.

```
reported($income, $year -2) )=>[OBL auxiliary=%freelancer, bearer=%employer]
                   paybenefit (f($income),$year)     (6)
```

The following fragment corresponds to the literal interpretation, i.e., (1)

```
<lrml:PrescriptiveStatement key="literal">
    <ruleml:Rule closure="universal" key=":literal-template">
        <ruleml:if>
            <ruleml:And>
                <ruleml:Atom key=":atom-earned">
                    <ruleml:Rel iri=":earned"/>
                     <ruleml:Var>income</ruleml:Var>
                     <ruleml:Expr>
                         <ruleml:Fun iri=":subtract"/>
                        <ruleml:Var>year</ruleml:Var>
```



```
                        <ruleml:Data xsi:type="xs:integer">2</ruleml:Data>
                    </ruleml:Expr>
                </ruleml:Atom>
                <ruleml:Atom key=":atom-reported">
                    <ruleml:Rel iri=":reported"/>
                    <ruleml:Var>income</ruleml:Var>
                    <ruleml:Expr>
                        <ruleml:Fun iri=":subtract"/>
                        <ruleml:Var>year</ruleml:Var>
                        <ruleml:Data xsi:type="xs:integer">2</ruleml:Data>
                    </ruleml:Expr>
                </ruleml:Atom>
            </ruleml:And>
        </ruleml:if>
        <ruleml:then>
             <lrml:Obligation key="obl-paybenefit">
                  <ruleml:slot>
                      <lrml:Bearer/>
                      <ruleml:Var>Employer</ruleml:Var>
                  </ruleml:slot>
                  <ruleml:slot>
                      <lrml:AuxiliaryParty/>
                      <ruleml:Var>Freelancer</ruleml:Var>
                  </ruleml:slot>
                  <ruleml:Atom>
                      <ruleml:Rel iri=":paybenefit"/>
                       <ruleml:Expr>
                           <ruleml:Fun iri=":80_percent_of_five-twelfths_of"/>
                           <ruleml:Var>income</ruleml:Var>
                      </ruleml:Expr>
                      <ruleml:Var>year</ruleml:Var>
                  </ruleml:Atom>
              </lrml:Obligation>
          </ruleml:then>
      </ruleml:Rule>
</lrml:PrescriptiveStatement>
```

The next snippet captures the interpretation of the freelancer, i.e., (5). Notice that inside this statement we can use `keyrefs` to refer to the elements already defined in the block corresponding to the literal interpretation.

```
<lrml:PrescriptiveStatement key="freelancer">
      <ruleml:Rule closure="universal" key=":freelancer-template">
        <ruleml:if>
            <ruleml:Atom keyref=":atom-earned"/>
        </ruleml:if>
        <ruleml:then>
          <lrml:Obligation keyref="#obl-paybenefit"/>
        </ruleml:then>
      </ruleml:Rule>
    </lrml:PrescriptiveStatement>
```

Similar considerations apply to the block modeling (6), the employer’s interpretation, below.

```
<lrml:PrescriptiveStatement key="employer">
      <ruleml:Rule closure="universal" key=":employer-template">
        <ruleml:if>
            <ruleml:Atom keyref=":atom-reported"/>
        </ruleml:if>
```



```
        <ruleml:then>
          <lrml:Obligation keyref="#obl-paybenefit"/>
        </ruleml:then>
      </ruleml:Rule>
    </lrml:PrescriptiveStatement>
```

The following LegalRuleML Constitutive Statement represents the principle expressed in (2), that earned income will be reported in the following year. Because a Constitutive Statement defines concepts and does not prescribe behaviours, the consequent of its `<ruleml:Rule>` Template does not contain deontic operators.

```
    <lrml:ConstitutiveStatement key="tax1">
         <ruleml:Rule closure="universal">
        <lrml:Paraphrase>If income is earned in some year, then it is reported
in the following year.
        </lrml:Paraphrase>
        <ruleml:if>
          <ruleml:Atom>
            <ruleml:Rel iri=":earned"/>
            <ruleml:Var>income</ruleml:Var>
            <ruleml:Var>year</ruleml:Var>
          </ruleml:Atom>
        </ruleml:if>
        <ruleml:then>
          <ruleml:Atom>
            <ruleml:Rel iri=":reported"/>
            <ruleml:Var>income</ruleml:Var>
            <ruleml:Expr key=":year+1">
              <ruleml:Fun iri=":add"/>
              <ruleml:Var>year</ruleml:Var>
              <ruleml:Data xsi:type="xs:integer">1</ruleml:Data>
            </ruleml:Expr>
          </ruleml:Atom>
        </ruleml:then>
      </ruleml:Rule>
    </lrml:ConstitutiveStatement>
```

Similarly, the following fragment represents the principle that reported income was earned in the previous year, as expressed in (3).

```
   <lrml:ConstitutiveStatement key="tax2">
         <ruleml:Rule closure="universal">
        <lrml:Paraphrase>If income is reported in some year, then it was
earned in the previous year.
        </lrml:Paraphrase>
        <ruleml:if>
          <ruleml:Atom>
            <ruleml:Rel iri=":reported"/>
            <ruleml:Var>income</ruleml:Var>
            <ruleml:Var>year</ruleml:Var>
          </ruleml:Atom>
        </ruleml:if>
        <ruleml:then>
          <ruleml:Atom>
            <ruleml:Rel iri=":earned"/>
            <ruleml:Var>income</ruleml:Var>
            <ruleml:Expr key=":year-1">
              <ruleml:Fun iri=":subtract"/>
```



```
            <ruleml:Var>year</ruleml:Var>
            <ruleml:Data xsi:type="xs:integer">1</ruleml:Data>
          </ruleml:Expr>
        </ruleml:Atom>
      </ruleml:then>
    </ruleml:Rule>
  </lrml:ConstitutiveStatement>
```

After the renderings of the alternative interpretations and the relationships between the predicates earned and reported given by the three constitutive rules, we have to specify that they are mutually exclusive formalisations of the same norm. This can be achieved by following Alternatives block that represents a mutually-exclusive collection of renderings of the Legal Norms from the Legal Source `#ls1`. The `<lrml:LegalSource>` with key `#ls1`, not shown in the text, contains the references to the actual text of the norm.

```
   <lrml:Alternatives key="maternity-alts">
     <lrml:Comment>
       These alternatives are mutually incompatible formalizations of the same
legal source: keyref="#ls1".
     </lrml:Comment>
     <lrml:hasAlternative keyref="#literal"/>
    <lrml:hasAlternative keyref="#freelancer"/>
    <lrml:hasAlternative keyref="#employer"/>
  </lrml:Alternatives>
```

A `<lrml:Context>` block is used to render a collection of Associations, e.g. the Association of a Legal Source with a rendering of it as a LegalRuleML Statement, or to constrain other Contexts with respect to Alternatives. The following Context establishes a constraint that at most one of the Alternatives from the collection #maternity-alts may be selected by each Context. The `<Context>` metadata, e.g. authorship, source, authority, temporal and jurisdictional properties, are specified in an external (to the `<Contex<t`) `<Association>` block with identifier `asn-alts`, not shown in the paper, which is referenced using @`keyref`. Similarly other `<Context>` blocks (also not shown in the paper) are given with the metadata about the authors of the various Statements. This allows us to establish the provenance of the interpretations.

```
   <lrml:Context key="maternity-alts-ctxt">
     <lrml:appliesAssociations keyref="#asn-alts"/>
     <lrml:appliesAlternatives keyref="#maternity-alts"/>
   </lrml:Context>
```

In the following fragment, a particular Alternative – that proposed by the freelancer – is selected, leading to the generation of the corresponding `<ruleml:Rule>` from the rule Template `:freelancer-template`.

```
   <lrml:Context key="adjudication">
     <lrml:appliesAssociation keyref="#asn-adjudication"/>
     <lrml:inScope keyref="#freelancer"/>
   </lrml:Context>
```

Unlike the first `<Context>` block, this one contains an `<lrml:inScope>` element. Such Contexts render interpretations that select one or more Statements as their scope of interpretation. When a Context is processed for presentation or inference, Legal rules are generated from the `<ruleml:Rule>`. Templates of in-scope Statements, annotated and optionally modified semantically by the Associations of the Context.

In this example the external Association `asn-adjudication` links the metadata for the adjudication of the case with a particular rendering of the norm, the rendering freelancer, corresponding to the interpretation proposed by the freelancer and confirmed by the judge[39].

6.3 US Code section 504

We use a fragment of the US Code, Title 17, sec. 504, point (c) on copyright infringement to present how LegalRuleML can model complex legal norms in elegant way. Section 504 was modified seven times over several years. However only three versions are relevant in our scenario: i) the version entered into force at Oct. 19, 1976; ii) the version entered into force at Oct. 31, 1988; iii) the version entered into force at Dec. 9, 1999 that is valid till today. The original version is:

> *17 USC Sec. 504*
> *(c) Statutory Damages.*
> *(1) Except as provided by clause (2) of this subsection, the copyright owner may elect, at any time before final judgement is rendered, to recover, instead of actual damages and profits, an award of statutory damages for all infringements involved in the action, with respect to any one work, for which any one infringer is liable individually, or for which any two or more infringers are liable jointly and severally, in a sum of not less than $250 or more than $10,000 as the court considers just. For the purposes of this subsection, all the parts of a compilation or derivative work constitute one work.*
> *(2) In a case where the copyright owner sustains the burden of proving, and the court finds that infringement was committed willfully, the court in its discretion may increase the award of statutory damages to a sum of not more than $50,000. In a case where the infringer sustains the burden of proving, and the court finds, that such infringer was not aware and had no reason to believe that his or her acts constituted an infringement of copyright, the court in its discretion may reduce the award of statutory damages to a sum of not less than $100.*

The Copyright Act establishes conditions to protect various types of intellectual property or work, by preventing, in general, the use of such works without a license and by providing exceptions to the general provision. The conditions can be paraphrased using the following prescriptive rule:

```
R1: if a piece of work is covered by copyright, then it is forbidden to use it. (1)
```

And its companion constitutive rule:

```
C1: an infringer is defined as somebody who used a piece of work when it was forbidden to use it. (2)
```

The provisions in Section 504 can now be paraphrased as follows:

- R2: if the copyright owner claims statutory damages then the penalty for the infringer is to pay statutory damages of between USD250 and USD10,000.
- R3: if the copyright owner sustains the burden of proof and the infringer infringes copyright willfully then the penalty for the infringer is to pay statutory damages of between USD250 and USD50,000.
- R4: if the infringer sustains the burden of proof and the infringer infringes NOT willfully then the penalty for the infringer is to pay statutory damages of between USD100 and USD10,000.
- Defeasability: R4 > R3 > R2

[39] The full example is available from examples/compactified/ex5-section29new-compact.lrml

Over time the penalties change as follow:

Statutory Damages

Interval of efficacy of the norm	min	max	Willfully	Not Willfully
[1976-10-19, 1995-03-01[	USDUSD250	USD10,000	USD50,000	USD100
[1995-03-01, 2001-02-01[	USD500	USD20,000	USD100,000	USD200
[2001-02-01, today [	USD750	USD30,000	USD150,000	USD200

The prescriptive rule that represents the first case is the following:

```
<lrml:PrescriptiveStatement key="ps2-tblock1">
         <ruleml:Rule key=":rule2-tblock1" closure="universal">
                <ruleml:if>
                       <ruleml:And>
                              <ruleml:Atom keyref=":rule0-ruleml-Atom1"/>
                              <ruleml:Atom key=":rule2-tblock1-ruleml-Atom1">
                                     <ruleml:Rel
iri="glevo:claimStatutoryDamages"> claims statutory damages
                                     </ruleml:Rel>
                                     <ruleml:Var
type="lovo:copyrightOwner">X</ruleml:Var>
                              </ruleml:Atom>
                       </ruleml:And>
                </ruleml:if>
                <ruleml:then>
                       <lrml:Reparation keyref="#rep1-tblock1"/>
                </ruleml:then>
         </ruleml:Rule>
   </lrml:PrescriptiveStatement>
```

The `<lrml:Reparation keyref="#rep1-tblock1"/>` is a reference to the following fragment of code that connects `penalty1` related to the time `tblock1` (keyref="#penalty1-tblock1") with the prescriptive rule `#ps1` that is violated:

```
                <lrml:ReparationStatement>
                       <lrml:Reparation key="rep1-tblock1">
                              <lrml:appliesPenalty keyref="#penalty1-tblock1"/>
                              <lrml:toPrescriptiveStatement keyref="#ps1"/>
                       </lrml:Reparation>
                </lrml:ReparationStatement>
```

Finally the penalty is modelled in the following way for representing the range of the sanction:

```
                <lrml:PenaltyStatement key="penalty1-tblock1">
                       <lrml:Obligation key="penalty1-tblock1-obl1">
                              <ruleml:slot>
                                     <lrml:Bearer iri="deovo:oblBearer"/>
                                     <ruleml:Var>Y</ruleml:Var>
                              </ruleml:slot>
                              <ruleml:slot>
                                     <lrml:AuxiliaryParty
iri="deovo:auxParty"/>
                                     <ruleml:Var>X</ruleml:Var>
                              </ruleml:slot>
                              <ruleml:Atom key=":penalty1-tblock1-obl1-axm1">
                                     <ruleml:Rel
iri="lovo:payStatutoryDamages"/>
```



```
                        <ruleml:slot>
                                <ruleml:Ind iri="lovo:payMin"/>
                                <ruleml:Ind>$250</ruleml:Ind>
                        </ruleml:slot>
                        <ruleml:slot>
                                <ruleml:Ind iri="lovo:payMax"/>
                                <ruleml:Ind>$10,000</ruleml:Ind>
                        </ruleml:slot>
                </ruleml:Atom>
        </lrml:Obligation>
</lrml:PenaltyStatement>
```


7 Conformance

#1 A XML file is compliant with the LegalRuleML specifications as a LegalRuleML-XML file if it is a well formed XML file whose root is <lrml:LegalRuleML> and it is valid against at least one XML LegalRuleML Schema:

1. As a Basic Dialect XML File, it MUST be valid against the LegalRuleML XSD Schema for the basic dialect of the compact serialization (xsd-schema/basic/lrml-basic.xsd).
2. As a Compact XML File
   2.1. the Compact XML File MUST be valid against the LegalRuleML XSD Schema for the compact serialization (xsd-schema/compact/lrml-compact.xsd) OR
   2.2. the Compact XML File MUST be valid against the LegalRuleML RelaxNG schema for the compact serialization (relaxng/lrml-compact.rnc) OR
   2.3. the Compact XML File MUST be valid against both schemas (xsd-schema/compact/lrml-compact.xsd and relaxng/lrml-compact.rnc).
3. As a Normalized XML file
   3.1. the Normalized XML File MUST be valid against the LegalRuleML XSD schema for the normal serialization (xsd-schema/normal/lrml-normal.xsd) OR
   3.2. the Normalized XML File MUST be valid against the LegalRuleML RelaxNG schema for the normal serialization (relaxng/lrml-normal.rnc) OR
   3.3. the Normalized XML File MUST be valid against both schemas (xsd-schema/normal/lrml-normal.xsd and relaxng/lrml-normal.rnc).

#2 The following compliance conditions for LegalRuleML-XML Files are enforced by neither Relax NG nor XSD schema

1. Every conformance claim under this section MUST hold for both the original document and the modified document after application of the Prefix mapping.

2. RuleML collection edges, i.e. those edges with `@index` attributes, MUST have values of `@index` in agreement with their position in the node set of sibling collection edges.

3. IRIs occurring as attribute values, whether originally expressed as an IRI or a CURIE, are REQUIRED to be fully conformant to [RFC 3987]. In the case of CURIEs, this restriction applies after expansion to an IRI according to the prefix.

4. Each occurrence within any LegalRuleML document of `@key` on LegalRuleML and RuleML elements MUST have a value (after deletion of the leading colon on values of `@key` within RuleML elements) that is unique within that document.

5. In the LegalRuleML RDF abstract syntax representation, triples whose properties correspond to skippable edges in the concrete syntax MUST NOT be reified with `@rdf:id`.

#3. The RDF graph MUST be RDFS-entailed [1] by the graph that would be obtained if the normative ... XSLT were applied to the normative LegalRuleML XSLT (xslt/lrml-rdf/triplifyMerger-ids.xsl) to an LegalRuleML-XML file that is a manifestation of the LegalRuleML document.

#4 An implementation conforms with LegalRuleML specifications if it handles Basic Dialect or Normal or Compact LegalRuleML-XML files that satisfy respectivelyconditions #1.1 or #1.2 or #1.3, and #2 and optionally RDF files that satisfy condition #3.

8 Bibliography

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Appendix A. Acknowledgments

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Participants:

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Appendix B. RelaxNG schema - (normative)

Zip linked with hyperlink to the folder

relaxng

Appendix C. XML-schema - (normative)

Zip linked with hyperlink to the folder

xsd-schema

xsd-schema/basic

xsd-schema/compact

xsd-schema/datatypes

xsd-schema/normal

Appendix D. RDFS and XSLT – (normative)

Zip linked with hyperlink to the folder

rdfs

xslt/lrml-rdf

xslt/lrml-xml

Appendix E. Metamodel Graph – (non-normative)

Zip linked with hyperlink to the folder

diagrams

Appendix F. Examples – (non-normative)

Zip linked with hyperlink to the folder

examples/normalized

examples/compactified

Appendix G. Example Fragments in Normal Form–(non-normative)

Example 1 (normal form)[40]:

```
      <lrml:hasStatement>
        <lrml:OverrideStatement>
          <lrml:hasTemplate>
            <lrml:Override over="#cs2" under="#cs1"/>
          </lrml:hasTemplate>
        </lrml:OverrideStatement>
      </lrml:hasStatement>
```

Example 2 (normal form)[41]:

```
  <lrml:hasContext>
    <lrml:Context key="ruleInfo1">
      <lrml:appliesStrength
                iri="http://www.w3.org/2001/XMLSchema#defeasible2"/>
      <lrml:inScope keyref="#cs1"/>
    </lrml:Context>
  </lrml:hasContext>
```

Example 3 (normal form)[42]:

```
<ruleml:Rule key=":ruletemplate3" keyref=":ruletemplate2">
   <lrml:hasStrength>
          <lrml:Defeater key="str4"/>
   </lrml:hasStrength>
</ruleml:Rule>
```

Example 4 (normal form)[43]:

```
<lrml:hasStatements>
         <lrml:Statements key="textblock2">
                <lrml:hasStatement>
                       <lrml:PrescriptiveStatement key="ps1">
                              <lrml:hasTemplate>
                                     <ruleml:Rule key="ex:key1">
                                            <lrml:hasStrength>
                                                   <lrml:StrictStrength
key="str3" iri="http://www.w3.org/2001/XMLSchema#strict1"/>
                                            </lrml:hasStrength>
                                            <ruleml:if>
                                                   <ruleml:Atom
key=":atom1"></ruleml:Atom>
```

40 examples/normalized/ex8-defeasible-normal.lrml

41 examples/normalized/ex8-defeasible-normal.lrml

42 examples/normalized/ex8-defeasible-normal.lrml

43 examples/normalized/ex8-defeasible-normal.lrml


```
                                                </ruleml:if>
                                                <ruleml:then>

   <lrml:SuborderList></lrml:SuborderList>
                                                </ruleml:then>
                                        </ruleml:Rule>
                                </lrml:hasTemplate>
                        </lrml:PrescriptiveStatement>
                </lrml:hasStatement>
        </lrml:Statements>
   </lrml:hasStatements>
```

Example 5 (normal form)[44]:

```
   <lrml:hasStatements>
        <lrml:Statements key="textblock2">
                <lrml:hasStatement>
                        <lrml:ConstitutiveStatement key="ps1">
                                <lrml:hasTemplate>
                                        <ruleml:Rule key="ruleml:key1">
                                                <lrml:hasStrength>
                                                        <lrml:DefeasibleStrength
key="str1" iri="http://www.w3.org/2001/XMLSchema#defeasible1"/>
                                                </lrml:hasStrength>
                                                <ruleml:if>
                                                        <ruleml:Atom key=":atom1">
                        </ruleml:Atom>
                                                </ruleml:if>
                                                <ruleml:then>
                                                        <ruleml:Atom key=":atom1">
                                </ruleml:Atom>
                                                </ruleml:then>
                                        </ruleml:Rule>
                                </lrml:hasTemplate>
                        </lrml:ConstitutiveStatement>
                </lrml:hasStatement>
        </lrml:Statements>
   </lrml:hasStatements>
```

Example 6 (normal form):

```
<lrml:Obligation
    key="oblig1"
    iri="ex:achievementObligation">
    ...
</lrml:Obligation>
```

Example 7 (normal form)[45]:

```
   <lrml:hasAssociations>
        <lrml:Associations key="sourceBlock1">
                <lrml:hasAssociation>
                        <lrml:Association>
                                <lrml:appliesModality
iri="ex:maintenanaceObligation"/>
                                <lrml:toTarget keyref="#obl101"/>
```

44 examples/normalized/ex8-defeasible-normal.lrml

45 examples/normalized/ex3-deontic-normal.lrml


```
                </lrml:Association>
            </lrml:hasAssociation>
        </lrml:Associations>
    </lrml:hasAssociations>
```

Example 8 (normal form)[46]:

```
    <ruleml:formula index="1">
        lrml:Obligation key="oblig1" iri="ex:obl1">
            <ruleml:formula>
                <ruleml:Atom/>
            </ruleml:formula>
        </lrml:Obligation>
    </ruleml:formula>
    <ruleml:formula index="1">
        <lrml:Obligation key="oblig2" iri="ex:obl1">
                <ruleml:slot>
                <lrml:Bearer iri="ex:oblBearer"/>
                    <ruleml:Ind>Y</ruleml:Ind>
            </ruleml:slot>
            <ruleml:formula>
                <ruleml:Atom key="ex:atom2">
                    <ruleml:op>
                        <ruleml:Rel iri="ex:rel2"/>
                    </ruleml:op>
                    <ruleml:arg index="1">
                        <ruleml:Ind>X</ruleml:Ind>
                    </ruleml:arg>
                </ruleml:Atom>
            </ruleml:formula>
        </lrml:Obligation>
    </ruleml:formula>
```

Example 9 (normal form)[47]:

```
    <lrml:hasStatements>
        <lrml:Statements>
            <lrml:hasStatement>
                <lrml:PenaltyStatement key="pen1">
                    <lrml:hasTemplate>
                        <lrml:SuborderList> </lrml:SuborderList>
                    </lrml:hasTemplate>
                </lrml:PenaltyStatement>
            </lrml:hasStatement>
        </lrml:Statements>
    </lrml:hasStatements>
```

Example 10 (normal form)[48]:

```
<lrml:hasStatements>
        <lrml:Statements>
            <lrml:hasStatement>
                <lrml:ReparationStatement key="reps1">
                    <lrml:hasTemplate>
                        <lrml:Reparation key="rep1">
```

46 examples/normalized/ex3-deontic-normal.lrml

47 examples/normalized/ex3-deontic-normal.lrml

48 examples/normalized/ex3-deontic-normal.lrml


```
                                                        <lrml:appliesPenalty
keyref="#pen1"/>
                                                        <lrml:toPrescriptiveStatement
keyref="#ps1"/>
                                                </lrml:Reparation>
                                        </lrml:hasTemplate>
                                </lrml:ReparationStatement>
                        </lrml:hasStatement>
                </lrml:Statements>
        </lrml:hasStatements>
```

Example 11 (normal form)[49]:

```
    <lrml:hasAlternatives>
     <lrml:Alternatives key="alt1">
       <lrml:fromLegalSources keyref="#ls5"/>
       <lrml:hasAlternative keyref="#ps1"/>
       <lrml:hasAlternative keyref="#cs2"/>
     </lrml:Alternatives>
   </lrml:hasAlternatives>
```

Example 12 (normal form)[50]:

```
<lrml:hasAssociations>
        <lrml:Associations key="s1">
                <lrml:hasAssociation>
                        <lrml:Association>
                                <lrml:appliesSource keyref="#ref1"/>
                                <lrml:appliesSource keyref="#ref2"/>
                                <lrml:toTarget keyref="#rule1"/>
                        </lrml:Association>
                </lrml:hasAssociation>
        </lrml:Associations>
</lrml:hasAssociations>
<lrml:hasAssociations>
        <lrml:Associations key="s2">
                <lrml:hasAssociation>
                        <lrml:Association>
                                <lrml:appliesSource keyref="#ref3"/>
                                <lrml:appliesSource keyref="#ref2"/>
                                <lrml:toTarget keyref="#rule2"/>
                        </lrml:Association>
                </lrml:hasAssociation>
        </lrml:Associations>
</lrml:hasAssociations>

<lrml:hasAlternatives>
        <lrml:Alternatives key="alt1">
                <lrml:hasAlternative keyref="#s1"/>
                <lrml:hasAlternative keyref="#s2"/>
        </lrml:Alternatives>
</lrml:hasAlternatives>
```

[49] examples/normalized/ex9-alternatives-normal.lrml

[50] examples/normalized/ex9-alternatives-normal.lrml

Example 13 (normal form)[51]:

```
<lrml:Alternatives key="alt3">
       <lrml:fromLegalSources keyref="#ref1"/>
       <lrml:hasAlternative keyref="#ss1"/>
       <lrml:hasAlternative keyref="#ss2"/>
</lrml:Alternatives>

<lrml:Statements key="ss1">
   <lrml:ConstitutiveStatement keyref="#ps1"/>
   <lrml:ConstitutiveStatement keyref="#ps2"/>
</lrml:Statements>

<lrml:Statements key="ss2">
   <lrml:ConstitutiveStatement keyref="#ps3"/>
</lrml:Statements>
```

Example 14 (normal form)[52]:

```
<lrml:hasAssociations>
       <lrml:Associations key="s1">
              <lrml:hasAssociation>
                     <lrml:Association>
                            <lrml:appliesSource keyref="#ref1"/>
                            <lrml:appliesSource keyref="#ref2"/>
                            <lrml:toTarget keyref="#rule1"/>
                            <lrml:toTarget keyref="#rule2"/>
                     </lrml:Association>
              </lrml:hasAssociation>
       </lrml:Associations>
</lrml:hasAssociations>
<lrml:hasAssociations>
       <lrml:Associations key="s2">
              <lrml:hasAssociation>
                     <lrml:Association>
                            <lrml:appliesSource keyref="#ref1"/>
                            <lrml:appliesSource keyref="#ref2"/>
                            <lrml:toTarget keyref="#rule2"/>
                            <lrml:toTarget keyref="#rule3"/>
                     </lrml:Association>
              </lrml:hasAssociation>
       </lrml:Associations>
</lrml:hasAssociations>

<lrml:hasAlternatives>
       <lrml:Alternatives key="alt4">
              <lrml:hasAlternative keyref="#s1"/>
              <lrml:hasAlternative keyref="#s2"/>
       </lrml:Alternatives>
</lrml:hasAlternatives>
```

Example 15 (normal form)[53]:

```
<lrml:hasLegalReferences>
```

51 examples/normalized/ex9-alternatives-normal.lrml

52 examples/normalized/ex9-alternatives-normal.lrml

53 examples/normalized/ex2-references-normal.lrml


```
        <lrml:LegalReferences xmlns:appex="http://docs.oasis-open.org/legalruleml/examples/approved/"
refType="http://example.legalruleml.org/lrml#LegalSource">
                <lrml:hasLegalReference>
                        <lrml:LegalReference refersTo="ref1" refID="/au/2012-05-30/C628:2012/eng@/main#sec2.2" refIDSystemName="AkomaNtoso3.0-2016-03"/>
                </lrml:hasLegalReference>
                <lrml:hasLegalReference>
                        <lrml:LegalReference refersTo="ref6"
refID="ECLI:country:court:year:number" refIDSystemName="European Case Law
Identifier" refIDSystemSource="OJ:C:2011:127:0001:0007:EN:PDF"/>
                </lrml:hasLegalReference>
        </lrml:LegalReferences>
</lrml:hasLegalReferences>
```

Example 16 (normal form)[54]:

```
<lrml:hasLegalSources>
        <lrml:LegalSources>
                <lrml:hasLegalSource>
                        <lrml:LegalSource key="ref2"
sameAs="http://www.law.cornell.edu/uscode/text/17/504#psection-1"/>
                </lrml:hasLegalSource>
        </lrml:LegalSources>
</lrml:hasLegalSources>
```

Example 17 (normal form)[55]:

```
<lrml:hasSources>
        <lrml:Sources>
                <lrml:hasSource>
                        <lrml:Source key="ex-rule_1b"
sameAs="http://example.com/ex2.1.1-references-b#rule_1b"/>
                </lrml:hasSource>
                <lrml:hasSource>
                        <lrml:Source key="oasis-rule_1b"
sameAs="http://docs.oasis-open.org/legalruleml/examples/approved/ex2.1.1-references-b#rule_1b"/>
                </lrml:hasSource>
        </lrml:Sources>
</lrml:hasSources>
```

Example 18 (normal form)[56]:

```
<lrml:hasAssociations>
        <lrml:Associations key="sourceBlock2">
                <lrml:hasAssociation>
                        <lrml:Association>
                                <lrml:appliesSource keyref="#ref1"/>
                                <lrml:toTarget keyref="#rule1"/>
                                <lrml:toTarget keyref="#rule2"/>
                        </lrml:Association>
                </lrml:hasAssociation>
        </lrml:Associations>
</lrml:hasAssociations>
```

54 examples/normalized/ex2-references-normal.lrml

55 examples/normalized/ex2-references-normal.lrml

56 examples/normalized/ex9-alternatives-normal.lrml

Example 19 (normal form)[57]:

```
<lrml:hasAssociations>
	<lrml:Associations key="sourceBlock3">
		<lrml:hasAssociation>
			<lrml:Association>
				<lrml:appliesSource keyref="#ref1"/>
				<lrml:appliesSource keyref="#ref2"/>
				<lrml:toTarget keyref="#rule1"/>
			</lrml:Association>
		</lrml:hasAssociation>
	</lrml:Associations>
</lrml:hasAssociations>
```

Example 20 (normal form)[58]:

```
<lrml:hasAgents>
	<lrml:Agents>
		<lrml:hasAgent>
			<lrml:Agent key="mp"
sameAs="http:example.org/agents#MonicaPalmirani">
				<lrml:hasType
iri="http://example.org/types#Person"/>
			</lrml:Agent>
		</lrml:hasAgent>
		<lrml:hasAgent>
			<lrml:Agent key="ta"
sameAs="http://example.org/agents#TaraAthan"/>
		</lrml:hasAgent>
	</lrml:Agents>
</lrml:hasAgents>
```

Example 21 (normal form)[59]:

```
<lrml:hasFigures>
	<lrml:Figures>
		<lrml:hasMemberType iri="http://example.org/figure-
types#LegislativeFigure"/>
		<lrml:hasFigure>
			<lrml:Figure key="fs">
				<lrml:hasFunction
iri="http://example.org/functions#Senator"/>
				<lrml:hasActor keyref="#ta"/>
			</lrml:Figure>
		</lrml:hasFigure>
	</lrml:Figures>
</lrml:hasFigures>
```

Example 22 (normal form)[60]:

```
<lrml:hasRoles>
	<lrml:Roles>
		<lrml:hasRole>
```

57 examples/normalized/ex9-alternatives-normal.lrml

58 examples/normalized/ex4-meta-normal.lrml

59 examples/normalized/ex4-meta-normal.lrml

60 examples/normalized/ex4-meta-normal.lrml


```
                      <lrml:Role key="role1"
iri="http://example.org/roles#author">
                            <lrml:filledBy keyref="#mp"/>
                            <lrml:filledBy keyref="#ta"/>
                            <lrml:forExpression keyref="#rule1a"/>
                      </lrml:Role>
                </lrml:hasRole>
                <lrml:hasRole>
                      <lrml:Role key="role2"
iri="http://example.org/roles#author">
                            <lrml:filledBy keyref="#mp"/>
                            <lrml:forExpression keyref="#atom2a"/>
                            <lrml:forExpression keyref="#atom2b"/>
                      </lrml:Role>
                </lrml:hasRole>
          </lrml:Roles>
  </lrml:hasRoles>
```

Example 23 (normal form)[61]:

```
  <lrml:hasJurisdictions>
          <lrml:Jurisdictions>
                <lrml:hasJurisdiction>
                      <lrml:Jurisdiction key="us"
sameAs="http://example.org/jurisdiction#unitedStatesOfAmerica"/>
                </lrml:hasJurisdiction>
          </lrml:Jurisdictions>
  </lrml:hasJurisdictions>
```

Example 24 (compact form)[62]:

```
  <lrml:hasJurisdictions>
          <lrml:Jurisdictions>
                <lrml:hasJurisdiction>
                      <lrml:Jurisdiction key="exd"
sameAs="http://example.org/jurisdiction#executiveDepartments"/>
                </lrml:hasJurisdiction>
          </lrml:Jurisdictions>
  </lrml:hasJurisdictions>
```

Example 25 (normal form)[63]:

```
  <lrml:hasAuthorities>
          <lrml:Authorities>
                <lrml:hasAuthority>
                      <lrml:Authority key="house"
sameAs="http://example.org/authority#house-of-representatives"/>
                </lrml:hasAuthority>
          </lrml:Authorities>
  </lrml:hasAuthorities>
```

Example 26 (normal form)[64]:

```
  <lrml:hasTimes>
          <lrml:Times>
```

61 examples/normalized/ex4-meta-normal.lrml

62 examples/normalized /ex4-meta-normal.lrml

63 examples/normalized/ex4-meta-normal.lrml

64 examples/normalized/ex12-USC_17_504_context-normal.lrml


```
                <lrml:hasTime>
                        <ruleml:Time key=":t1">
                                <ruleml:arg index="1">
                                        <ruleml:Data xsi:type="xs:dateTime">1978-
01-01T00:00:00</ruleml:Data>
                                </ruleml:arg>
                        </ruleml:Time>
                </lrml:hasTime>
        </lrml:Times>
   </lrml:hasTimes>
```

Example 27 (normal form)[65]:

```
<lrml:hasTemporalCharacteristics>
        <lrml:TemporalCharacteristics key="tblock1">
                <lrml:hasTemporalCharacteristic>
                        <lrml:TemporalCharacteristic key="nev1">
                                <lrml:forStatus iri="http://docs.oasis-
open.org/legalruleml/ns/v1.0/vocab#Efficacious"/>
                                <lrml:hasStatusDevelopment
iri="http://docs.oasis-open.org/legalruleml/ns/v1.0/vocab#Starts"/>
                                <lrml:atTime keyref="#t1"/>
                        </lrml:TemporalCharacteristic>
                </lrml:hasTemporalCharacteristic>
                <lrml:hasTemporalCharacteristic>
                        <lrml:TemporalCharacteristic key="nev2">
                                <lrml:forStatus iri="http://docs.oasis-
open.org/legalruleml/ns/v1.0/vocab#InForce"/>
                                <lrml:hasStatusDevelopment
iri="http://docs.oasis-open.org/legalruleml/ns/v1.0/vocab#Starts"/>
                                <lrml:atTime keyref="#t2"/>
                        </lrml:TemporalCharacteristic>
                </lrml:hasTemporalCharacteristic>
        </lrml:TemporalCharacteristics>
   </lrml:hasTemporalCharacteristics>
```

Example 28 (compact form)[66]:

```
   <lrml:hasAssociations>
        <lrml:Associations>
                <lrml:hasAssociation>
                        <lrml:Association>
                                <lrml:appliesSource keyref="#ref1"/>
                                <lrml:toTarget keyref="#nev1"/>
                                <lrml:toTarget keyref="#nev2"/>
                        </lrml:Association>
                </lrml:hasAssociation>
        </lrml:Associations>
   </lrml:hasAssociations>
```

Example 29 (normal form)[67]:

```
   <lrml:hasAssociations>
        <lrml:Associations key="ascs1">
                <lrml:hasAssociation>
                        <lrml:Association>
```

65 examples/normalized/ex6-temporal-normal.lrml

66 examples/normalized/ex6-temporal-normal.lrml

67 examples/normalized/ex6-temporal-normal.lrml


```
                              <lrml:appliesTemporalCharacteristics
keyref="#tblock1"/>
                              <lrml:toTarget keyref="#rule1"/>
                              <lrml:toTarget keyref="#atom1"/>
                              <lrml:toTarget keyref="#body1"/>
                        </lrml:Association>
                  </lrml:hasAssociation>
            </lrml:Associations>
      </lrml:hasAssociations>

      <lrml:hasContext>
            <lrml:Context key="ruleContext1">
                  <lrml:appliesAssociations keyref="#ascs1"/>
                  <lrml:inScope keyref="#stmt1"/>
            </lrml:Context>
      </lrml:hasContext>
```

Example 30 (normal form)[68]:

```
      <lrml:hasAssociations>
            <lrml:Associations key="sourceBlock1">
                  <lrml:hasAssociation>
                        <lrml:Association>
                              <lrml:appliesTemporalCharacteristics
keyref="#tblock1"/>
                              <lrml:toTarget keyref="#ps1"/>
                              <lrml:toTarget keyref="#ps2"/>
                        </lrml:Association>
                  </lrml:hasAssociation>
                  <lrml:hasAssociation>
                        <lrml:Association>
                              <lrml:appliesAuthority keyref="#congress"/>
                              <lrml:appliesJurisdiction keyref="#us"/>
                              <lrml:toTarget keyref="#ps1"/>
                              <lrml:toTarget keyref="#ps3"/>
                        </lrml:Association>
                  </lrml:hasAssociation>
            </lrml:Associations>
      </lrml:hasAssociations>
```

Example 31 (normal form)[69]:

```
<lrml:appliesModality iri="/ontology/deontic/"/>
```

Example 32 (normal form)[70]:

```
<lrml:appliesSource keyref="#sec504-clsc-pnt1"/>
```

Example 33 (normal form)[71]:

```
<lrml:appliesTemporalCharacteristics keyref="#tblock1"/>
```

Example 34 (normal form)[72]:

```
<lrml:appliesStrength iri="/ontology/defeasible"/>
```

---

68 examples/normalized/ex9-alternatives-normal.lrml

69 examples/normalized/ex12-USC_17_504_context-normal.lrml

70 examples/normalized/ex12-USC_17_504_context-normal.lrml

71 examples/normalized/ex12-USC_17_504_context-normal.lrml

72 examples/normalized/ex12-USC_17_504_context-normal.lrml

Example 35 (normal form)[73]:

```
<lrml:appliesAuthority keyref="#congress"/>
```

Example 36 (normal form)[74]:

```
<lrml:appliesJurisdiction keyref="#us"/>
```

Example 37 (normal form)[75]:

```
<lrml:hasContext>
      <lrml:Context key="Context1">
            <lrml:appliesSource keyref="#sec504-clsc-pnt1"/>
            <lrml:appliesTemporalCharacteristics keyref="#tblock1"/>
            <lrml:appliesModality iri="/ontology/deontic/"/>
            <lrml:appliesStrength iri="/ontology/defeasible"/>
            <lrml:appliesAuthority keyref="#congress"/>
            <lrml:appliesJurisdiction keyref="#us"/>
            <lrml:appliesAssociations keyref="#assoc1"/>
            <lrml:appliesAlternatives keyref="#alt2"/>
            <lrml:inScope keyref="#s1"/>
      </lrml:Context>
</lrml:hasContext>
```

Example 38 (normal form)[76]:

```
<lrml:hasContext>
      <lrml:Context key="ruleInfo4" hasCreationDate="#t1">
            <lrml:appliesSource keyref="#sec504-clsc-pnt2"/>
            <lrml:appliesTemporalCharacteristics keyref="#tblock1"/>
            <lrml:appliesStrength iri="/ontology/defeater"/>
            <lrml:appliesAuthority keyref="#congress"/>
            <lrml:appliesJurisdiction keyref="#us"/>
            <lrml:appliesAssociations keyref="#assoc1"/>
            <lrml:appliesAlternatives keyref="#alt2"/>
            <lrml:inScope keyref="#rule1"/>
            <lrml:inScope keyref="#rule4"/>
      </lrml:Context>
</lrml:hasContext>
```

73 examples/normalized/ex12-USC_17_504_context-normal.lrml

74 examples/normalized/ex12-USC_17_504_context-normal.lrml

75 examples/normalized/ex12-USC_17_504_context-normal.lrml

76 examples/normalized/ex12-USC_17_504_context-normal.lrml

Appendix H. Acronyms (non normative)

RDF: Resource Description Framework.

RDFS: RDF Schema.

XML: eXtensible Markup Language.

FRBR: Functional Requirements for Bibliographic Records.

Appendix I. Generation – (non-normative)

This material aims to provide tools for automatically generate xsd-schemas from relaxng schemas. For more detalis see Section 5.18 XSD Schema Derivation.

generation

Appendix J. Revision History

Revision	Date	Editor	Changes Made
[01]	[09 May 2014]	[Monica Palmirani]	[Creation]
[02]	[1 July 2014]	[Monica Palmirani]	[Inclusion of fragment of text]
[03]	[17 July 2014]	[Monica Palmirani]	[Inclusion of fragment of text]
[04]	[05 August 2014]	[Monica Palmirani]	[Updating of the paragraph 4.2.1, 4.2.3, 4.2.4, 4.2.5.]
[05]	[12 August 2014]	[Tara Athan]	[Updating of the paragraph 5.2., 5.3., 5.4.]
[06]	[2 October 2013]	[Guido Governatori]	[Updating of paragraph 4.1, 4.1.1, swapped order between Deontic (4.1.2)and Constitutive/Prescriptive (4.1.3), updated new 4.1.2]
[07]	[2 October 2013]	[Monica Palmirani]	[Accepted all the revisions]
[08]	[2 October 2013]	[Monica Palmirani]	[Accepted all the revisions. Revised 4.2.6 and 4.2.7]
[09]	[7 January 2015]	[Guido Governatori]	[5.1 part: Modelling Legal Norms]
[10]	[7 January 2015]	[Adam Wyner, Tara Athan]	[revision and comments]
[11]	[12 January 2015]	[Monica Palmirani]	[consolidation and editing]
[12]	[12 January 2015]	[Guido Governatori]	[refining some little part]
[13]	[12 January 2015]	[Guido Governatori, Adam Wyner, Tara Athan, Monica Palmirani]	[refining some little part]
[14]	[09 March 2015]	[Guido Governatori, Adam Wyner, Tara Athan, Monica Palmirani]	[refining part concerning the metadata]
[15]	[2 July 2015]	Monica Palmirani	[including parts]
[16]	[9 July 2015]	Monica Palmirani, Tara Athan	[including parts]
[17]	[15 July 2015]	Adam Wyner	[refining]
[18]	[17 July 2015]	Monica Palmirani, Tara Athan	[including parts]]

[19]	[24 July 2015]	Monica Palmirani, Adam Wyner	[including parts and refining]
[20]	[26 August 2015]	All	[refining]
[21]	[3 Spet. 2015]	All	[refining]
[22]	[25 Sept 2015]	Guido Governatori, Tara Athan	[Bibliography and 3.7]
[24]	[3 Nov. 2015]	Tara Athan	[chapter 5]
[25]	[3 Nov. 2015]	Tara Athan, Guido Governatori,	[Suborderlist definition and Deontic Specification]
[26]	[3 Nov. 2015]	Tara Athan	[revision of chapter 5]
[27]	[5 Jan. 2016]	Tara Athan	[revision of chapter 5]
[28]	[12 Jan. 2016]	Tara Athan	[revision of chapter 5]
[29]	[12 Jan. 2016]	Tara Athan	[revision of chapter 5]
[30]	[21 Jan 2016]	Guido Governatori	[updated references in the text, cleared some formatting issues, corrected typos on <overrides>, mismatch in snippets and text]
[31]	[10 March 2016]	Monica Palmirani	[revision of all the examples in normal and compact forms]
[32]	[4 April 2016]	Monica Palmirani	[revision of all the examples in normal and compact forms]
[33]	[11 April 2016]	Adam Wyner	[revision]
[34]	[12 April 2016]	All	[common revision of the text]
[35]	[24 May 2016]	All	[common revision of the text]
[36]	[2 June 2016]	All	[common revision of the text]
[37]	[8 June 2016]	All	[common revision of the text]
[38]	[21 June 2016]	All	[common revision of the text]
[39]	[23 June 2016]	All	[Tara revision of 1.4 and conformance paragraph]
[40]	[12 July 2016]	Guido Governatori	Applied typographical convention up to Section 4 (included)
[41]	[19 August 2016]	Monica Palmirani	Applied typographical convention up to Section 6 (included) and some editorial modifications
[42]	[20 August 2016]	Monica Palmirani	Refinement of the conformance rules.
[43]	[21 September 2016]	Monica Palmirani, Guido Governatori	Refinement of the conformance rules.
[44]	[5 October 2016]	Monica Palmirani, Guido Governatori	Refinement of the conformance rules.

		Tara Athan	
[45]	[19 October 2016]	Monica Palmirani, Guido Governatori Tara Athan	Refinement of the conformance rules.
[46]	[26 October 2016]	Monica Palmirani	Inserted the HTTP links, correct <Overrides> typos, inserted the referecenes into the text.
[46]	[26 October 2016]	All	Editing
[47]	[28 October 2016]	Monica Palmirani	Folder of material, links check

