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Temporal Dimensions in Rules Modelling

Monica PALMIRANI[*], Guido GOVERNATORI[+], Giuseppe CONTISSA[*]
*CIRSFID, University of Bologna
+NICTA - Australia

Abstract. Typically legal reasoning involves multiple temporal dimensions. The contribution of this work is to extend LKIF-rules (LKIF is a proposed mark-up language designed for legal documents and legal knowledge in ESTRELLA Project [3]) with temporal dimensions. We propose an XML-schema to model the various aspects of the temporal dimensions in legal domain, and we discuss the design choices. We illustrate the use of the temporal dimensions in rules with the help of real life examples.

Keywords: LKIF-Rule, Temporal dimension, Rule modelling

1 LKIF-Rule Extension

The main goal of the research is to extened LKIF-rules with the temporal dimension with the aim of fulfilling the requirements to be expressive, concise, not redundant, detecting times at rules level and at sentences level, to have versioning of rules and finally to satisfy the isomorphism principle. We find several connected works in literature concerning this domain [5][8][4], nevertheless our research aims to go beyond the limitations of the current state of the art. Some of those limitations were presented in [2]:

a) existing rule XML standards like RIF, RuleML or LKIF-Rule permit to define temporal predicates, but they do not have a temporal model natively embedded, clean and easy to use. Following this approach each application could, in principle, define different local vocabularies, grammars and predicates affecting the interoperability inside of a community;
b) often the temporal model, mostly based on the events, is not specific for the legal domain that required at least tree axis: time of in force, time of efficacy and time of application of the norms. Those times are structured as events and a pair of two events (start and end) defines an interval;
c) the temporal model proposed in this work permits to assign the temporal model above mentioned to each part of the rule: antecedent, consequent, result of reasoning. This granularity of assertions opens new frontiers for legal reasoning especially in term of expressiveness, compactness and performance;
d) our LKIF-rules extension follows the isomorphism principle stated by Bench-Capon [1] and Karpf for connecting the legal resources (text) with the formalized rules;
e) the model proposed is designed for reducing the redundancy of references to textual sources, definitions of temporal events and intervals, and connections with the ontology concepts (TBox). This approach is clean, compact, and guarantees high maintainability of the standard over the time.

1.1 Temporal Dimension Elements

Following the principles listed above we have modified LKIF-rule by adding temporal arguments, in particular three elements are added: a block `meta` that includes sub-blocks `sources`, `events`, and `timeInfo`.

The block `sources` defines the link between the rules and a textual fragment using URI. In the following example the sentence S1 is referred to the fragment in the text `section 25, subsection1, point a)` of the Terrorism Act, 2006 of UK.

```
<source element="s1" uri="http://act/11/2006#sec25_1_a"/>
```

Figure 1. Source element that connect the sentence s1 with the text.

The block `events` tracks all the temporal events involved in the rules: external and internal times[1]. The following example defines four events that are used in the `timesBlock` for providing the semantics of each event. This mechanism prevents the explosion of date information and it minimizes the redundancy in the syntax annotation.

```
<events>
 <!-- events of the Order 2007 UK-->
 <event id="e1" element="2007-07-25T01:01:00.0Z"/>
 <!-- Terrorism Act of 2006 -->
 <event id="e2" element="2006-03-30T01:01:00.0Z"/>
 <event id="e3" element="2006-07-17T01:01:00.0Z"/>
 <event id="e4" element="2006-07-25T01:01:00.0Z"/>
</events>
```

Figure 2. Events into LKIF-Rule.

The block `timesInfo` is a container of metadata concerning the temporal dimensions and assigns for each sub-block times the semantics of each interval or instant of time.

```
<timesInfo>
 <!- Order 2007 UK-->
 <times id="t1">
  <time start="#e1" timeType="efficacy"/>
  <time start="#e1" timeType="inforce"/>
 </times>
</timesInfo>
```

Figure 3. Times block into LKIF-Rule.

It is possible to model well defined intervals using the attributes `start` and `end`, or to define a simple instant setting `start` equal to `end` and finally to use the undefined interval expressed by a duration. In the following example time `t2` is the application date of a rule and the interval is defined with a starting date (event `e1`) and with a duration[2].

```
<times id="t2">
 <time start="#e1" duration="P01Y"timeType="application"/>
</times>
```

Figure 4. Time duration modelling and representation.

[1] External time is the time not stated in the norm but that leads the lifecycle of the provision. Internal time is the time specified in the norm. In the example "The additional tax is applicable to the earn of the financial year 2010-2011. This section enters into force at January 1st", the financial year 2010-2011 is an internal time and the Jan 1st is an external time.

[2] The duration follows the annotation of the `xsd:type` duration compliance with the W3C standard data type definition. In our case P01Y means one year.

In this way we define the events in the metadata and we assign the semantics and the behavior of these events in the `timesInfo` block. With the mechanism of the ID (using URI for permitting an externalization of these metadata in other physical files) we connect the temporal dimension information directly with rule, head and sentence elements.

1.1 Temporal Dimension in Rule Modelling

The `timeBlock` attribute embedded into the sentences (<s id="id3b" timeBlock="t1">) defines the "enter into force" and the "efficacy" temporal parameters of either the textual provisions or the conditions. The `timeBlock` of the rule (<rule id="order2007" timeBlock="t2">) indicates when the rule is valid, and finally the `timeBlock` of the head (<head timeBlock="t2">) determines when the consequent is applicable. So in the next example we have the following representation of our pilot case simplified for favouring the reader. The rule `order2007` models the disapplication of Section 25 of the Terrorism Act 2006 using the predicate `mod:suspension`. This suspension freezes the internal time of Section 25.

```
<rules>
 <rule id="order2007" ruleType="strict" timesBlock="t2">
 <!-- Disapplication sect. 25 of the Terrorism act 2006 -->
  <head timesBlock="t2">
   <s pred="mod:suspension" id="id1a">
    <v value="sec25_2006">x</v>is suspended</s>
  </head>
  <body>
   <s pred="mod:enterInForce" id="id3b" timesBlock="t1">
    <v id="sec2_2007">x</v> enters into in force</s>
  </body>
 </rule>
```

Figure 5. Sentence definition in the LKIF-Rule extended.

This means that the days of detention pass from 28 to 14, as originally stated, and this new rules is applicable in an interval of time starting at `e1` (`2007-07-25T01`) and ending one year later (`P01Y`).

With this annotation a reasoning engine can provide two different answers to the query "What is it the applicable term for the detention?": "14 days after July 2008", "28 days during the application of the suspension".

```
<rule id="sec25_2006" ruleType="strict" timesBlock="t3">
 <!--Sect.25 Terr. Act/2006 modifies Sch.8 Terr. Act/2000 -->
 <head timesBlock="t3">
  <s pred="mod:substituted" id="id4a">
   <v value="sche8_2000">x</v> is modified as if for "28 days"
there were substituted "14 days"</s>
 </head>
 <body>
  <s pred="mod:intoOperation" id="id4b" timesBlock="t3">
   <v value="sec25_2006">y</v> into operation.</s>
 </body>
 </rule>
```

Figure 6. Modification frozen.

2 Future Work

The LKIF-Rule experiences[3] underlines several considerations concerning the gap between the five levels[4] [7] of information that we need to model for describing a legal document especially in the management of the temporal argument:

- the granularity of the XML document marked-up is not isomorphic to the rules and statements modelling in term of part of text (word, paragraphs, etc.);
- the relationship between rules and text exhibits an N:M cardinality, so the LKIF-rules syntax was improved in the `sources` metadata blocks;
- the interaction between text, rules and concepts concerning the temporal dimension are mediated by the usage of an ontology about legal temporal definitions. This mechanism permits each legal system to define its appropriate set of temporal dimensions according to the legal tradition (e.g. in the constitutional monarchy some concepts like promulgation or enter into force do not have a foundation in legal theory);
- legal documents change over the time so in the LKIF-rule a mechanism for managing the dynamicity over the time as well as into rules in a separate level is necessary.

We learnt the lesson that we need a strong architecture of the temporal arguments, clean, embedded and granular enough to permit reasoning on every level: text, body, header and rule. Our future work will go in the direction to use non-monotonic logic and the temporal arguments for managing retroactive rules, rules conditioned by undefined events, modifications *ex-tunc* and temporal modifications (suspension, inapplicability, annulment) fostering those information and using a reasoner engine [4].

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[3] Estrella Project, European Project IST-2004-027655.
[4] Following the semantic web cake: text, structure, metadata, ontology, rules.