Using Knowledge Graph Technologies to Contextualize and Validate Declarations in the Social Security Domain

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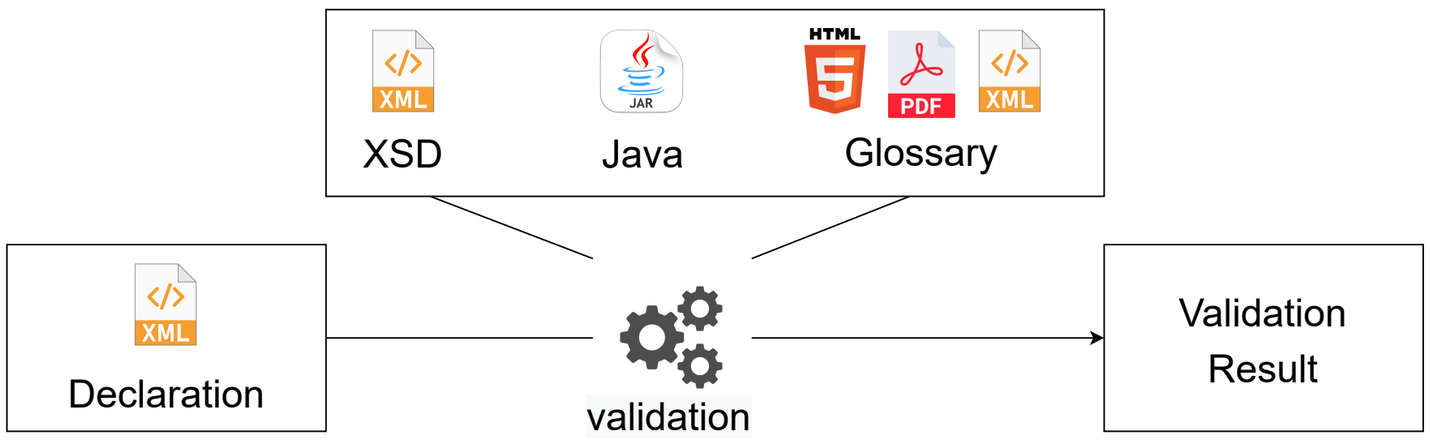
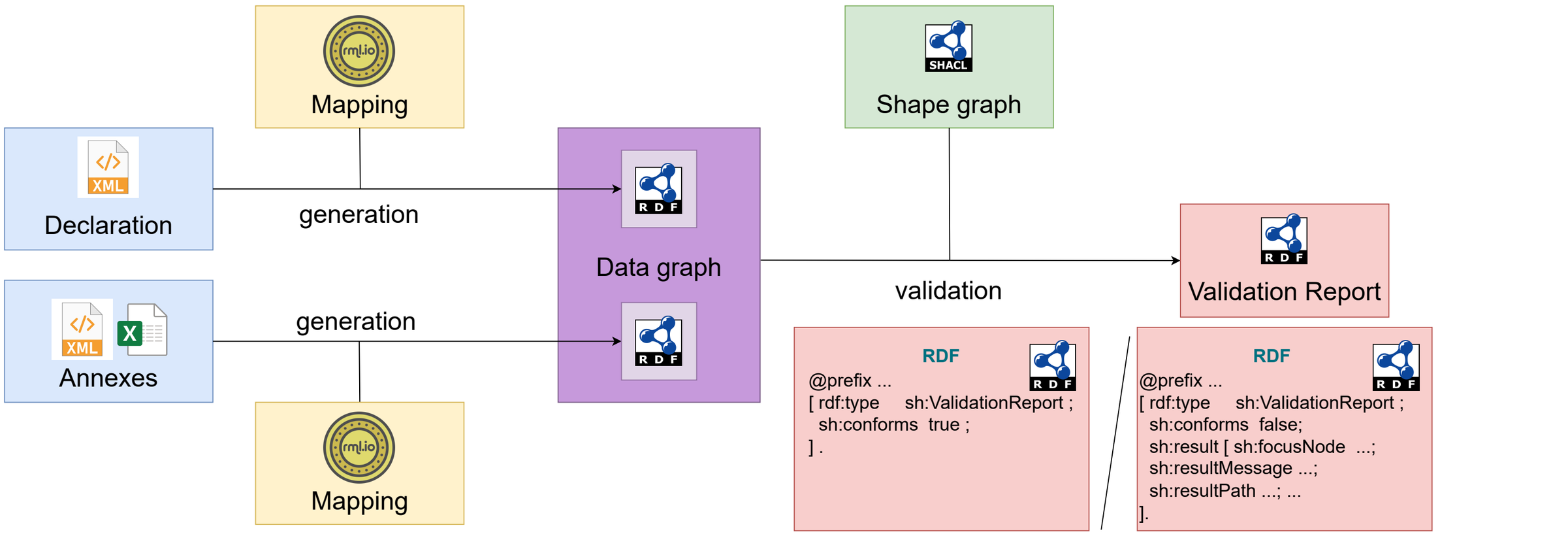
Current situation



Problems

- XSD: Not expressive enough for all rules
- Java: Expressive enough for all rules but not in an interoperable format
- Glossary: Specifies rules in natural language which cannot be processed by a computer agent

Graph Technologies



DmfA.xml

```
<DmfAOriginal> ...
 <Form> ...
  <Identification>DMFA</Identification> ...
  <EmployerDeclaration> ...
   <Quarter>20223</Quarter> ...
   <NaturalPerson> ...
     <NaturalPersonSequenceNbr>1</NaturalPersonSequenceNbr> ...
   </NaturalPerson>
   <NaturalPerson> ...
     <NaturalPersonSequenceNbr>2</NaturalPersonSequenceNbr> ...
   </NaturalPerson>
   <NaturalPerson> ...
     <NaturalPersonSequenceNbr>3</NaturalPersonSequenceNbr> ...
   </NaturalPerson>
...
```

RML

```
@prefix rml: <http://semweb.mmlab.be/ns/rml#> .
...
<#Form-Mapping> a rr:TriplesMap ;
  rml:logicalSource [ rml:source "DmfA.xml" ; ... ] ;
  rr:subjectMap [ ... ] ;
  rr:predicateObjectMap [
    rr:predicate ont:Identification;
    rr:objectMap [
      rml:reference "Identification";
      rr:datatype xs:string ; ] ; ] ;
  rr:predicateObjectMap [
    rr:predicate ont:R_90059_90007 ;
    rr:objectMap [
      rr:parentTriplesMap <#EmployerDeclaration-Mapping> ;
      rr:joinCondition [ ... ] ; ] ; ] ;
...
```

RDF

```
@prefix rdfs: ...

_:DmfAOriginal0 rdfs:type ont:DmfAOriginal .
_:Form0 rdfs:type ont:Form .
_:Form0 ont:Identification "DMFA".
_:Form0 ont:R_90059_90007 _:EmployerDeclaration0.
_:EmployerDeclaration0 rdfs:type
      ont:EmployerDeclaration.
_:EmployerDeclaration0 ont:Quarter
      "20222"^^xsd:integer.
_:EmployerDeclaration0 ont:R_90007_90017
      _:NaturalPerson0.
ont:NaturalPerson0 rdfs:type ont:NaturalPerson.
ont:NaturalPerson0 ont:NaturalPersonSequenceNbr
      "1"^^xsd:integer.
```

SHACL

```
kg:FormShape a sh:NodeShape ;
   sh:targetClass ont:Form ;
   sh:property [
      sh:path ont:Identification;
      sh:datatype xs:string;
      sh:minCount 1 ;
      sh:maxCount 1 ;
      sh:maxLength 7 ;
      sh:sparql _:codeIsValid;
      sh:sparql _:codeInQuarterRange;
   ]
.
```

Constraint value to belong to a set defined by an annex

```
_:codeIsValid a sh:SPARQLConstraint;
   sh:prefixes <> ;
   sh:select """
      SELECT $this ?value WHERE {
        { SELECT $this ?value (SUM (?match) as ?nbrMatch) WHERE {
          $this $PATH ?value.
          ?idtype a an11:IdentificationType ; rdfs:label ?allowedvalue.
          BIND (IF (?value = ?allowedvalue, 1, 0 ) AS ?match)
        } GROUP BY ?value $this}
        FILTER(?nbrMatch = 0)
      }""" ;
.
```

Constraint value to be temporally valid as defined by an annex

```
_:codeInQuarterRange a sh:SPARQLConstraint;
   sh:prefixes <> ;
   sh:select """
   SELECT $this ?value WHERE {
      {SELECT $this ?value (SUM (?match) as ?nbrMatch) WHERE {
         $this $PATH ?value.
         ?wc a an11:IdentificationType; rdfs:label ?value;
            an11:validFromQuarter ?sQuarter;
            an11:validToQuarter ?eQuarter;
         .
         $this ont:R_90059_90007/ont:Quarter ?quarter.
         BIND( IF(?sQuarter < ?quarter && ?quarter < ?eQuarter, 1, 0) AS ?match)
      } GROUP BY ?value $this}
      FILTER(?nbrMatch = 0)
   }""" ;
.
```

Constraint value to be unique

```
_:valueIsUnique a sh:SPARQLConstraint;
   sh:prefixes <> ;
   sh:select """
      SELECT ?this
      WHERE {
        {
          SELECT ?this (COUNT(?s) as ?sOcc)
          WHERE {
            $this ont:R_90007_90017 ?np
            ?np ont:NaturalPersonSequenceNbr ?s.
          }
          GROUP BY ?s $this
        }
        FILTER(?seqNbrOcc > 1)
      }""" ;
.
```

Advantages

- Integration of data from various sources in multiple formats into a single data model (RDF)
- SHACL is a W3C standard hence the rules are defined in an interoperable format
- SHACL is more expressive than XSD and more complex rules can be acheived.
  - See examples on the left
  - Checksums
  - Simple arithmetic
  - And many more ...