Validating RDF data tutorial

ShEx/SHACL by example

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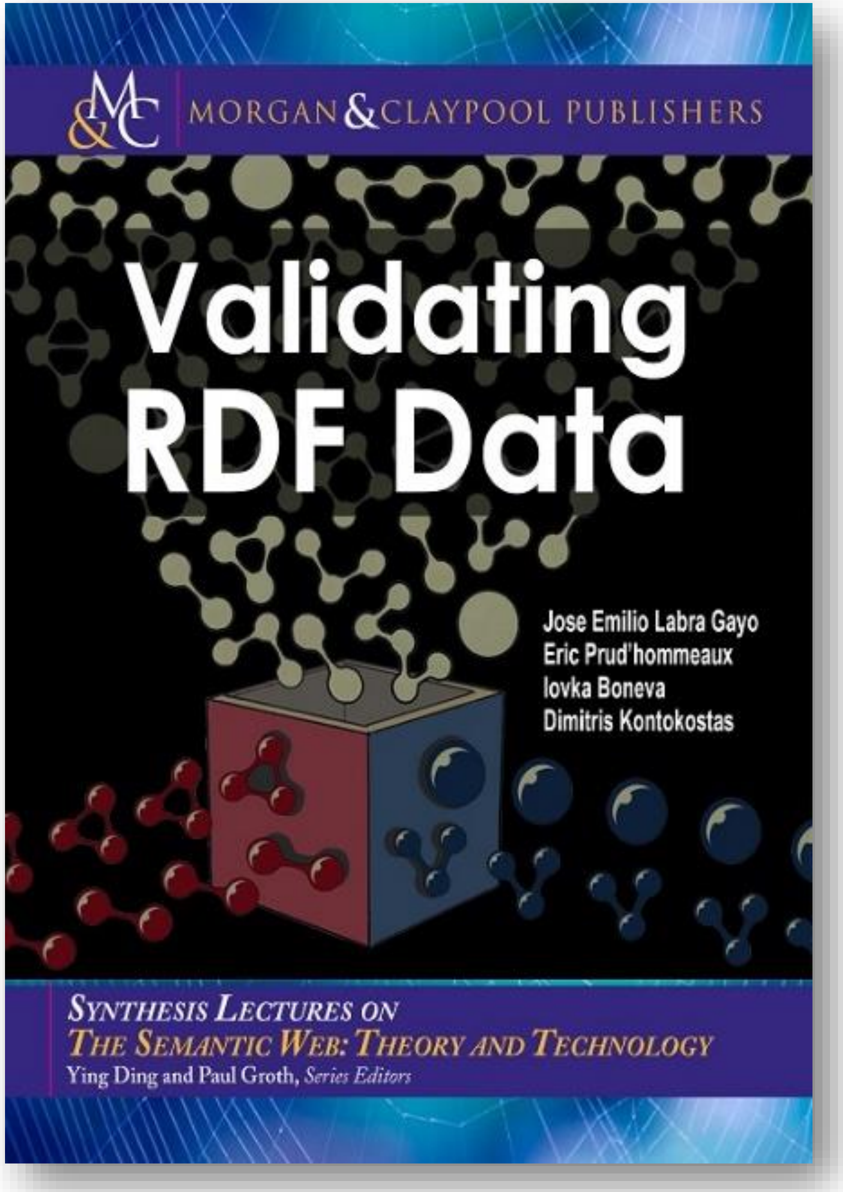
More info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Validating RDF Data
Jose Emilio Labra Gayo
Eric Prud'hommeaux
Iovka Boneva
Dimitris Kontokostas
SYNTHESIS LECTURES ON THE SEMANTIC WEB: THEORY AND TECHNOLOGY
Ying Ding and Paul Groth, Series Editors

HTML version: http://book.validatingrdf.com
Examples: https://github.com/labra/validatingRDFBookExamples

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RDF data model (short overview)

Motivation for RDF data Validation

ShEx by example

SHACL by example

Comparing ShEx and SHACL

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RDF Data Model

Overview of RDF Data Model and simple exercise

Link to slides about
RDF Data Model

https://figshare.com/articles/RDF_data_model/7159796

RDF, the good parts...

- RDF as an integration language
- RDF as a *lingua franca* for semantic web and linked data
- RDF data stores & SPARQL
- RDF flexibility
  - Data can be adapted to multiple environments
  - Open and reusable data by default

RDF, the other parts

- Inference & knowledge representation
  - RDF should combine well with KR vocabularies (RDF Schema, OWL...)
  - Performance of RDF based systems with inference = challenging
- Consuming & producing RDF
  - Multiple serializations: Turtle, RDF/XML, JSON-LD, ...
  - Embedding RDF in HTML
  - Describing and validating RDF content

Why describe & validate RDF?

- For producers
  - Developers can understand the contents they are going to produce
  - They can ensure they produce the expected structure
  - Advertise and document the structure
  - Generate interfaces
- For consumers
  - Understand the contents
  - Verify the structure before processing it
  - Query generation & optimization

Similar technologies

Technology	Schema
Relational Databases	DDL
XML	DTD, XML Schema, RelaxNG, Schematron
Json	Json Schema
RDF	?

Fill that gap

Understanding the problem

RDF is composed by nodes and arcs between nodes

We can describe/check

- The form of the node itself (node constraint)
- The number of possible arcs incoming/outgoing from a node
- The possible values associated with those arcs

RDF Node

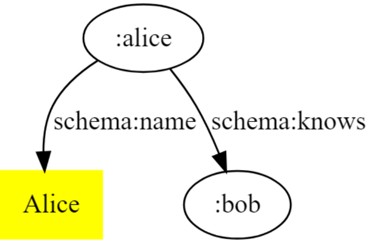
```
:alice schema:name   "Alice";
       schema:knows  :bob .
```

```
IRI schema:name   string   1
    schema:knows  IRI      0, 1,...
```

Shape
RDF Node that
represents a User

ShEx

```
<UserShape> IRI {
  schema:name   xsd:string    ;
  schema:knows  IRI         *
}
```

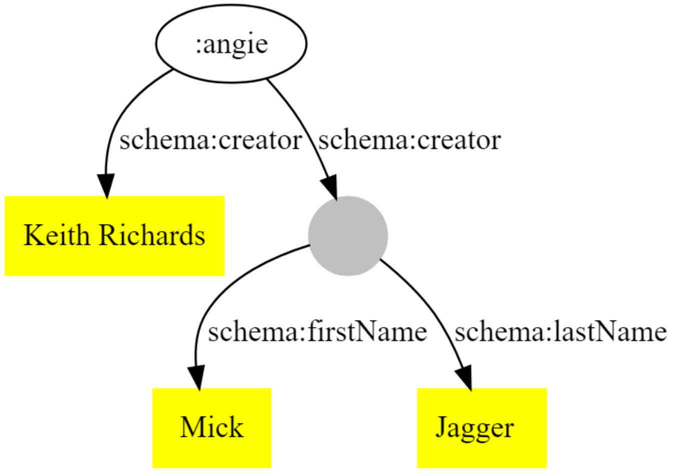


Understanding the problem

RDF flexibility

- Mixed use of objects & literals
- Example:
  - Values of `schema:creator` can be:
    - **`string`** or
    - `schema:Person`
  - in the same data

```
:angie schema:creator "Keith Richards" ;
       schema:creator [
         schema:firstName "Mick" ;
         schema:lastName  "Jagger"
       ] .
```



Lots of examples at http://schema.org

Understanding the problem

Repeated properties

- The same property can be used for different purposes in the same data
- Example: A product must have 2 codes with different structure

```
:product schema:productID "isbn:123-456-789";
         schema:productID "code456" .
```

A practical example from FHIR

See: http://hl7-fhir.github.io/observation-example-bloodpressure.ttl.html

Understanding the problem

Shapes ≠ types

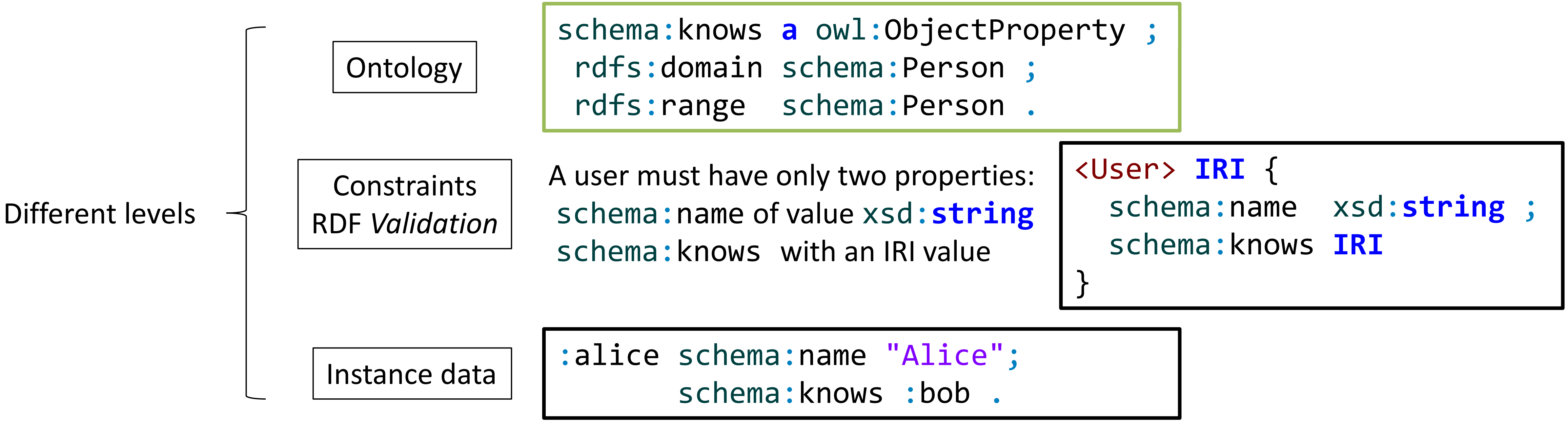
Nodes in RDF graphs can have zero, one or many `rdf:type` declarations

- One type can be used for multiple purposes (`foaf:Person`)
- Data doesn't need to be annotated with fully discriminating types
  - `foaf:Person` can represent friend, invitee, patient,...
  - Different meanings and different structure depending on the context
    - Specific validation constraints for different contexts

Understanding the problem

RDF validation ≠ ontology definition ≠ instance data

- Ontologies are usually focused on real world entities
- RDF validation is focused on RDF graph features (lower level)



Different levels

Ontology

```
schema:knows a owl:ObjectProperty ;
 rdfs:domain schema:Person ;
 rdfs:range  schema:Person .
```

Constraints
RDF *Validation*

A user must have only two properties:
schema:name of value xsd:string
schema:knows with an IRI value

```
<User> IRI {
  schema:name  xsd:string ;
  schema:knows IRI
}
```

Instance data

```
:alice schema:name "Alice";
       schema:knows :bob .
```

Previous RDF validation approaches

- SPARQL based
  - Plain SPARQL
  - SPIN: http://spinrdf.org/
- OWL based
  - Stardog ICV
    - http://docs.stardog.com/icv/icv-specification.html
- Grammar based
  - OSLC Resource Shapes
    - https://www.w3.org/Submission/2014/SUBM-shapes-20140211/

Define SPARQL queries that detect errors

Pros:

- Expressive
- Ubiquitous

Cons

- Expressive
- Idiomatic - many ways to encode the same constraint

Example: SPARQL query to check that…

There is one schema:name which must be a xsd:string and one schema:gender must be schema:Male or schema:Female

```
ASK {{ SELECT ?Person {
      ?Person schema:name ?o .
    } GROUP BY ?Person HAVING (COUNT(*)=1)
  }
  { SELECT ?Person {
      ?Person schema:name ?o .
      FILTER ( isLiteral(?o) &&
               datatype(?o) = xsd:string )
     } GROUP BY ?Person HAVING (COUNT(*)=1)
  }
  { SELECT ?Person (COUNT(*) AS ?c1) {
      ?Person schema:gender ?o .
    } GROUP BY ?Person HAVING (COUNT(*)=1)}
    { SELECT ?Person (COUNT(*) AS ?c2) {
      ?S schema:gender ?o .
      FILTER ((?o = schema:Female ||
               ?o = schema:Male))
    } GROUP BY ?Person HAVING (COUNT(*)=1)}
    FILTER (?c1 = ?c2)
}
```

SPIN

SPARQL inferencing notation http://spinrdf.org/

- Developed by TopQuadrant
- Commercial product

Vocabulary associated with user-defined functions in SPARQL

SPIN has influenced SHACL (see later)

Stardog ICV

ICV - Integrity Constraint Validation

- Commercial product

OWL with unique name assumption and closed world

Compiled to SPARQL

More info: http://docs.stardog.com/icv/icv-specification.html

OSLC Resource Shapes

OSLC Resource Shapes

https://www.w3.org/Submission/shapes/

- Grammar based approach
- Language for RDF validation
- Input for ShEx and SHACL

```
:user a rs:ResourceShape ;
 rs:property [
  rs:name "name" ;
  rs:propertyDefinition schema:name ;
  rs:valueType xsd:string ;
  rs:occurs rs:Exactly-one ;
] ;
 rs:property [
  rs:name "gender" ;
  rs:propertyDefinition schema:gender ;
  rs:allowedValue schema:Male, schema:Female ;
  rs:occurs rs:Zero-or-one ;
].
```

Other approaches

Dublin Core Application profiles (K. Coyle, T. Baker)

http://dublincore.org/documents/dc-dsp/

RDF Data Descriptions (Fischer et al)

http://ceur-ws.org/Vol-1330/paper-33.pdf

RDFUnit (D. Kontokostas)

http://aksw.org/Projects/RDFUnit.html

...

ShEx and SHACL

2013 RDF Validation Workshop

- Conclusions of the workshop:
  - *There is a need of a higher level, concise language for RDF Validation*
- ShEx initially proposed (v 1.0)

2014 W3c Data Shapes WG chartered

2017 SHACL accepted as W3C recommendation

2017 ShEx 2.0 released as Community group draft

Continue this tutorial with...

ShEx by example	https://figshare.com/articles/ShExByExample_pptx/6291464
SHACL by example	https://figshare.com/articles/SHACL_by_example/6449645
ShEx and SHACL compared	https://figshare.com/articles/ShEx_and_SHACL_compared/6449648
Applications and future work	https://figshare.com/articles/Applications_and_future_work_validating_RDF_data/7159835