RDF Validation tutorial
ShEx/SHACL by example

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RDF Data Model

Overview of RDF Data Model and simple exercise

Link to slides about
RDF Data Model

http://www.slideshare.net/jelabra/rdf-data-model

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 RDF producers

- Developers can understand the contents they are going to produce
- They can ensure they produce the expected structure
- Advertise the structure
- Generate interfaces

For RDF 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
Json	Json Schema
RDF	?

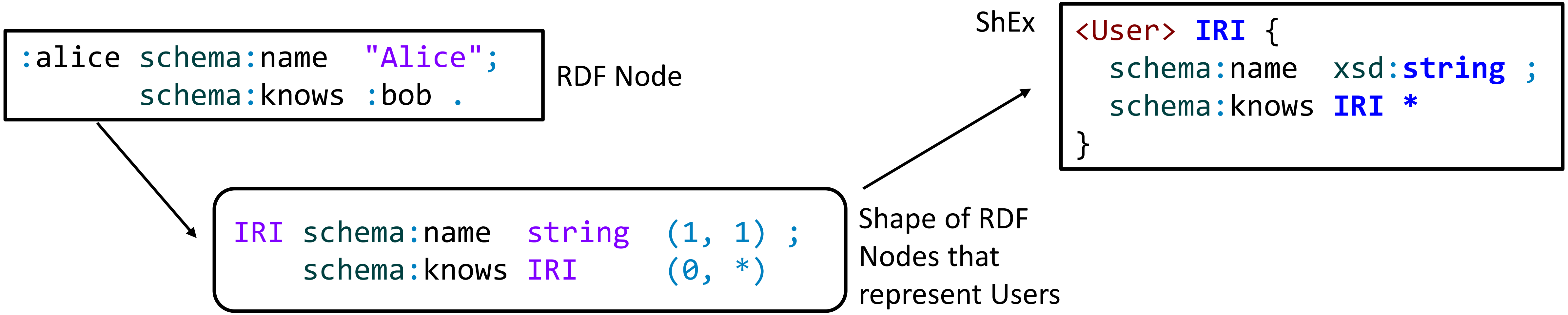
Our goal is to fill that gap

Understanding the problem

RDF is composed by nodes and arcs between nodes

We can describe/check

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



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

RDF Node

```
IRI schema:name  string  (1, 1) ;
    schema:knows IRI     (0, *)
```

Shape of RDF Nodes that represent Users

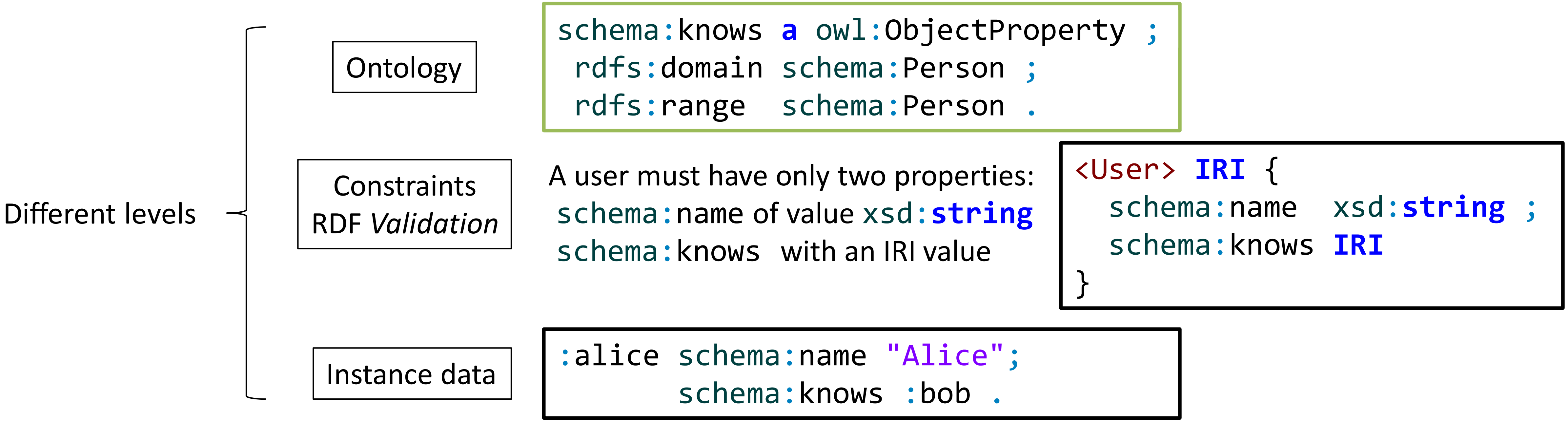
ShEx

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

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 .
```

Understanding the problem

- Shapes ≠ types
- Nodes in RDF graphs can have zero, one or many `rdf:type` arcs
  - 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
      - We should be able to define specific validation constraints in different contexts

Understanding the problem

RDF flexibility

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

```
:angie schema:creator "Keith Richards" ,
       [ a schema:Person ;
           schema:singleName "Mick" ;
           schema:lastName "Jagger"
       ] .
```

See other examples from http://schema.org

Understanding the problem

Repeated properties

- Sometimes, the same property is used for different purposes in the same data
- Example: A book record must have 2 codes with different structure

```
:book 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

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/

Use SPARQL queries to detect errors

Pros:

- Expressive
- Ubiquitous

Cons

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

Example:

schema:name must be a xsd:string

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

Less expressive than ShEx

```
: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 by Eric Prud'hommeaux
- 2014 W3c Data Shapes WG chartered
- 2015 SHACL as a deliverable from the WG

Continue this tutorial with...

ShEx by example	→	http://www.slideshare.net/jelabra/shex-by-example
SHACL by example	→	http://www.slideshare.net/jelabra/shacl-by-example
ShEx vs SHACL	→	http://www.slideshare.net/jelabra/shex-vs-shacl
Future work and applications	→	http://www.slideshare.net/jelabra/rdf-validation-future-work-and-applications