COMP318

Ontologies and Semantic Web

RDF - Part 13

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Where were we

- RDF(S) semantics: entailment vs interpretation
- RDF entailment

RDFS entailment

- The W3C recommendation "RDF Semantics" defines the various form of entailments mentioned:
  - simple entailment
  - RDF entailment
  - RDFS entailment
- Determine which RDF graphs entail (or are equivalent to) which RDF graphs under which semantics,
  - or which RDF graphs are unsatisfiable nonsense under which semantics
- We define the semantics of the RDFS vocabulary, which covers the types of entailments we need

rdfs:domain, rdfs:range,
rdfs:Resource, rdfs:Literal,
rdfs:Datatype,
rdfs:Class, rdfs:subClassOf,
rdfs:subPropertyOf,
rdfs:member, rdfs:Container,
rdfs:ContainerMembershipProperty,
rdfs:comment, rdfs:seeAlso,
rdfs:isDefinedBy, rdfs:label

RDFS Interpretations

- RDFS semantics extends the RDF semantics with additional semantic conditions
- We define an interpretation function for classes, properties and datatypes in terms of their semantics
  - adding the interpretation functions to the RDFS interpretations
  - Refer to Foundations of Semantic Web Technologies, Chapter 3
- The set of RDFS axiomatic triples is satisfied

```
rdfs:type          rdfs:domain    rdfs:Resource ; rdfs:range  rdfs:Class .
rdfs:domain        rdfs:domain    rdf:Property ; rdfs:range  rdfs:Class .
rdfs:range         rdfs:domain    rdf:Property ; rdfs:range  rdfs:Class .
rdfs:subject       rdfs:domain rdf:Statement ; rdfs:range
rdfs:Resource  .
rdfs:predicate   rdfs:domain rdf:Statement ; rdfs:range  rdfs:Resource  .
rdfs:object       rdfs:domain rdf:Statement ; rdfs:range  rdfs:Resource  .
rdf:first          rdfs:domain rdf:List ; rdfs:range  rdfs:Resource  .
rdf:rest           rdfs:domain rdf:List ; rdfs:range  rdfs:Resource  .
rdfs:seeAlso     rdfs:domain rdfs:Resource ; rdfs:range  rdfs:Resource  .
rdfs:comment   rdfs:domain rdfs:Resource ; rdfs:range  rdfs:Literal  .
rdfs:label         rdfs:domain rdfs:Resource ; rdfs:range  rdfs:Literal  .
rdfs:subClassOf  rdfs:domain rdfs:Class ; rdfs:range  rdfs:Class  .
rdfs:isDefinedBy  rdfs:domain rdfs:Resource ; rdfs:range
rdfs:Resource  .
rdfs:subPropertyOf    rdfs:domain    rdf:Property ; rdfs:range
rdfs:Property .
```

Let’s state the formalism

- `:a, :b,`
  - refer to any arbitrary URI,
    - (i.e. anything that can appear in the **predicate** of a triple)
- `:u, :v,`
  - refer to any arbitrary URI or blank node ID
    - (i.e. anything that can appear in the **subject** of a triple)
- `:x, :y,`
  - refer to an arbitrary URI, blank node ID or literal
    - (i.e. anything that can appear in the **object** of a triple)
- `_:n,`
  - refer to the ID of a blank node
    - (i.e. appearing as a **subject** or **object**)
- `:l,`
  - refers to a literal
    - (i.e. a string that is sometimes found in the **object**)

Important property of binary relations

- binary relation R on a set A is said to be:
  - Reflexive: if x R x, for all x ∈ A
    - A number **is equal to** itself
  - Irreflexive: if not x R x, for all x ∈ A
    - A number x **is not equal to** (x+1)
  - Symmetric: if x R y implies y R x, for all x, y ∈ A
    - **marriedTo**: if Ross **marriedTo** Rachel then Rachel **marriedTo** Ross
  - Asymmetric: if x R y not A implies y R x, for all x, y ∈ A
    - **parentOf**: if Rachel **parentOf** Emma then it does not imply Emma **parentOf** Rachel
  - Transitive: if x R y and y R z implies x R z, for all x, y, z ∈ A
    - **friendOf**: if Monica **friendOf** Joey and Joey **friendOf** Phoebe then Monica **friendOf** Phoebe

Inference Rules for RDFS-entailment

- Assign “meaning” to the RDFS vocabulary

- **(rdfsx)** Infer the triple `u a x.` for every RDFS axiomatic triple `u a x.`

- **(RDFS1, literal)** If G contains `u a l.` where `l` is a plain literal (with or without language information), then infer the triple:
  - `_:n rdf:type rdfs:literal.`

Domain and range restrictions

- (rdfs2) If G contains a triples `a rdfs:domain x.` `u a y.` then we can infer
  - `u rdf:type x.`

- (rdf3) If G contains a triples `a rdfs:range x.` `u a v.` then we can infer
  - `v rdf:type x.`

Everything is a resource

- (rdfs4a) If G contains a triple `u a x.` then we can infer
  - `u rdf:type rdfs:Resource`.
- (rdfs4b) If G contains a triple `u a v.` then we can infer
  - `v rdf:type rdfs:Resource`.
- We do not need an inference rule for predicates:
  - the relevant triple can be derived using rdf1 and rdfs4

Reflexivity and Transitivity of `rdfs:subPropertyOf`

- (rdfs5) If G contains the triples `u rdfs:subPropertyOf v.` and `v rdfs:subPropertyOf x.` we can infer
  - `u rdfs:subPropertyOf x.`

- (rdfs6) If G contains the triple `u rdf:type rdf:Property.` we can infer
  - `u rdfs:subPropertyOf u.`

More on Subproperties

- **(rdfs7)** If G contains the triples `a rdfs:subPropertyOf b.` and `u a y.` we can infer
  - `u b y`.

Classes and instances

- (rdfs8) If G contains the triple `u rdf:type rdfs:Class.` we can infer
  - `u rdfs:subClassOf rdfs:Resource`.
- (rdfs9) If G contains the triples `u rdfs:subClassOf x.` and `v rdf:type u.` we can infer
  - `v rdf:type x`.

Reflexivity and Transitivity of `rdfs:subClassOf`

- **(rdfs10)** If G contains the triple
  `u rdf:type rdfs:Class.` we can infer
  - `u rdfs:subClassOf u`.

- **(rdfs11)** If G contains the triples
  `u rdfs:subClassOf v.` and `v rdfs:subClassOf x.` we can infer
  - `u rdfs:subClassOf x.`

Containers

- (rdfs12) If G contains the triple `u rdf:type rdfs:ContainerMembershipProperty.` we can infer
  - `u rdfs:subPropertyOf rdfs:member.`

Datatypes

- (rdfs13) If G contains the triple
  `u rdf:type rdfs:Datatype.` we can infer
  - `u rdfs:subClassOf rdfs:Literal.`

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End of RDF - Part 13

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