Knowledge Representation and Reasoning – Mod. 2

Exercise Sheet 1: RDF

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Exercise 1: RDF Triples

Notation

Until we see the Turtle syntax in more detail, we may write IRIs, blank nodes and literals as follows:

- IRIs are delimited by angle brackets, – e.g., `<http://xmlns.com/foaf/0.1/Person>` – or can be abbreviated using a prefix from a known vocabulary – e.g., `foaf:Person`. Common prefixes are:
  - `foaf` for `<http://xmlns.com/foaf/0.1/>`
  - `rdf` for `<http://www.w3.org/1999/02/22-rdf-syntax-ns#>`
  - `ex` for `<http://example.org/>`
  - `xsd` for `<http://www.w3.org/2001/XMLSchema#>` (used for most datatype IRIs such as `xsd:string` and `xsd:integer`)
- Literals are double-quoted strings paired with a datatype IRI or a language tag, e.g.:
  - `"Bob"^^xsd:string` for the literal with lexical form `Bob` and datatype IRI `xsd:string`.
  - `"Roma"@it` for the literal with lexical form `Roma`, datatype IRI `rdf:langString` and language tag `@it`
- Blank nodes are prefixed with an underscore and colon, e.g., `_:X`, `_:y`, `_:person`.

Exercises:

1. Which of the triples from Fig. 1 are valid? If a triple is not valid, explain why.
2. Write down the triples and draw the graph corresponding to the following description.
   - Bob is a person, whose name is "Robert" and surname is "Taylor".
   - Bob knows Alice. Alice's full name is "Alice Gorlami", she is 55 years old, she was born in Milan, and she is 176.5 cm tall.
   - Alice knows some person that knows Bob.

   You may use the FOAF and RDF vocabularies for some properties, or use `https://example.org/` to introduce your own IRIs (e.g., `<https://example.org/whatever>` or `ex:whatever`). If you use a literal, include its datatype.

	Subject	Predicate	Object	Valid?
1	<http://example.org/alice>	rdf:type	foaf:Person	...
2	_:alice	_:Type	_:Person	...
3	ex:bob	rdf:type	foaf:Person	...
4	_:Alice	rdf:type	foaf:Person	...
5	"bob"^^xsd:string	rdf:type	_:Person	...
6	_:alice	rdf:type	"Person"^^xsd:string	...
7	_:bob	rdf:type	_:Person	...
8	_:Bob	"Type"^^xsd:string	foaf:Person	...

Figure 1: Triples for exercise 1

Exercise 2: Blank Nodes and RDF Graphs

1. Draw the union and the merge of the following RDF graphs:

RDF Graph G_1

ex:PinkFloyd	ex:member	_:x
_:x	rdf:type	foaf:Person
_:x	foaf:firstName	"David"
_:x	foaf:surname	"Gilmour"
_:y	ex:hasMother	ex:alice
_:y	ex:interestedIn	ex:PinkFloyd

RDF Graph G_2

ex:alice	foaf:knows	_:x
_:x	ex:plays	ex:trumpet
ex:alice	ex:hasMother	_:y
_:y	rdf:type	foaf:Person
_:y	foaf:knows	_:x

Exercise 3: Simple Interpretations and Entailment

1. Write down a simple interpretation that satisfies the union of the RDF graphs G_1 and G_2 from Exercise 2.
2. Does the RDF graph G_3 entail the RDF graphs G_4 and G_5? If not, give a counterexample.

RDF Graph G_3

ex:a	ex:p	_:b
_:c	ex:q	ex:d

RDF Graph G_4

ex:a	ex:p	_:x
_:y	ex:q	ex:d

RDF Graph G_5

ex:a	ex:p	_:x
_:x	ex:q	ex:d

3. Prove that every RDF graph is simply satisfiable.

Exercise 4: Turtle

1. Write down the merge of G_1 and G_2 from Exercise 2 as a Turtle document.
2. Use an online validator such as the following to ensure that your syntax is valid.
   - http://ttl.summerofcode.be/. Turtle validator.
   - https://www.easyrdf.org/converter. Here you can convert RDF data between different serializations. An error will be thrown if your syntax is not correct.
   - https://www.w3.org/RDF/Validator/. Here you can validate RDF data serialized as RDF/XML (you can use the previous converter to convert it to this format). If you select "Triples and Graph" among the Display Result Options you can also see a graph representation of your RDF triples.

Exercise 5: Reification

1. Write down a Turtle document that expresses:
   - Alice knows that Bob knows Carol.
   - Alice knows that the probability of her passing the Algebra exam is 99%.
2. Reification puzzle: translate the RDF graph of Fig. 2 to natural language.

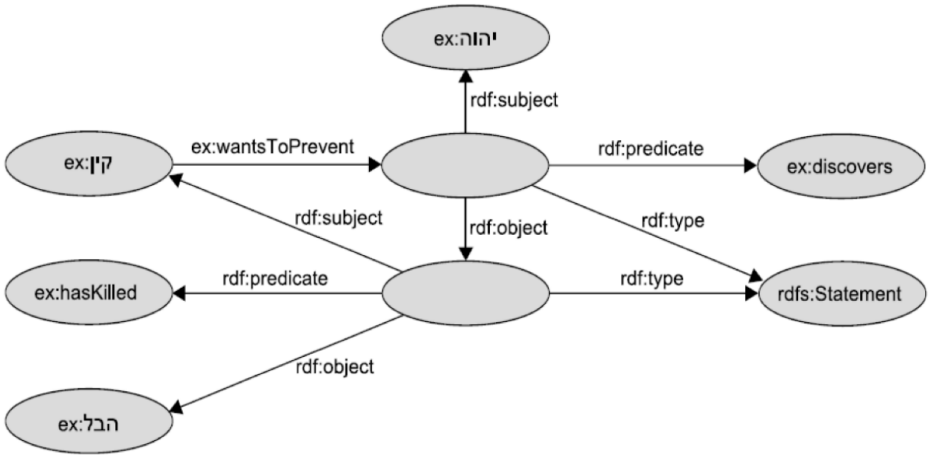

Figure 2: Reification puzzle (source)

Additional Exercises

Exercise A Properties of Simple Entailment

A graph E is an *instance* of a graph G if there is some mapping $m : B \to B \cup U \cup L$ such that E is obtained from G by replacing some or all of the blank nodes x in G with $m(x)$.

Prove the following:

1. An RDF graph is simply entailed by any of its instances.
2. The empty graph is simply entailed by any graph, and does not simply entail any graph except itself.
3. A graph simply entails all of its subgraphs.
4. Interpolation lemma for simple entailment: G simply entails a graph E if and only if a subgraph of G is an instance of E.

Exercise B D-interpretations and Entailment

Let $D_1 = \{\texttt{xsd:integer}, \texttt{xsd:decimal}\}$ and $D_2 = \{\texttt{xsd:decimal}\}$ and consider the following RDF graphs:

RDF Graph G_6

ex:a	ex:p	"25.0"^^xsd:decimal

RDF Graph G_7

ex:a	ex:p	"25"^^xsd:decimal

RDF Graph G_8

ex:a	ex:p	"25"^^xsd:integer

RDF Graph G_9

ex:a	ex:p	"book"^^xsd:integer

Answer the following:

1. For $i \in \{1, 2\}$, does G_6 D_i-entail G_7 and G_8?
2. For $i \in \{1, 2\}$, is G_9 D_i-satisfiable?

Exercise C RDF Interpretations and Entailment

Let $D = \{$xsd:integer, xsd:decimal, xsd:string, rdf:langString$\}$.

Consider the following RDF graphs:

RDF Graph G_{10}

ex:a	ex:p	"25.0"^^xsd:decimal

RDF Graph G_{11}

ex:a	ex:p	_:x
_:x	rdf:type	xsd:decimal

RDF Graph G_{12}

ex:p	rdf:type	rdf:Property

RDF Graph G_{13}

_:x	rdf:type	xsd:string
_:x	rdf:type	xsd:integer

1. Answer the following:
   (a) Does G_{10} RDF-entail G_{11} and G_{12} (recognizing D)?
   (b) Is G_{13} RDF satisfiable (recognizing D)?
2. Show that the interpolation lemma does not hold for RDF entailment.

Acknowledgements

- The reification puzzle of Fig. 2 was taken from this set of slides by Werner Nutt.