INF3580/4580 – Semantic Technologies – Spring 2018

Lecture 2: Resource Description Framework (RDF)

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23rd January 2018

Department of Informatics

University of Oslo

Today's Plan

1. Introduction
2. RDF data model
   - Technicalities
   - Features
3. RDF serialisations
4. RDF vocabularies
5. RDF on the web
6. Subtleties
7. Summary

Mandatory exercises

- First oblig published today (23.01) after lecture.
- Topic RDF.
- Hand in by Tuesday next week (31.01).
- Same schedule for the other small obligs:
  - #2 (30.01 – 07.02),
  - #3 (06.02 – 14.02), and
  - #4 (20.02 – 07.03).
- The larger obligs with two possible attempts:
  - #5 (06.03 – 21.04/11.04) and
  - #6 (03.04 – 25.04/16.05).
- See *obliger* on the semester page.
- Mr. Oblig.

Outline

RDF: W3C Overview

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- Thus allows data to be mixed, exposed, and shared across different applications.
- This linking structure forms a directed, labelled graph.
- This graph view is the easiest possible mental model for RDF and is often used in easy-to-understand visual explanations.

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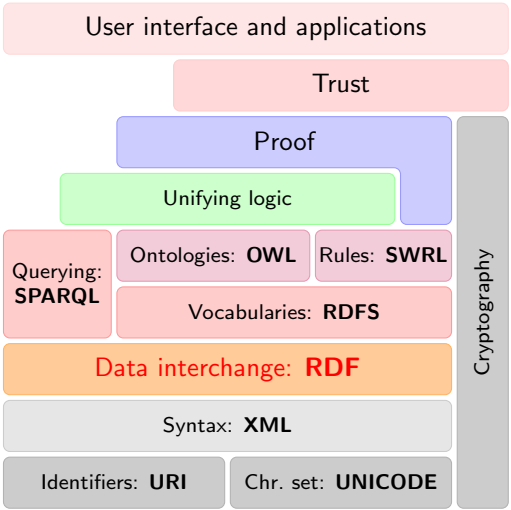
Semantic Web Stack

- Central block in the SW stack.



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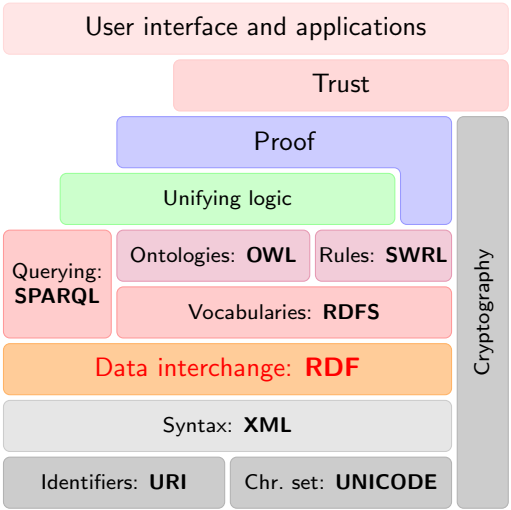

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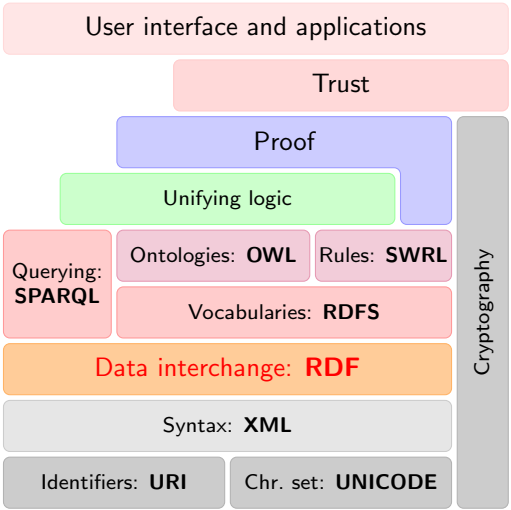

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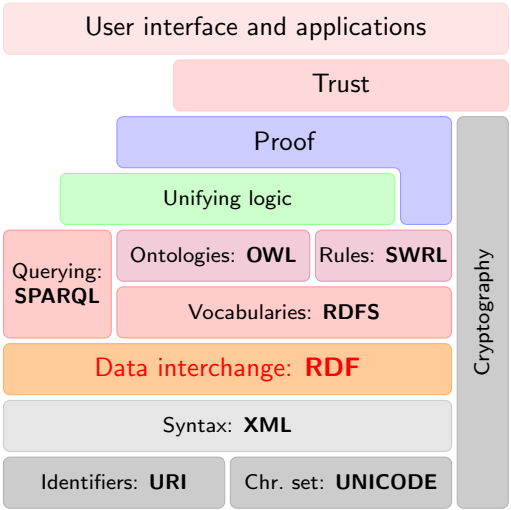

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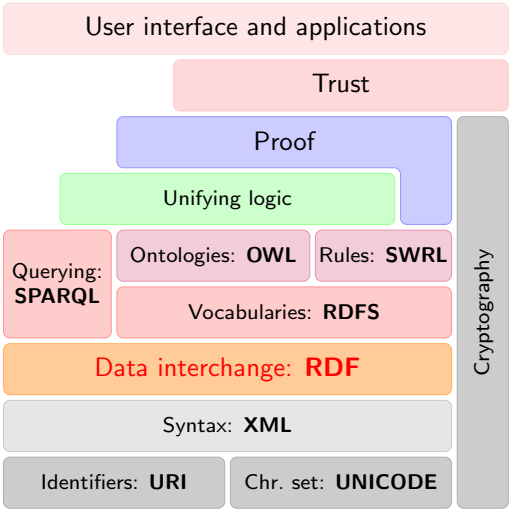

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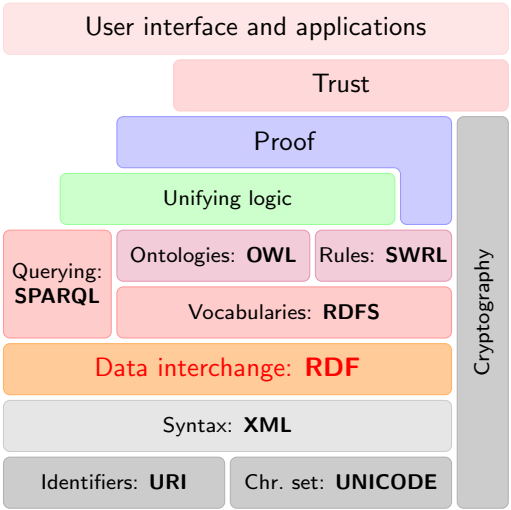

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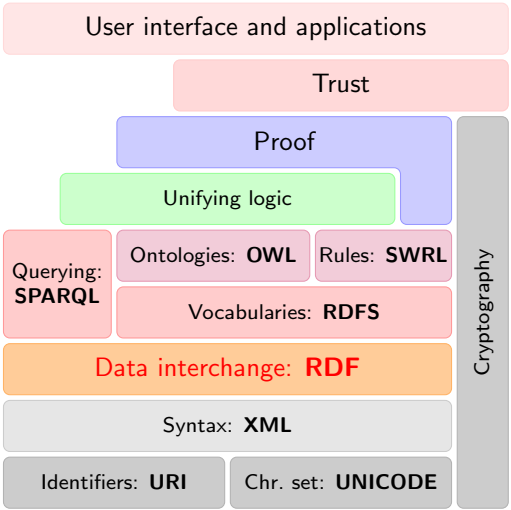

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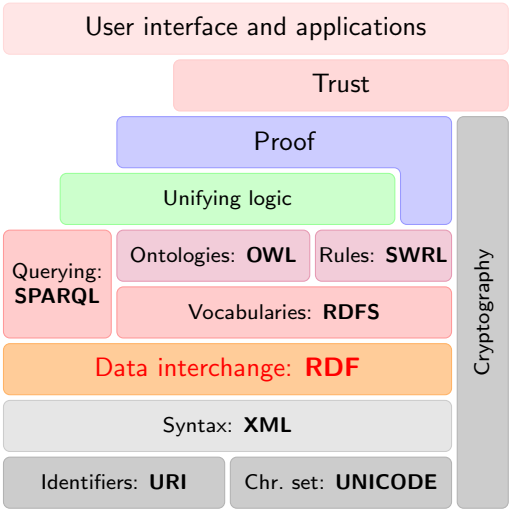

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- It is considered the basic representation format underlying the Semantic Web.

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- IRIs (Internationalised Resource Identifier) is just URIs but encoded in Unicode.

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- Remember: It's all just URIs!

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- We cannot have one URI for every integer, decimal number, string etc.

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- One can also specify the language of a string using a *language tag*:

```
dbp:Norway rdfs:label "Norge"@no .
dbp:Norway rdfs:label "Norwegen"@de .
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RDF Graphs

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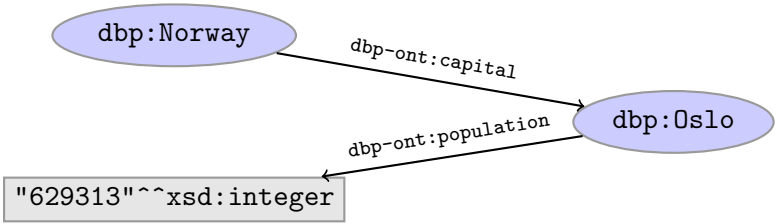
- RDF graphs are often represented as a directed labelled graph:



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  dbp:UiO dbp-ont:hasAddress "Problemveien 7 0313 Oslo" .

Problems

- Can all knowledge be nicely represented with only triples containing URIs and literals?
- What if we didn't know what the capital of Norway was, only that it has a population of 629313 people?

  dbp:Norway dbp-ont:hasCapitalWithPopulation "629313"^^xsd:integer .
- What if we want to model something which is not nicely represented as one URI, e.g. an address?
- UiO has the address "Problemveien 7 0313 Oslo". How should we model this? As a literal?

  dbp:UiO dbp-ont:hasAddress "Problemveien 7 0313 Oslo" .
- As several literals?

  dbp:UiO dbp-ont:addressPlace "Oslo" .
  dbp:UiO dbp-ont:addsressStreet "Problemveien" .
  dbp:UiO dbp-ont:addressStreetNumber "7" .
  dbp:UiO dbp-ont:addressPostcode "0313" .

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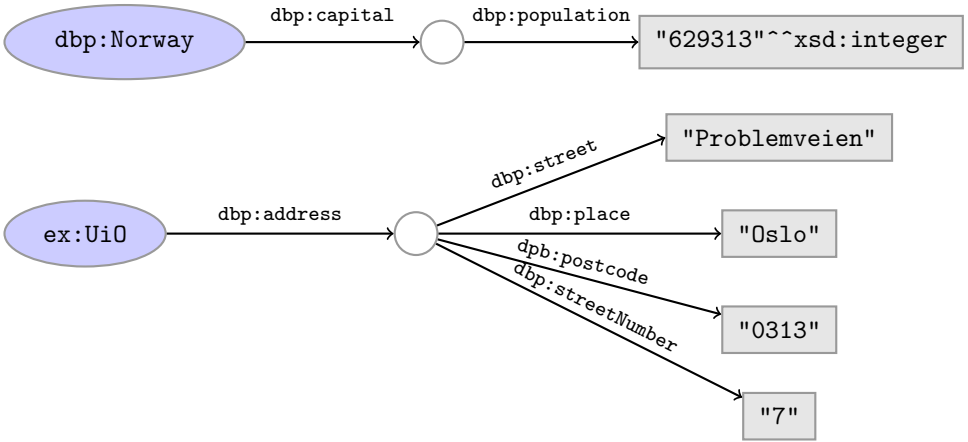
- Use when resource is unknown, or has no (natural) identifier. E.g.:



RDF Triple Grammar

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  - Blank nodes in predicate position deemed “too meaningless” and confusing.

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  - Need not redefine the database table, or
  - to restructure the XML schema.

Outline

RDF Serialisations

There are many serialisations for the RDF data model:

RDF/XML the W3C standard. Complicated!

```
<?xml version="1.0"?>
<rdf:RDF xmlns:dbp="http://dbpedia.org/resource/"
 xmlns:foaf="http://xmlns.com/foaf/0.1/"
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Others N3, TriX, TriG, RDF/JSON, ...

Turtle: URI references and triples

Full URIs are surrounded by < and >:

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Statements are triples terminated by a period:

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Turtle allows any non-zero amount of space between elements in triples.

Turtle: Namespaces

QNames are written without any special characters.

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Namespace prefixes are declared with `@prefix`:

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```

A default namespace may be declared:

```
@prefix dbp: <http://dbpedia.org/resource/> .
@prefix : <http://dbpedia.org/ontology/> .

dbp:Oslo a :Place .
```

Turtle: Literals

Literal values are enclosed in double quotes:

```
@prefix dbp: <http://dbpedia.org/resource/> .
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dbp:Norway :officialName "Norge" .
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```

Numbers and booleans may be written without quotes:

```
dbp:Oslo :population 629313 .
dbp:Oslo :isCapital true .
```

Turtle: Statements sharing elements

Instead of:

```
dbp:Oslo rdf:type dbo:City .
dbp:Oslo :officialName "Oslo" .
dbp:Oslo :population 629313 .
```

Turtle: Statements sharing elements

. . . statements may share a subject with ';':

```
dbp:Oslo rdf:type dbo:City ;
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Turtle: Statements sharing elements

Instead of:

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dbp:Norway rdfs:label "Norway"@en .
dbp:Norway rdfs:label "Norwegen"@de .
dbp:Norway rdfs:label "Norge"@no .
```

Turtle: Statements sharing elements

...statements may share subject and predicate with ‘,’:

```
dbp:Norway rdfs:label "Norway"@en ,
                      "Norwegen"@de ,
                      "Norge"@no .
```

Turtle: Statements sharing elements

. . . and in combination:

```
dbp:Norway rdfs:label "Norway"@en, "Norwegen"@de, "Norge"@no ;
           :capital dbp:Oslo .
```

Turtle: Blank nodes

Blank nodes are designated with underscores or `[...]`.

Norway has a capital with population 629313:

```
dbp:Norway :capital _:someplace .
_:someplace :population 629313 .
```

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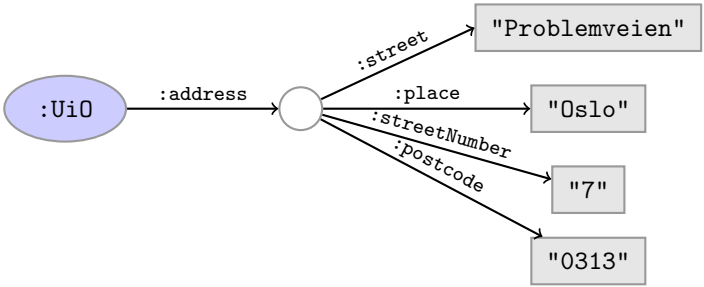
UiO has address Problemveien 7, 0313 Oslo:

```
:UiO :address [ :street "Problemveien" ;
                :streetNumber "7";
                :place "Oslo" ;
                :postcode "0313" ] .
```

Question

The blank node here:



has no ‘name.’

Why does Turtle use ‘blank node identifiers’ like `_:someplace`?

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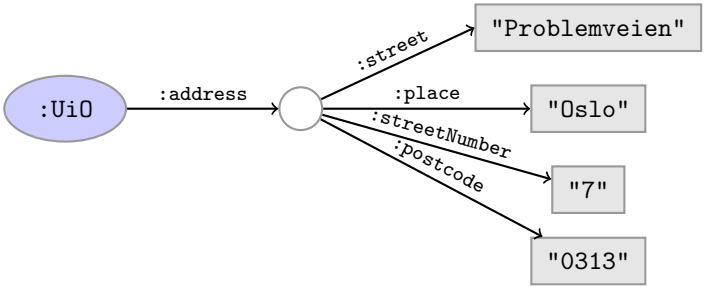

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Why does Turtle use ‘blank node identifiers’ like `_:someplace`?

Answer: makes it easy to use same node in several triples.

Turtle: Other things

Use '#' to comment:

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Use '\' to escape special characters:

```
:someGuy :foaf:name "James \"Mr. Man\" Olson" .
```

Turtle specification: `http://www.w3.org/TR/turtle/`.

Outline

Vocabularies

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- Some important, well-known namespaces—and prefixes:

`rdf:` `<http://www.w3.org/1999/02/22-rdf-syntax-ns#>` – RDF
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  - `@prefix rdf:` `<http://xmlns.com/foaf/0.1/>` would be highly irregular.

Example vocabularies: RDF, RDFS

Some example resources:

RDF: describing RDF graphs.

- `rdf:Statement`
- `rdf:subject`,
  `rdf:predicate`,
  `rdf:object`
- `rdf:type`

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Some example resources:

RDF: describing RDF graphs.

- `rdf:Statement`
- `rdf:subject`, `rdf:predicate`, `rdf:object`
- `rdf:type`

RDFS: describing RDF vocabularies.

- `rdfs:Class`
- `rdfs:subClassOf`, `rdfs:subPropertyOf`
- `rdfs:domain`, `rdfs:range`
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Examples:

```
dbp:Oslo rdf:type dbp-ont:Place .
dbp:Norway rdfs:label "Norge"@no .
dbp:Capital rdfs:subClassOf dbp:City .
```

Example vocabularies: FOAF, Dublin Core

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FOAF: person data and relations.

- `foaf:Person`
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Examples:

```
ifi:leifhka rdf:type foaf:Person .
ifi:leifhka foaf:knows ifi:martingi .
ifi:leifhka dcterms:creator ifi:rdf-lecture .
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- Use `http://www.example.[com|net|org]` for prototyping and documentation.

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- Decouples data from applications.
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- Semantic Web applications should be/are generic and general purpose, exploiting rich and knowledge intensive data sets.

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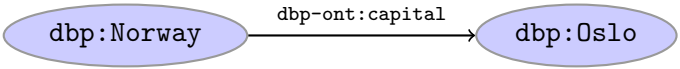
- *Trust* is an important (and work-in-progress) layer in the SW stack.

RDF graphs are not graphs



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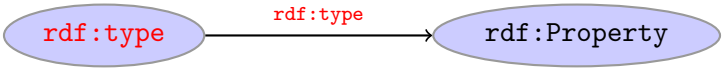

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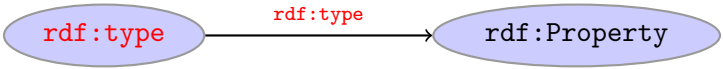

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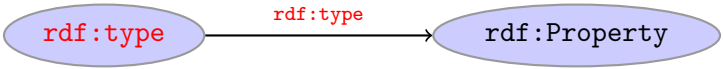

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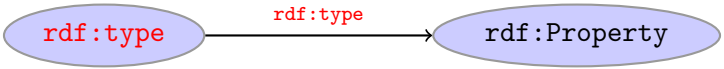

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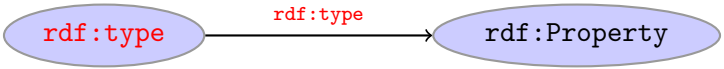

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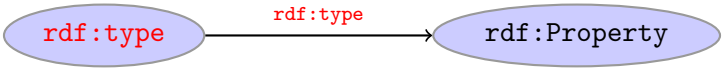

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  - edges are vocabulary elements.

Be careful when merging RDF *files*

Merging the two RDF files containing named blank nodes

File 1

```
ifi:martige :owns _:myCar .
_:myCar a  lotus:Esprit .
```

File 2

```
ifi:martingi :owns _:myCar .
_:myCar    a    iicv:Sahara .
```

gives the RDF graph:

File 1 ∪ File 2

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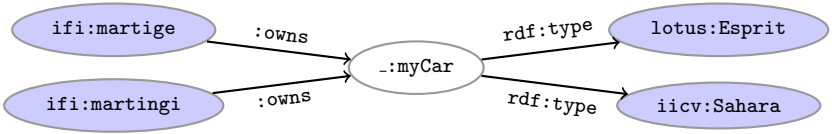

Rename blank nodes

Renaming `_:myCar` to `_:myCar2` in File 2.

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More complex statements

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Data structures

```
:inf3580 :hasLecturers
           [ rdf:first :martingi ;
             rdf:rest [ rdf:first :ernesto ;
                        rdf:rest [ rdf:first :leifhka ;
                                   rdf:rest rdf:nil .
                                 ] .
                      ] .
           ] .
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Turtle shorthand for lists

```
:inf3580 :hasLecturers (:martingi :ernesto :leifhka ) .
```

More complex statements (cont.)

What if I want to state that "Leif Harald thinks Vim is better than Emacs, but Martin does not."

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Reification, statements describing statements

```
_:s rdf:subject ex:vim ;
    rdf:predicate ex:betterThan ;
    rdf:object ex:emacs .

:leifhka :thinks _:s .
:martingi :thinksNot _:s .
```

More complex statements (cont.)

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Reification allows us to describe agents' (e.g. people, sensors) beliefs, knowledge, etc. or meta information about a statement, e.g. "added by", "timestamp", etc.

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- Is completely independent of any application.

That's it for today!

Remember the mandatory assignment.