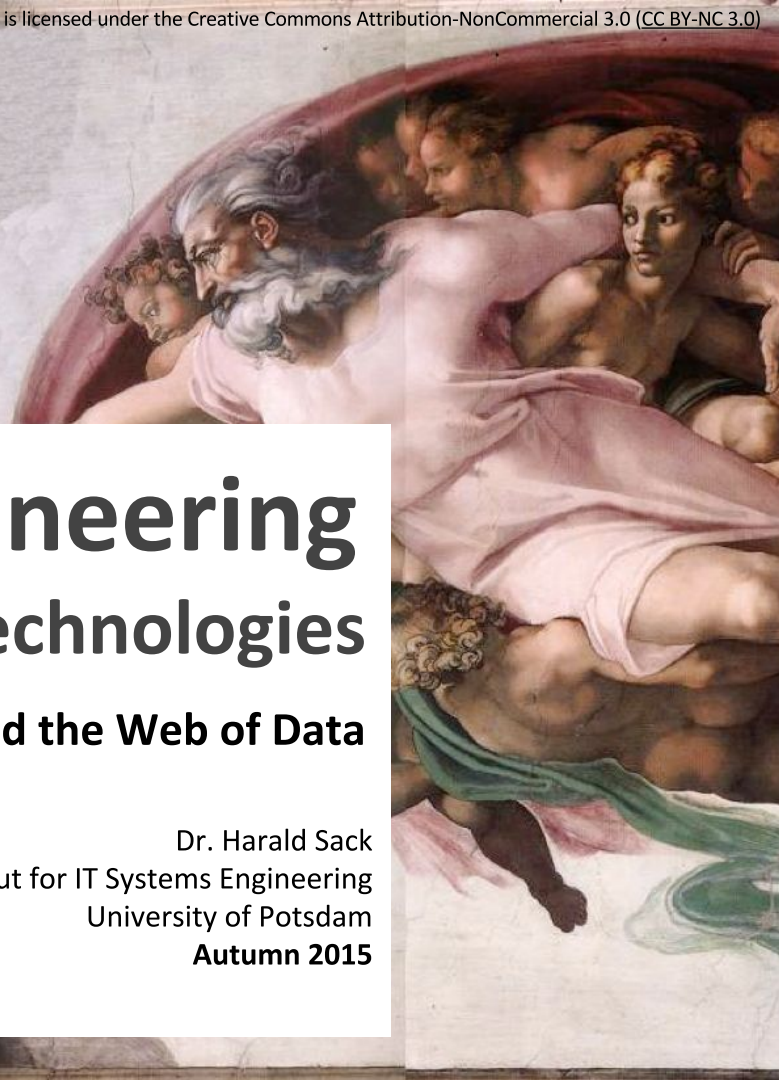
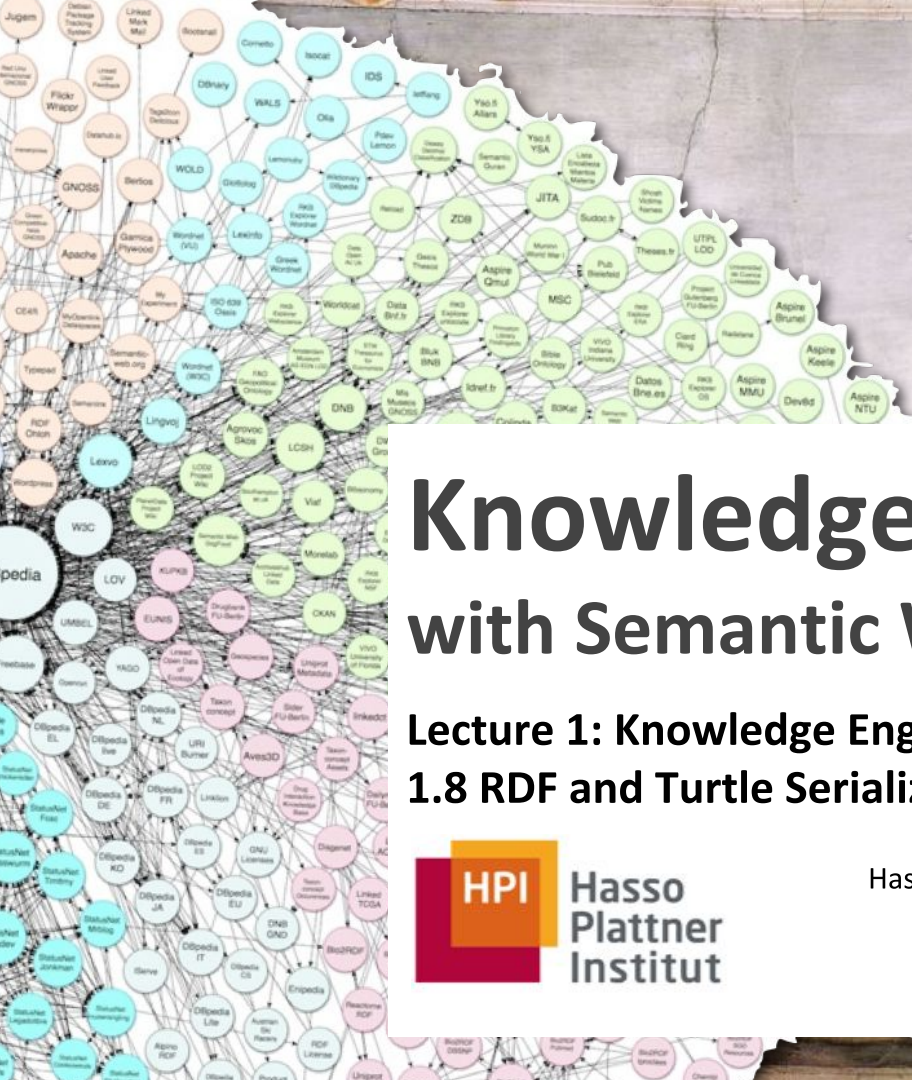




Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data 1.8 RDF and Turtle Serialization



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The Semantic Web Technology Stack (not a piece of cake...)

Most apps use only a subset of the stack

Querying allows fine-grained data access

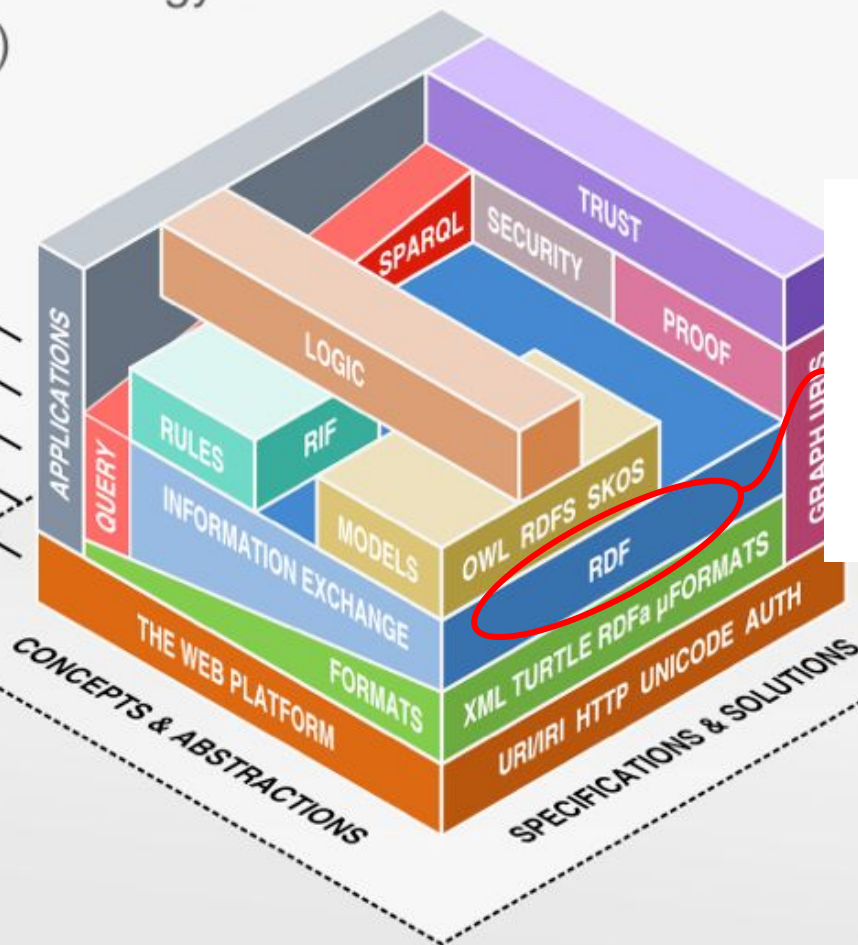
Standardized information exchange is key

Formats are necessary, but not too important

The Semantic Web is based on the Web

Linked Data uses a small selection of technologies

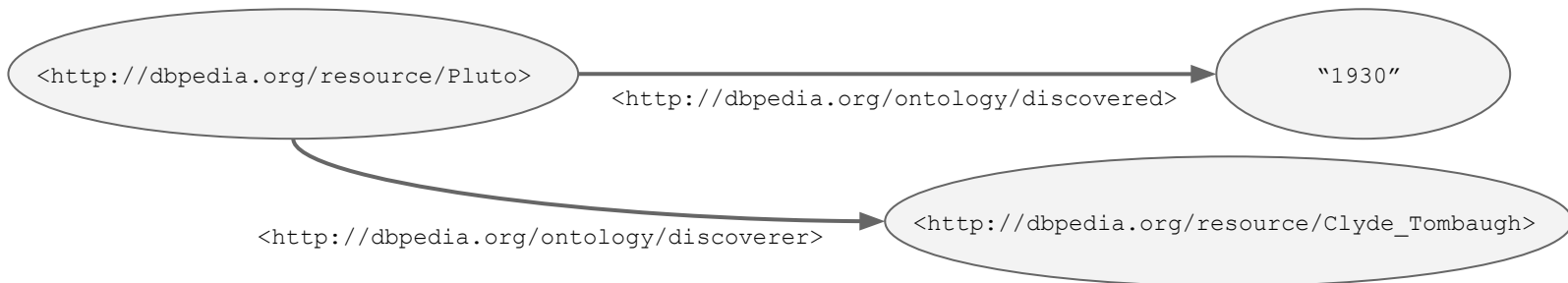
LINKED DATA



Resource
Description
Framework
(RDF)



Turtle - Terse RDF Triple Language



- starting with N-Triples

```
<http://dbpedia.org/resource/Pluto> <http://dbpedia.org/ontology/discovered> "1930" .  
<http://dbpedia.org/resource/Pluto> <http://dbpedia.org/ontology/discovered>  
<http://dbpedia.org/resource/Clyde_Tombaugh> .
```

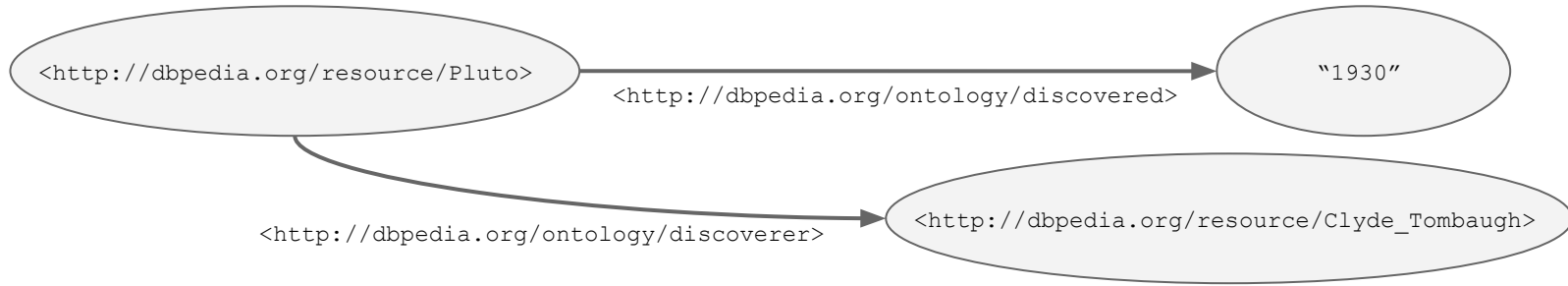
```
@prefix dbo: <http://dbpedia.org/ontology/> .  
@base <http://dbpedia.org/resource/> .  
<Pluto> dbo:discovered "1930" .  
<Pluto> dbo:discoverer <Clyde_Tombaugh> .
```

@prefix directive associates prefix-label with URI

@base directive provides URI to complement all relative URIs



Turtle - Terse RDF Triple Language



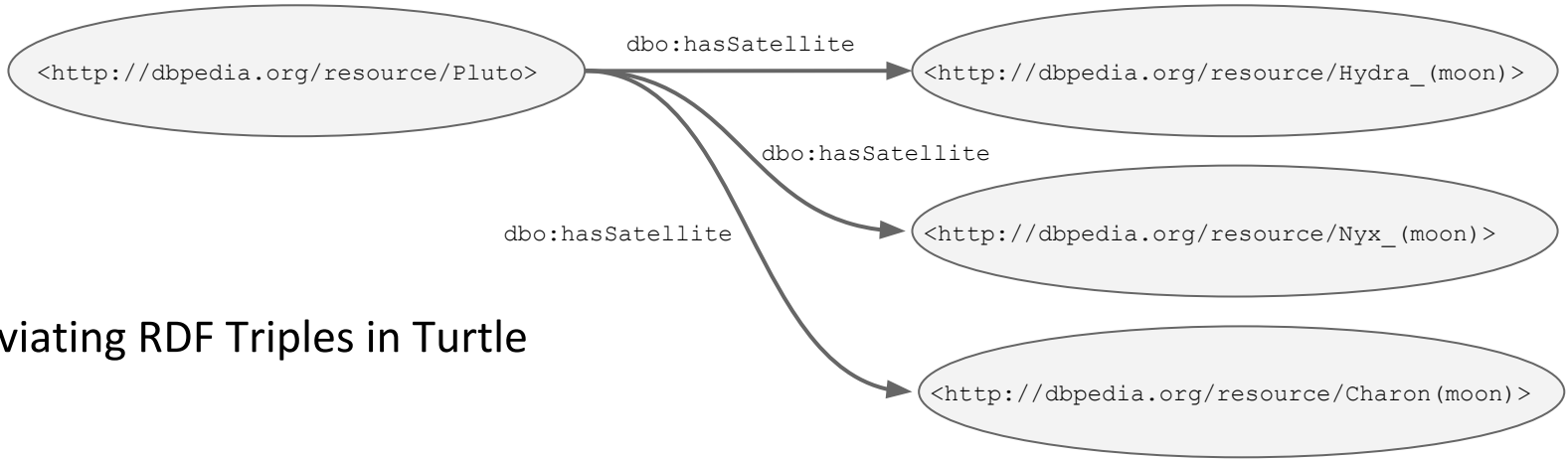
- Abbreviating RDF Triples in Turtle

```
@prefix dbo: <http://dbpedia.org/ontology/> .  
@base <http://dbpedia.org/resource/> .  
  
<Pluto> dbo:discovered "1930" ;  
        dbo:discoverer <Clyde_Tombaugh> .
```

semicolon indicates that subsequent triples have the same subject (**predicate list**)



Turtle - Terse RDF Triple Language



- Abbreviating RDF Triples in Turtle

```
@prefix dbo: <http://dbpedia.org/ontology/> .  
@base <http://dbpedia.org/resource/> .  
  
<Pluto> dbo:hasSatellite <Hydra_(moon)> ,  
                                <Nyx_(moon)> ,  
                                <Charon_(moon)> .
```

comma indicates that subsequent triples have same subject and property (**object list**)

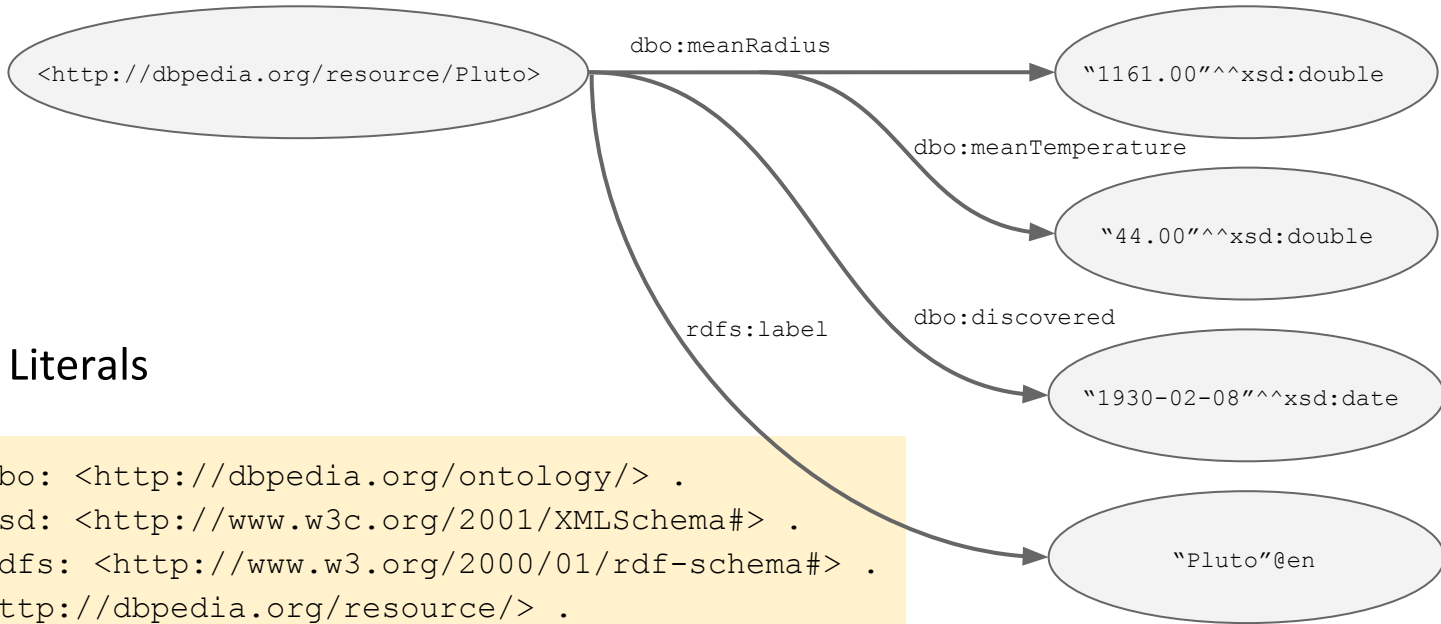


Turtle - Terse RDF Triple Language

- Typed Literals

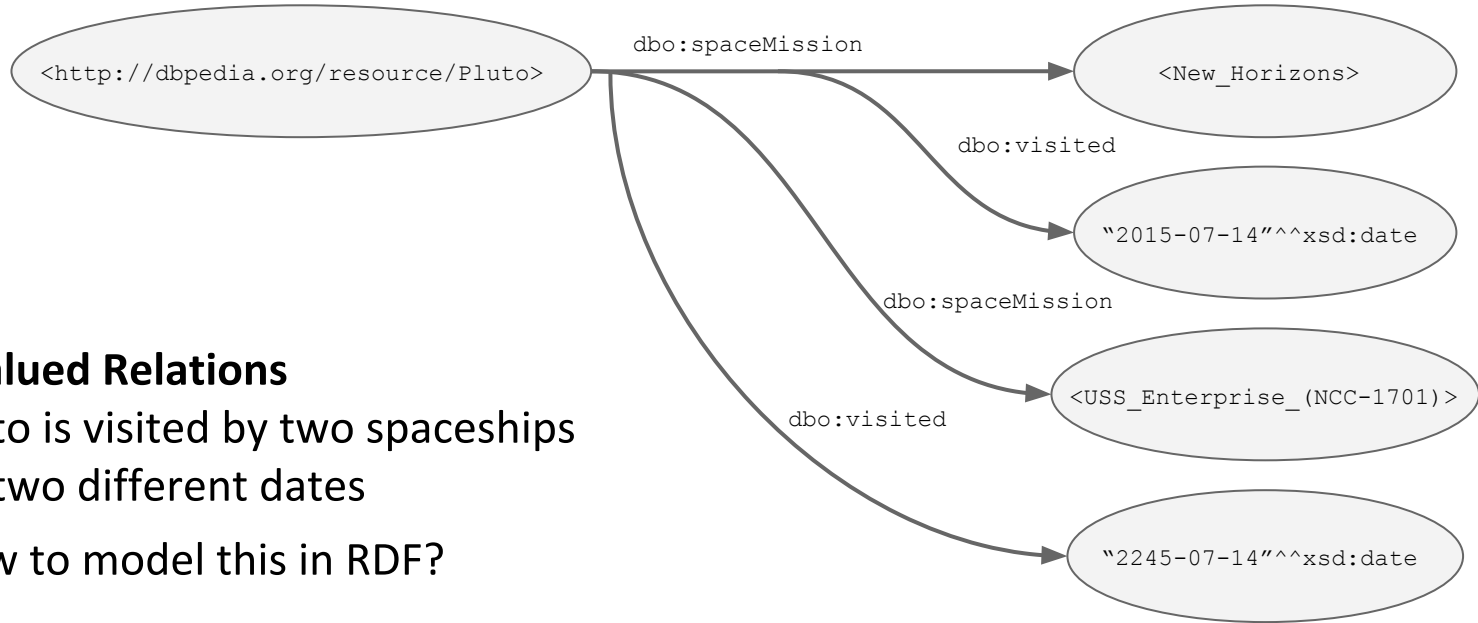
```
@prefix dbo: <http://dbpedia.org/ontology/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://dbpedia.org/resource/> .

<Pluto> dbo:meanRadius "1161.00"^^xsd:double ;
        dbo:meanTemperature "44.00"^^xsd:double ;
        dbo:discovered "1930-02-18"^^xsd:date ;
        rdfs:label "Pluto"@en .
```





Turtle - Terse RDF Triple Language

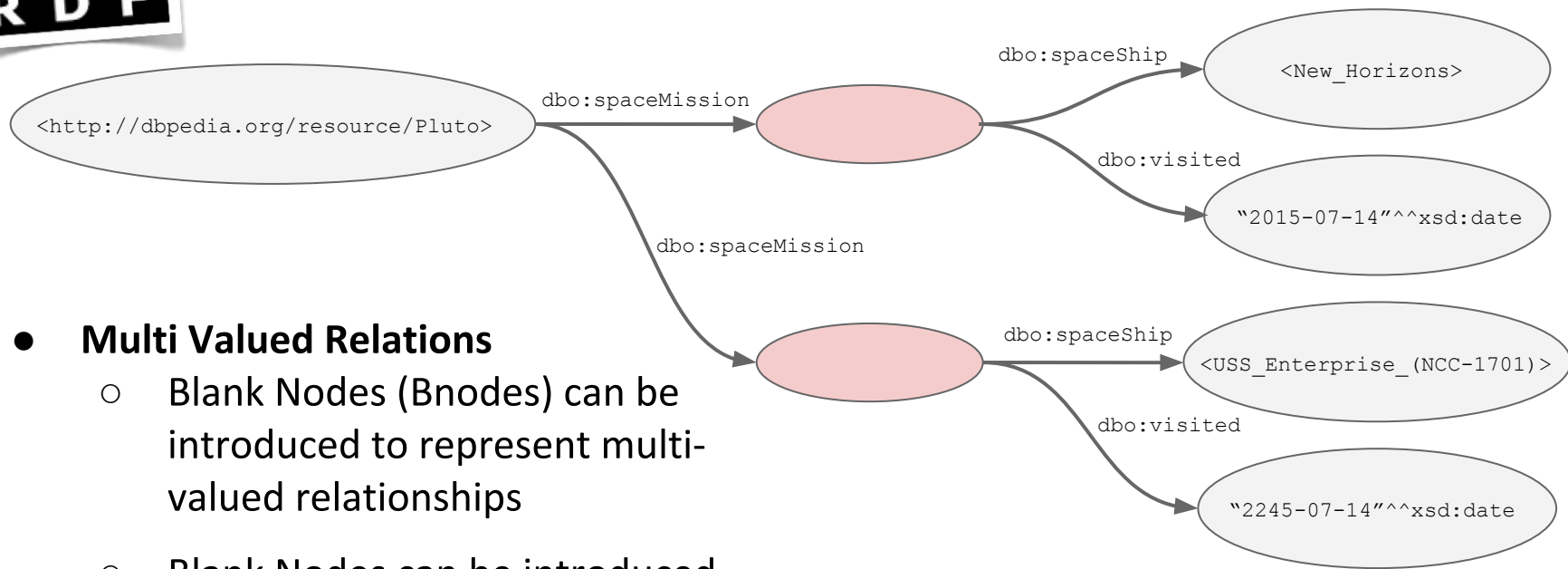


- **Multi Valued Relations**

- Pluto is visited by two spaceships on two different dates
- How to model this in RDF?
- **Problem:** unique association



Turtle - Terse RDF Triple Language

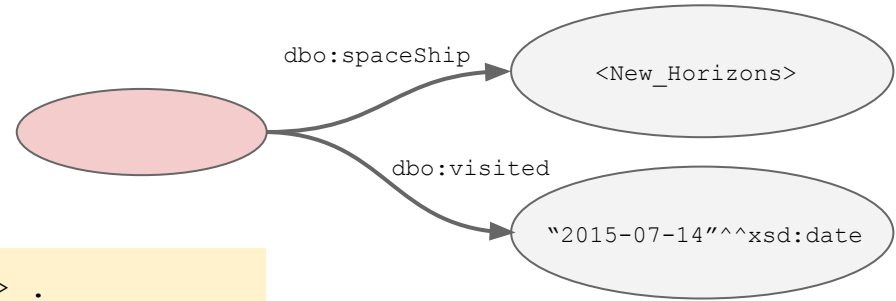


- **Multi Valued Relations**

- Blank Nodes (Bnodes) can be introduced to represent multi-valued relationships
- Blank Nodes can be introduced for resources that don't need a name (auxiliary nodes)



Turtle - Terse RDF Triple Language



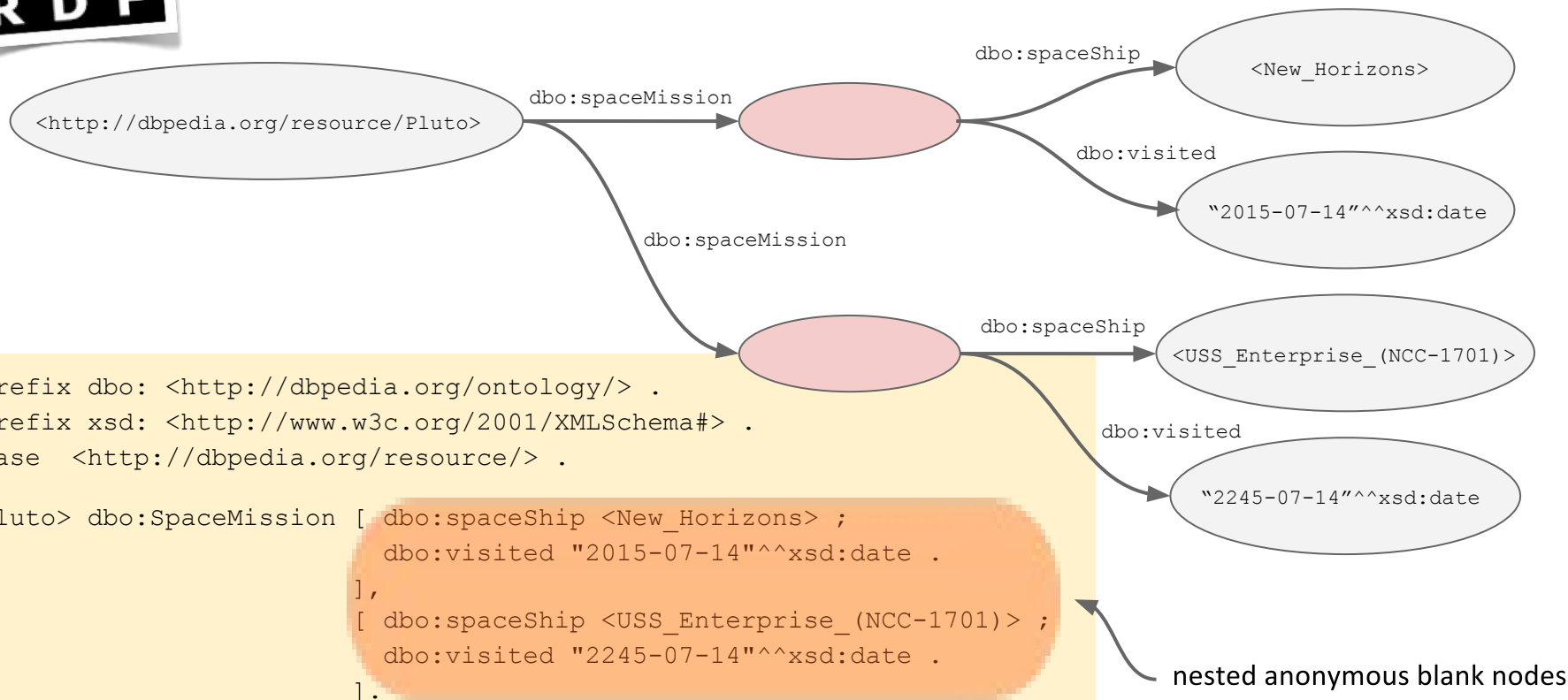
```
@prefix dbo: <http://dbpedia.org/ontology/> .  
@prefix xsd: <http://www.w3c.org/2001/XMLSchema#> .  
@base <http://dbpedia.org/resource/> .
```

```
[ ] dbo:spaceShip <New_Horizons> ;  
    dbo:visited "2015-07-14"^^xsd:date .
```

anonymous blank node as subject

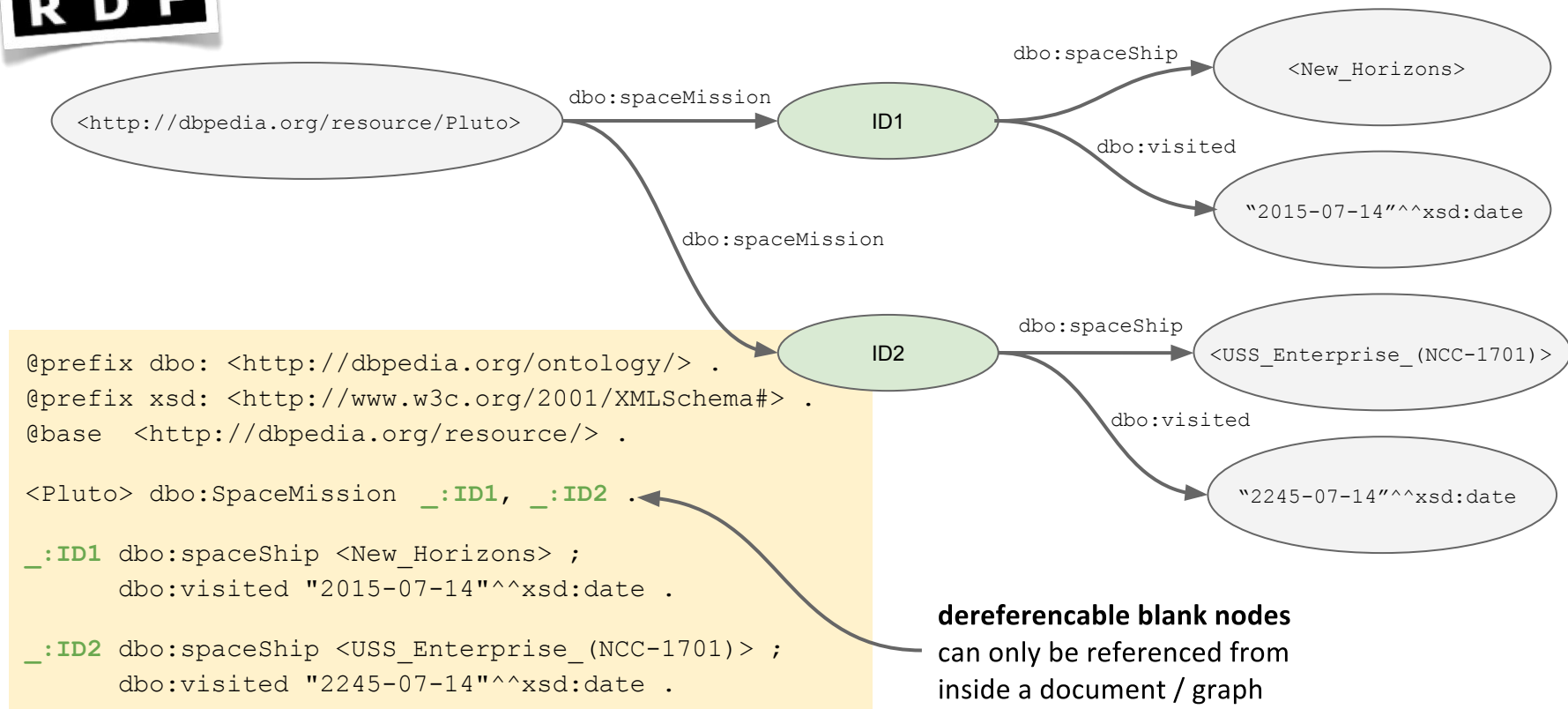


Turtle - Terse RDF Triple Language





Turtle - Terse RDF Triple Language



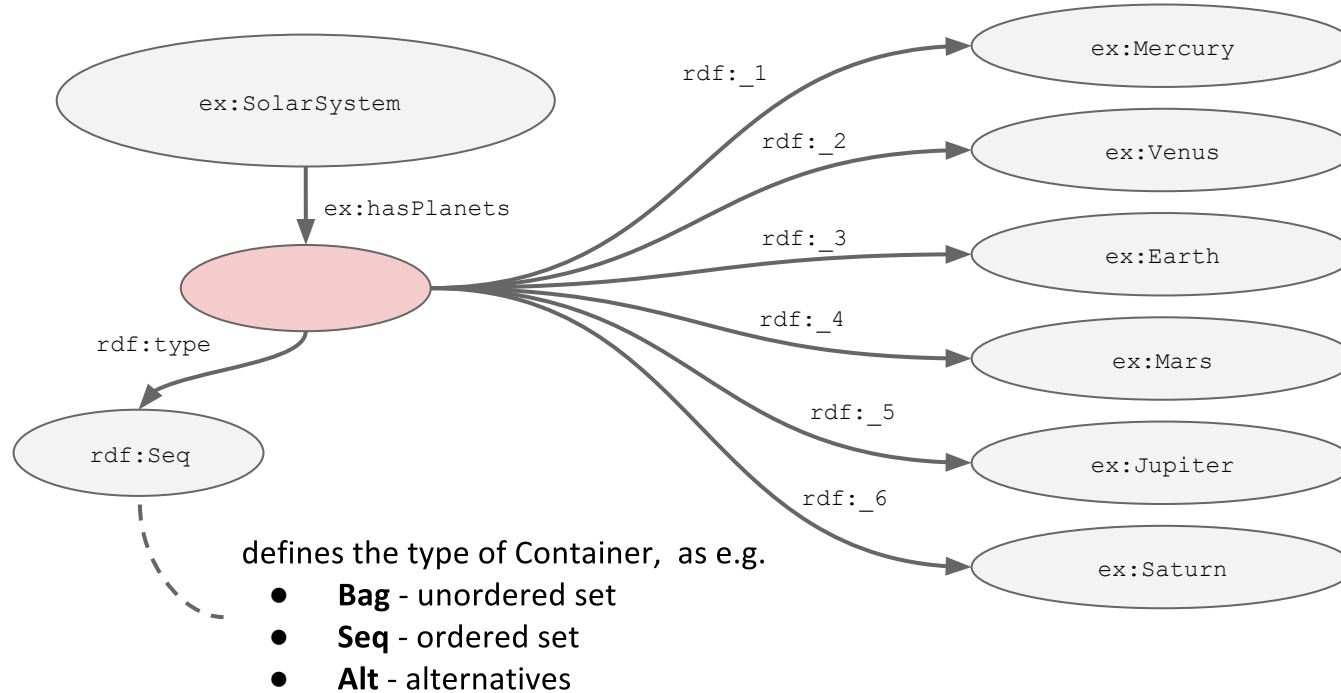


RDF Lists

- General Data structure to enumerate any resources or literals
- Only shortcuts without additional semantic expressivity
- Distinguish between
 - **Container**
open list, i.e. extension (new entries) possible
 - **Collections**
closed list, i.e. no extension possible



RDF Container

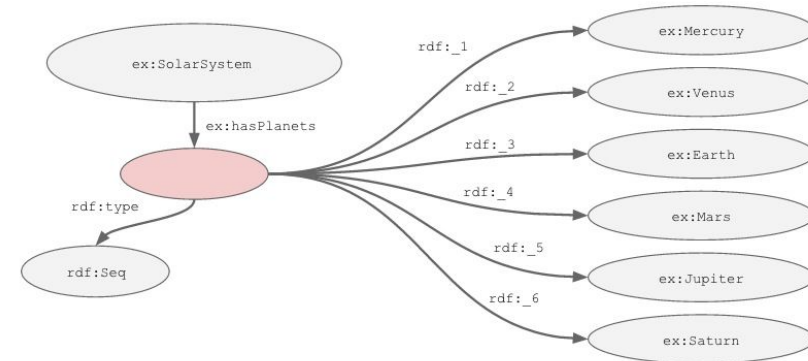




RDF Container

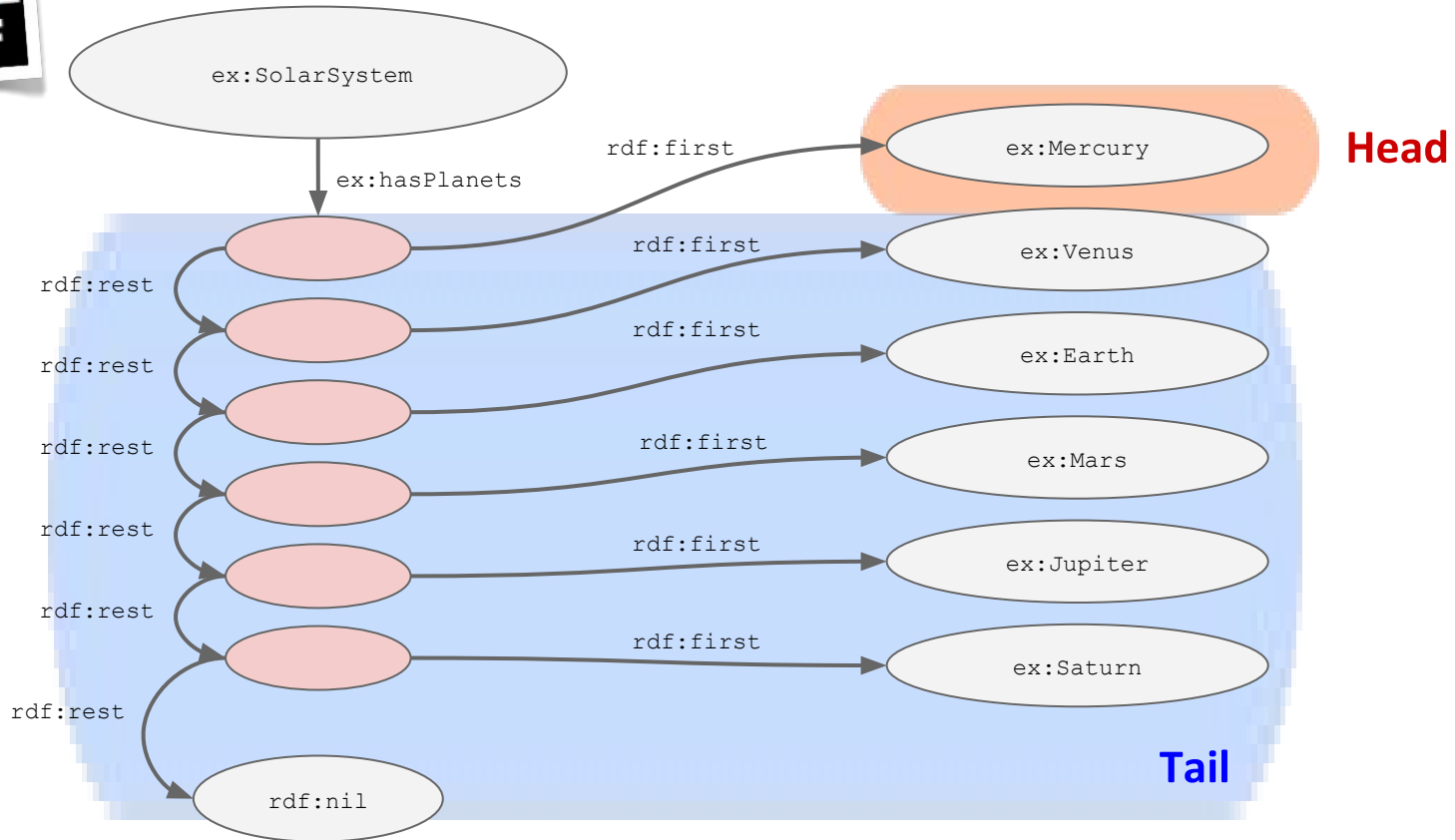
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix ex: <http://example.org/test#> .
```

```
ex:SolarSystem ex:hasPlanets [  
  a rdf:Seq ;  
  rdf:_1 ex:Mercury ;  
  rdf:_2 ex:Venus ;  
  rdf:_3 ex:Earth ;  
  rdf:_4 ex:Mars ;  
  rdf:_5 ex:Jupiter ;  
  rdf:_6 ex:Saturn  
] .
```





RDF Collection

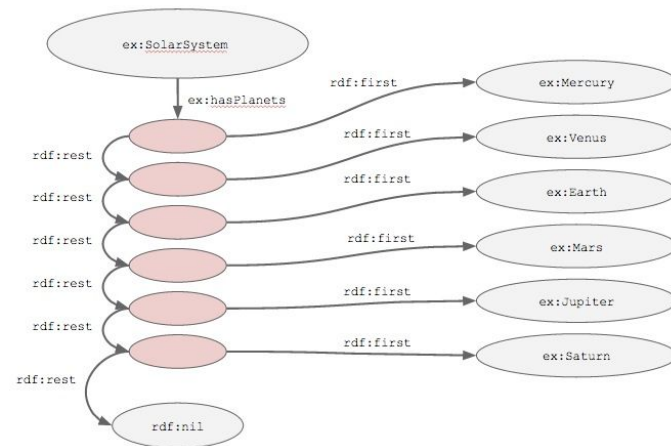




RDF Collection

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix ex: <http://example.org/test#> .
```

```
ex:SolarSystem ex:hasPlanets [  
  rdf:first ex:Mercury ; rdf:rest [  
    rdf:first ex:Venus ; rdf:rest [  
      rdf:first ex:Earth ; rdf:rest [  
        rdf:first ex:Mars ; rdf:rest [  
          rdf:first ex:Jupiter ; rdf:rest [  
            rdf:first ex:Saturn ;  
            rdf:rest rdf:nil  
          ]  
        ]  
      ]  
    ]  
  ]  
]
```



```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix ex: <http://example.org/test#> .
```

```
ex:SolarSystem ex:hasPlanets (  
  ex:Mercury ex:Venus ex:Earth ex:Mars ex:Jupiter ex:Saturn  
) .
```



Next: Lecture 2: RDF Based Knowledge Representation

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies