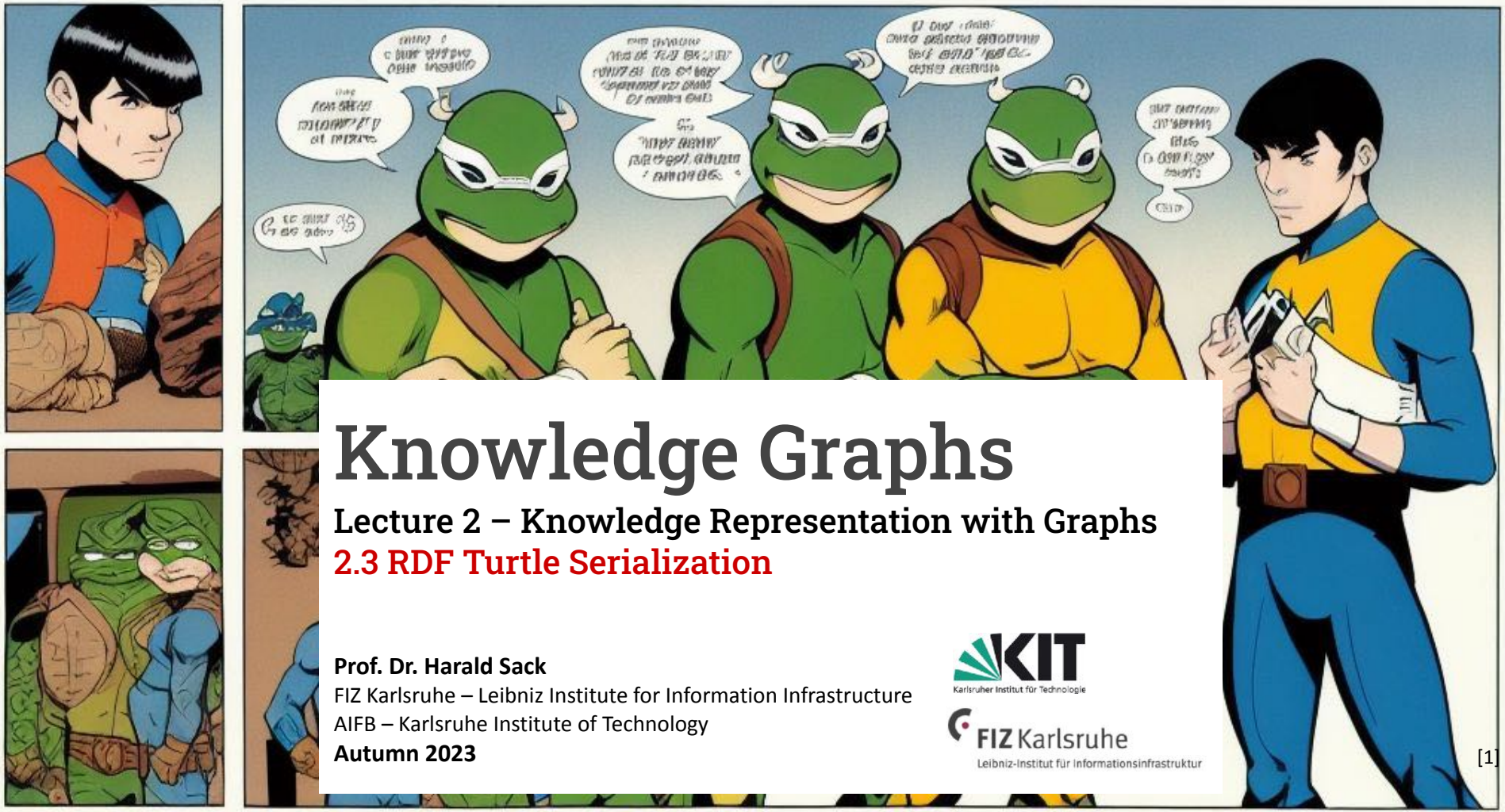

Knowledge Graphs

Lecture 2 – Knowledge Representation with Graphs

2.3 RDF Turtle Serialization

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Autumn 2023

Karlsruher Institut für Technologie

FIZ Karlsruhe
Leibniz-Institut für Informationsinfrastruktur

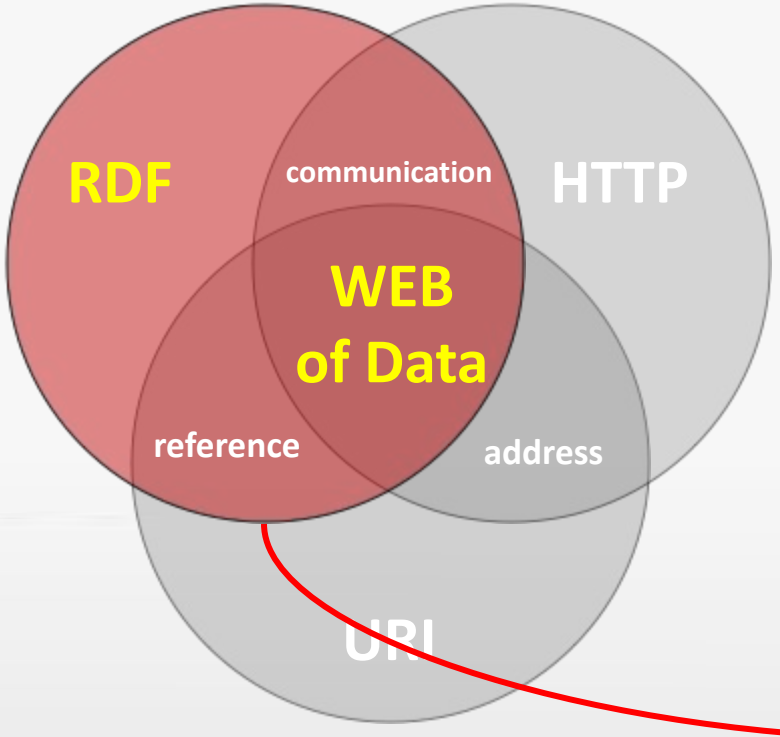
[1]

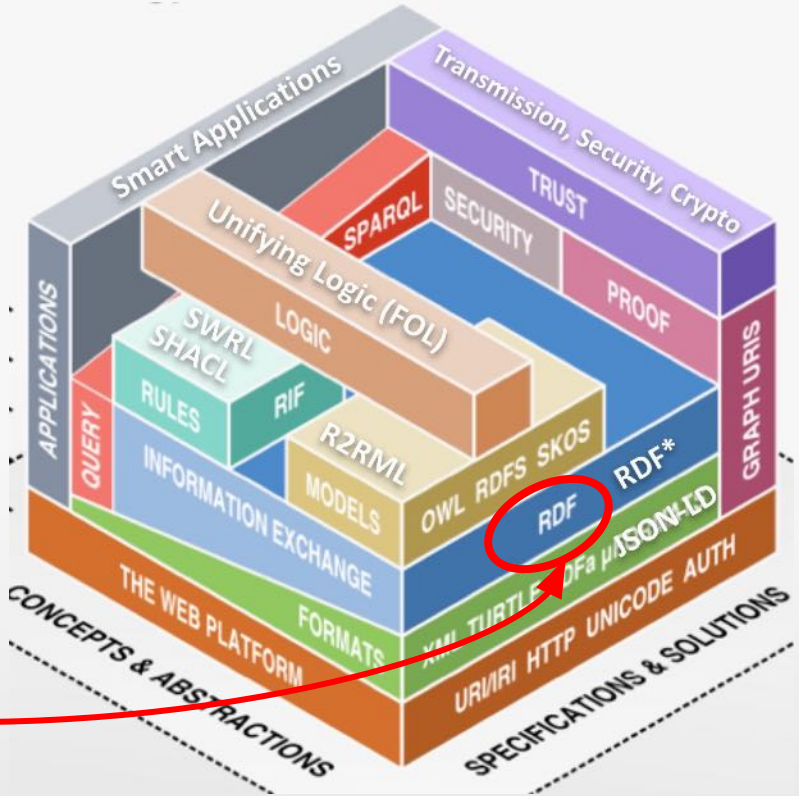
Knowledge Graphs

Lecture 2: Basic Knowledge Graph Infrastructure

[1]

Basic Architecture of the Web of Data



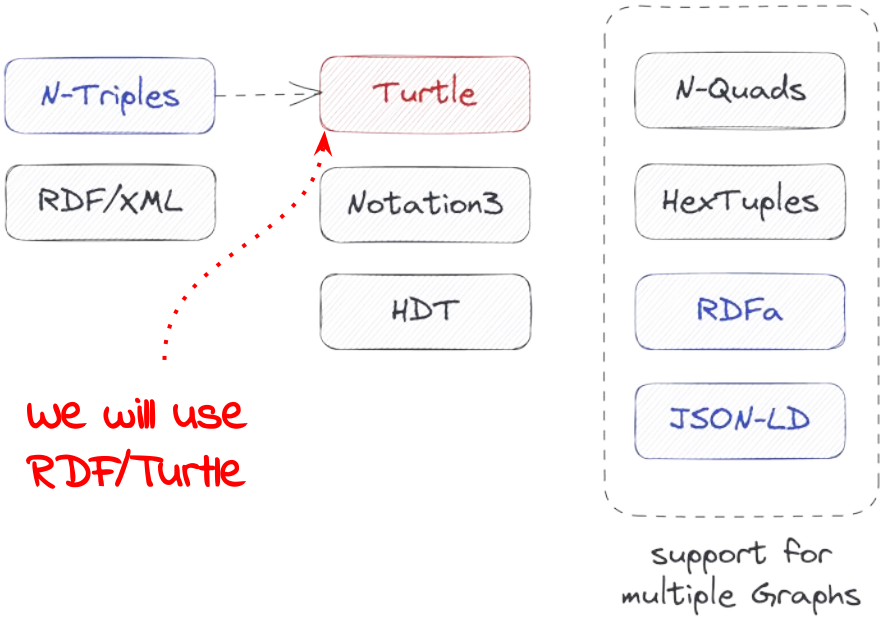


[2]

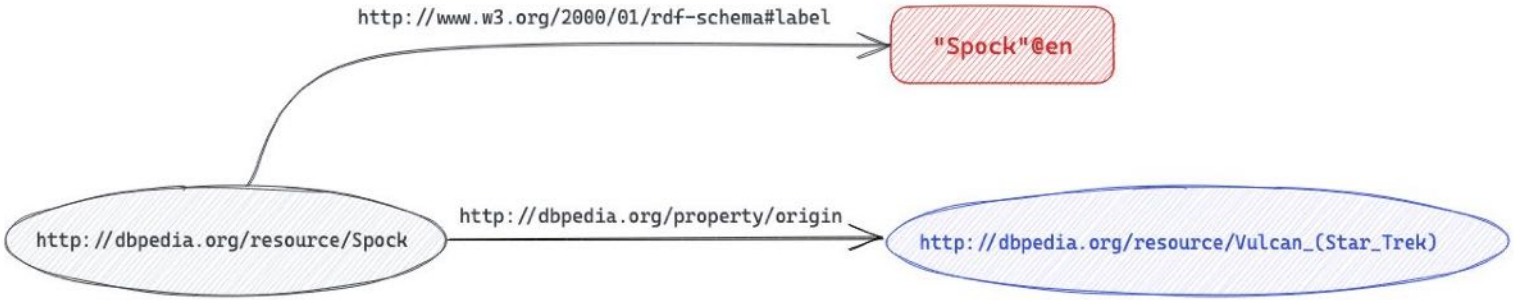
RDF Serializations

RDF comes with several different **serialization formats**:

→ N-Triples, RDF/XML, JSON-LD, Turtle, N-Quads, RDFa, Notation3, HexTuples...



N-Triples Serialization



N-Triples Notation

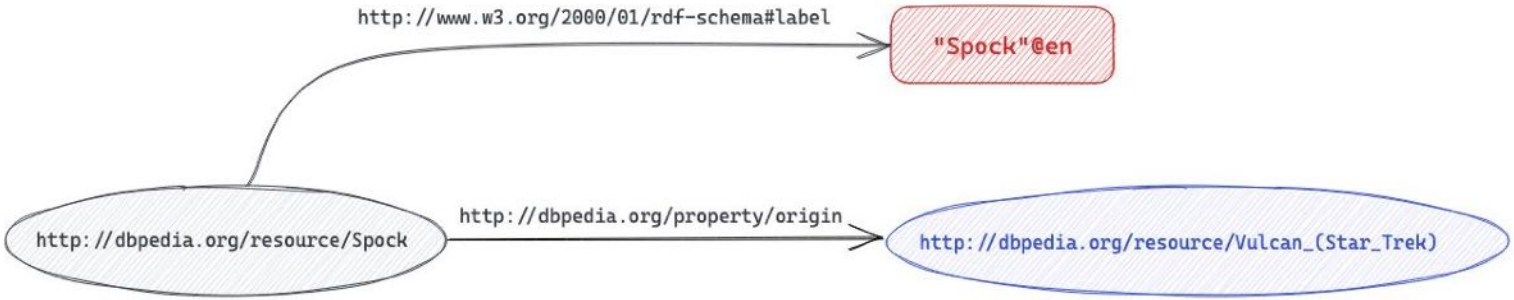
- **URIs/IRIs** in angle brackets
- **Literals** in quotation marks
- Triple ends with a **period**

N-Triples Serialization

```
<http://dbpedia.org/resource/Spock> <http://www.w3.org/2000/01/rdf-schema#label> “Spock”@en .

<http://dbpedia.org/resource/Spock> <http://dbpedia.org/property/origin> <http://dbpedia.org/resource/Vulcan_(Star_Trek)> .
```

RDF Turtle Serialization



Turtle (Terse RDF Triple Language) Notation

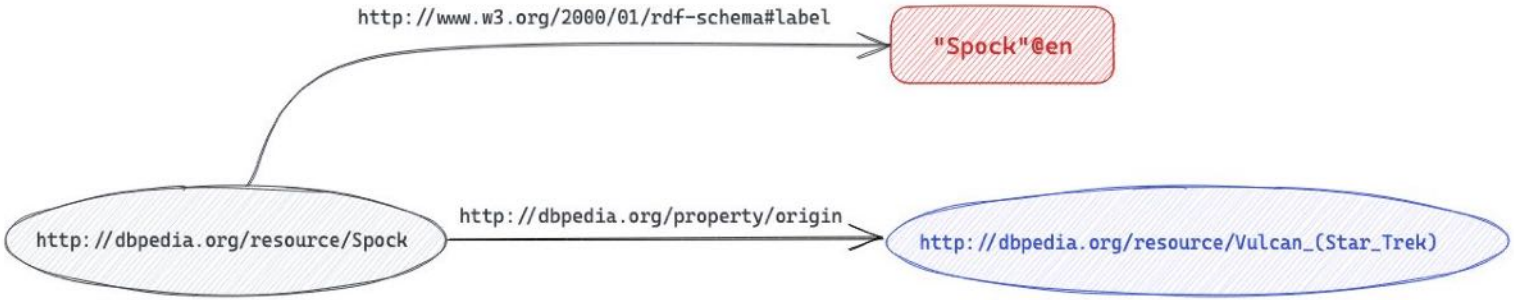
is an extension of N-Triples

```
@prefix dbp:  <http://dbpedia.org/property/> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base  <http://dbpedia.org/resource/> .

<Spock> rdfs:label "Spock"@en .
<Spock> dbp:origin <Vulcan_(Star_Trek)> .
```

RDF/Turtle allows shortcuts and abbreviations for readability.

RDF Turtle Serialization



Turtle (Terse RDF Triple Language) Notation

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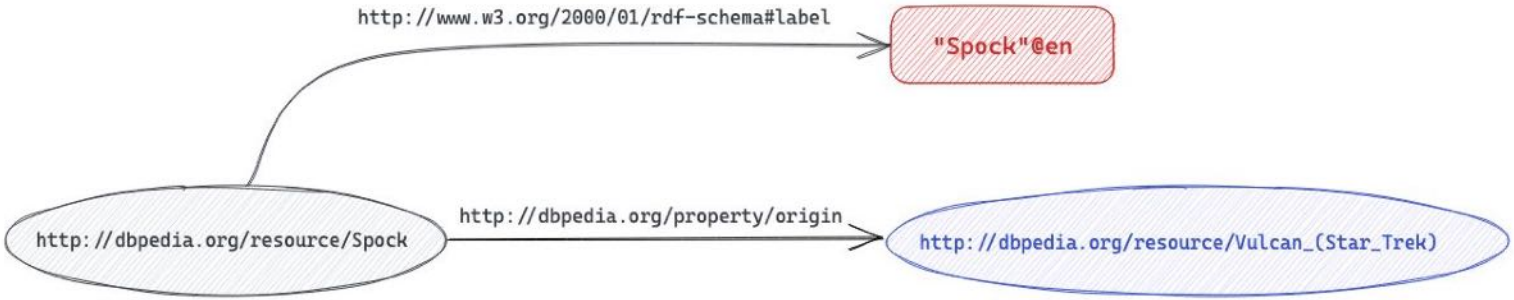
```
@prefix dbp:  <http://dbpedia.org/property/> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base  <http://dbpedia.org/resource/> .

<Spock> rdfs:label "Spock"@en .
<Spock> dbp:origin <Vulcan_(Star_Trek)> .
```

@prefix directive associates prefix-label with URI

@base directive provides URI to complement all relative URIs

RDF Turtle Serialization



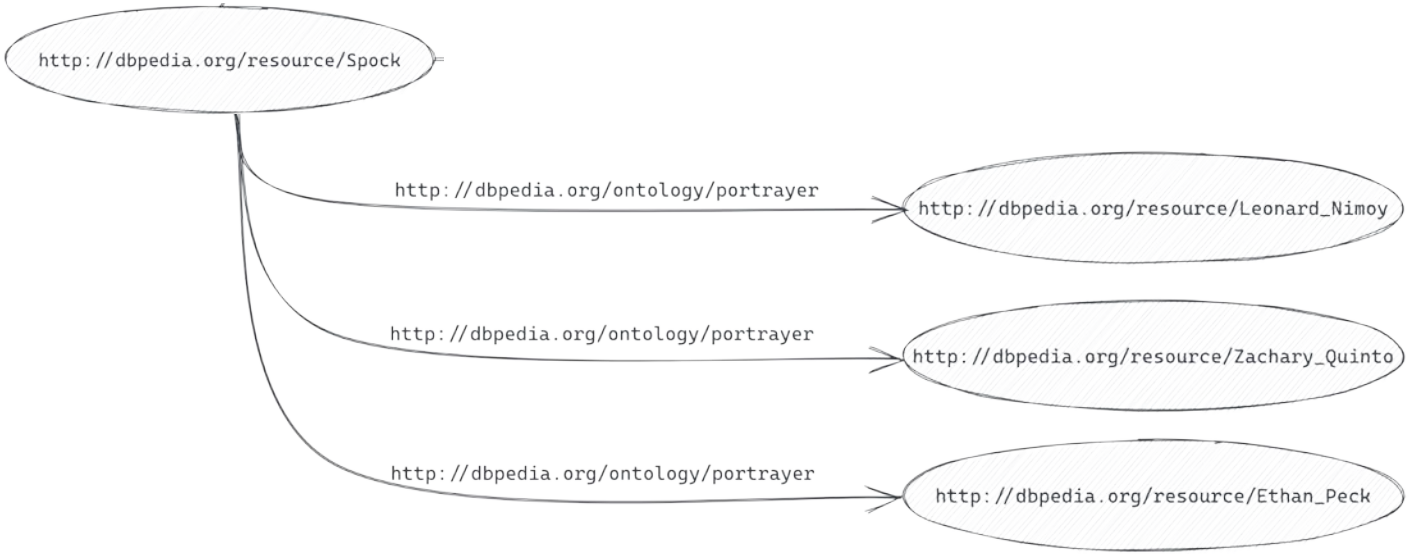
Further RDF abbreviations with Turtle:

```
@prefix dbp:  <http://dbpedia.org/property/> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base  <http://dbpedia.org/resource/> .

<Spock> rdfs:label "Spock"@en ;
        dbp:origin <Vulcan_(Star_Trek)> .
```

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

RDF Turtle Serialization



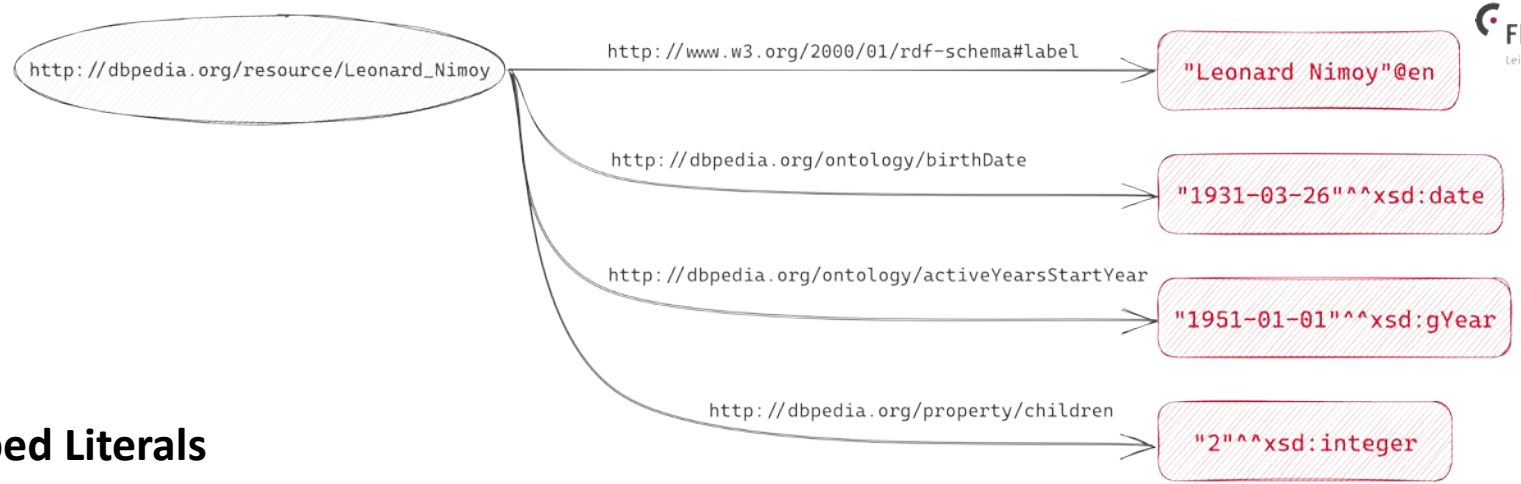
Further RDF abbreviations with Turtle:

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

<Spock> dbo:portrayer <Zachary_Quinto>,
                      <Leonard_Nimoy>,
                      <Ethan_Peck> .
```

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

RDF Turtle Serialization

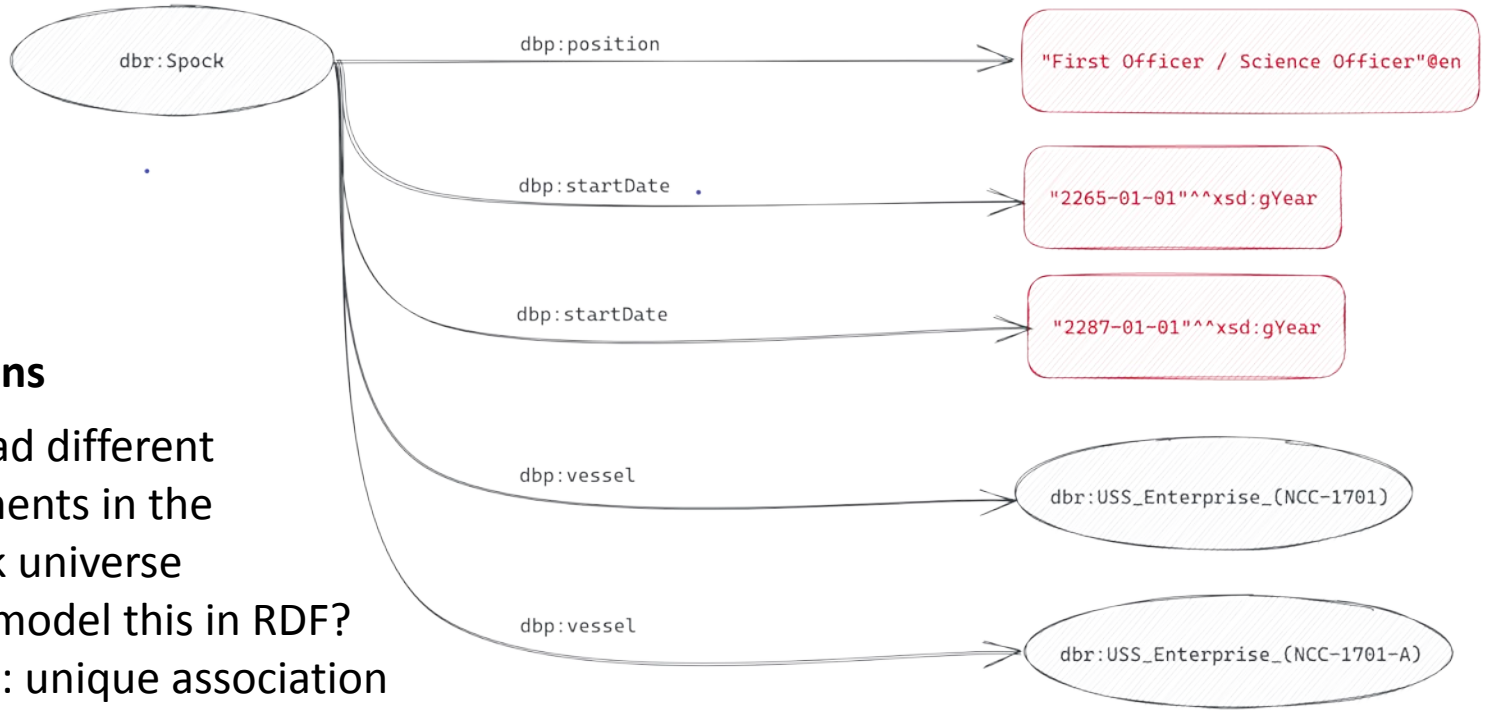


Typed Literals

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

<Leonard_Nimoy> rdfs:label "Leonard Nimoy"@en ;
                dbo:birthDate "1931-03-26"^^xsd:date ;
                dbo:activeYearsStartYear "1951-01-01"^^xsd:gYear ;
                dbr:children "2"^^xsd:integer .
```

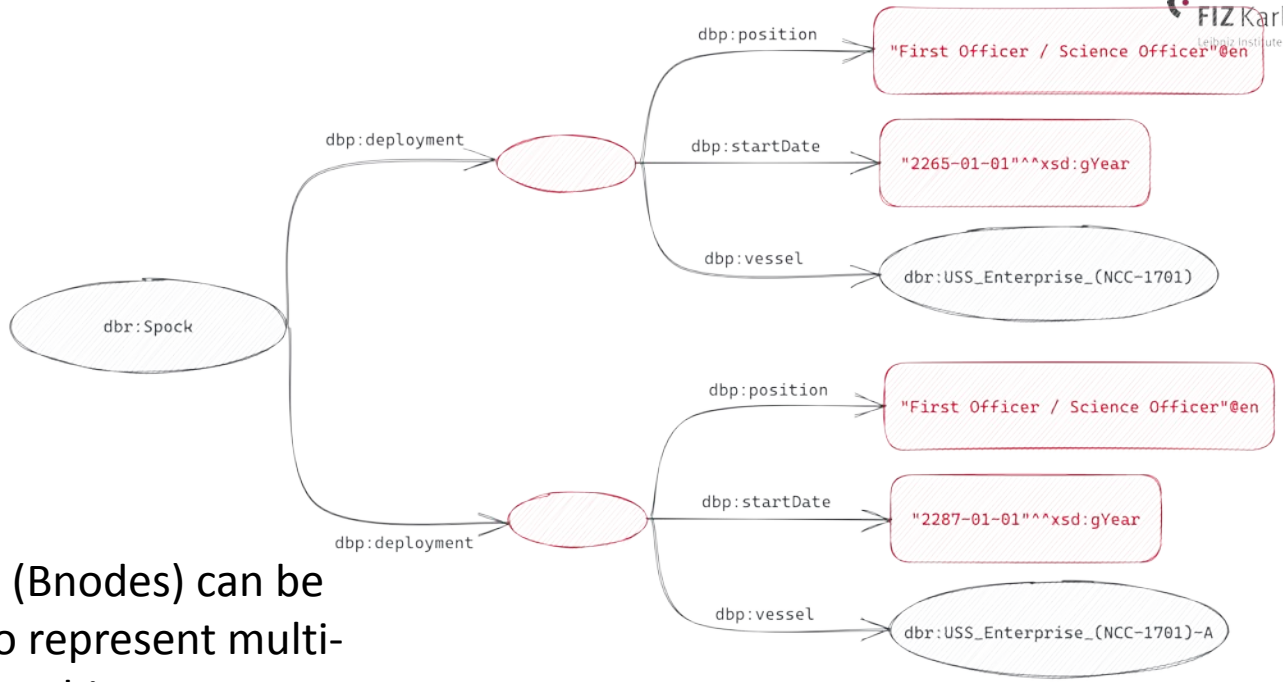
RDF Turtle Serialization



N-ary Relations

- Spock had different deployments in the Star Trek universe
- How to model this in RDF?
- Problem: unique association

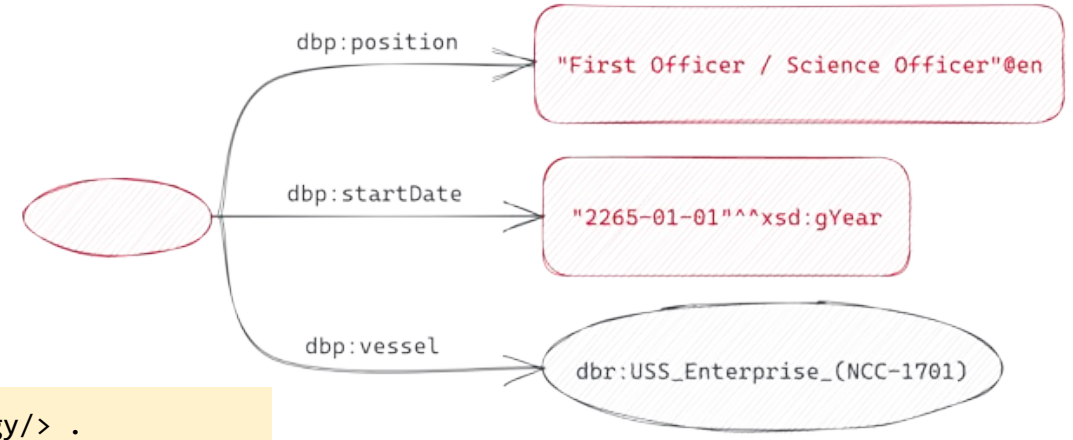
Anonymous Blank Nodes



N-ary 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).

Anonymous Blank Nodes

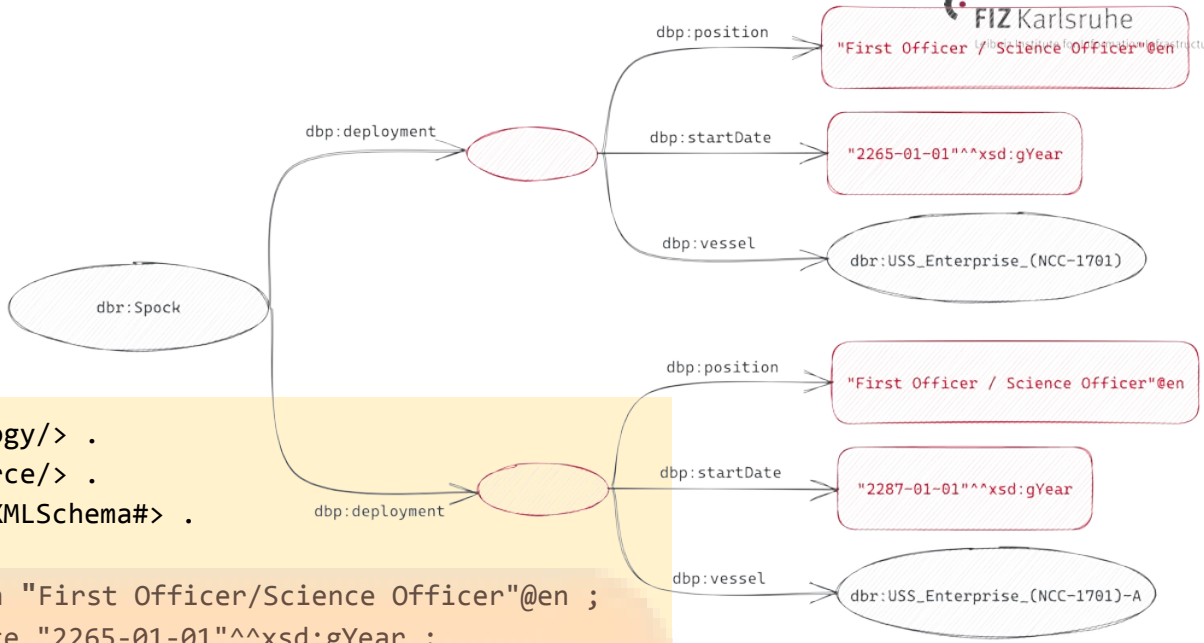



```
@prefix dbp: <http://dbpedia.org/ontology/> .
@prefix dbr: <http://dbpedia.org/resource/> .
@prefix xsd: <http://www.w3c.org/2001/XMLSchema#> .

[] dbp:position "First Officer/ Science Officer"@en ;
   dbp:startDate "2265-01-01"^^xsd:gYear ;
   dbp:vessel    dbr:USS_Enterprise_(NCC-1701) .
```

anonymous blank node as subject

Anonymous Blank Nodes

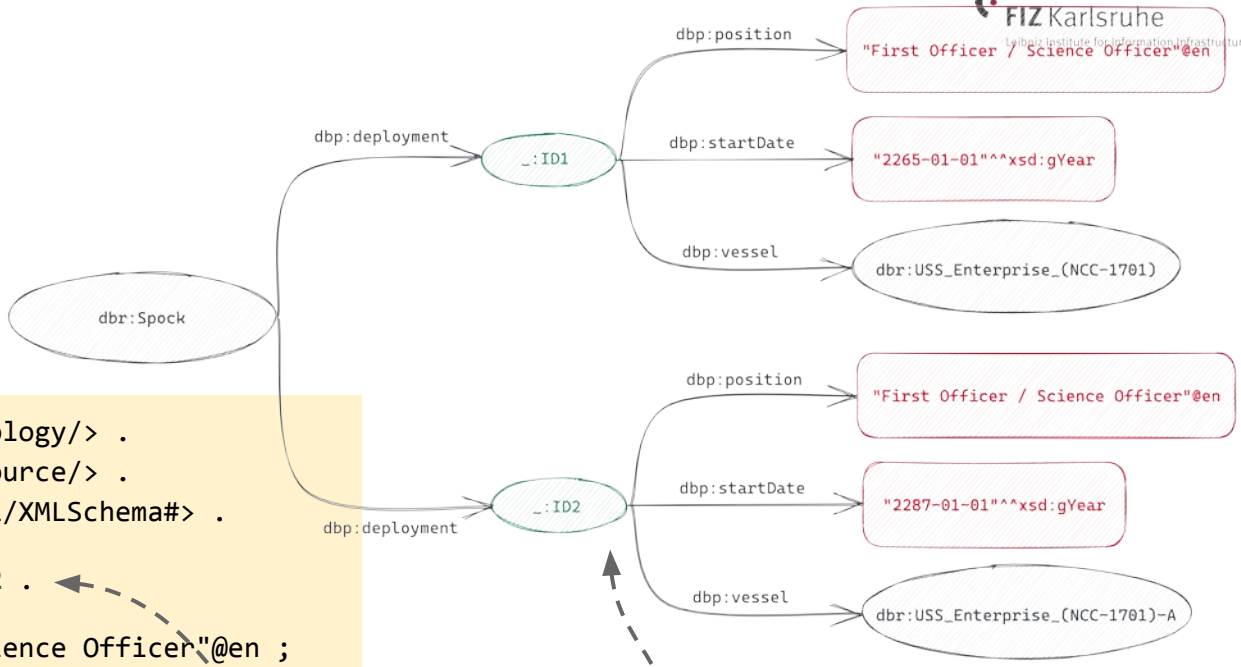



```
@prefix dbp: <http://dbpedia.org/ontology/> .
@prefix dbr: <http://dbpedia.org/resource/> .
@prefix xsd: <http://www.w3c.org/2001/XMLSchema#> .

dbr:Spock dbp:deployment [ dbp:position "First Officer/Science Officer"@en ;
                           dbp:startDate "2265-01-01"^^xsd:gYear ;
                           dbp:vessel    dbr:USS_Enterprise_(NCC-1701) .
                         ],
                         [ dbp:position "First Officer/Science Officer"@en ;
                           dbp:startDate "2287-01-01"^^xsd:gYear ;
                           dbp:vessel    dbr:USS_Enterprise_(NCC-1701-A) .
                         ] .
```

nested anonymous blank nodes

Dereferencable Blank Nodes



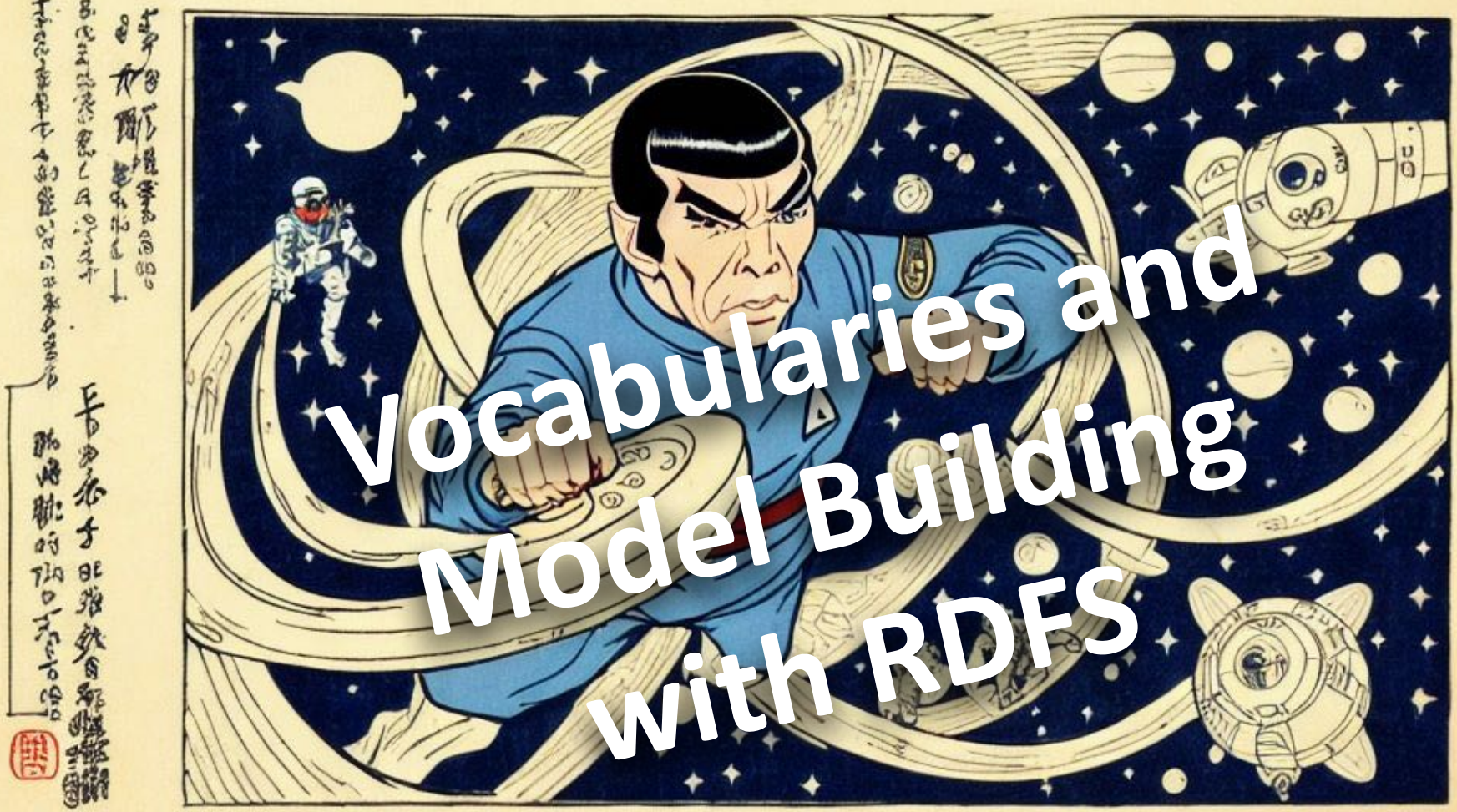

```
@prefix dbp: <http://dbpedia.org/ontology/> .
@prefix dbr: <http://dbpedia.org/resource/> .
@prefix xsd: <http://www.w3c.org/2001/XMLSchema#> .

dbr:Spock dbp:deployment _:ID1, _:ID2 .

_:ID1 dbp:position "First Officer/Science Officer"@en ;
      dbp:startDate "2265-01-01"^^xsd:gYear ;
      dbp:vessel    dbr:USS_Enterprise_(NCC-1701) .

_:ID2 dbp:position "First Officer/Science Officer"@en ;
      dbp:startDate "2287-01-01"^^xsd:gYear ;
      dbp:vessel    dbr:USS_Enterprise_(NCC-1701-A) .
```

dereferenceable blank nodes can only be referenced from inside a document / graph



Next Lecture...

Bibliographic References:

- Guus Schreiber, Yves Raimond (2014), *RDF 1.1 Primer*, W3C Working Group Note 24 June 2014
- Joem Madertma (2019), *What's the best RDF serialization format?*, ontola.io
- Eric Prud'hommeaux, Gavin Carothers (Eds.) (2014), *RDF 1.1 Turtle - Terse RDF Triple Language*, W3C Recommendation 25 February 2014

Picture References:

[1] "In this comic book-style illustration, the Teenage Mutant Ninja Turtles are depicted meeting Mr. Spock, the science officer of the USS Enterprise. The image shows information about each turtle, including their names, abilities, and relationships to one another, using RDF's standardized method for describing and linking resources." , created via ArtBot, Protogen Diffusion, 2023, [CC-BY-4.0], https://tinybots.net/artbot

[2] Benjamin Nowack, *The Semantic Web - Not a Piece of cake…*, at bnode.org, 2009-07-08 , [CC BY 3.0], https://web.archive.org/web/20220628120341/http://bnode.org/blog/2009/07/08/the-semantic-web-not-a-piece-of-cake

[3] "Mr. Spock, science officer of the USS Enterprise, is fighting a space monster covered with interlinked the RDF source code fragments in the style of a Hokusai woodcut." , created via ArtBot, ProtoGen Diffusion, 2023, [CC-BY-4.0], https://tinybots.net/artbot