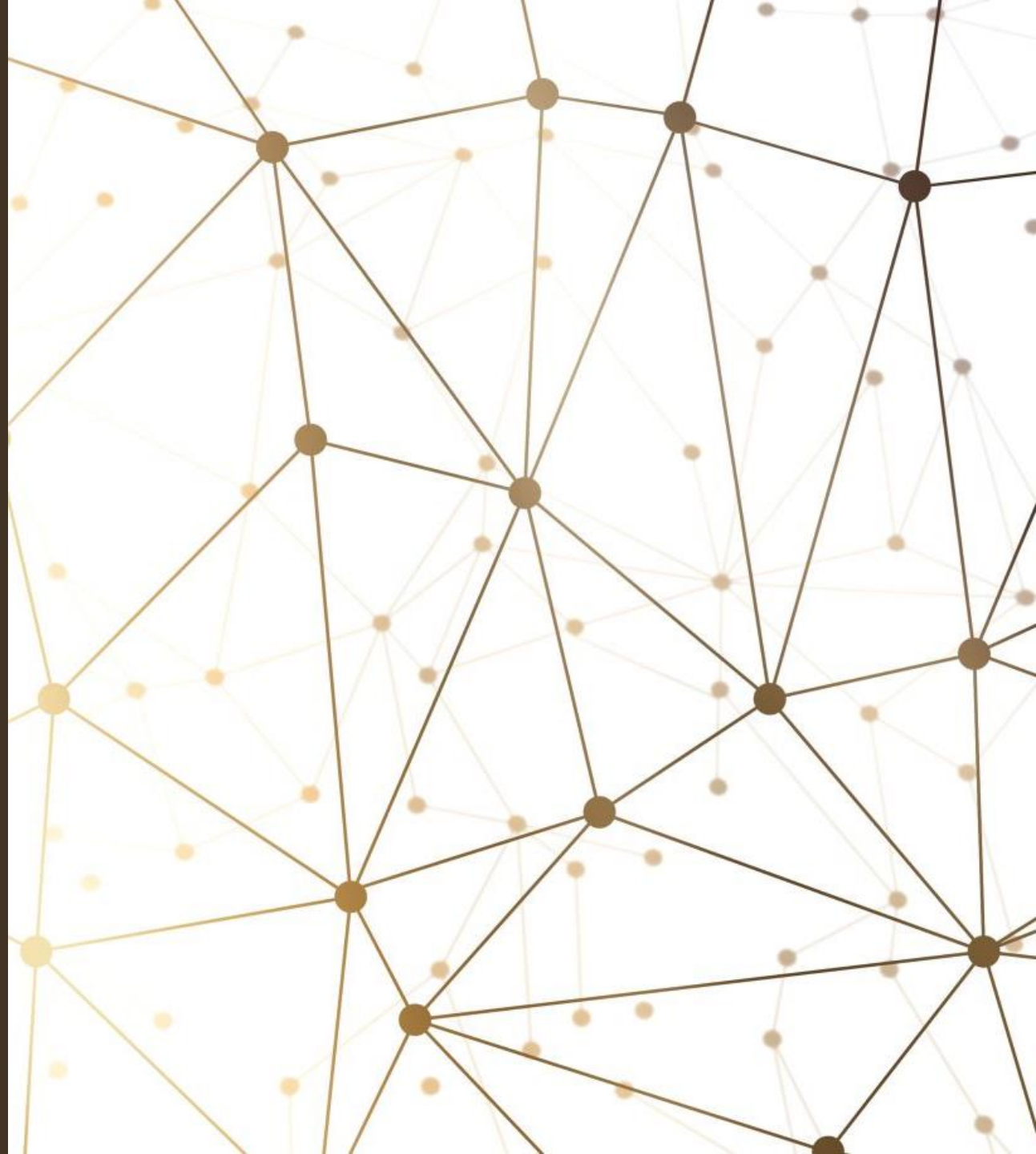
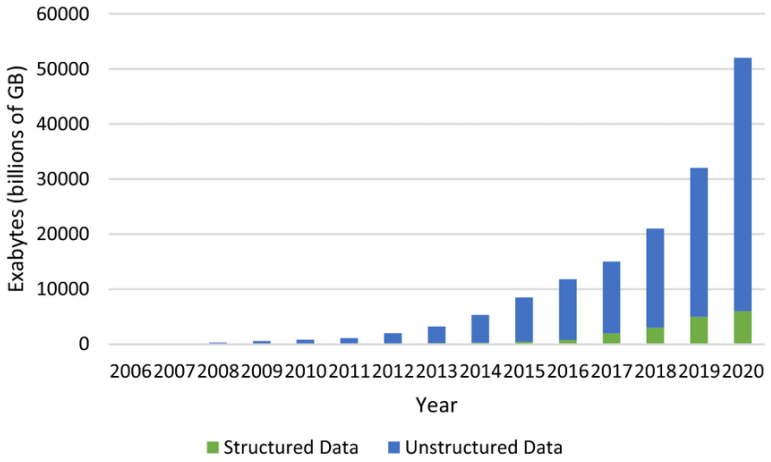
The Resource Description Framework (RDF)

By: Andreas Kruff



Problems of the World Wide Web

- Data is designed to be humanreadable
  - Unstructured format (not machine-readable)
- Lack of understanding about the syntax of the informations
  - Machines cannot use relations of the informations for improving
    - Search Results
    - Knowledge Representation
- Achieving interoperability between systems is hard



Source: [1]

Semantic Web – Idea

"The Semantic Web is not a separate Web but an extension of the current one, in which information is given **well-defined meaning, better enabling computers and people to work in cooperation.**"

Tim Berners-Lee

Solution: RDF

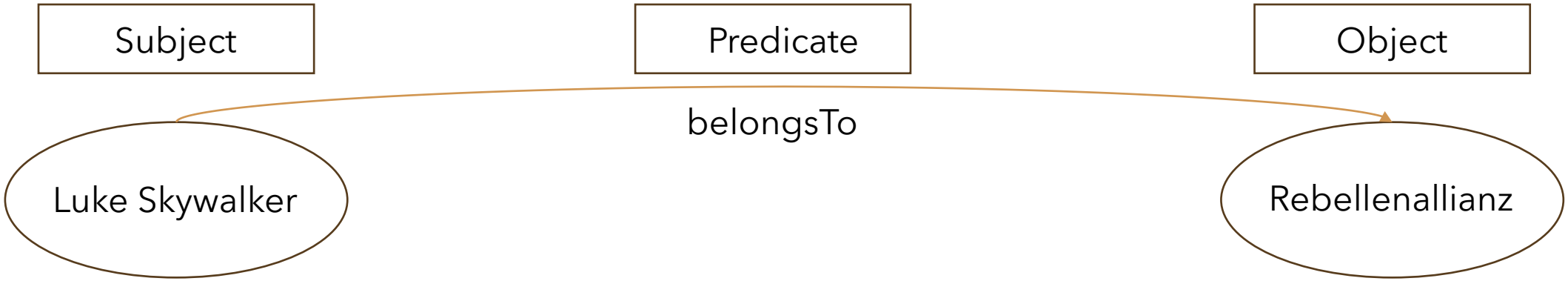
- RDF is a **data model** for metadata
- „RDF allows to state anything about anything“
- Recommended by the World Wide Web Consortium (W3C) in 1999
  - RDF 1.0 was released in 2004
- Method for description and exchange of graph data
- Directed graph composed of triple statements

Triple Statements

Triple Statements contain…

- A node for the **subject**
- An edge for the **predicate**
- A node for an **object**

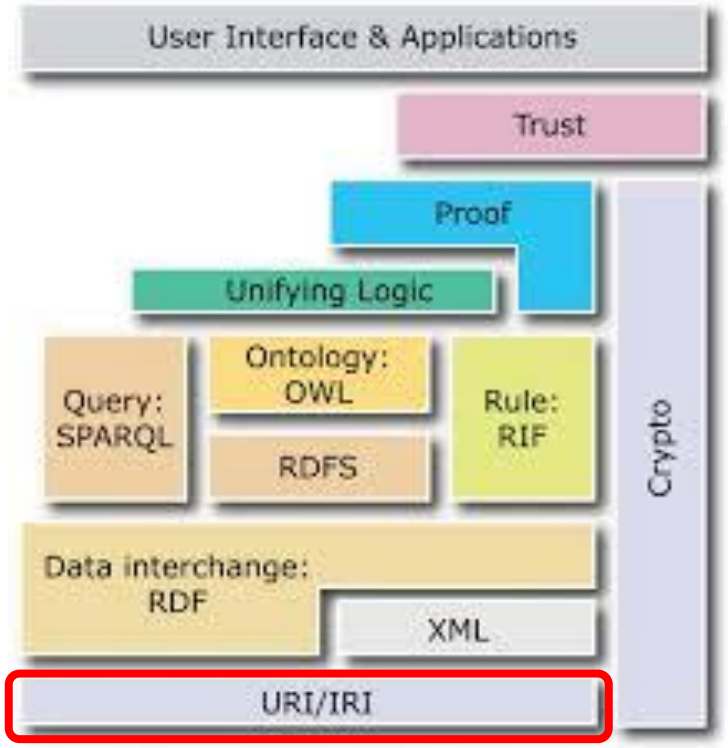
Example:



Or mode technically using URIs…

```
Subjekt: <http://example.org/starwars/Luke_Skywalker>
Prädikat: <http://example.org/ontology/belongsTo>
Objekt: <http://example.org/starwars/Rebellen_Allianz>
```

Requirements



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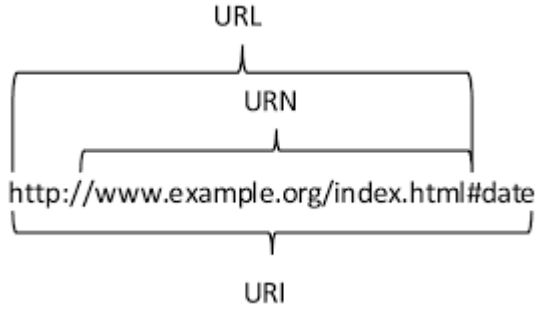
RDF: Triple Statements

Nodes can be defined as…

- Ressources (defined by URIs)

Recap URIs

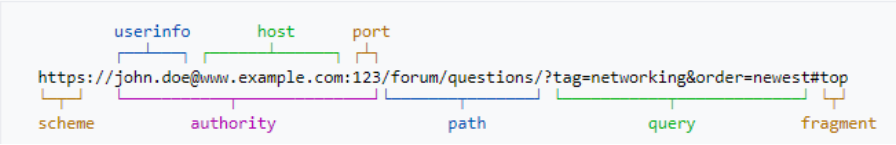
- Is a string for uniquely identifying resources on the web
- URIs can be
  - URLs that identify and locate resources in the web
  - URNs – Globally unique names for the resources without location
- Limited to ASCII



Source: [2]

Additional option: IRIs (Internationalized Resource Identifier)

- Similar to URIs but allowing for special characters

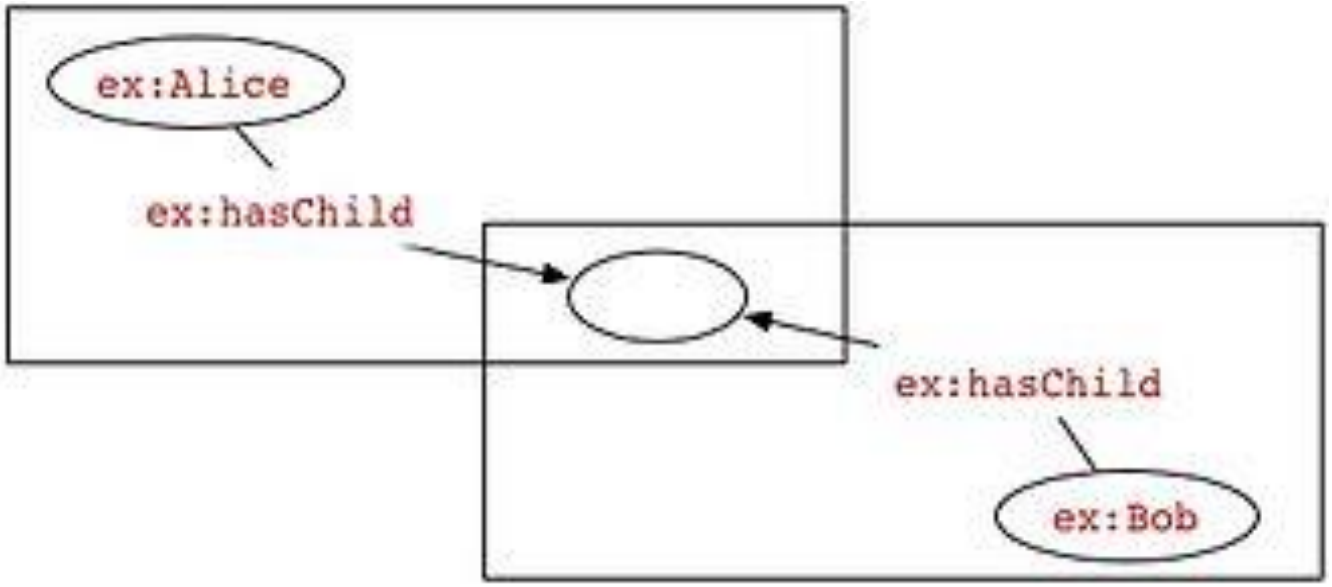


Source: https://www.baeldung.com/cs/uniform-resource-identifiers

RDF: Triple Statements

Nodes can be defined as…

- Ressources (defined by URIs)
- Blank Nodes (bnodes)



Source: https://en.wikipedia.org/wiki/Blank_node

RDF: Triple Statements

Nodes can be defined as…

- Ressources (defined by URIs)
- Blank Nodes (bnodes)
- Literals

RDF: Triple Statements

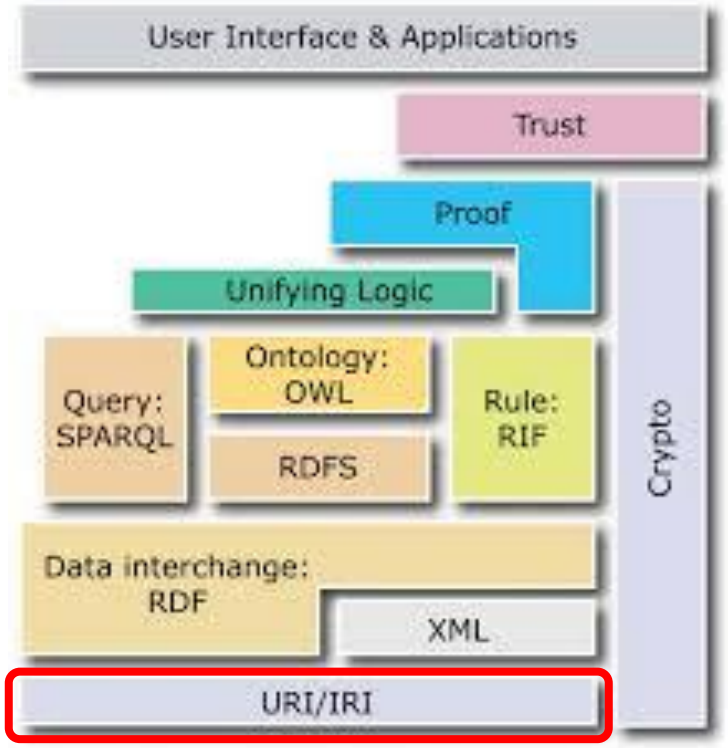
Triple Statements contain…

- A node for the **subject**
- An edge for the **predicate**
- A node for an **object**

Can be identified by an Uniform Resource Identifier (URI)

Can be defined as literal

Requirements



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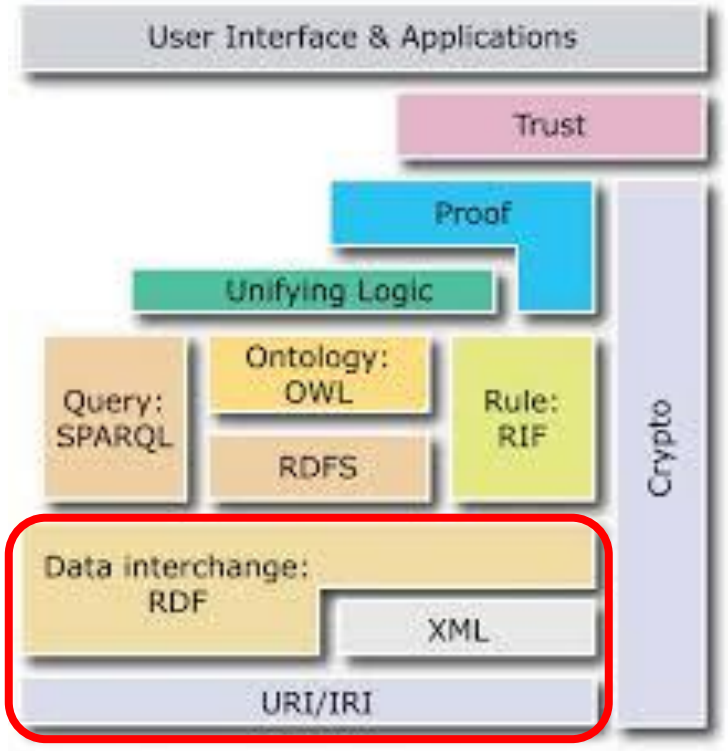

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Semantic Web Concepts

Serialization of the syntax for depiciting RDF triples and ontologies

- Usage of RDFa, JSON-LD, RDF/XML, Turtle

RDFa

```
<div xmlns:dc="http://purl.org/dc/elements/1.1/"
  about="http://www.example.com/books/wikinomics">
  <span property="dc:title">Wikinomics</span>
  <span property="dc:creator">Don Tapscott</span>
  <span property="dc:date">2006-10-01</span>
</div>
```

Source: https://www.mageworx.com/wiki/structured-data-definitions

Representations

RDF/XML

Example

```
<?xml version="1.0"?>

<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:cd="http://www.recshop.fake/cd#">

<rdf:Description
rdf:about="http://www.recshop.fake/cd/Beatles">
  <cd:artist>
    <rdf:Bag>
      <rdf:li>John</rdf:li>
      <rdf:li>Paul</rdf:li>
      <rdf:li>George</rdf:li>
      <rdf:li>Ringo</rdf:li>
    </rdf:Bag>
  </cd:artist>
</rdf:Description>

</rdf:RDF>
```

JSON-LD

```
<script type="application/ld+json">
{
  "@context": "http://schema.org",
  "@type": "Person",
  "name": "John Doe",
  "jobTitle": "Graduate research assistant",
  "affiliation": "University of Dreams",
  "additionalName": "Johnny",
  "url": "http://www.example.com",
  "address": {
    "@type": "PostalAddress",
    "streetAddress": "1234 Peach Drive",
    "addressLocality": "Wonderland",
    "addressRegion": "Georgia"
  }
}
</script>
```

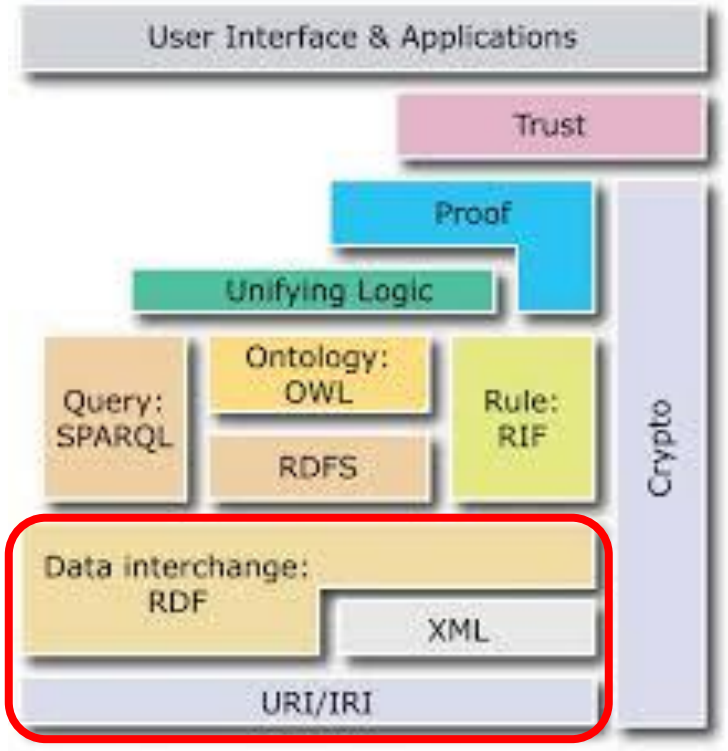
Turtle

```
@prefix dbr:    <http://dbpedia.org/resource/> .
@prefix dbo:    <http://dbpedia.org/ontology/> .
@prefix rdfs:   <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf:   <http://xmlns.com/foaf/0.1/> .
@prefix geo:    <http://www.w3.org/2003/01/geo/wgs84_pos#> .
@prefix xsd:    <http://www.w3.org/2001/XMLSchema#> .
@prefix schema: <http://schema.org/> .

dbr:Bob_Marley
   a foaf:Person ;
   rdfs:label "Bob Marley"@en ;
   rdfs:label "Bob Marley"@fr ;
   rdfs:seeAlso dbr:Rastafari ;
   dbo:birthPlace dbr:Jamaica .

dbr:Jamaica
   a schema:Country ;
   rdfs:label "Jamaica"@en ;
   rdfs:label "Giamaica"@it ;
   geo:lat "17.9833"^^xsd:float ;
   geo:long "-76.8"^^xsd:float ;
   foaf:homepage <http://jis.gov.jm/> .
```

Sources:

- https://slideplayer.com/slide/3416105/12/images/33/Example.jpg
- https://hallanalysis.com/wp-content/uploads/2016/03/json-ld.png
- https://miro.medium.com/v2/resize:fit:916/1*WgqGqn1tcd_aSpQbN45aBw.png

Requirements



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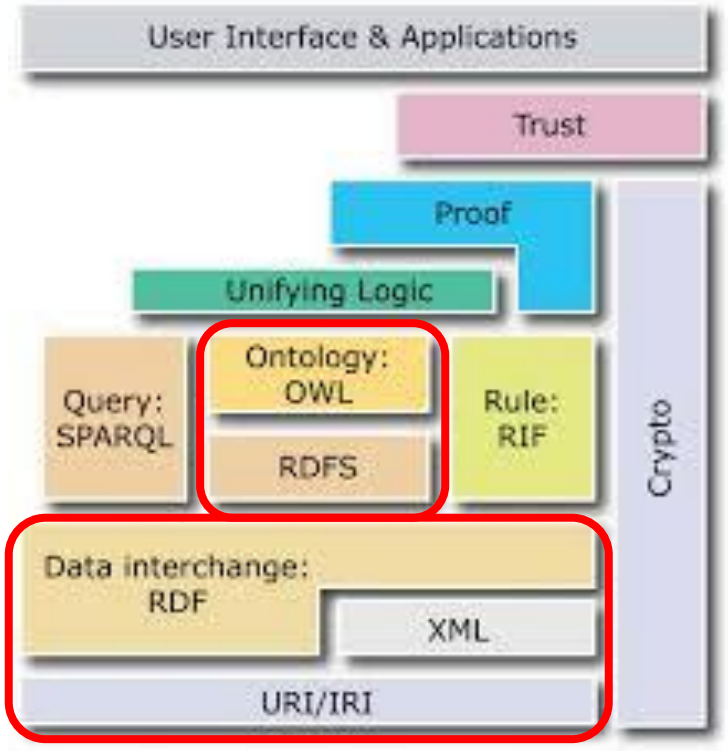

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Semantic Web Concepts

Creating ontologies/vocabularies & schemas in the semantic web

- Usage of RDF Schema / OWL / schema.org

Ontology

Definition:

"In the context of computer and information sciences, an **ontology defines a set of representational primitives** with which to model a domain of knowledge or discourse. The representational **primitives are typically classes** (or sets), **attributes** (or properties), and **relationships** (or relations among class members). The definitions of the representational primitives **include information about their meaning and constraints on their logically consistent application.**"

Tom Gruber

Gruber, T. (2009). Ontology. In: LIU, L., ÖZSU, M.T. (eds) Encyclopedia of Database Systems. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-39940-9_1318

Semantic Web Concepts

Creating ontologies/vocabularies & schemas in the semantic web

- Usage of RDF Schema / OWL / schema.org
- Can be combined
- Defines Classes, Predicates & Axioms

Example:

Class Definition:	ex: Person	rdf: type	rdfs: Class
Axiom Definition:	ex Student	rdf: subClassOf	ex: Person
Predicate Definition:	ex: hasName	rdf: type	rdf: Property

Semantic Web Concepts

Creating Metadata-Schemata for Ressources in the Web

- Usage of Dublin Core & FOAF

Dublin Core

```
@prefix dc: <http://purl.org/dc/elements/1.1/>.

ex:Document rdf:type ex:Document ;
    dc:title "Mein großartiges Dokument" ;
    dc:creator "John Doe" .
```

specialized for general metadata (title,author,year)

FOAF (Friend of a Friend)

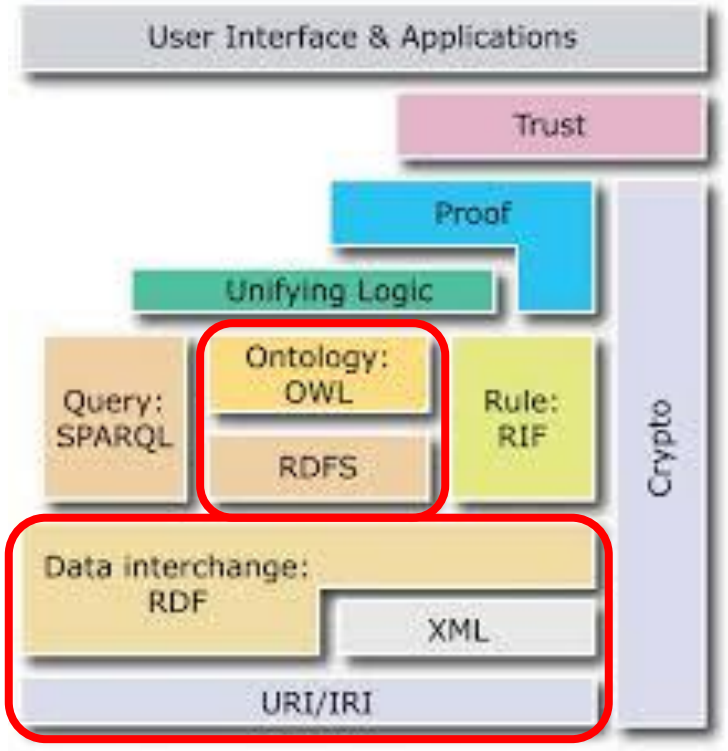
```
@prefix foaf: <http://xmlns.com/foaf/0.1/>.

ex:JohnDoe rdf:type foaf:Person ;
    foaf:name "John Doe" ;
    foaf:mbox <mailto:john@example.com> .

ex:JaneSmith rdf:type foaf:Person ;
    foaf:name "Jane Smith" ;
    foaf:mbox <mailto:jane@example.com> .
```

specialized for person and connections between persons

Requirements



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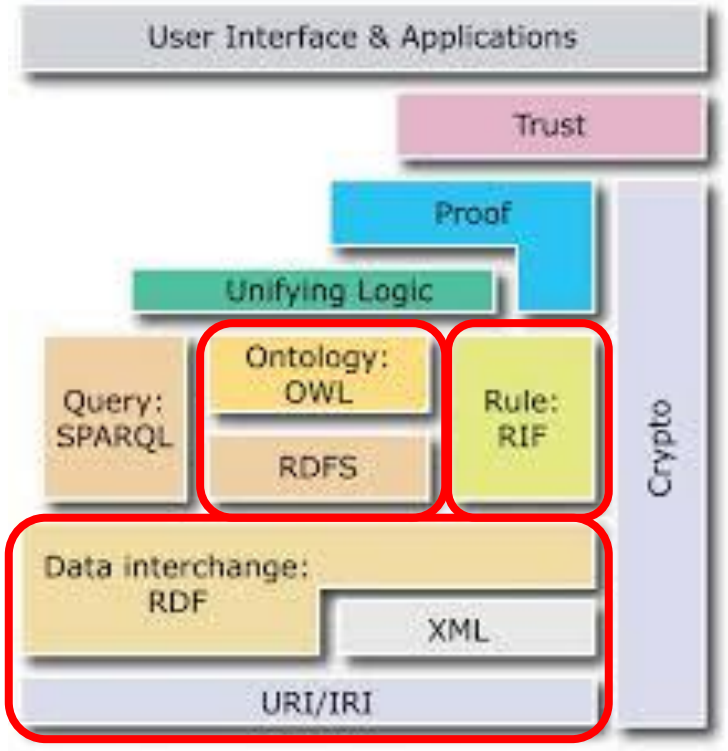

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Semantic Web Concepts

Improving RDF with RIF (Rule Interchange Format)

- Compatible with OWL & RDF
- Includes multiple dialects
  - RIF-Core
  - Basic Logic Dialect (BLD)
  - Production Rule Dialect (PRD)
- Benefits
  - Consistency checking
  - Better (automized) Data Integration

Summary

- RDF is still State of the Art for implementing the Semantic Web
- Key Ideas:
  - Assigning machine-readable relations between entitites
  - The usage of URIs/IRIs allow linkage of clearly defined entities
  - Improvement of interoperability

Sources

1. Azad, Poupak & Navimipour, Nima & Rahmani, Amir & Sharifi, Arash. (2020). The role of structured and unstructured data managing mechanisms in the Internet of things. Cluster Computing. 23. 1-14. 10.1007/s10586-019-02986-2.
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