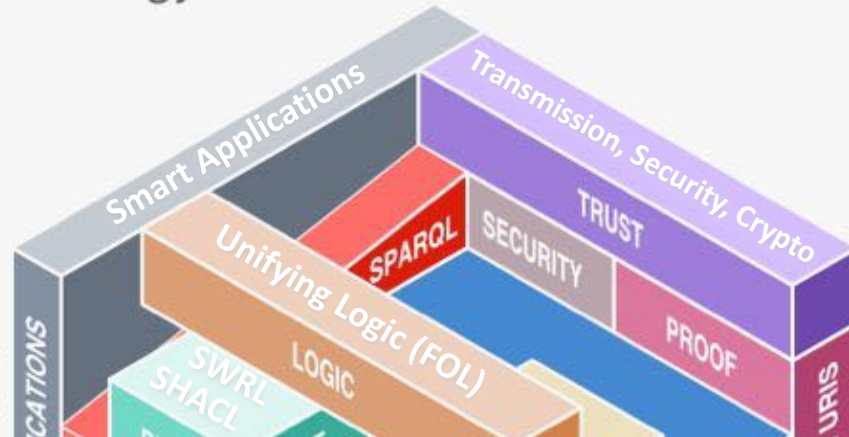


The Semantic Web Technology Stack (not a piece of cake...)



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 sufficient

The Semantic Web is based on standards

Linked Data uses a small selection of technologies

Knowledge Graphs

Lecture 1 – Knowledge Representation with Graphs

1.6 The Semantic Web

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FIZ Karlsruhe – Leibniz Institute for Information Infrastructure

AIFB – Karlsruhe Institute of Technology

Autumn 2023



LINKED DATA

Knowledge Graphs

Lecture 1: Knowledge Representation with Graphs

1.1 From Data to Knowledge

1.2 Knowledge and how to represent it

1.3 The Art of Understanding

1.4 Graphs and Triples

1.5 Knowledge Graphs

1.6 The Semantic Web

1.7 Linked Data and the Web of Data

The Semantic Web – A Web of Data



“The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation.”

Tim Berners-Lee, James Hendler, Ora Lassila: [The Semantic Web](#), Scientific American, 284(5), pp. 34-43(2001)

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

Most apps use only a subset of the stack

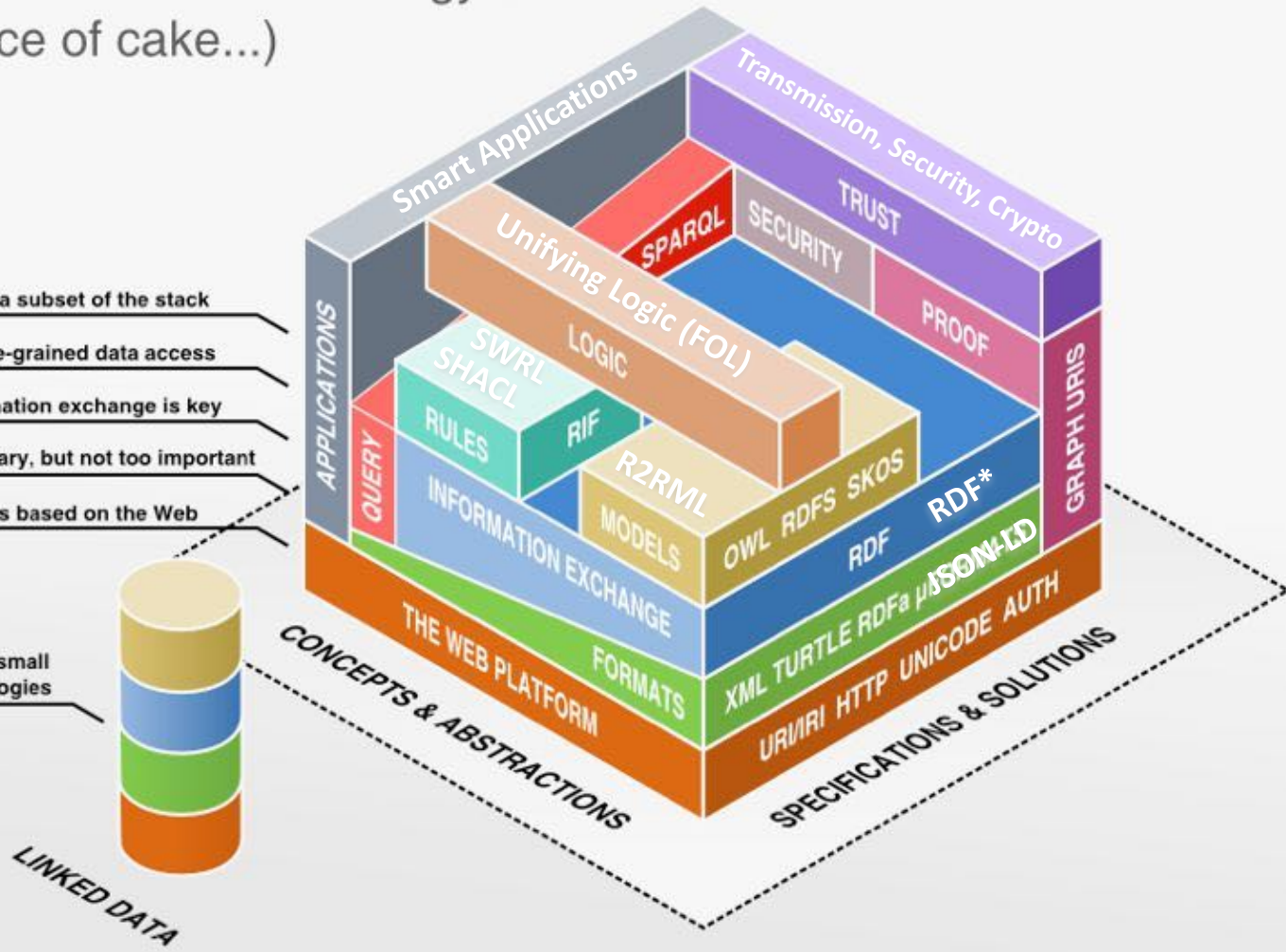
Querying allows fine-grained data access

Standardized information exchange is key

Formats are necessary, but not too important

The Semantic Web is based on the Web

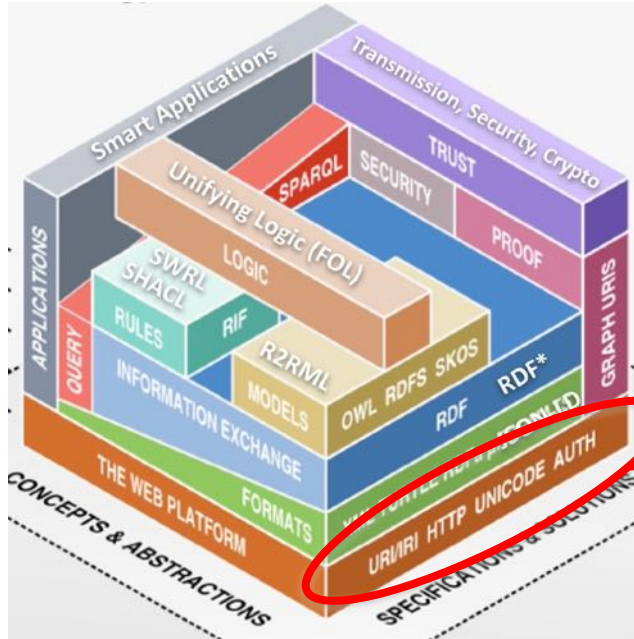
Linked Data uses a small
selection of technologies



The Semantic Web – A Web of Data

- The Semantic Web is an **Extension of the traditional Web**.
- The meaning of information (Semantics) is made explicit by **formal (structured) and standardized knowledge representations (Ontologies)**.
- Thereby it will be possible,
 - to **process** the meaning of information automatically,
 - to **relate** and **integrate** heterogeneous data,
 - to **deduce** implicit (not evident) information from existing (evident) information in an automated way.
- The Semantic Web is kind of a **global database** that contains a **universal network of semantic propositions**.

The Semantic Web Technology Stack



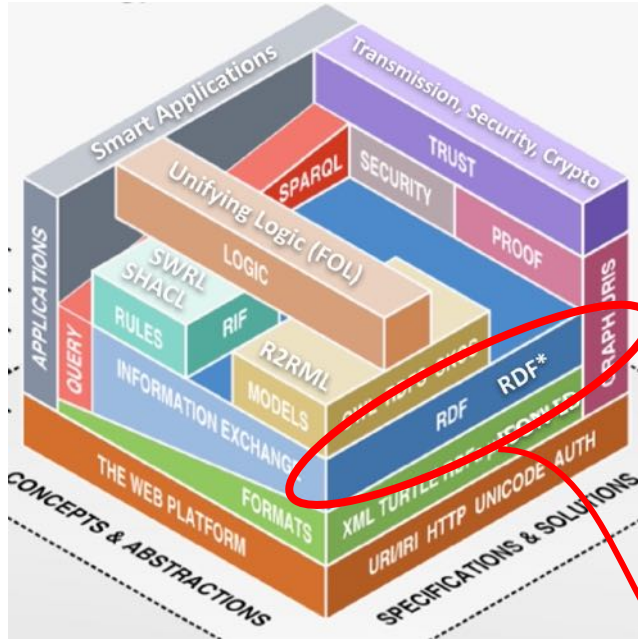
URI - Uniform Resource Identifier

Obi-Wan Kenobi

=

https://dbpedia.org/resource/Obi-Wan_Kenobi

The Semantic Web Technology Stack



https://dbpedia.org/resource/Obi-Wan_Kenobi

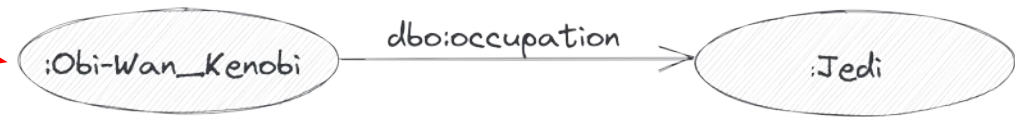
```
:Obi-Wan_Kenobi rdf:type dbo:agent .  
:Obi-Wan_Kenobi foaf:name "Obi-Wan Kenobi"@en .  
:Obi-Wan_Kenobi dbo:occupation :Jedi .  
:Obi-Wan_Kenobi dbo:series :StarWars .  
:Obi-Wan_Kenobi dbo:portrayer :Alec_Guinness .  
:Obi-Wan_Kenobi dbo:portrayer :Ewan_McGregor .  
...
```



RDF - Resource Description Framework



RDF Triple

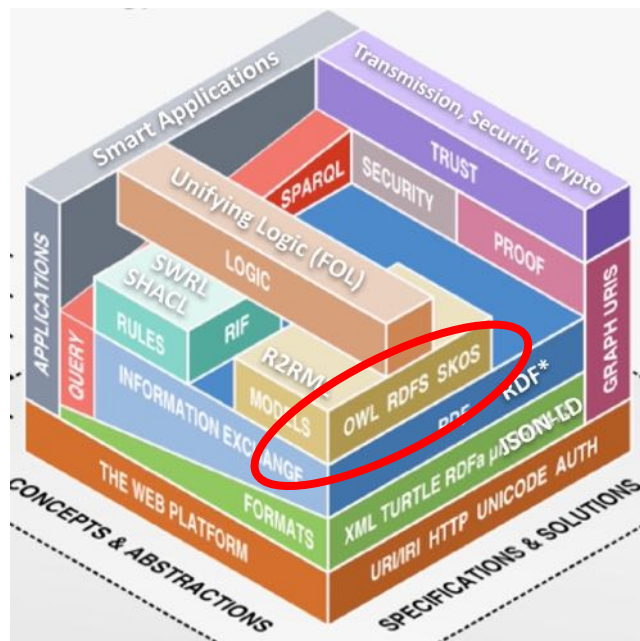


RDF Subject

RDF Property

RDF Object

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<https://dbpedia.org/ontology/Agent>

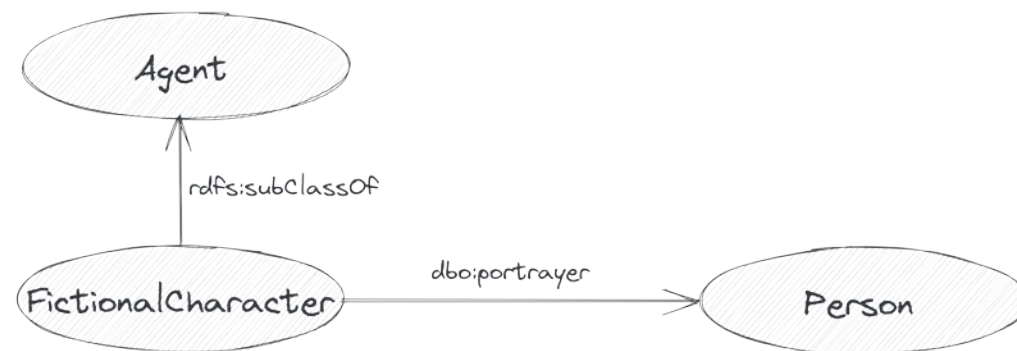
```

dbo:Agent rdf:type owl:Class .
dbo:FictionalCharacter rdfs:subClassOf dbo:Agent .
dbo:portrayer rdf:type rdf:Property .
dbo:portrayer rdfs:domain dbo:FictionalCharacter .
dbo:portrayer rdfs:range dbo:Person .
...

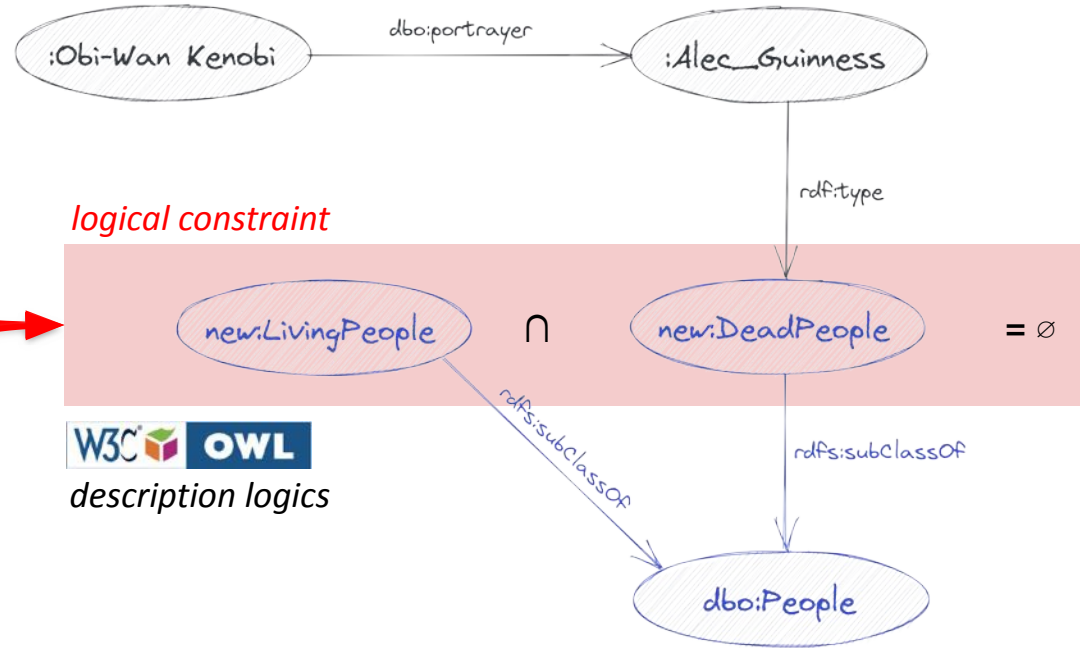
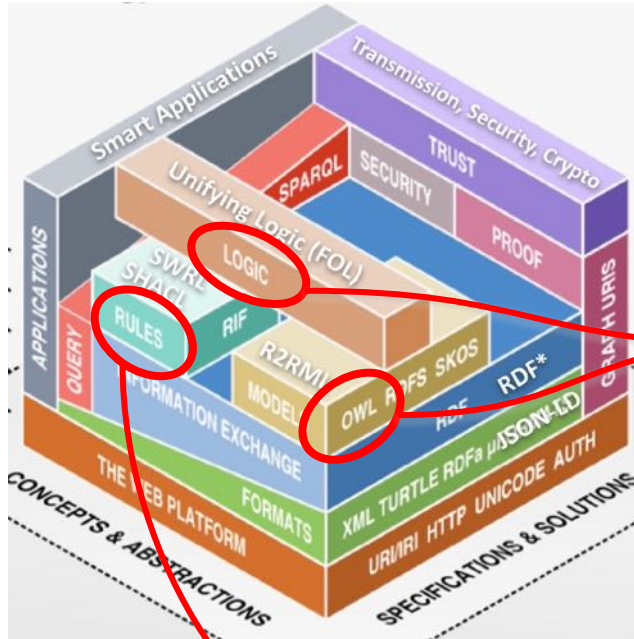
```



RDFS - RDF Schema



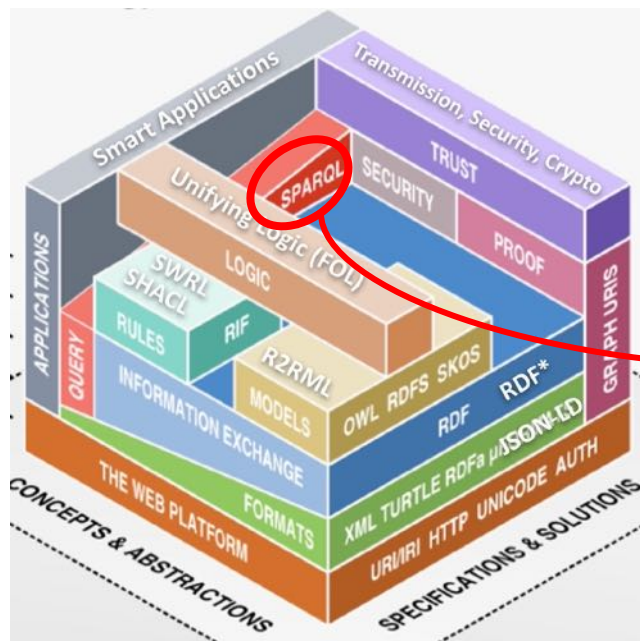
The Semantic Web Technology Stack



+ logical rules

$$\forall x. \exists y. \text{deathDate}(x, y) \wedge \text{Person}(x) \wedge \text{Date}(y) \rightarrow \text{DeadPeople}(x)$$

The Semantic Web Technology Stack



Which of the actors who portrayed
Obi-Wan Kenobi acted in other movies?

PREFIX rdf: <<https://www.w3.org/1999/02/22-rdf-syntax-ns#>>

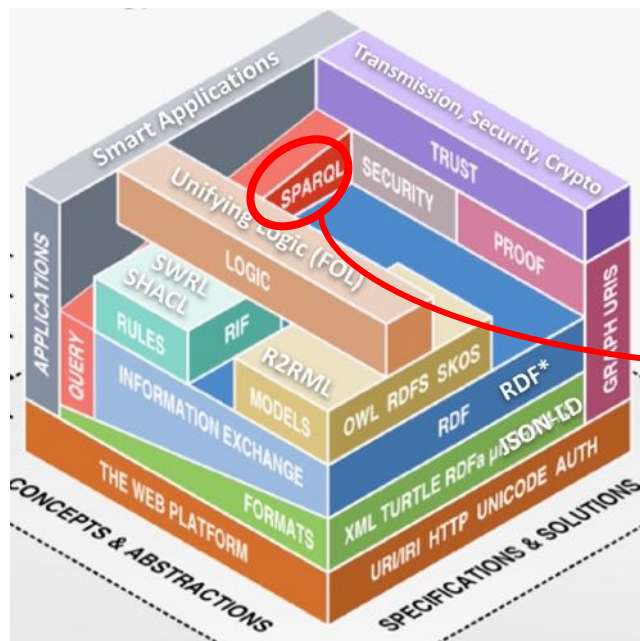
PREFIX dbo: <<http://dbpedia.org/ontology/>>

```
SELECT ?actor (COUNT(DISTINCT ?movie) AS ?num) WHERE {  
  dbr:Obi-Wan_Kenobi dbo:portrayer ?actor .  
  ?movie dbo:starring ?actor .  
}  
GROUP BY ?actor
```

[try SPARQL query at public DBpedia SPARQL endpoint](#)



The Semantic Web Technology Stack



Which of the actors who portrayed
Obi-Wan Kenobi did act in more movies?



```
SELECT ?actorLabel (COUNT(DISTINCT ?movie)AS ?num) WHERE {  
  wd:Q51740 wdt:P175 ?actor .  
  ?movie wdt:P161 ?actor .  
  SERVICE wikibase:label  
    { bd:serviceParam wikibase:language "en, de, fr, es, it" }  
}  
GROUP BY ?actorLabel
```

[try SPARQL query at public Wikidata SPARQL endpoint](#)


The Semantic Web Technology Stack

On which locations did the actors who portrayed Obi-Wan Kenobi shoot their movies?



[try SPARQL query at public Wikidata SPARQL endpoint](#)



A globe showing the Earth's continents and oceans, overlaid with a complex network of white lines that represent data connections or the Web of Data. The lines crisscross the globe, connecting various points across the surface.

Linked Data and the Web of Data

Next Lecture...

Bibliographic References:

Tim Berners-Lee, James Hendler, Ora Lassila (2001). The Semantic Web, Scientific American, 284(5), pp. 34–43.

Picture References:

- [1] LOD Cloud, 2014-08-30, [cc-by-4.0], <https://lod-cloud.net/versions/2014-08-30/lod-cloud.png>
- [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] "An image of the Semantic Web which is an extension of the World Wide Web...", created via ArtBot, Dreamlike Diffusion, 2023, [CC-BY-4.0], <https://tinybots.net/artbot>