

# Knowledge Graphs

## Lecture 2 - Basic Semantic Technologies

### 2.6 Logical Inference with RDF(S)

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# Knowledge Graphs

## Lecture 2: Basic Semantic Technologies

2.1 How to Identify and Access Things

2.2 How to Represent Simple Facts with RDF

2.3 RDF Turtle Serialization

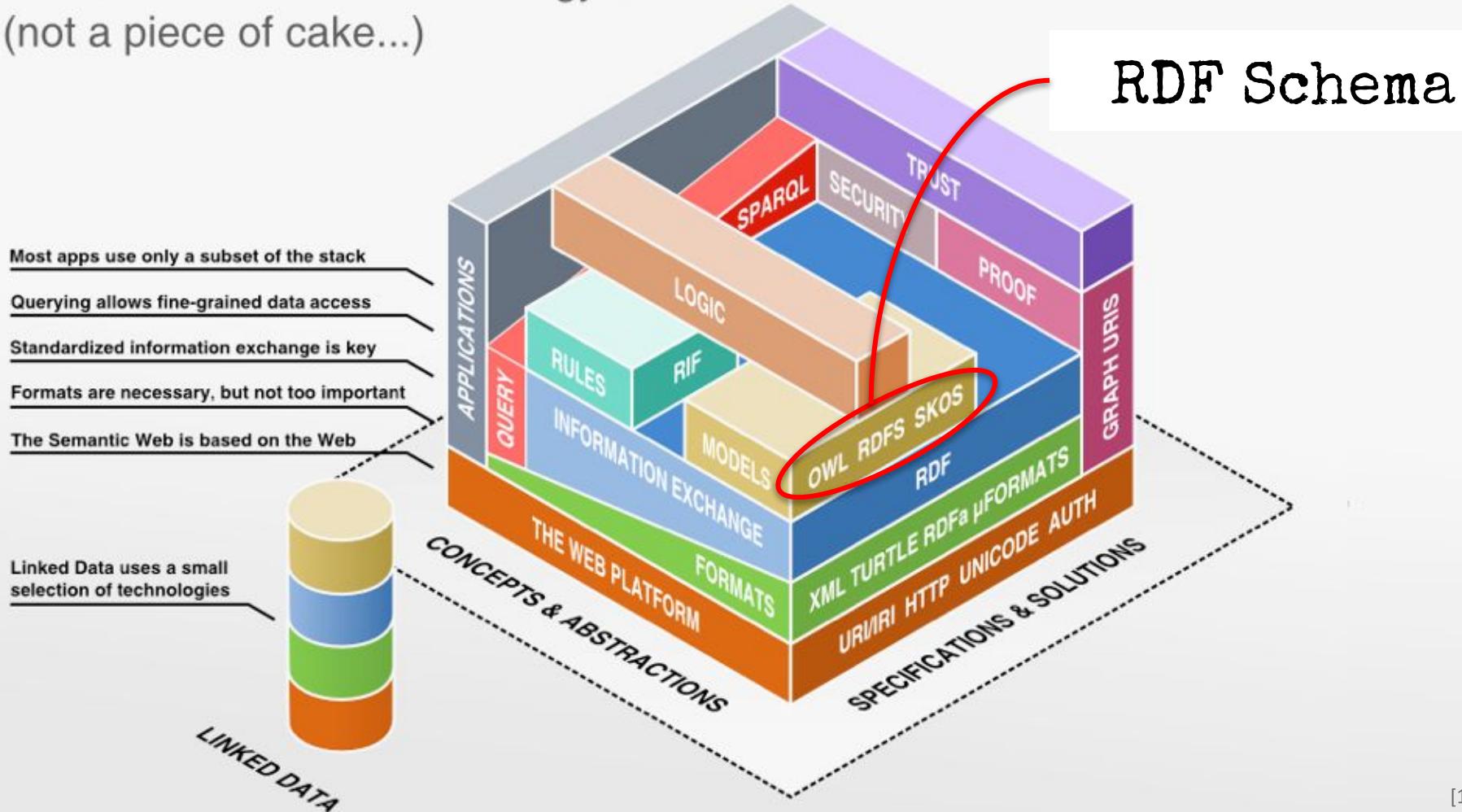
2.4 RDF Complex Data Structures

2.5 Model Building with RDFS

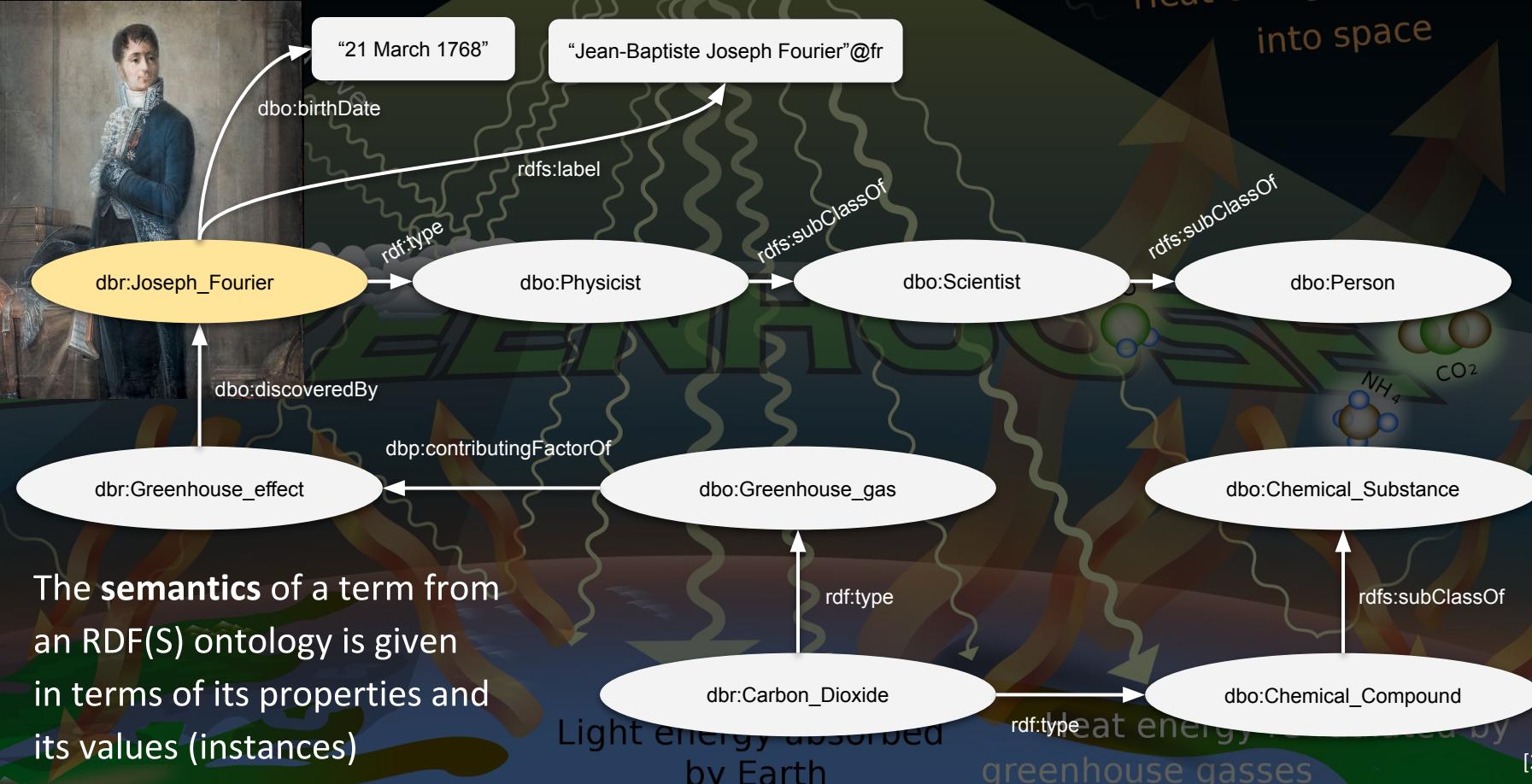
2.6 Logical Inference with RDF(S)

Excursion 1: RDFa - RDF and the Web

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



# How much knowledge (semantics) is there?



# RDF(S) Semantics

- In difference to other data definition languages RDF(S) is based on a **formal semantics**
- Formal semantics enables RDF(S) to draw **valid** and **sound logical inferences**
- Examples:
  - dbr:Joseph\_Fourier **rdf:type** dbo:Physicist .
  - dbo:Physicist **rdfs:subClassOf** dbo:Scientist .
  - dbo:discoveredBy **rdfs:subPropertyOf** dbo:perceivedBy

dbr:Joseph\_Fourier  $\in$  dbo:Physicist  
dbo:Physicist  $\subseteq$  dbo:Scientist  
dbo:discoveredBy  $\subseteq$  dbo:perceivedBy

## Model-theoretic Semantics

# Which Conclusions can we deduce with RDF(S) Semantics



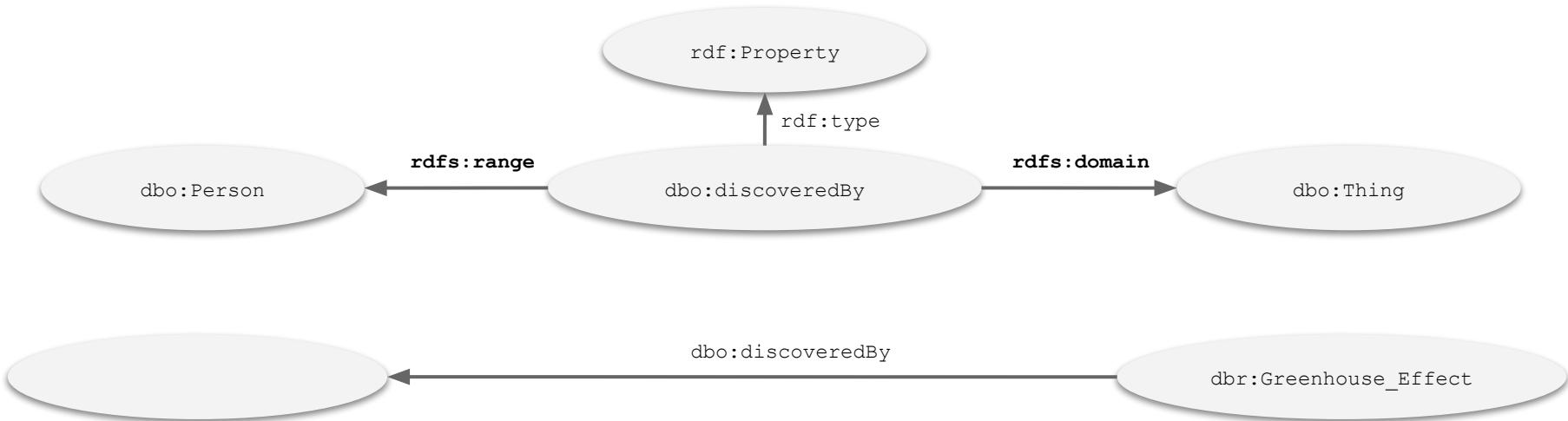
# Which Conclusions can we deduce with RDF(S) Semantics



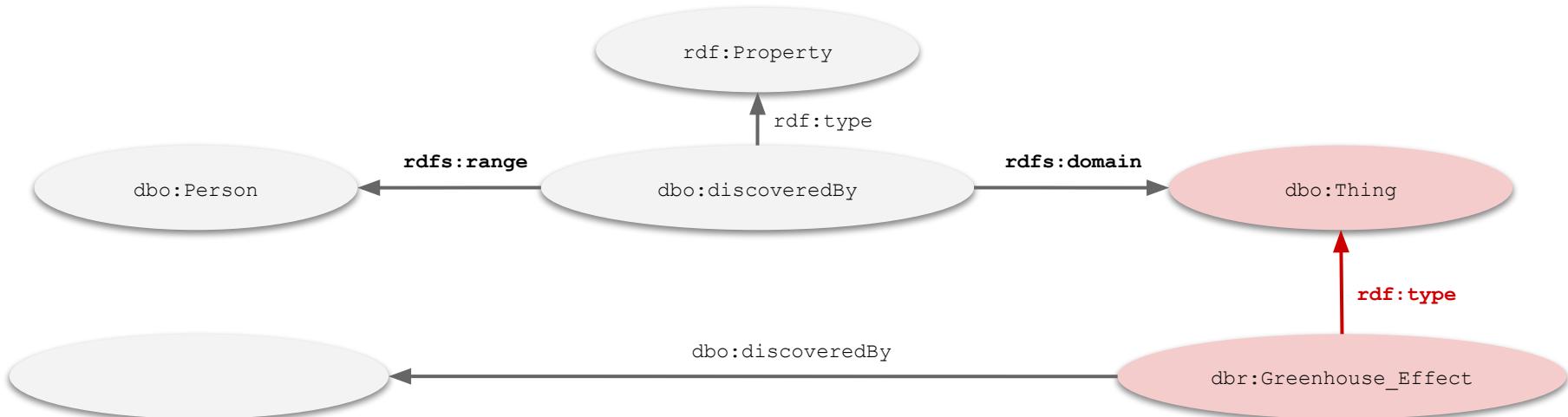
(1) Deduction of **new facts** from a **class hierarchy**.

$$\forall i, c_1, c_2: T(i, \text{rdf:type}, c_1) \wedge T(c_1, \text{rdfs:subClassOf}, c_2) \rightarrow T(i, \text{rdf:type}, c_2)$$

# Which Conclusions can we deduce with RDF(S) Semantics



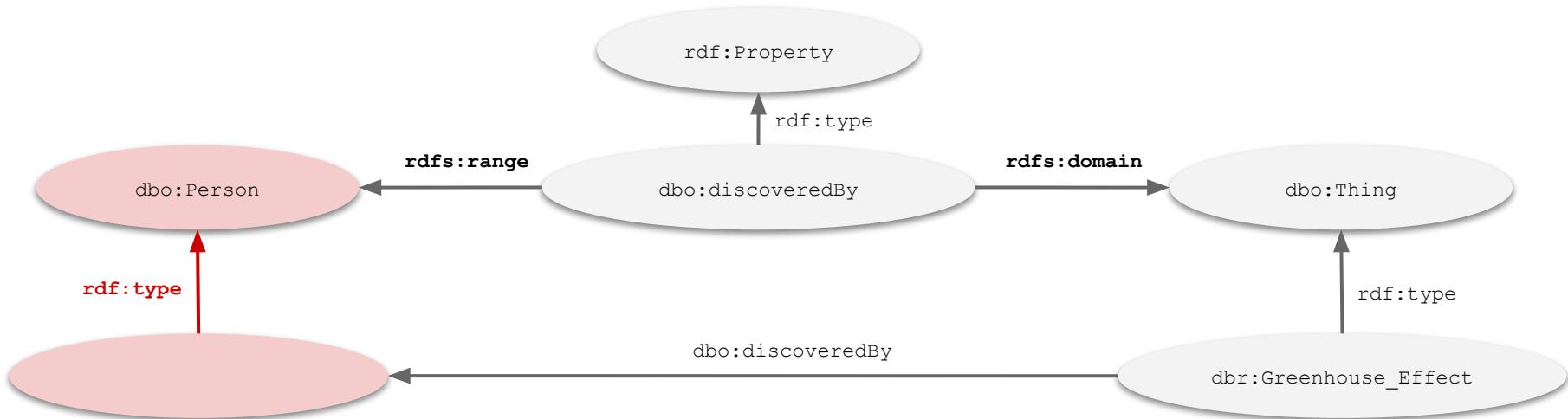
# Which Conclusions can we deduce with RDF(S) Semantics



(2) Deduction of entity **class membership** from the **domain** of one of its properties

$$\begin{aligned}
 \forall i_1, i_2, c_1, c_2, p: & T(i_1, p, i_2) \wedge \\
 & T(p, \text{rdfs:domain}, c_1) \wedge T(p, \text{rdfs:range}, c_2) \\
 \rightarrow & T(i_1, \text{rdf:type}, c_1) \wedge T(i_2, \text{rdf:type}, c_2)
 \end{aligned}$$

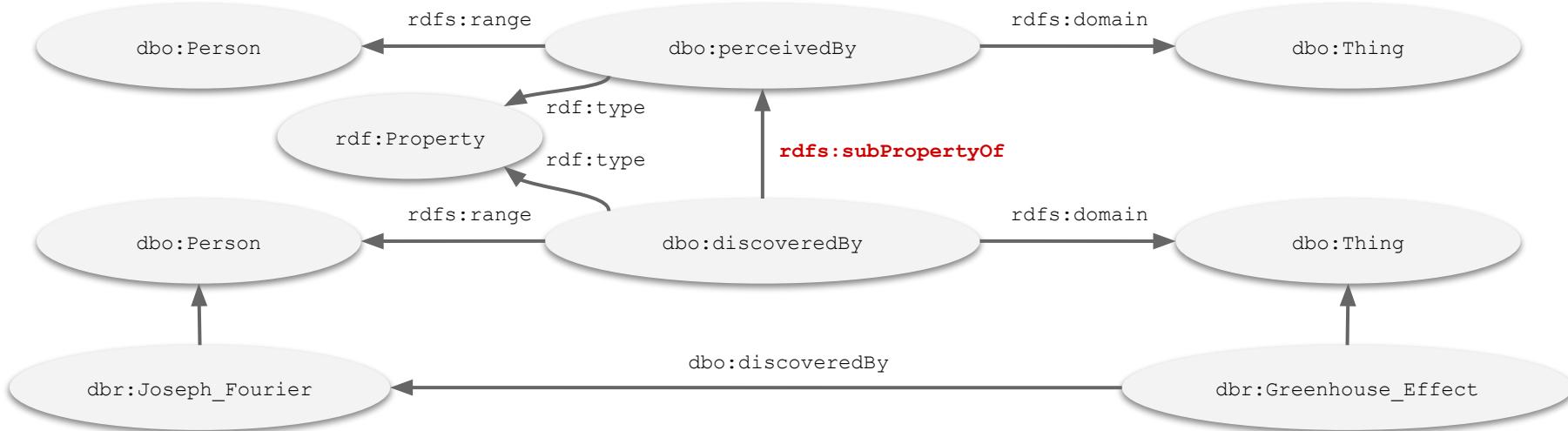
# Which Conclusions can we deduce with RDF(S) Semantics



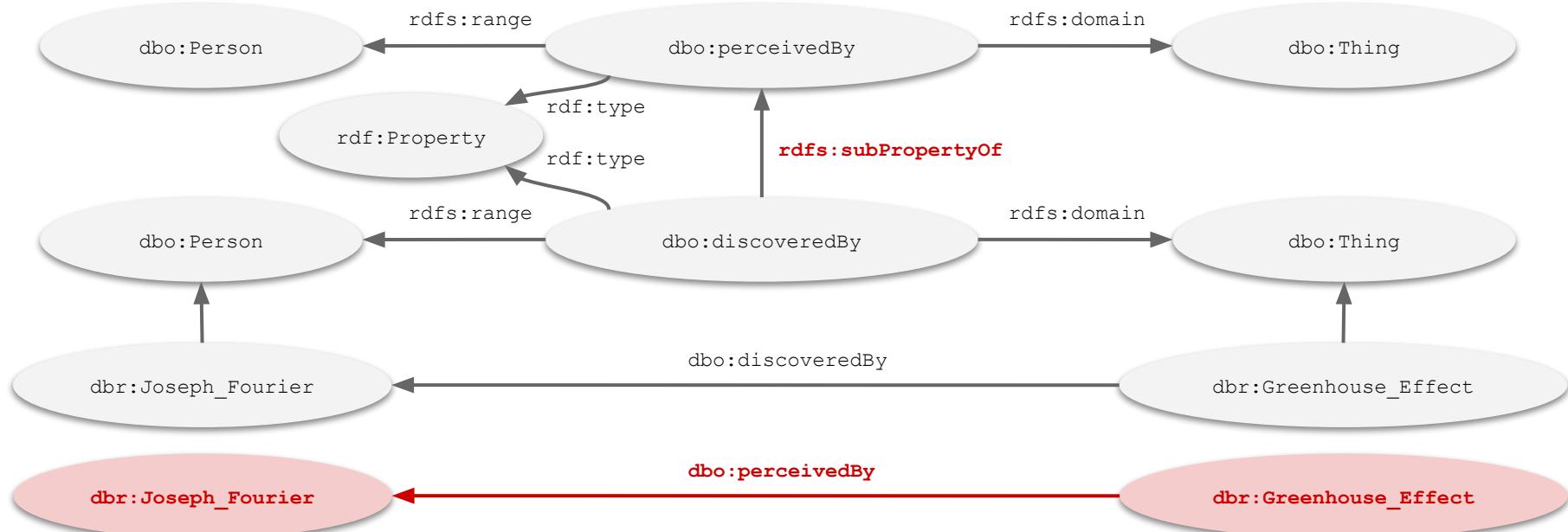
(3) Deduction of entity **class membership** from the **range** of one of its properties

$$\begin{aligned}
 & \forall i_1, i_2, c_1, c_2, p: T(i_1, p, i_2) \wedge \\
 & T(p, \text{rdfs:domain}, c_1) \wedge T(p, \text{rdfs:range}, c_2) \\
 \rightarrow & T(i_1, \text{rdf:type}, c_1) \wedge T(i_2, \text{rdf:type}, c_2)
 \end{aligned}$$

# Which Conclusions can we deduce with RDF(S) Semantics



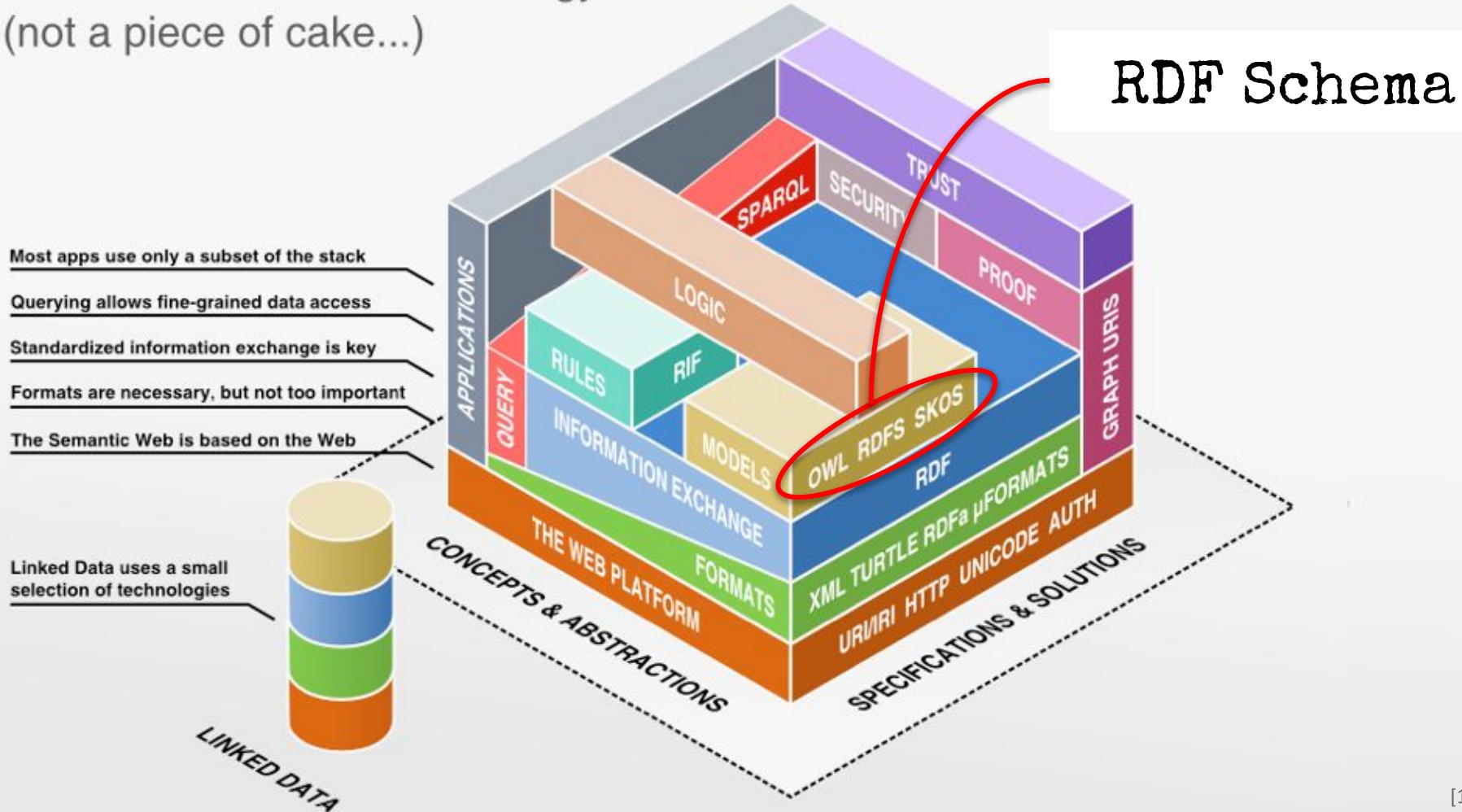
# Which Conclusions can we deduce with RDF(S) Semantics



## (4) Deduction of new facts from subproperty relationships

$$\forall i_1, i_2, p_1, p_2: T(i_1, p_1, i_2) \wedge T(p_1, \text{rdfs:subPropertyOf}, p_2) \rightarrow T(i_1, p_2, i_2)$$

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



# EXCURSION 1

# RDFa - RDF on the Web

Next Lecture...

### Picture References:

- [1] Benjamin Nowack, *The Semantic Web - Not a Piece of cake...*, at bnode.org, 2009-07-08 , [CC BY 3.0]  
<http://bnode.org/blog/2009/07/08/the-semantic-web-not-a-piece-of-cake>
- [2] The Green House Effect, A loose necktie [CC BY-SA]  
<https://commons.wikimedia.org/wiki/File:Greenhouse-effect-t445.svg>
- [3] Fourier, in his prefect's garb, Pierre-Claude Gautherot, (1806), [Public Domain]  
[https://commons.wikimedia.org/wiki/File:Fourier\\_in\\_his\\_coat\\_of\\_prefect.jpg?uselang=de](https://commons.wikimedia.org/wiki/File:Fourier_in_his_coat_of_prefect.jpg?uselang=de)
- [4] Hell. Engraving after Buonamico di Martino called Buffalmacco, between 1480 and 1489, The Wellcome Collection, [CC-BY-4.0]  
[https://upload.wikimedia.org/wikipedia/commons/a/ad/The\\_British\\_Museum%3B\\_the\\_reading\\_room\\_under\\_construction\\_Woo\\_Wellcome\\_V0013519.jpg](https://upload.wikimedia.org/wikipedia/commons/a/ad/The_British_Museum%3B_the_reading_room_under_construction_Woo_Wellcome_V0013519.jpg)