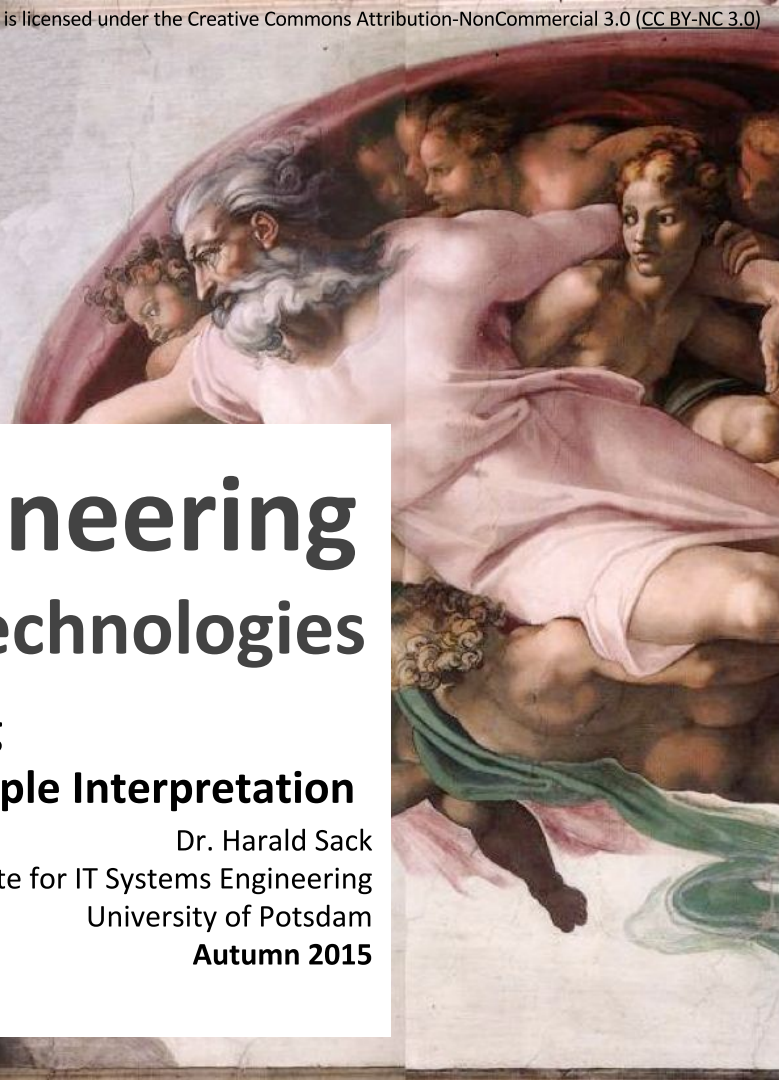
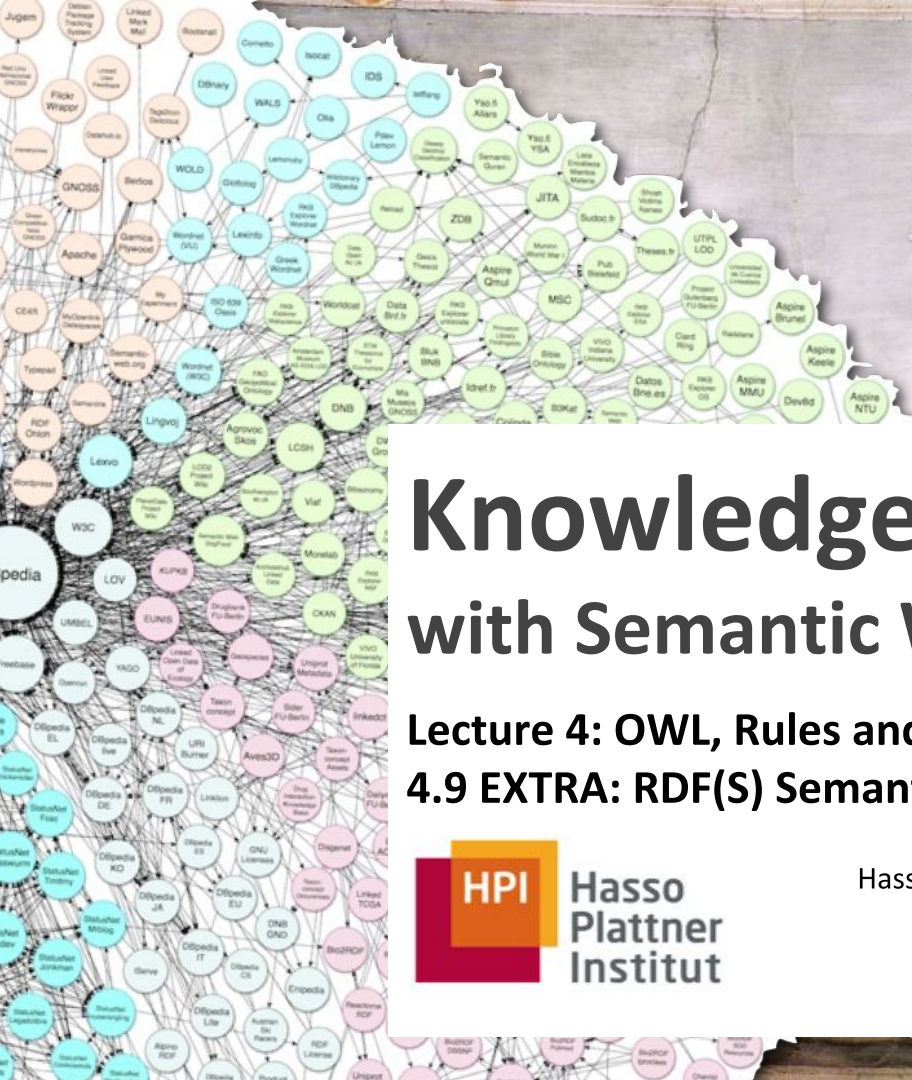




Knowledge Engineering with Semantic Web Technologies

Lecture 4: OWL, Rules and Reasoning

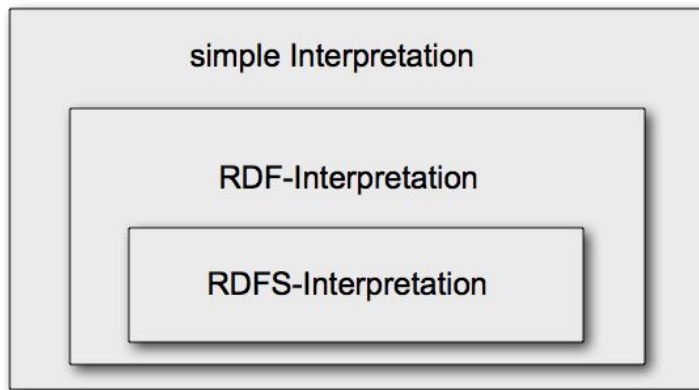
4.9 EXTRA: RDF(S) Semantics (2), Simple Interpretation



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Model-theoretic Semantics for RDF(S)

- **Statements** in RDF(S): Triples (s,p,o) and RDF(S) graphs
- **Entailment Relation:** define a set of interpretations and denote which interpretation is a model of a given graph



- **Goal:** formally correct mapping of the intention behind RDF(S)

Simple Interpretation (1/3)

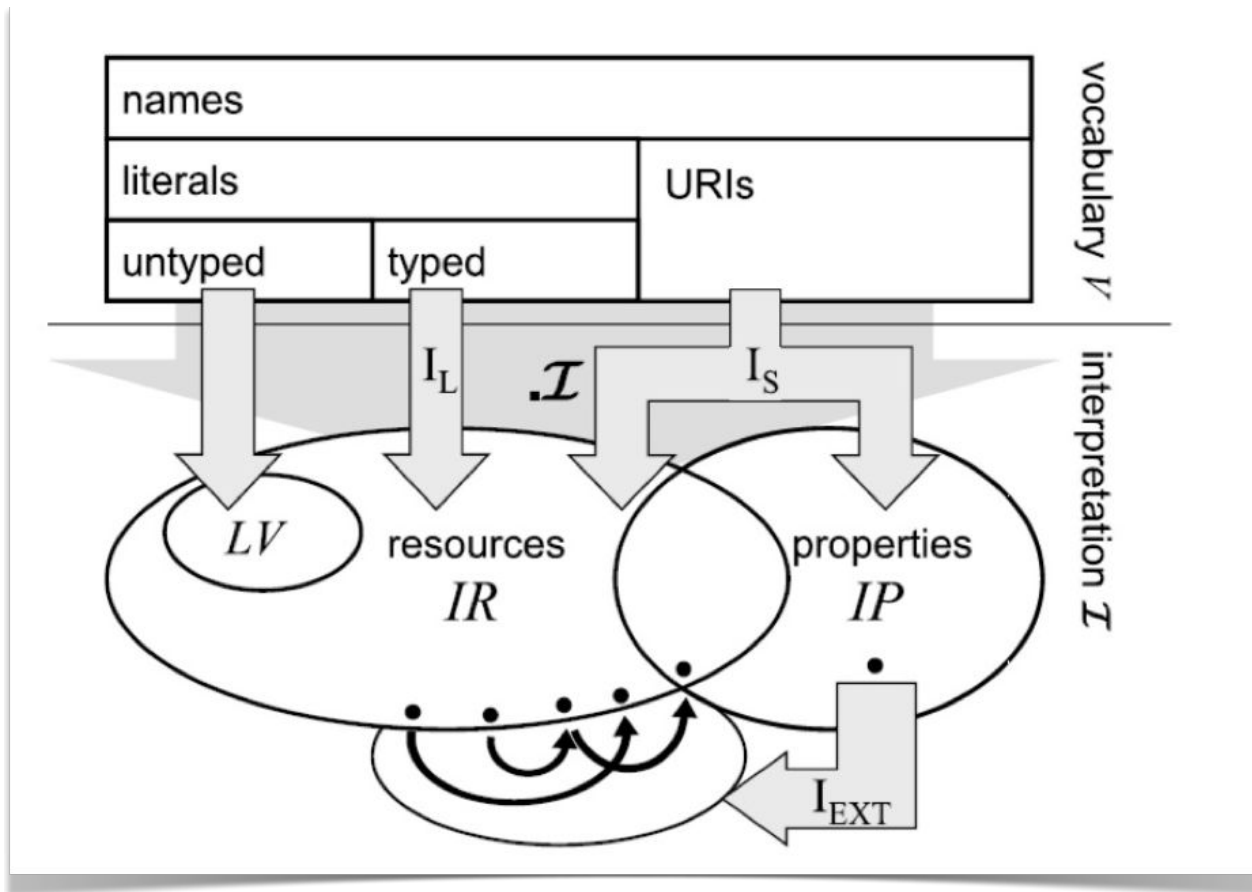
A **simple Interpretation I** of the RDF(S) **vocabulary V** consists of

- **IR**, a non-empty set of **Resources**, *Domain* or *Universe of Discourse* of I,
- **IP**, the set of **Properties** of I,
- **I_{EXT}**, a function assigning each property to a set of pairs from IR,
i.e. $I_{EXT} : IP \rightarrow 2^{IR \times IR}$, where $I_{EXT}(p)$ is called **Extension** of the Property p,
- **I_S**, a function mapping URIs from V to the union of the sets IR and IP,
i.e. $I_S : V \rightarrow IR \cup IP$,
- **I_L**, a function from the (typed) Literals of V into the set IR of resources,
i.e. $I_L : V \rightarrow IR$
- **LV** $\subseteq$ IR, a set of Literal values containing (at least) all untyped Literals from V

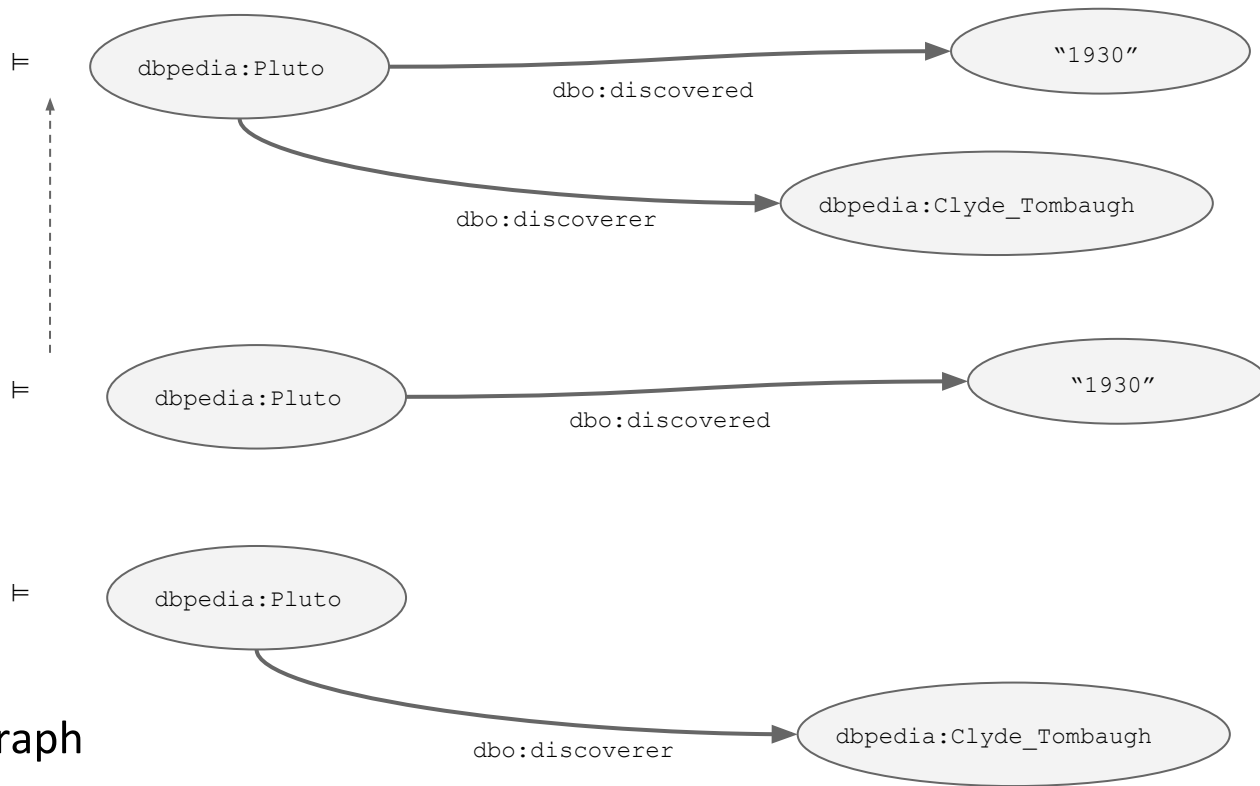
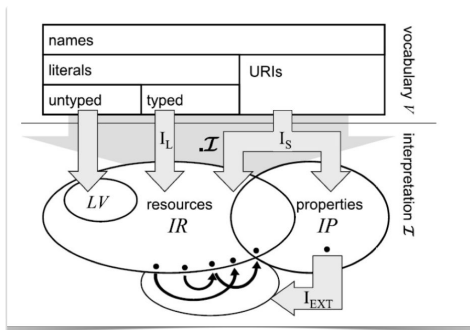
Simple Interpretation (2/3)

- We define a simple **Interpretation Function** $\cdot^I$
mapping all Literals and URIs from $\mathbf{V}$ to Resources $\mathbf{IR}$ and Properties $\mathbf{IP}$.
 - every untyped Literal “a” is mapped to a: $(\text{“a”})^I = a$
 - every untyped Literal with language tag “a”@t is mapped to the pair $\langle a, t \rangle$ i.e. $(\text{“a@t”})^I = \langle a, t \rangle$
 - every typed Literal l is mapped to $\mathbf{I}_L(l)$: $l^I = \mathbf{I}_L(l)$
 - every URI u is mapped to $\mathbf{I}_S(u)$: $u^I = \mathbf{I}_S(u)$

Simple Interpretation (3/3)

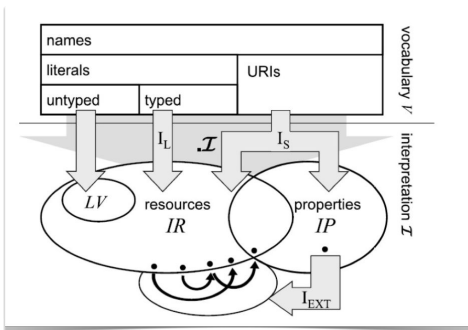


When is an Interpretation a Model of a Graph?

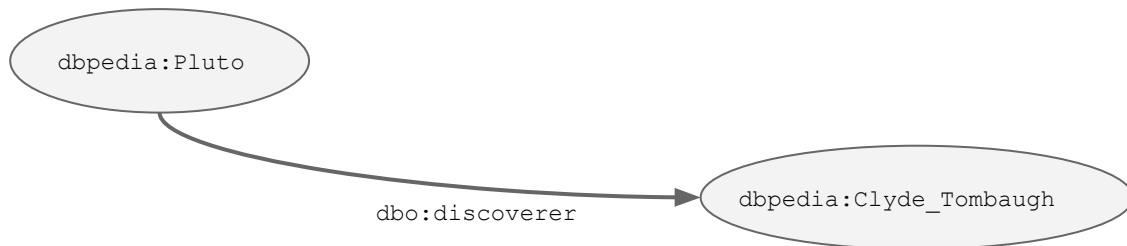


...if the interpretation is a model for **all** triples of the graph

When is an Interpretation a Model of a Triple?



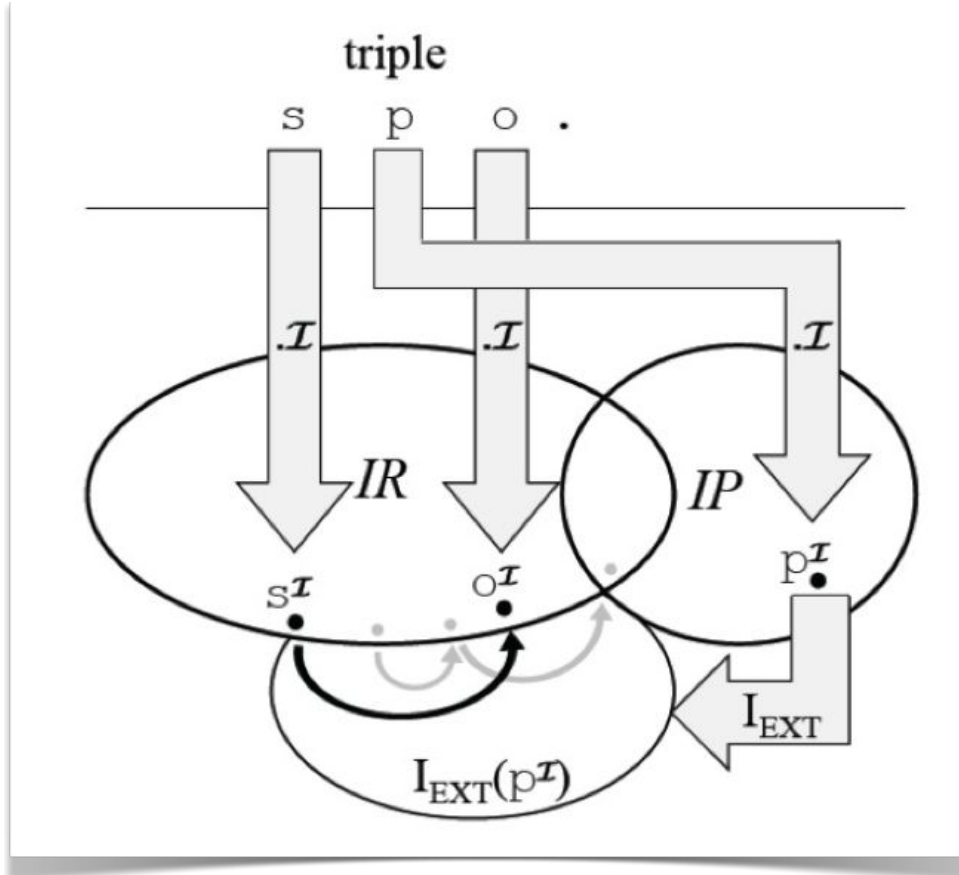
$\models$



- iff $s, p, o \in V$ and $\langle s^I, o^I \rangle \in I_{EXT}(p^I)$

** this holds for grounded triples only,
i.e. triples that do not contain blank nodes.*

Simple Interpretation of a Triple (Schematics)

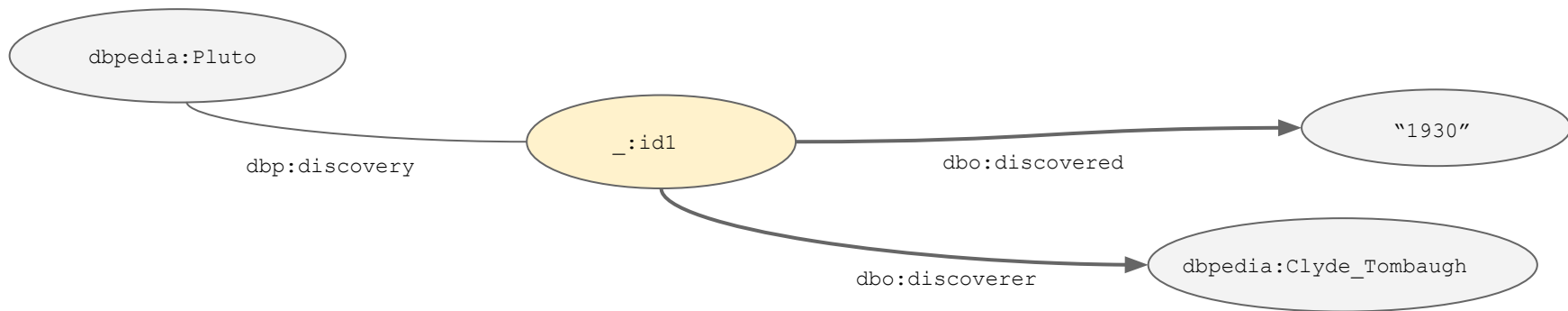


- The Interpretation $\cdot^I$ assigns a truth value to the Graph G
- $G^I = \text{true}$ iff $T^I = \text{true}$ for all triples $T \in G$

What about Blank Nodes?

- Let **A** be a function assigning all bnodes to elements of **IR**
 - for the interpretation *I* let **I+A** be defined as *I* where in addition for all bnodes *b* it holds that
 - $\mathbf{b}^{I+A} = \mathbf{A(b)}$
 - an Interpretation *I* is a **model** of an RDF-Graph *G*,
if there exists an *A* such as all triples of *G* wrt. *I+A* are true
- **Conclusion:**
A Graph G_1 *simply entails* a Graph G_2 ,
if every simple Interpretation that is a model of G_1
is also a model of G_2 .

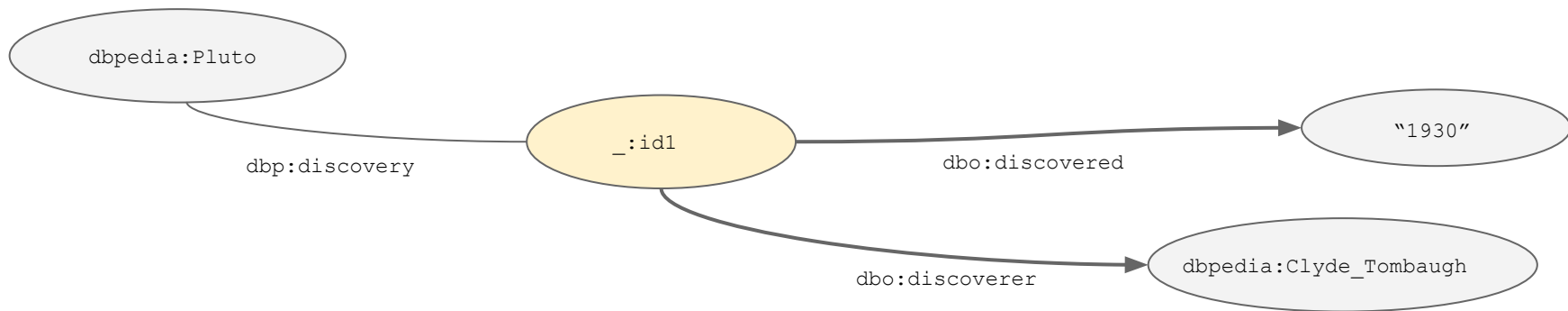
Example



$I_S = \text{dbpedia:Pluto} \rightarrow \chi$
 $\text{dbpedia:Clyde_Tombaugh} \rightarrow v$
 $\text{dbp:discovery} \rightarrow \tau$
 $\text{dbo:discoverer} \rightarrow v$
 $\text{dbo:discovered} \rightarrow \iota$
 $I_L = \text{empty, no typed literals}$
 $A = _:\text{id1} \rightarrow \varepsilon$

$IR = \{\chi, v, \tau, v, \varepsilon, \iota, 1930\}$
 $IP = \{\tau, v, \iota\}$
 $LV = \{1930\}$
 $I_{EXT} = \tau \rightarrow \{\langle \chi, \varepsilon \rangle\}$
 $v \rightarrow \{\langle \varepsilon, v \rangle\}$
 $\iota \rightarrow \{\langle \varepsilon, 1930 \rangle\}$

Example



If you chose **A: $_:\text{id1} \rightarrow \varepsilon$** then the result is

$$\begin{aligned}\langle \text{dbpedia:Pluto}^{I+A}, _:\text{id1}^{I+A} \rangle &= \langle \chi, \varepsilon \rangle \in I_{\text{EXT}}(\tau) &&= I_{\text{EXT}}(\text{dbp:discovery}^{I+A}) \\ \langle _:\text{id1}^{I+A}, \text{dbpedia:Clyde_Tombaugh}^{I+A} \rangle &= \langle \varepsilon, v \rangle \in I_{\text{EXT}}(v) &&= I_{\text{EXT}}(\text{dbo:discoverer}^{I+A}) \\ \langle _:\text{id1}^{I+A}, 1930^{I+A} \rangle &= \langle \varepsilon, 1930 \rangle \in I_{\text{EXT}}(1) &&= I_{\text{EXT}}(\text{dbo:discovered}^{I+A})\end{aligned}$$

Therefore also the full graph will become true.
I is a model of the Graph (wrt. simple Interpretation)



10 EXTRA RDF(S) Semantics (3)- RDF(S) Interpretation

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

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