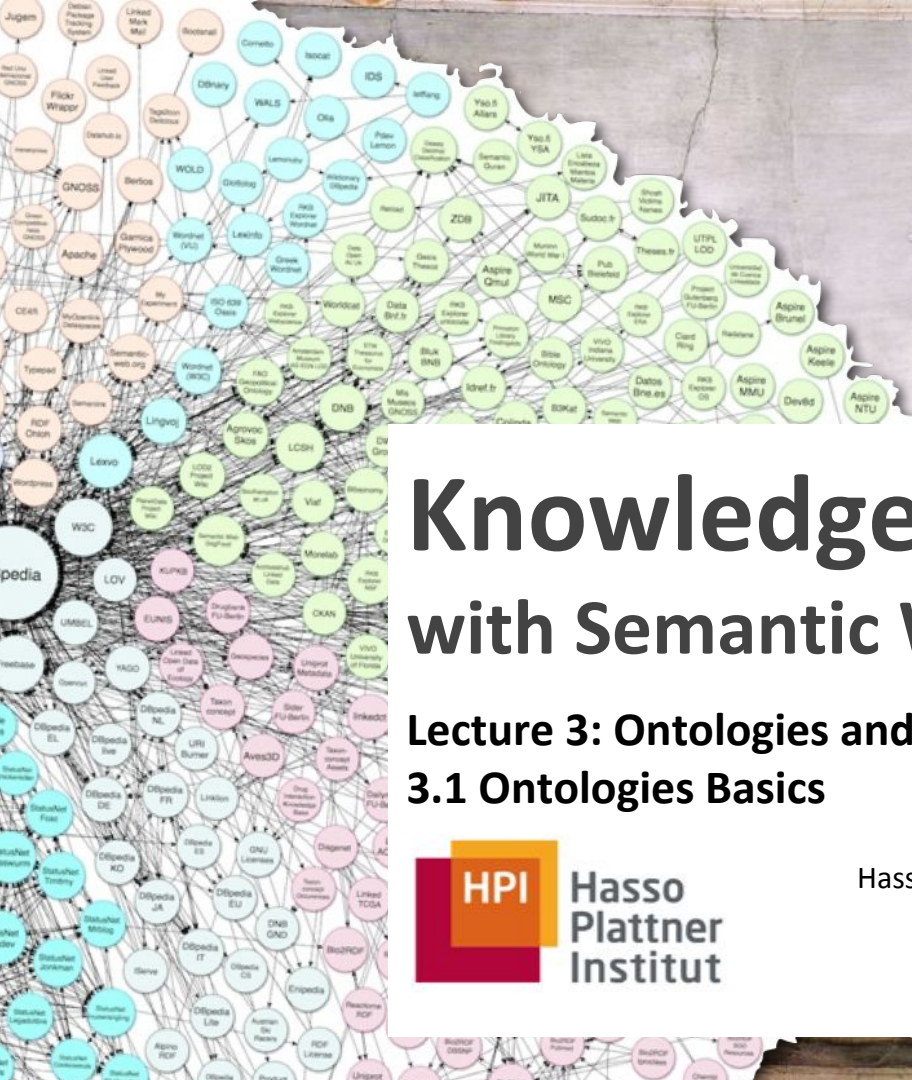




Knowledge Engineering with Semantic Web Technologies

Lecture 3: Ontologies and Logic 3.1 Ontologies Basics



Dr. Harald Sack
Hasso Plattner Institute for IT Systems Engineering
University of Potsdam
Autumn 2015





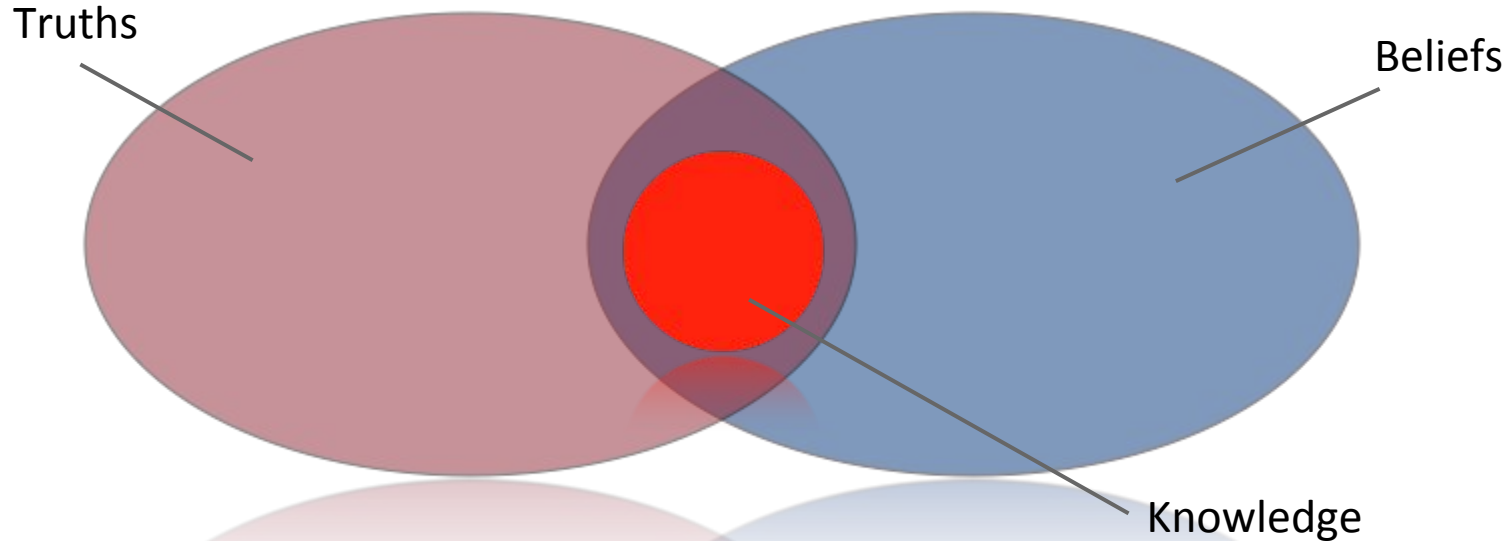
„People can't share knowledge if
they don't speak a common language“

Thomas Davenport (1997)

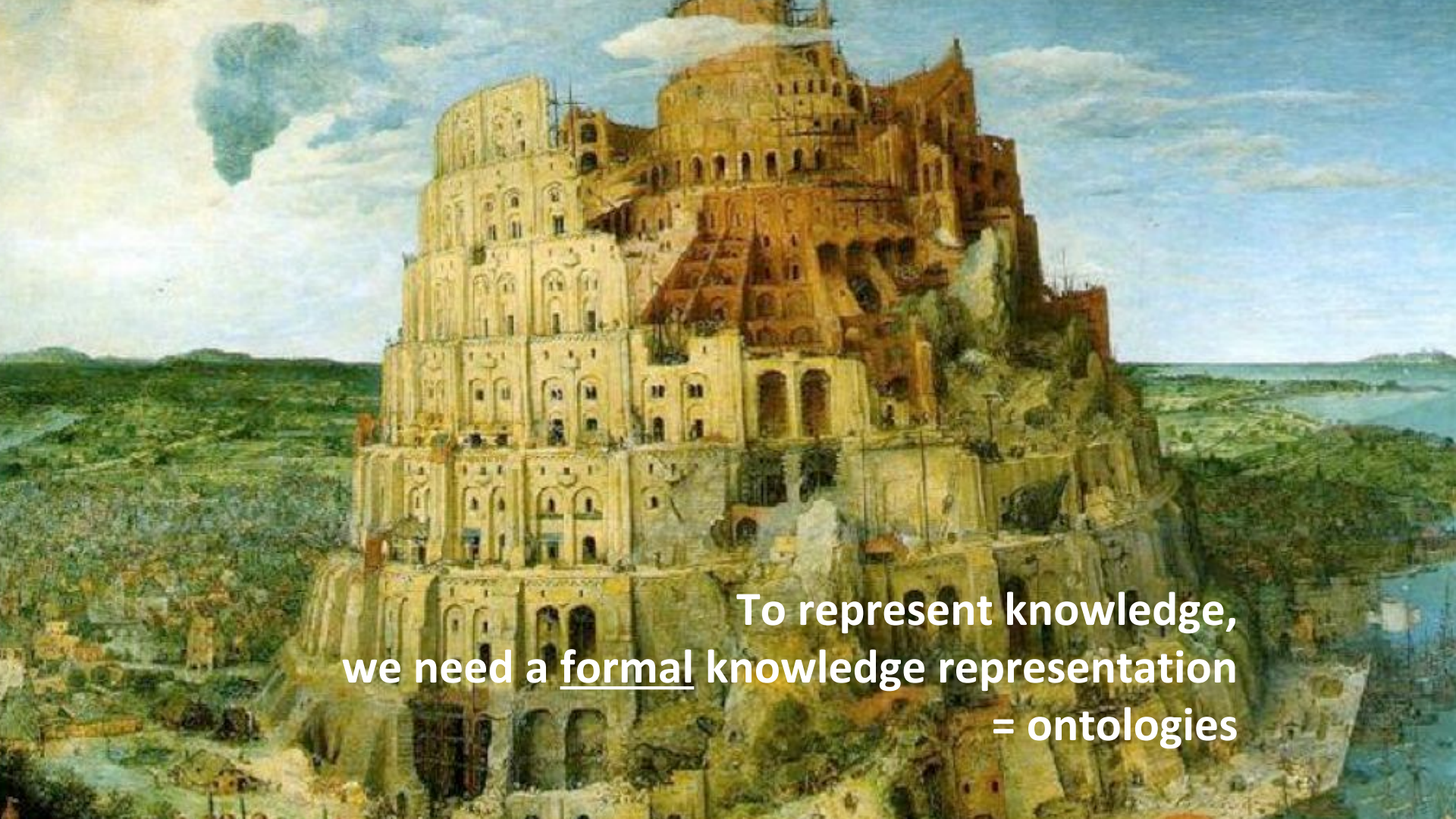
...to speak a common Language

- common symbols and concepts (**Syntax**)
- agreement about their meaning (**Semantics**)
- classification of concepts (**Taxonomy**)
- associations and relations of concepts (**Thesauri**)
- rules and knowledge about which relations are allowed and make sense (**Ontologies**)

What is Knowledge?



Traditional Definition: „Knowledge is a subset of all true beliefs“



To represent knowledge,
we need a formal knowledge representation
= ontologies

Ontology is the philosophical study of the nature of being, existence, or reality, as well as the basic categories of being and their relations...



Fundamental Questions of Ontology

1. What does it mean for a being to be?

- When are two things identical?
- Is everything that exists also real?
- Does something exist, if it is only possible?
- Are there non-existing things?

2. What categories of objects do exist?

- Do things exist that are only unique or only multiple (Universalia)?
- Do things exist that are unilaterally dependent of others (Substances)?
- Of which sort is this dependency (Causality)?
- Do necessary properties exist (Essences)?
- How do composed things relate to their components?

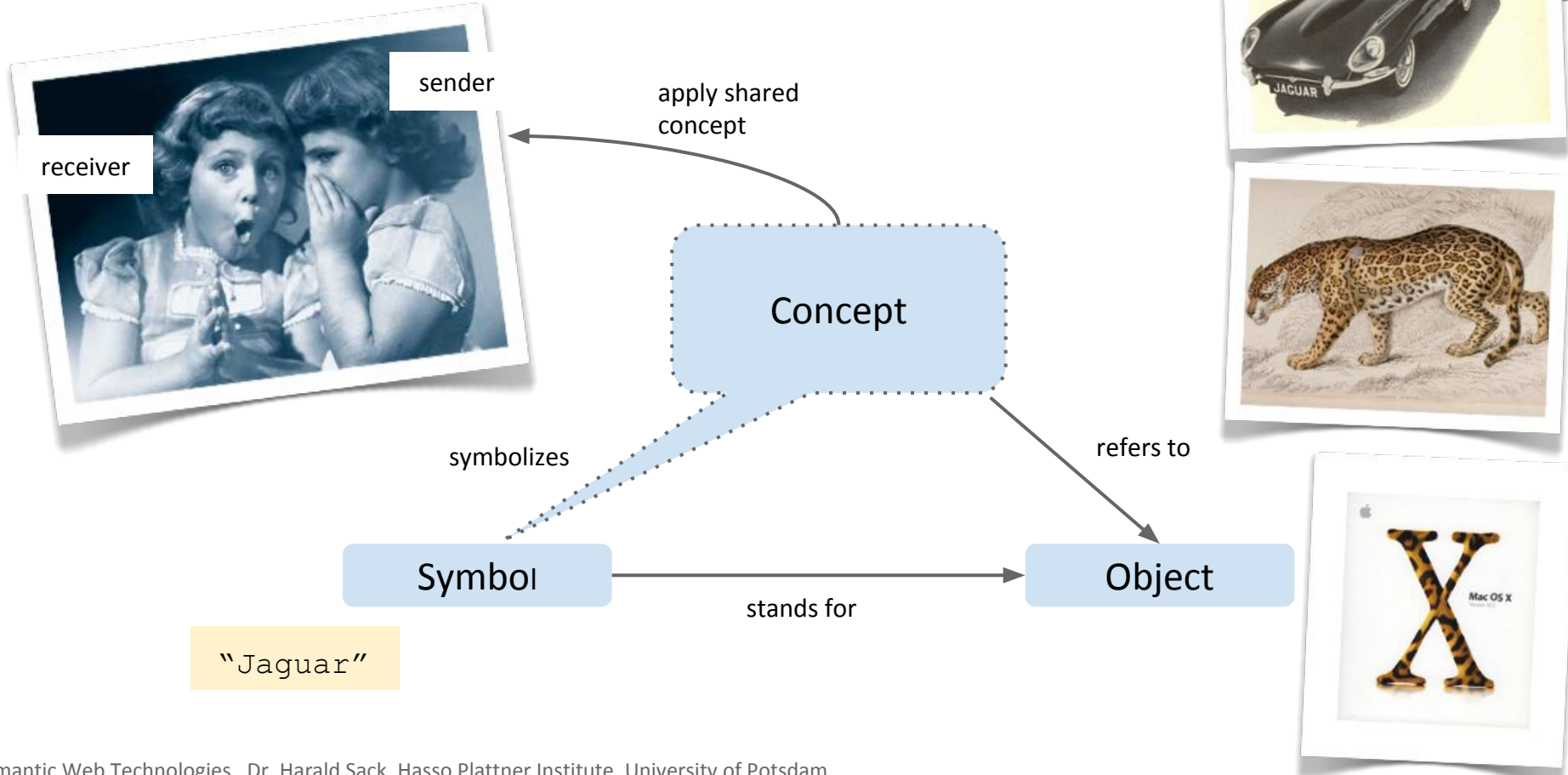
Ontology in Computer Science

"An ontology is an **explicit, formal specification of a shared conceptualization**. The term is borrowed from philosophy, where an Ontology is a systematic account of existence. For AI systems, what ‘exists’ is that which can be represented.“

according to Thomas R. Gruber: A Translation Approach to Portable Ontology Specifications. Knowledge Acquisition, 5(2):199-220, 1993.

conceptualization:	abstract model (domain, identified relevant concepts, relations)
explicit:	meaning of all concepts must be defined
formal:	machine understandable
shared:	consensus about ontology

Conceptualization



How to represent Ontologies

- Ontologies can be represented via **Classes**, **Relations** and **Instances**
- **Classes** are abstract groups, sets, or collections of objects and represent **ontology concepts**
- Classes are characterised via **attributes**
- **Attributes** are name-value pairs

*„The address contains the name, title,
and place of residence of the person
addressed“*

informal description

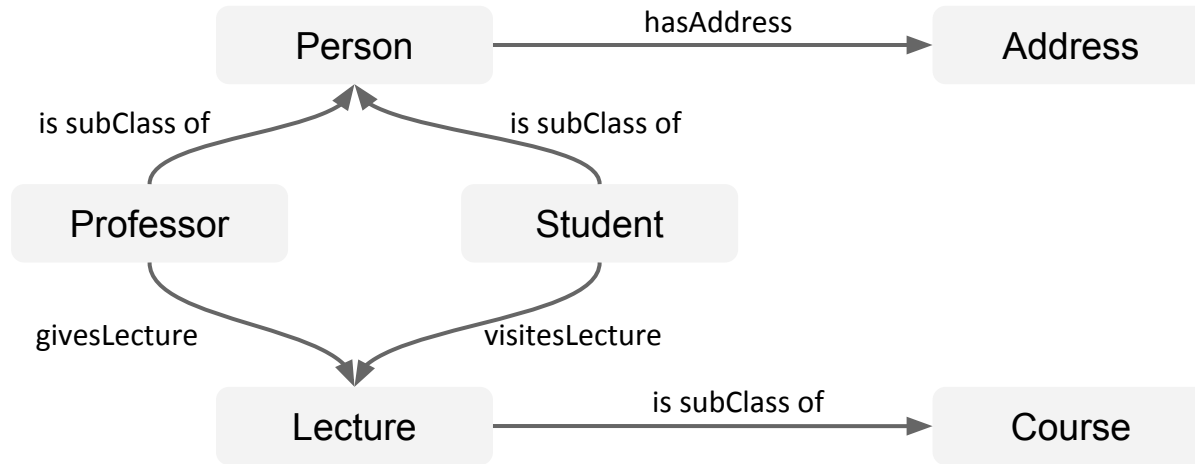
Address

- *given name <string>*
- *family name <string>*
- *street <string>*
- *ZIP code <int>*
- *city <string>*
- ...

semi-formal description

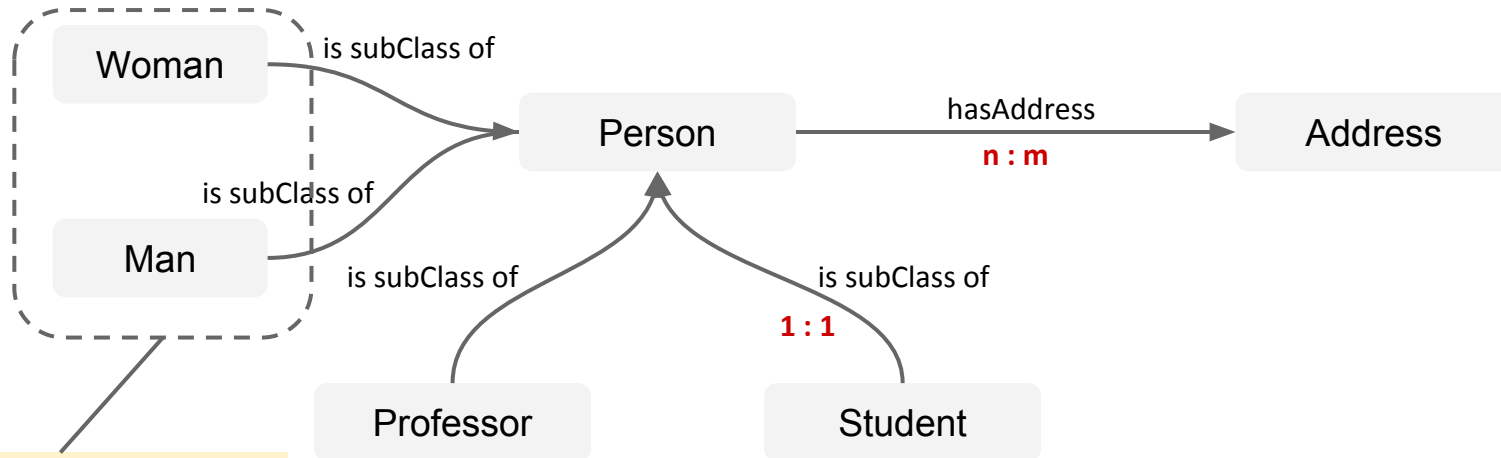
How to represent Ontologies

- Classes can be **related** to other classes
- **Relations** are special attributes, whose values are objects of (other) classes



How to represent Ontologies

- For Relations and Attributes **Rules (Constraints)** can be defined that determine allowed/valid values



$$\text{Woman} \cap \text{Man} = \emptyset$$

constraint

How to represent Ontologies

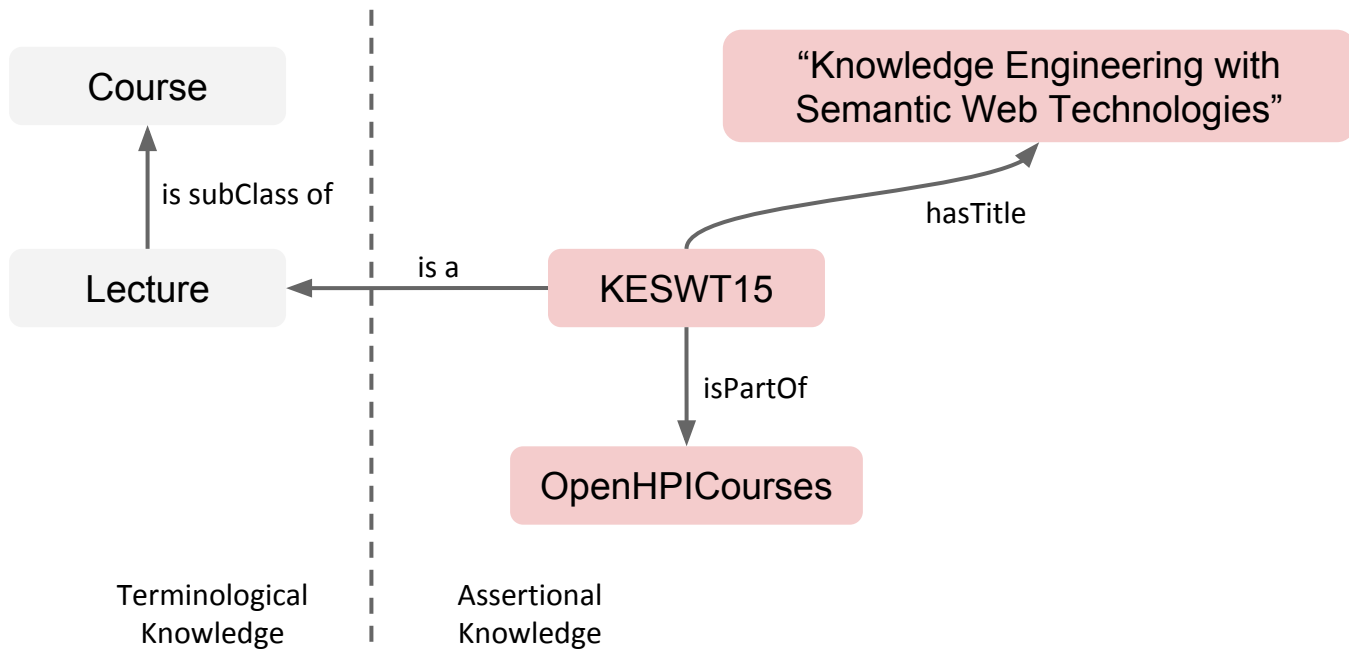
- Classes, relations, and constraints can be put together to form (complex) **Statements / Assertions**
- Special Case: **formal Axioms**

Example:

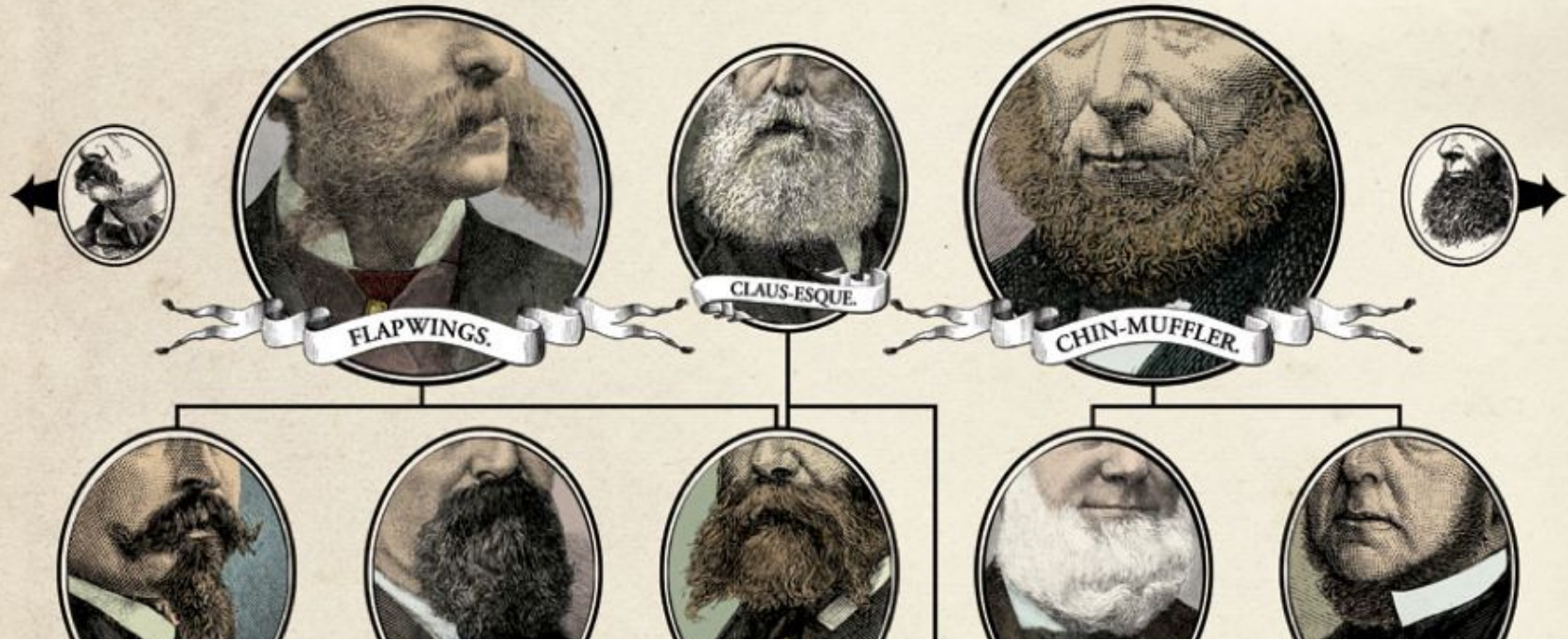
- *„it is not possible to attend two courses at the same time“*
-
- **Axioms** describe knowledge that can't be expressed simply with the help of other existing components.

How to represent Ontologies

- **Instances** describe individuals of an ontology



HIERARCHY OF BEARDS.



02: Ontologies Types

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 3: Ontologies and Logic