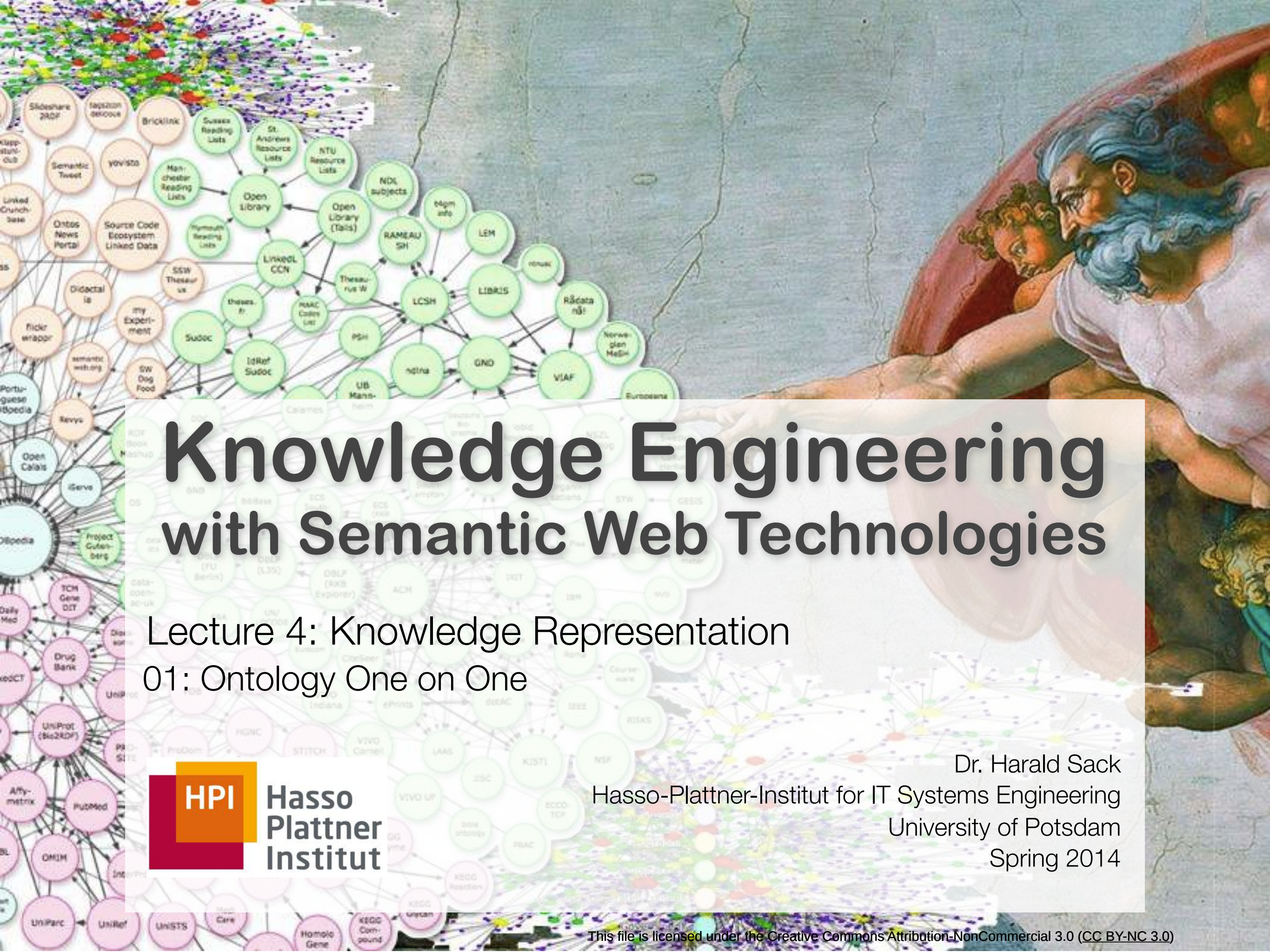


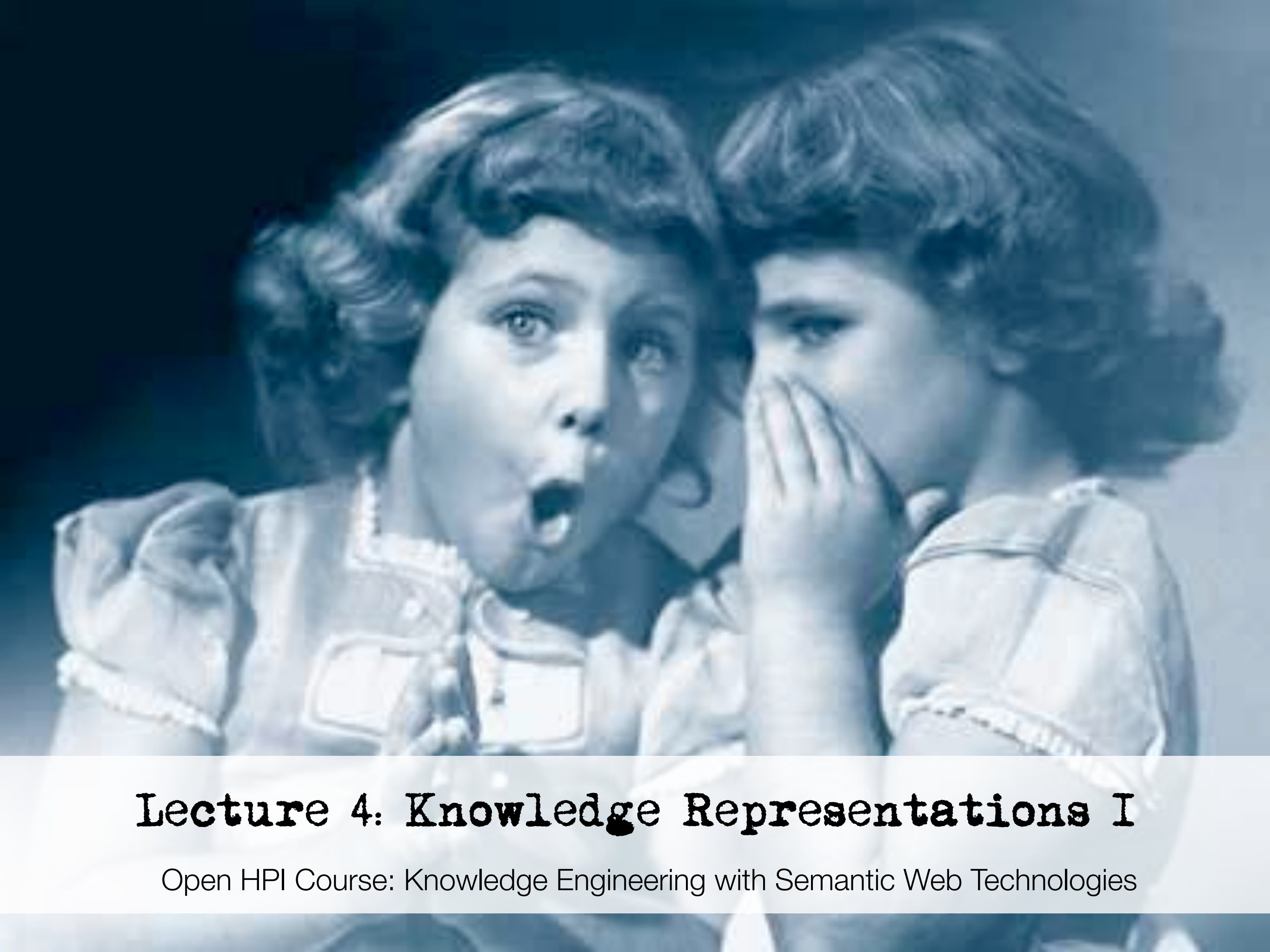


Knowledge Engineering with Semantic Web Technologies

Lecture 4: Knowledge Representation 01: Ontology One on One

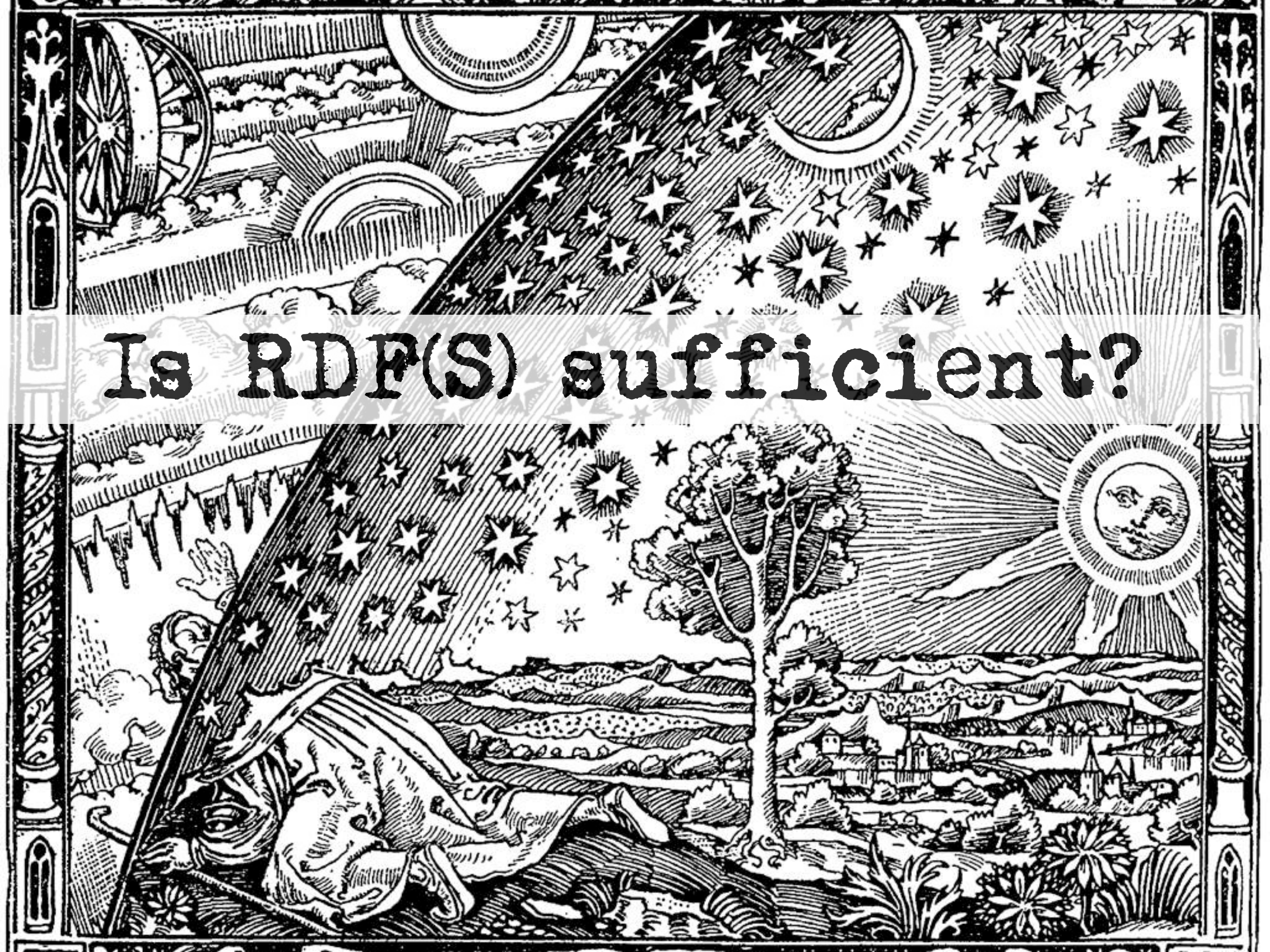


Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 4: Knowledge Representations I

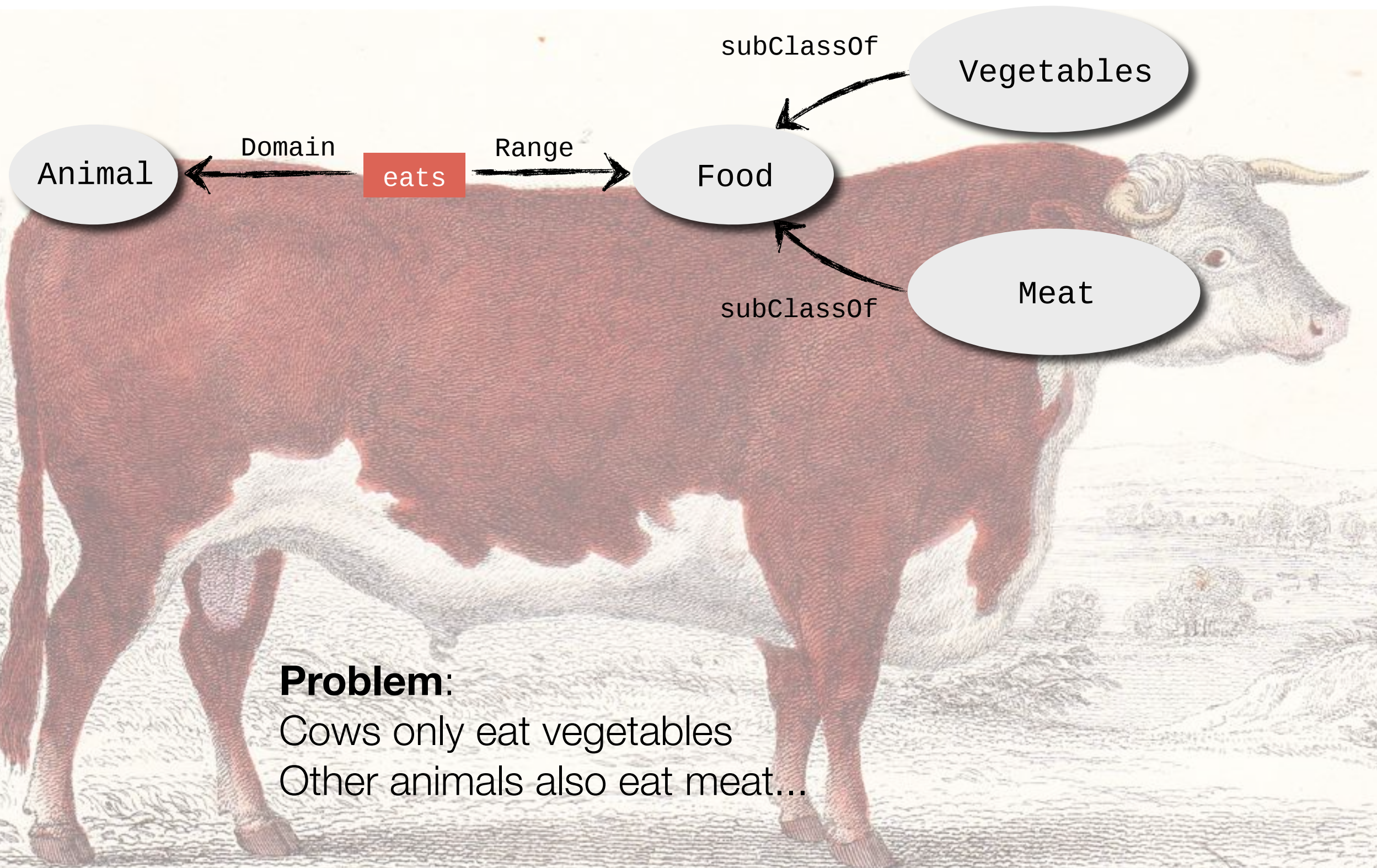
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Is RDF(S) sufficient?

Just one example...

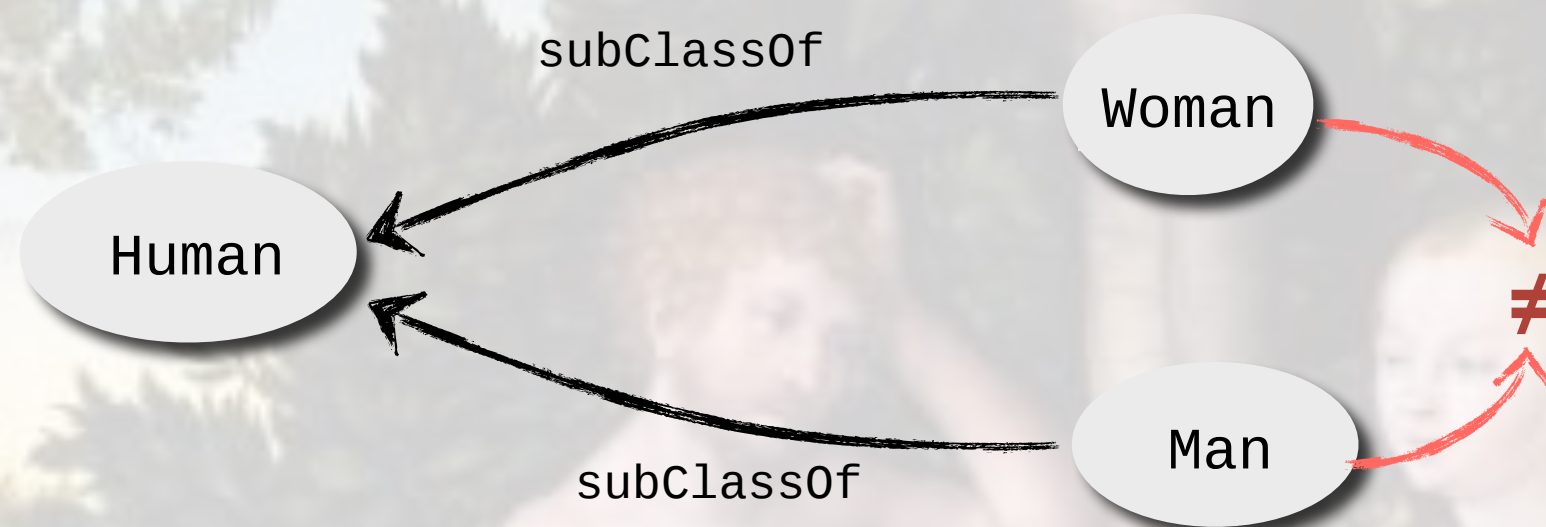
4



Problem:

Cows only eat vegetables
Other animals also eat meat...

Just another example...



Problem:

Subclass relation cannot express disjunctive class (subclass) membership

4. Knowledge Representations

Ontology One on One

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

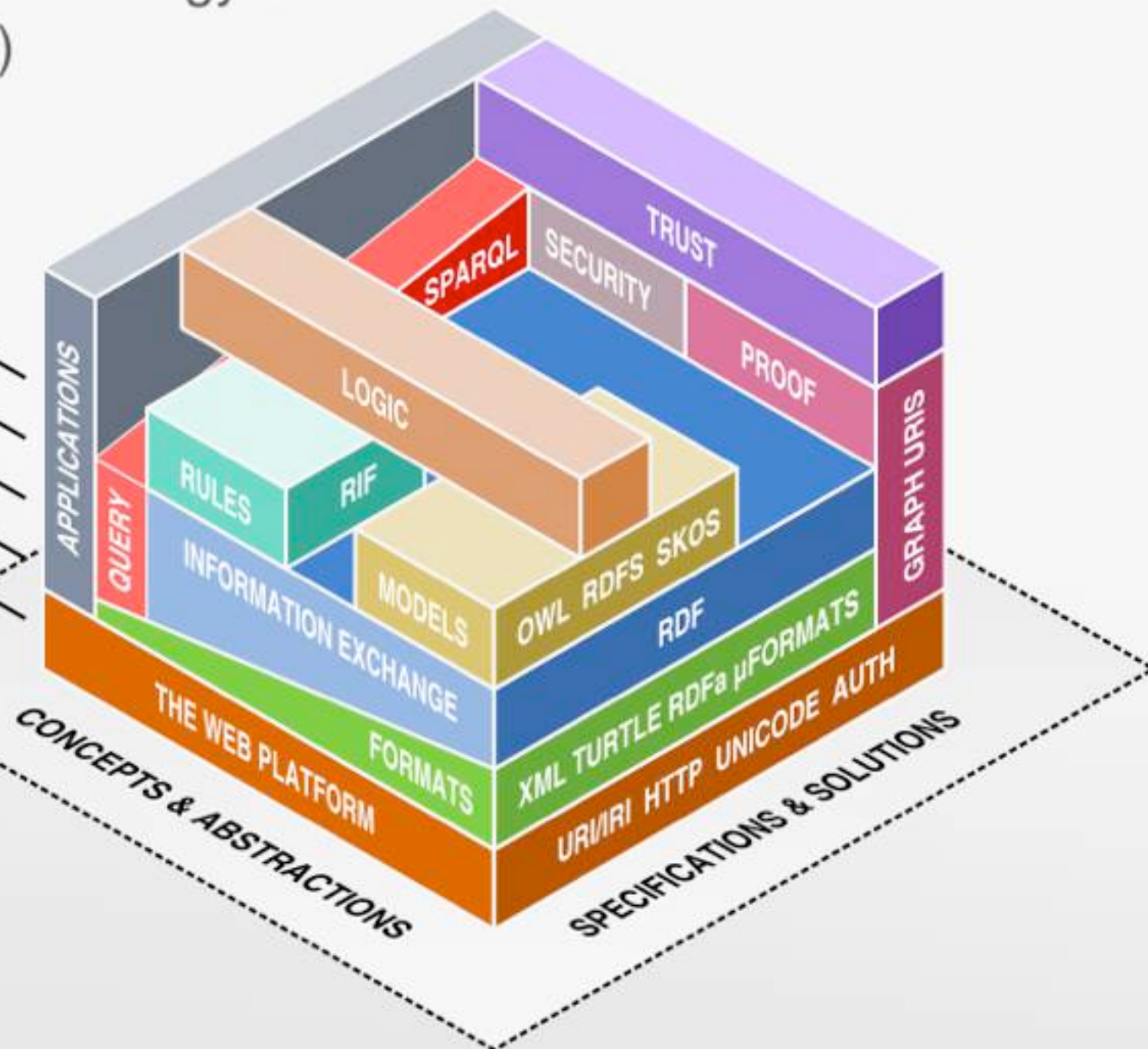
Standardized information exchange is key

Formats are necessary, but not too important

The Semantic Web is based on the Web

Linked Data uses a small
selection of technologies

LINKED DATA





01 Ontology One on One

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Lecture 04: Knowledge Representations Pt.2



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

Thomas Davenport (1997)



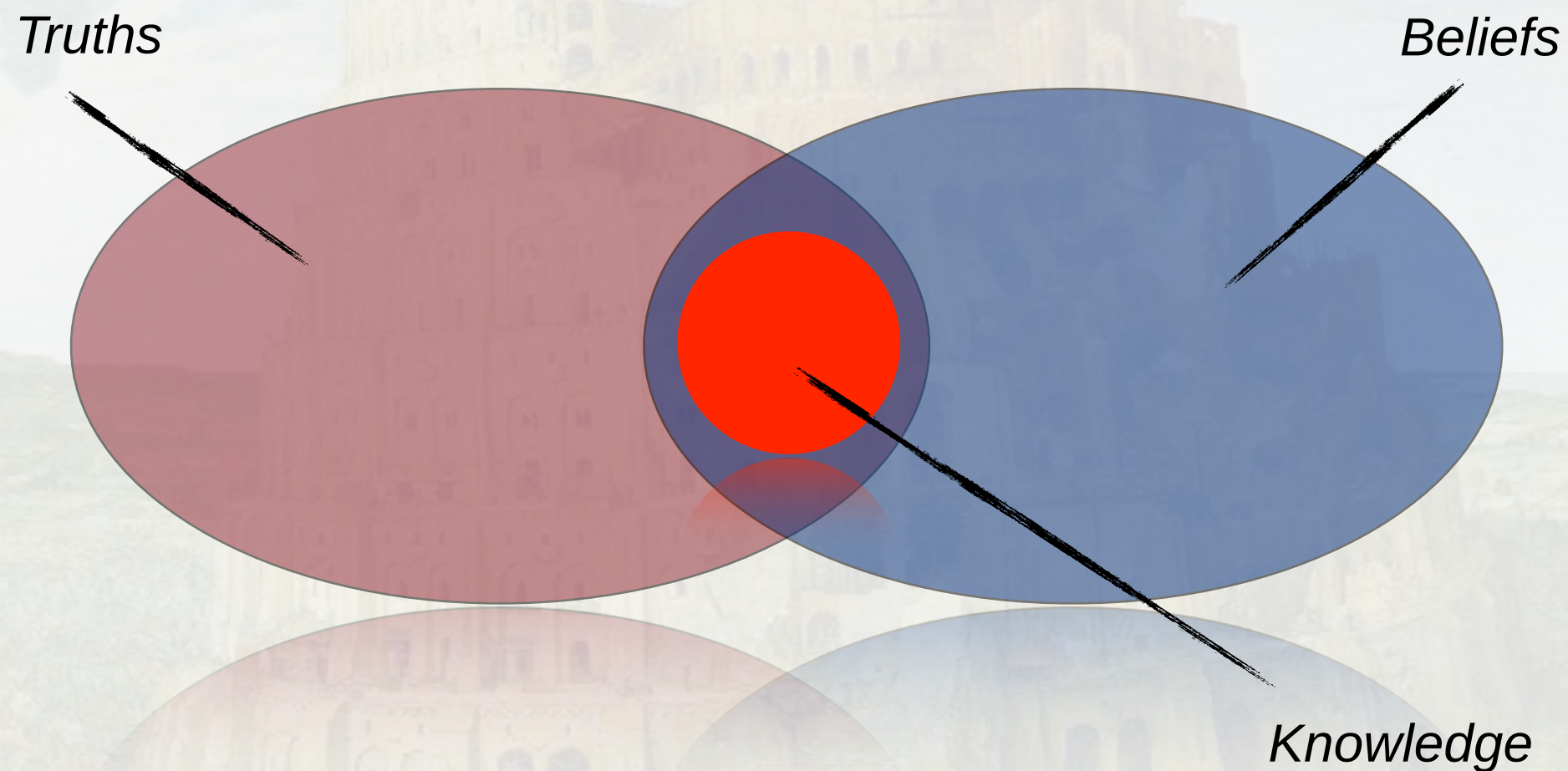
Turmbau zu Babel, Pieter Bruegel, 1563

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?

10



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...



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?

The Concept of 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."

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:

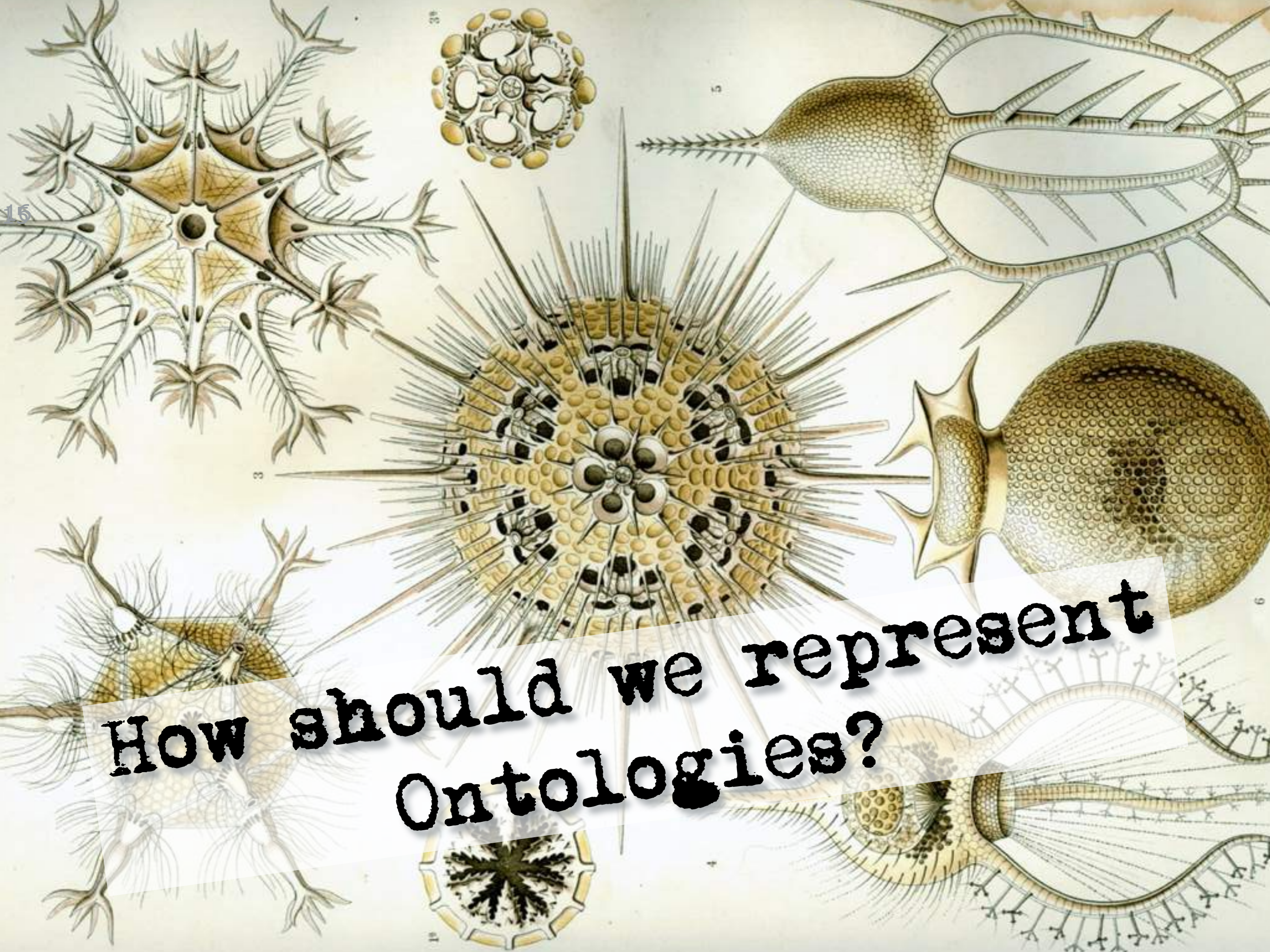
meaning of all concepts must be defined

formal:

machine understandable

shared:

consensus about ontology



How should we represent
Ontologies?

- Classes, Relations and Instances
- **Classes** represent concepts
- Classes are described via attributes
- Attributes are Name Value pairs

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

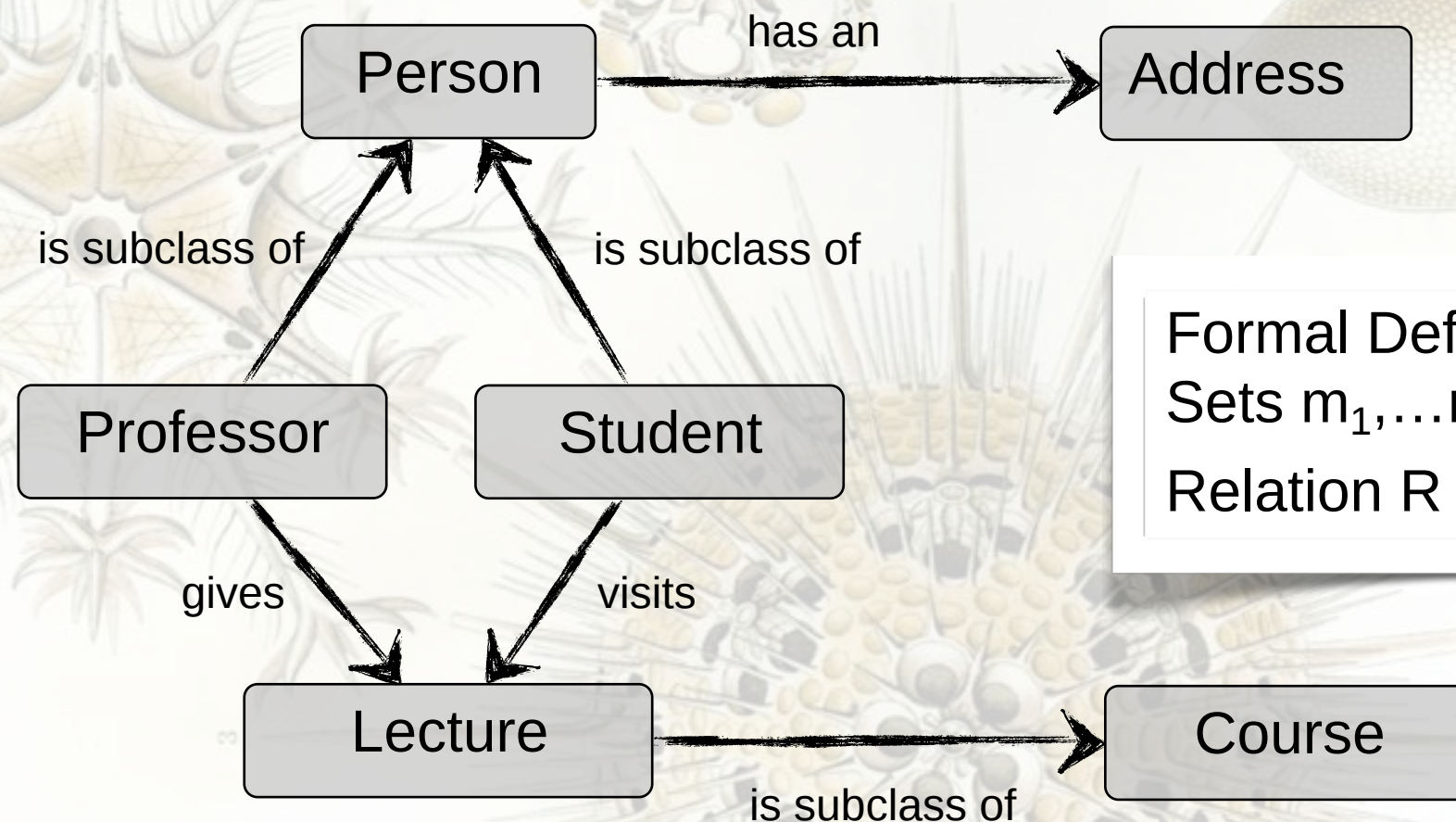
Informal Description

Address

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

Semi informal Description

- **Classes** are related to other classes



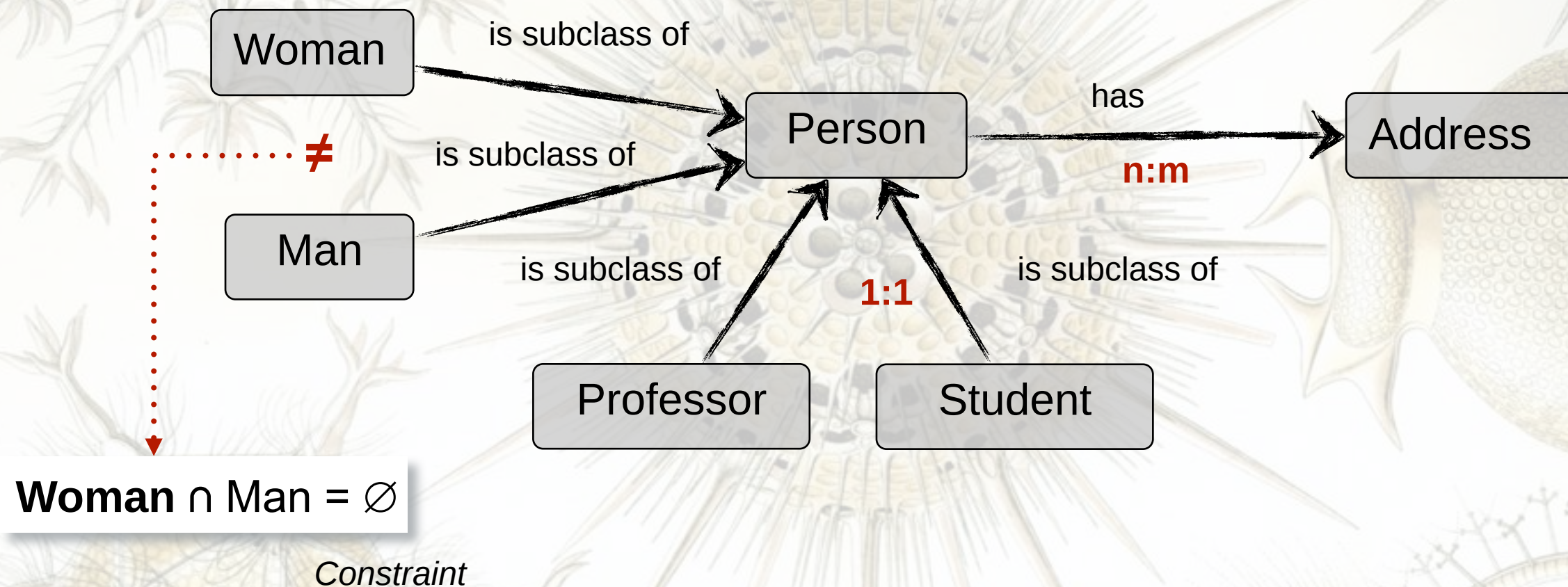
Formal Definition:

Sets $m_1, \dots, m_n$

Relation $R \subseteq m_1 \times \dots \times m_n$

- **Relations** are special attributes, whose values are objects of (other) classes

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



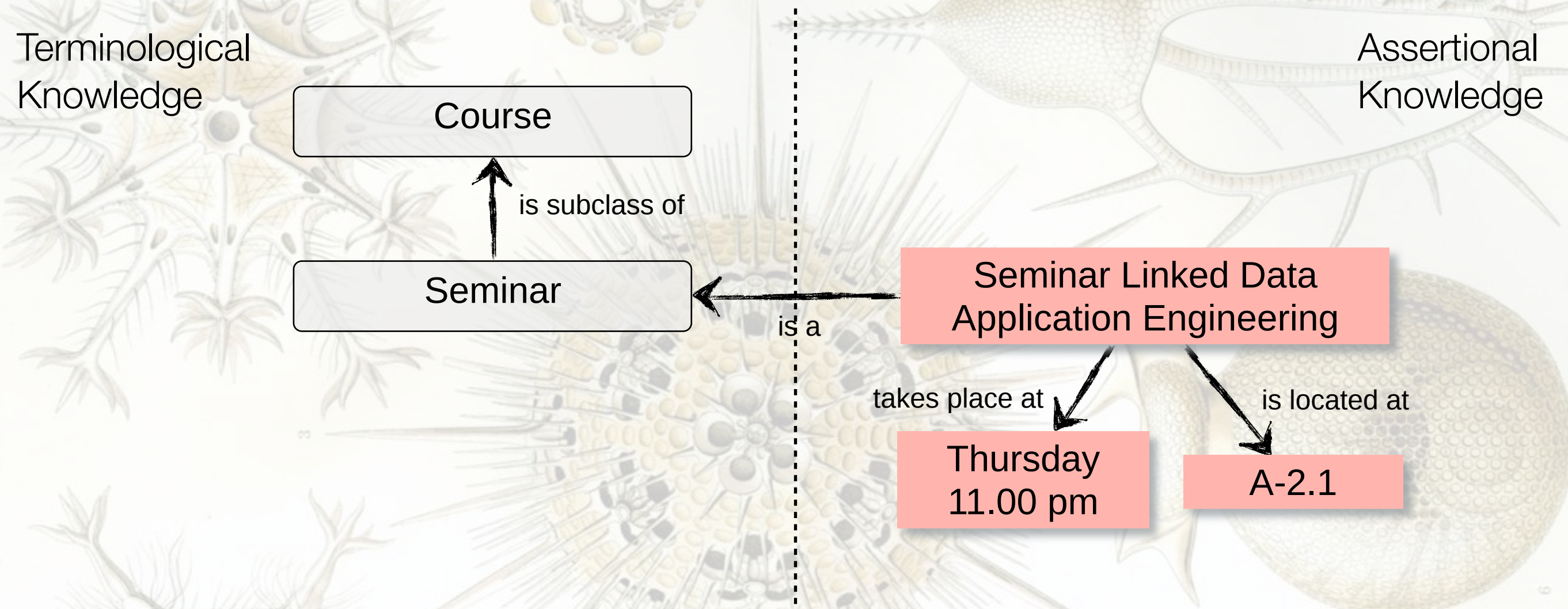
- Classes, relations, and constraints can be put together to form **statements / assertions**
- Special Case: **formal Axioms**

Example:

It is not possible to lecture two courses at the same time.

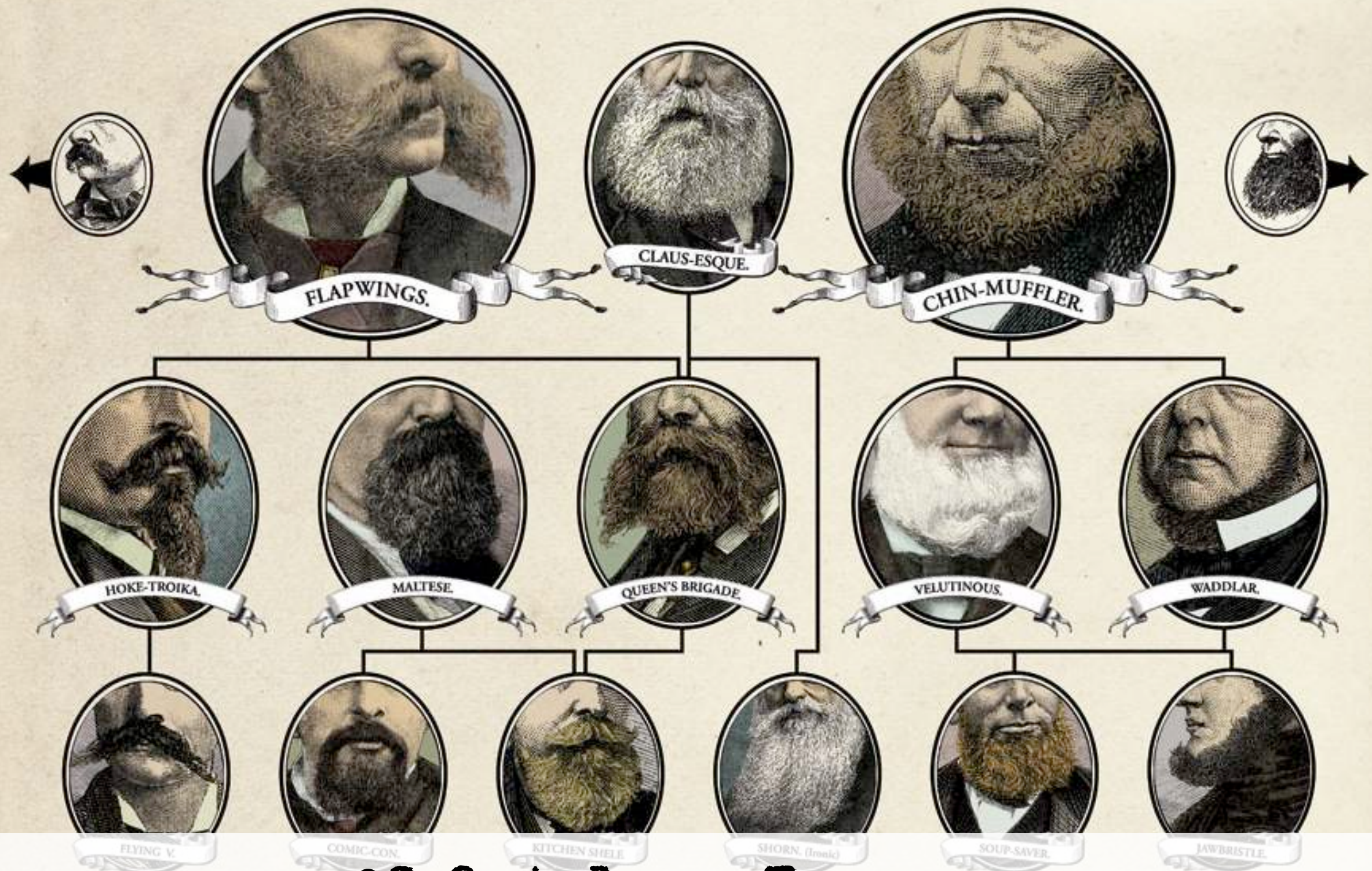
- **Axioms** describe knowledge that can't be expressed simply with the help of other existing components.

- **Instances** describe individuals of an ontology



Individuals (instances) are the basic components of an ontology. The individuals in an ontology may include concrete objects such as people, animals, tables, automobiles, molecules, and planets, as well as abstract individuals such as numbers and words.

HIERARCHY OF BEARDS.



02 Ontology Types

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Lecture 04: Knowledge Representations Pt.2