QPTDat
Quality | Plasma Technology | Data

FIZ Karlsruhe
Leibniz-Institut für Informationsinfrastruktur

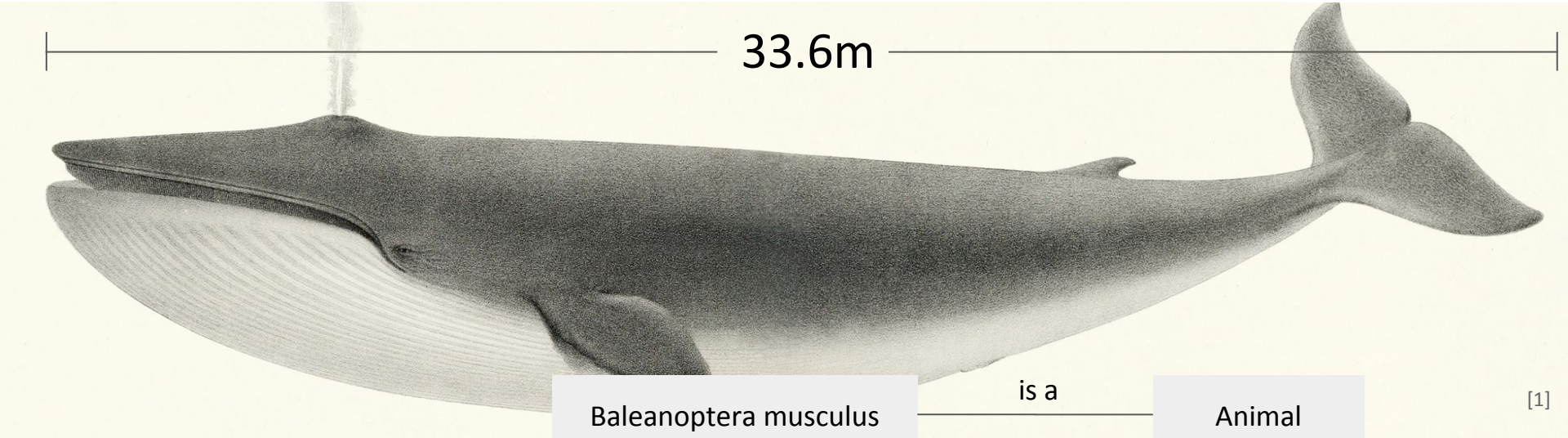
Knowledge Graphs for Research Data Management

Prof. Dr. Harald Sack
QPTDat Workshop 2020
FIZ Karlsruhe, 23 January 2020

33.6

33.6 m

From Data to Knowledge



Baleanoptera musculus — is a — Animal

[1]

maxLength

33.6 m

$\mathtt{BaleanopteraMusculus} \sqsubseteq \mathtt{Animal} \sqcap \forall \mathtt{maxLength}.\leq 33.6$

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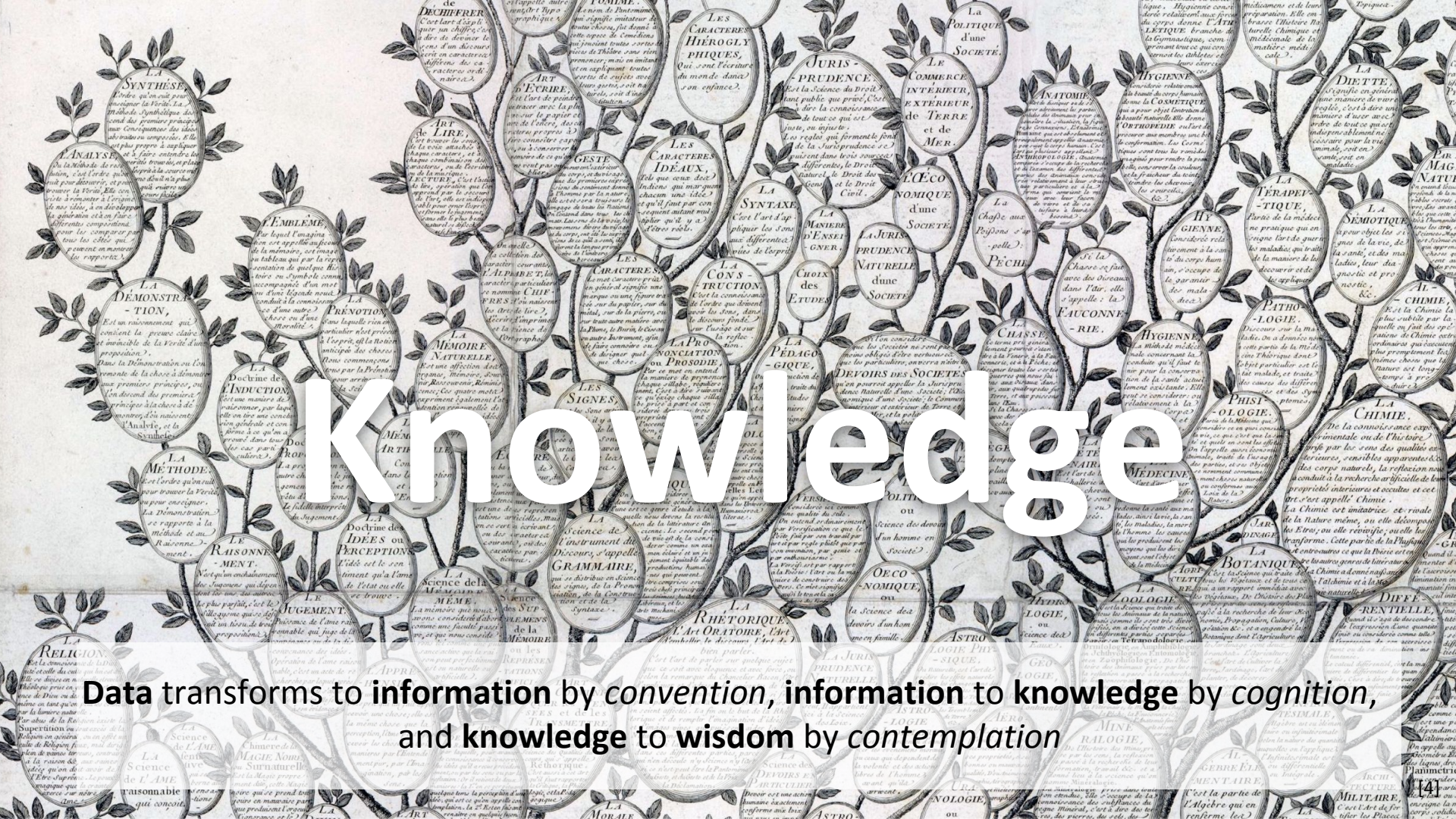
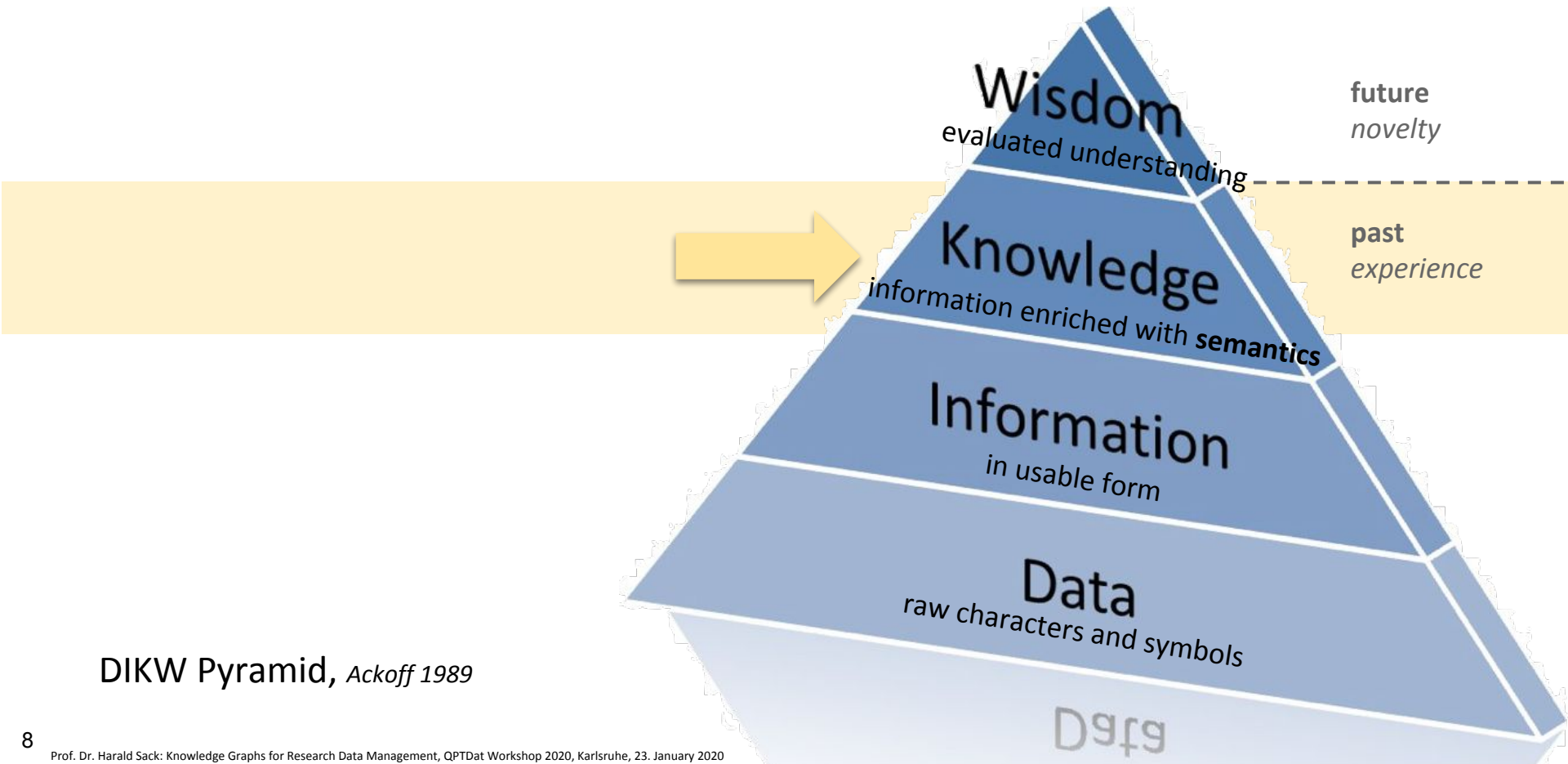
[2]

[3]



Data transforms to **information** by *convention*, **information** to **knowledge** by *cognition*, and **knowledge** to **wisdom** by *contemplation*

From Data to Knowledge

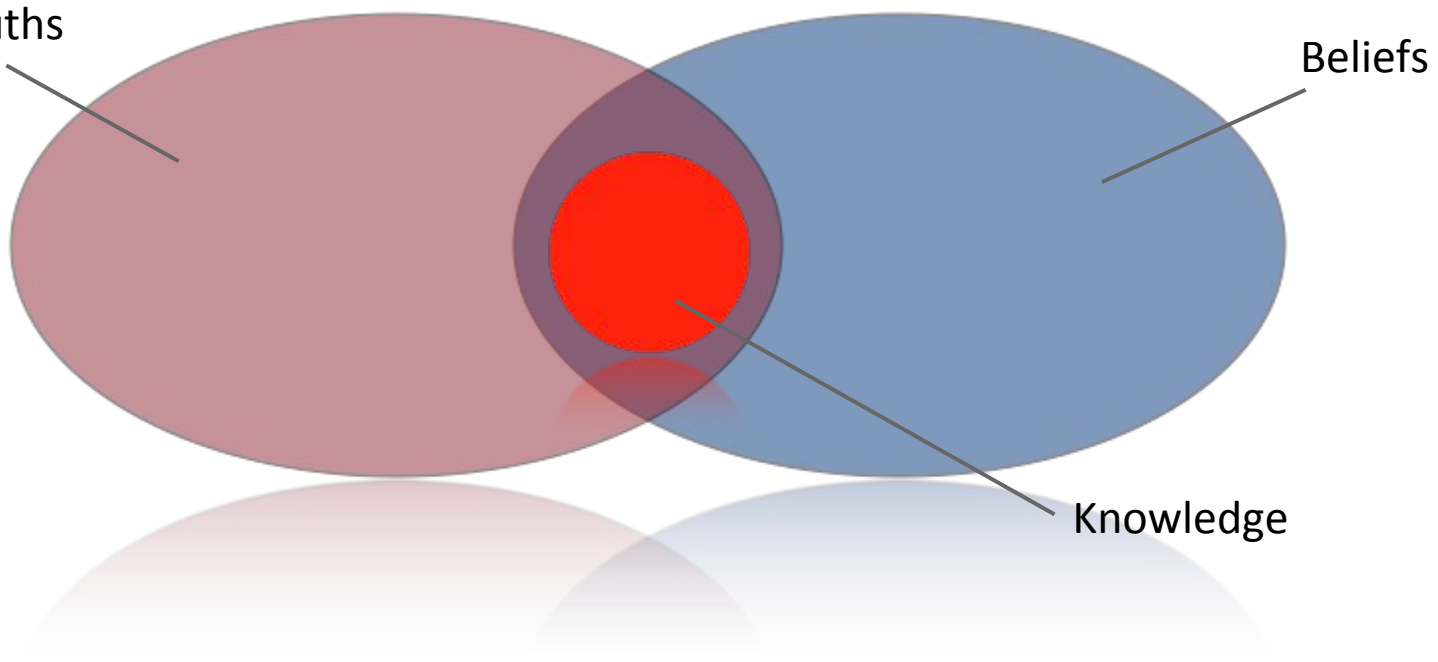


DIKW Pyramid, *Ackoff 1989*

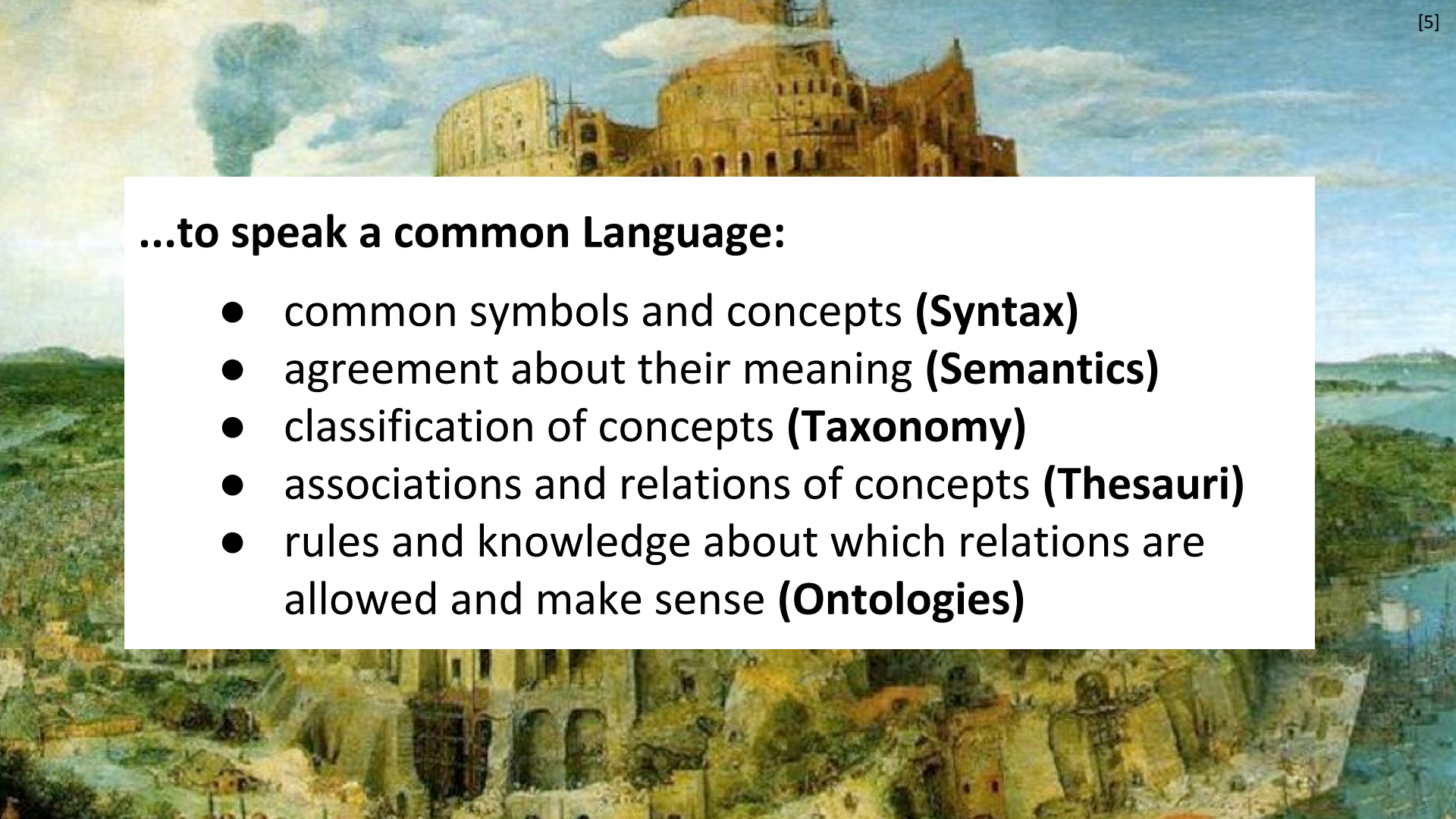
„People can‘t share knowledge if they don‘t speak a common language“

Thomas Davenport (1997)

What is Knowledge?

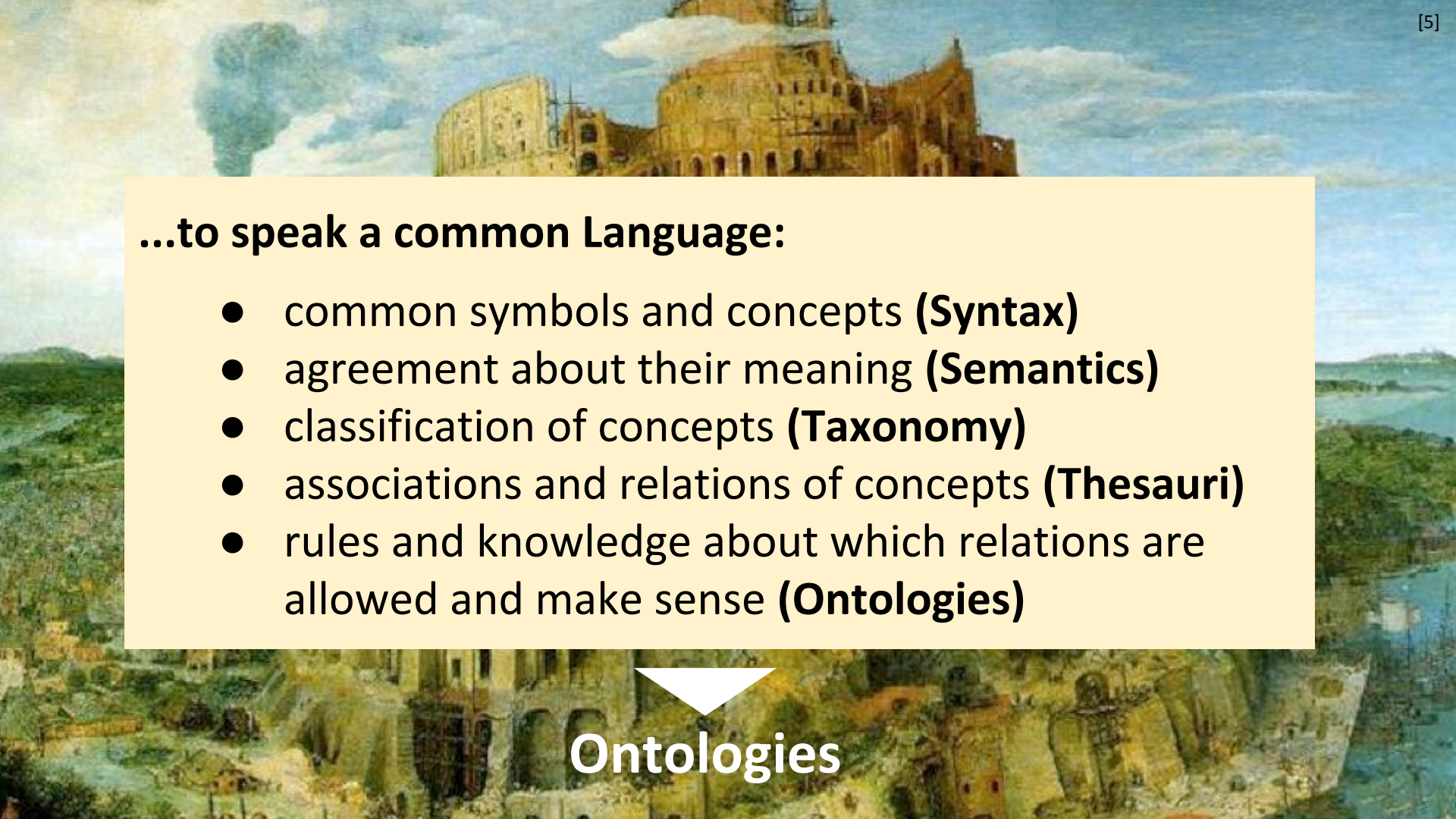


Traditional Definition: „Knowledge is a subset of all true beliefs“



...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)**



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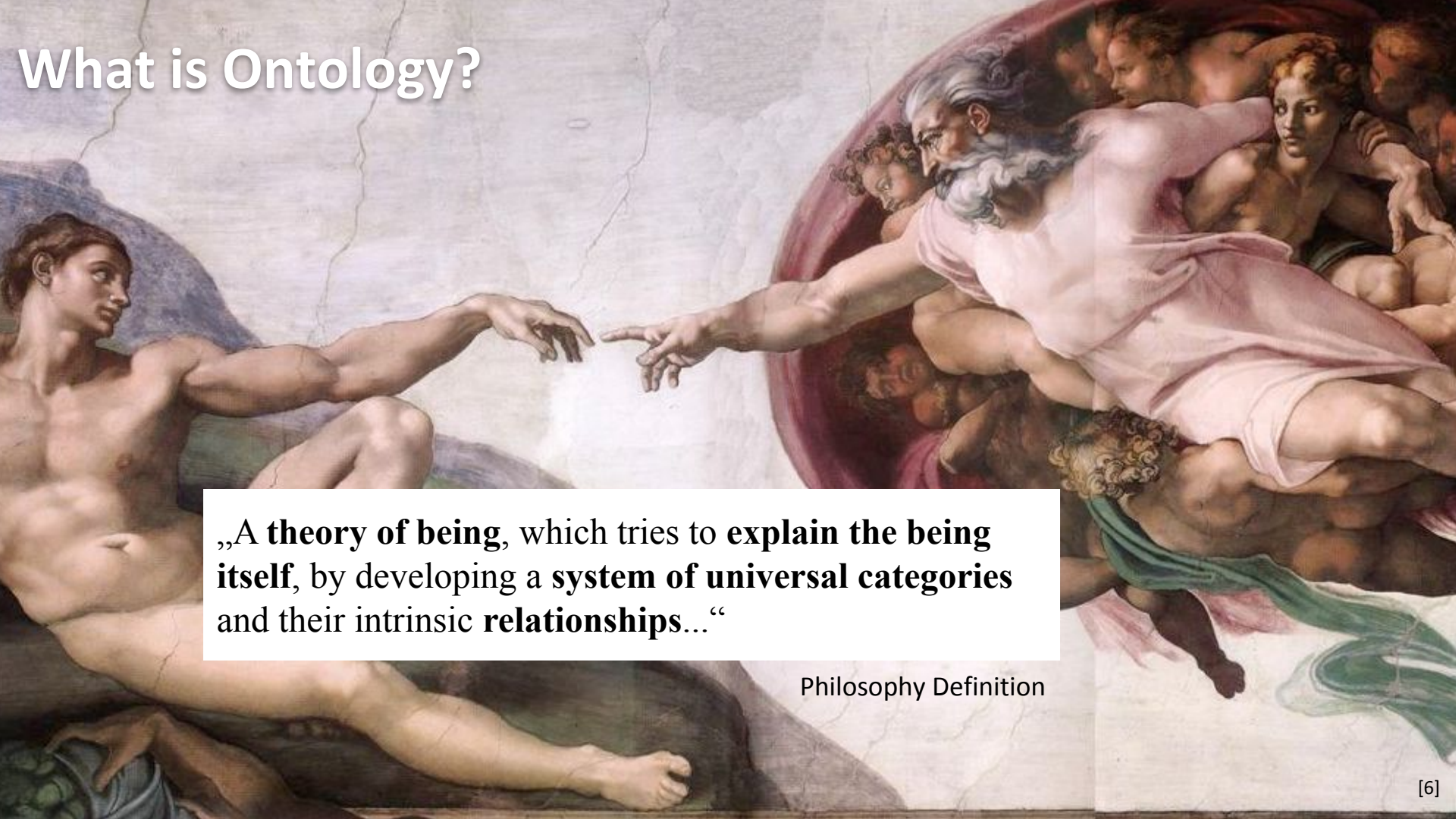
Ontologies

What is Ontology?

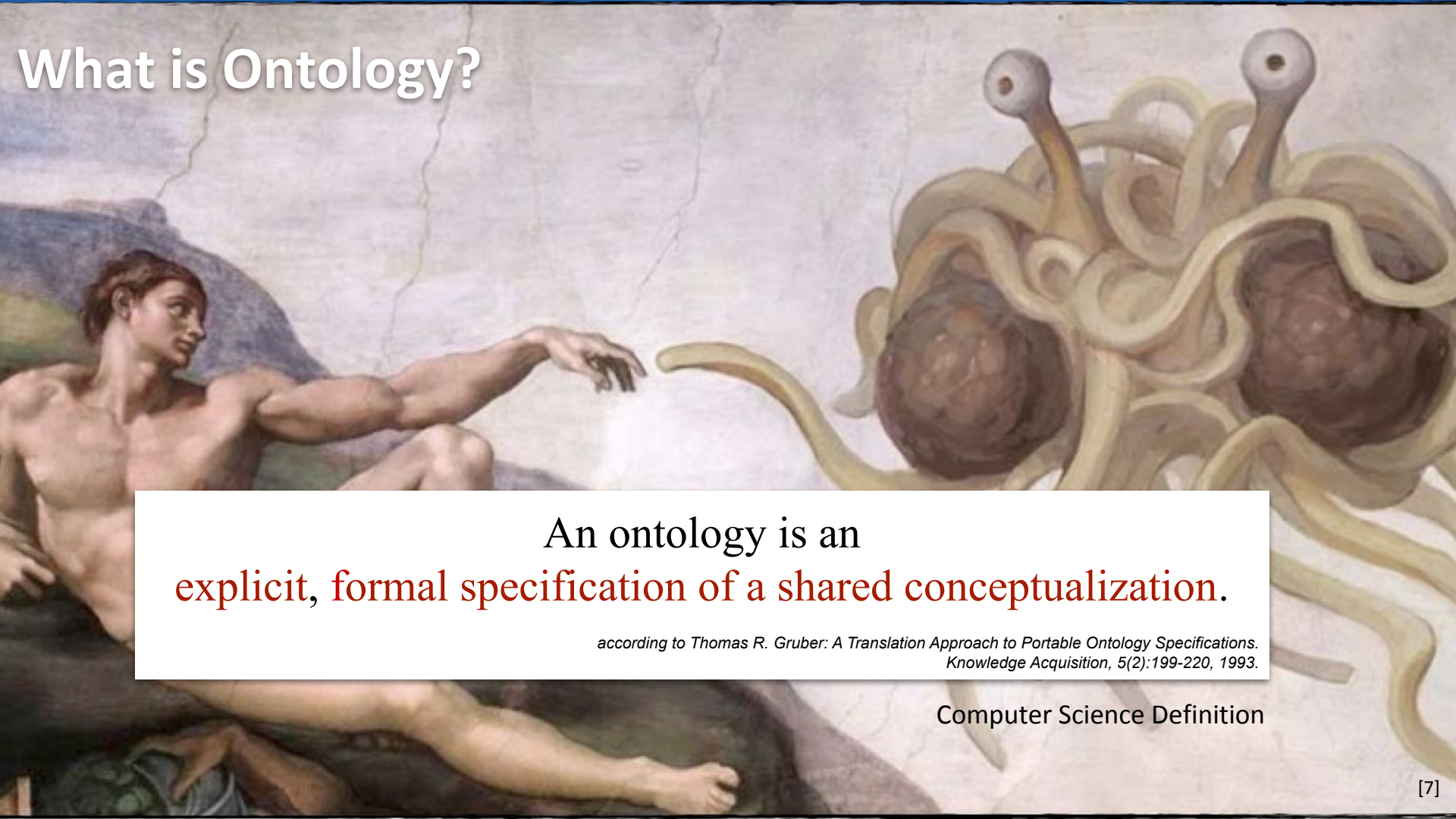


„A **theory of being**, which tries to **explain the being itself**, by developing a **system of universal categories** and their intrinsic **relationships**...“

Philosophy Definition

[6]

What is Ontology?



An ontology is an
explicit, formal specification of a shared conceptualization.

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

Computer Science Definition

What is Ontology?

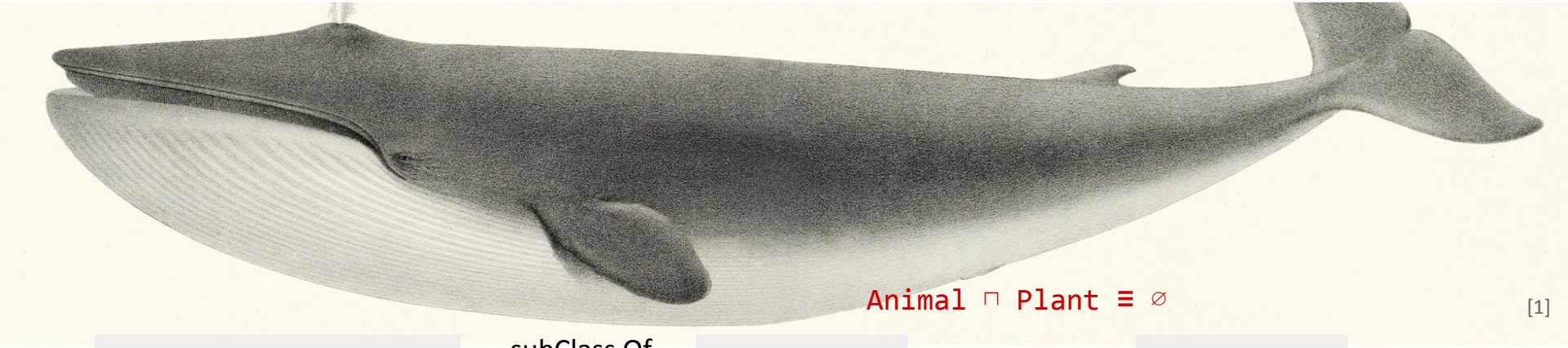
An ontology is an
explicit, formal specification of a shared conceptualization.

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

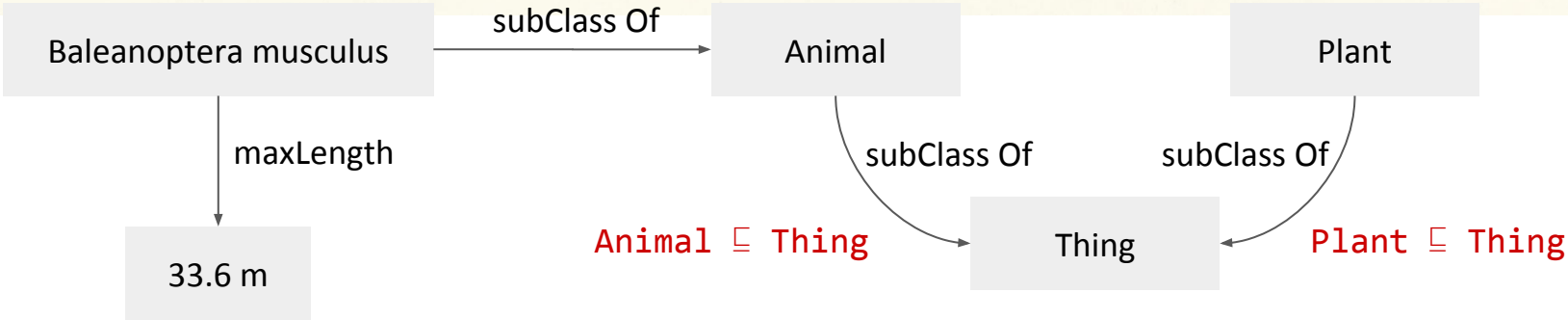
PARENTAL
ADVISORY
EXPLICIT SEMANTICS

Miniature Example Ontology



$\text{Animal} \sqcap \text{Plant} \equiv \varnothing$

[1]



$\text{Animal} \sqsubseteq \text{Thing}$

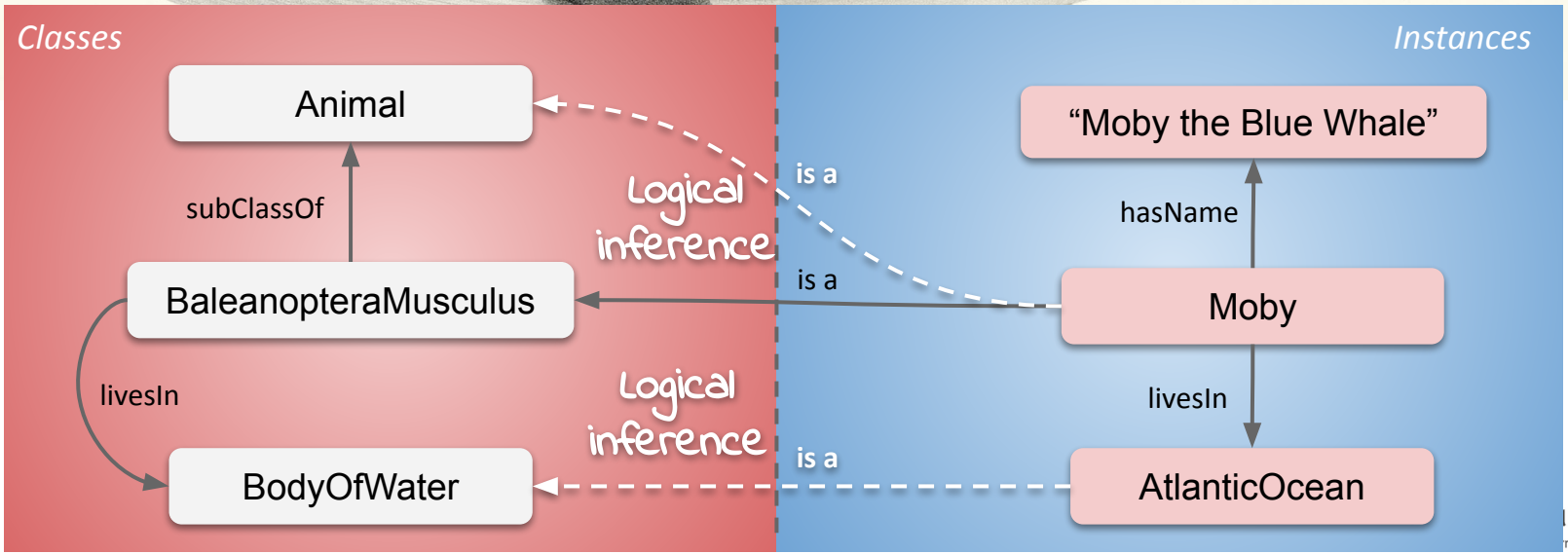
$\text{Plant} \sqsubseteq \text{Thing}$

$\text{BaleanopteraMusculus} \sqsubseteq \text{Animal} \sqcap \forall \text{maxLength}.\leq 33.6$

Class Class Property Constraint

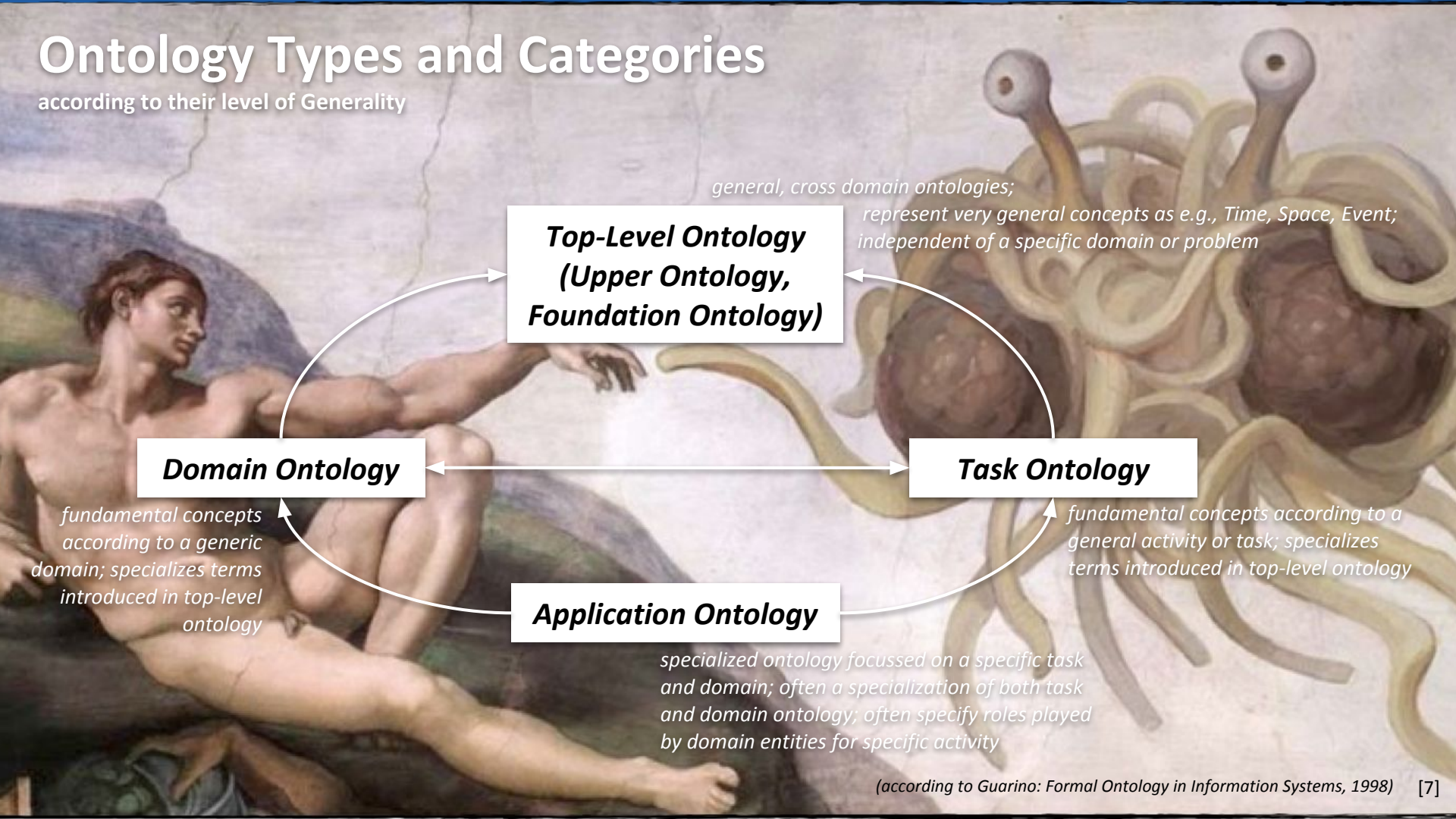
Miniature Example Knowledge Graph

[1]



Ontology Types and Categories

according to their level of Generality



(according to Guarino: Formal Ontology in Information Systems, 1998)

Ontology Types and Categories

according to their level of Generality

general, cross domain ontologies;
*represent **very general concepts** as e.g., Time, Space, Event;*
independent of a specific domain or problem

Top-Level Ontology (Upper Ontology, Foundation Ontology)

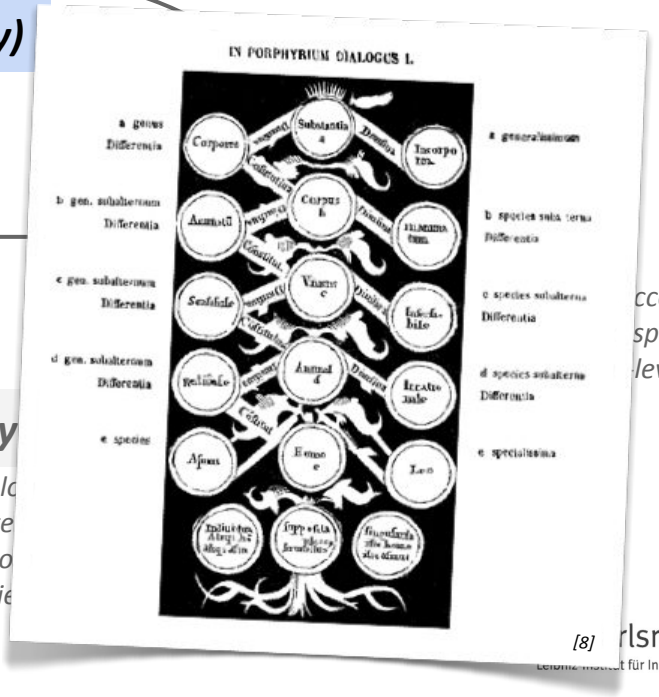
Domain Ontology

fundamental concepts according to a generic domain; specializes terms introduced in top-level ontology

Application Ontology

specialized ontolo
and domain; ofte
and domain onto
by domain entitie

ccording to a
specializes
level ontology



[8]

(according to Guarino: Formal Ontology in Information Systems, 1998)

Ontology Types and Categories

according to their level of Generality

Top- *Space, Event;*
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Domain Ontology

*fundamental concepts according to a **generic domain**; specializes terms introduced in top-level ontology*

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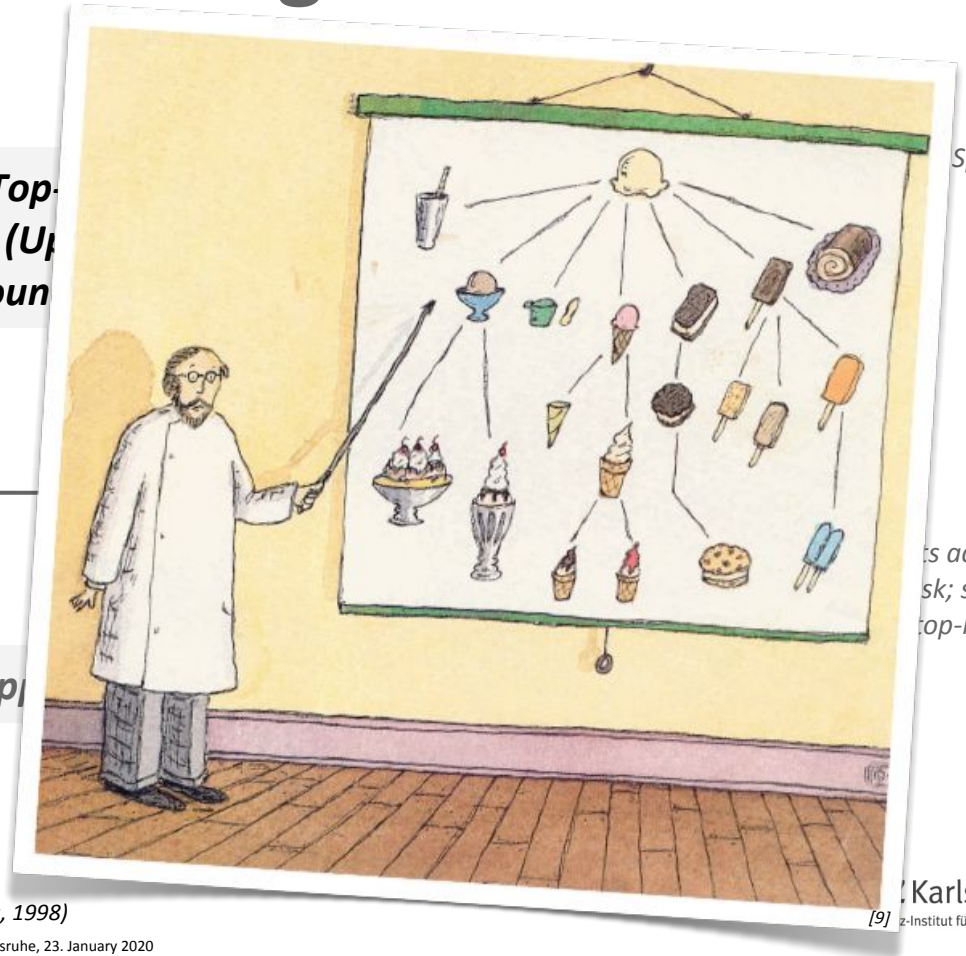
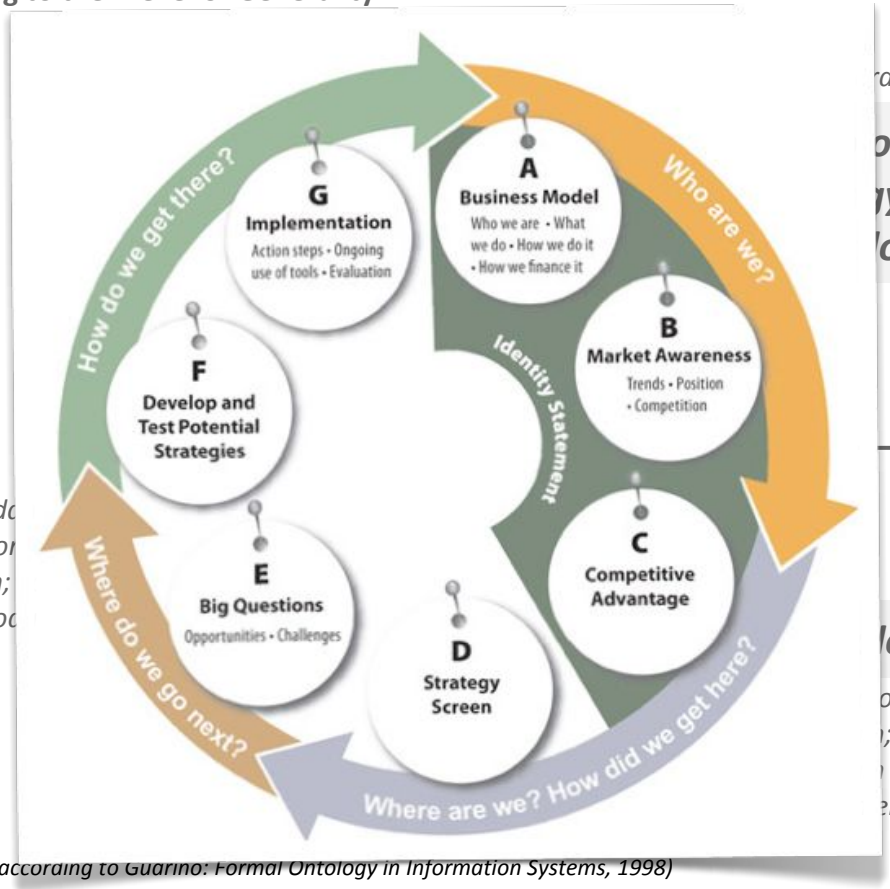


[9]

(according to Guarino: Formal Ontology in Information Systems, 1998)

Ontology Types and Categories

according to their level of Generality



(according to Guarino: Formal Ontology in Information Systems, 1998)

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represent very general concepts as e.g., Time, Space, Event;
independent of a specific domain or problem

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logy)

funda
accor
domain;
introd

Task Ontology

*fundamental concepts according to a **general activity or task**; specializes terms introduced in top-level ontology*

logy

ontology focussed on a specific task
; often a specialization of both task
ontology; often specify roles played
ntities for specific activity

Ontology Types and Categor

according to their level of Generality

general, cross

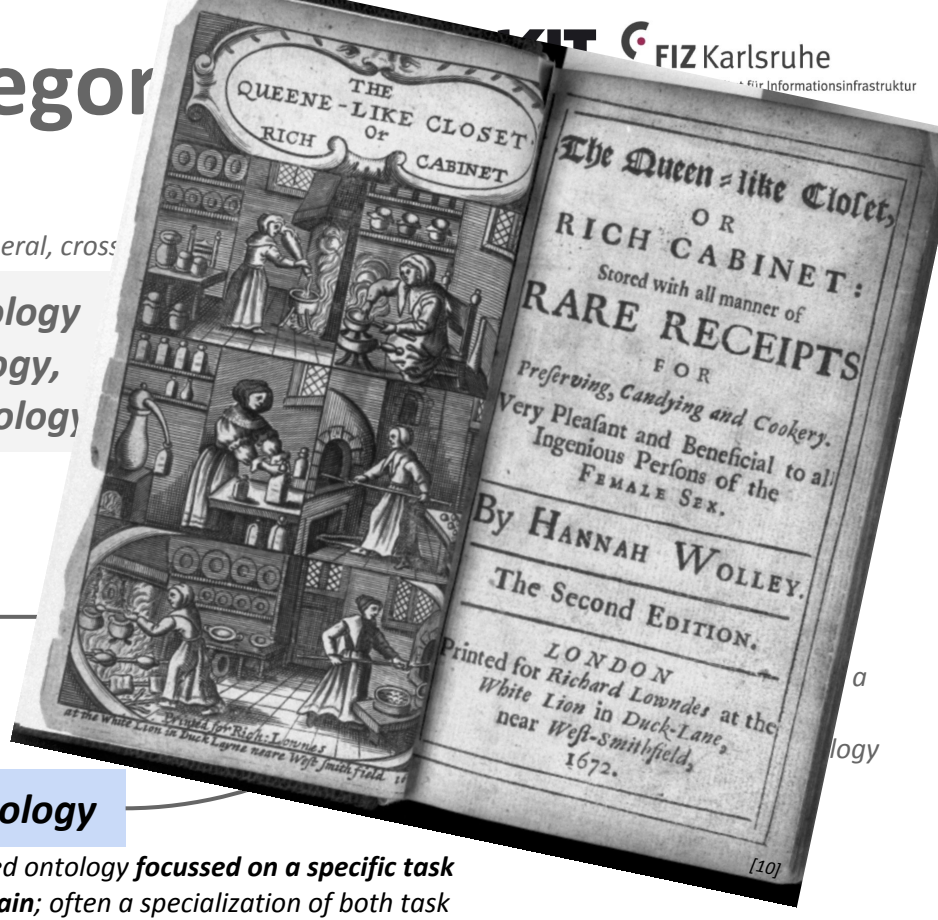
Top-Level Ontology (Upper Ontology, Foundation Ontology

Domain Ontology

fundamental concepts according to a generic domain; specializes terms introduced in top-level ontology

Application Ontology

*specialized ontology **focussed on a specific task and domain**; often a specialization of both task and domain ontology; often specify roles played by domain entities for specific activity*

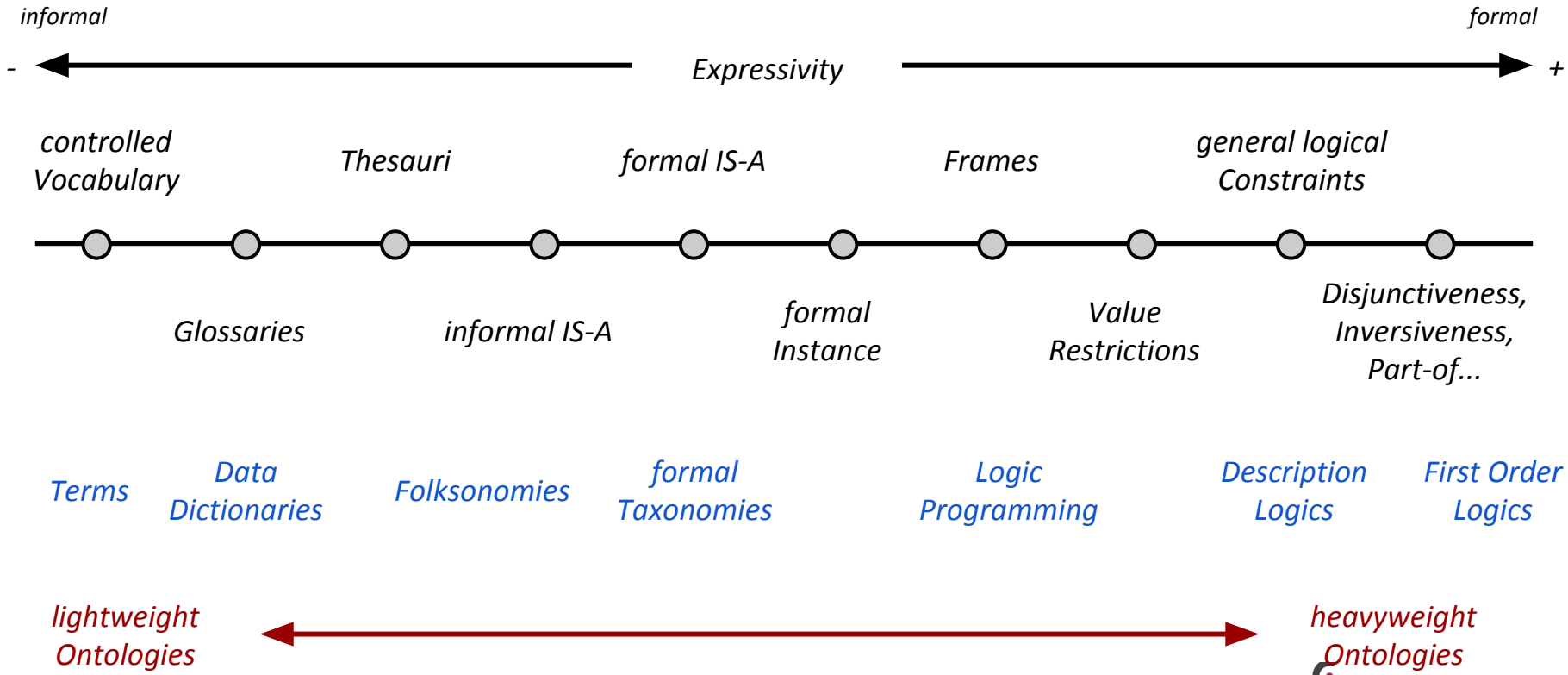


[10]

(according to Guarino: Formal Ontology in Information Systems, 1998)

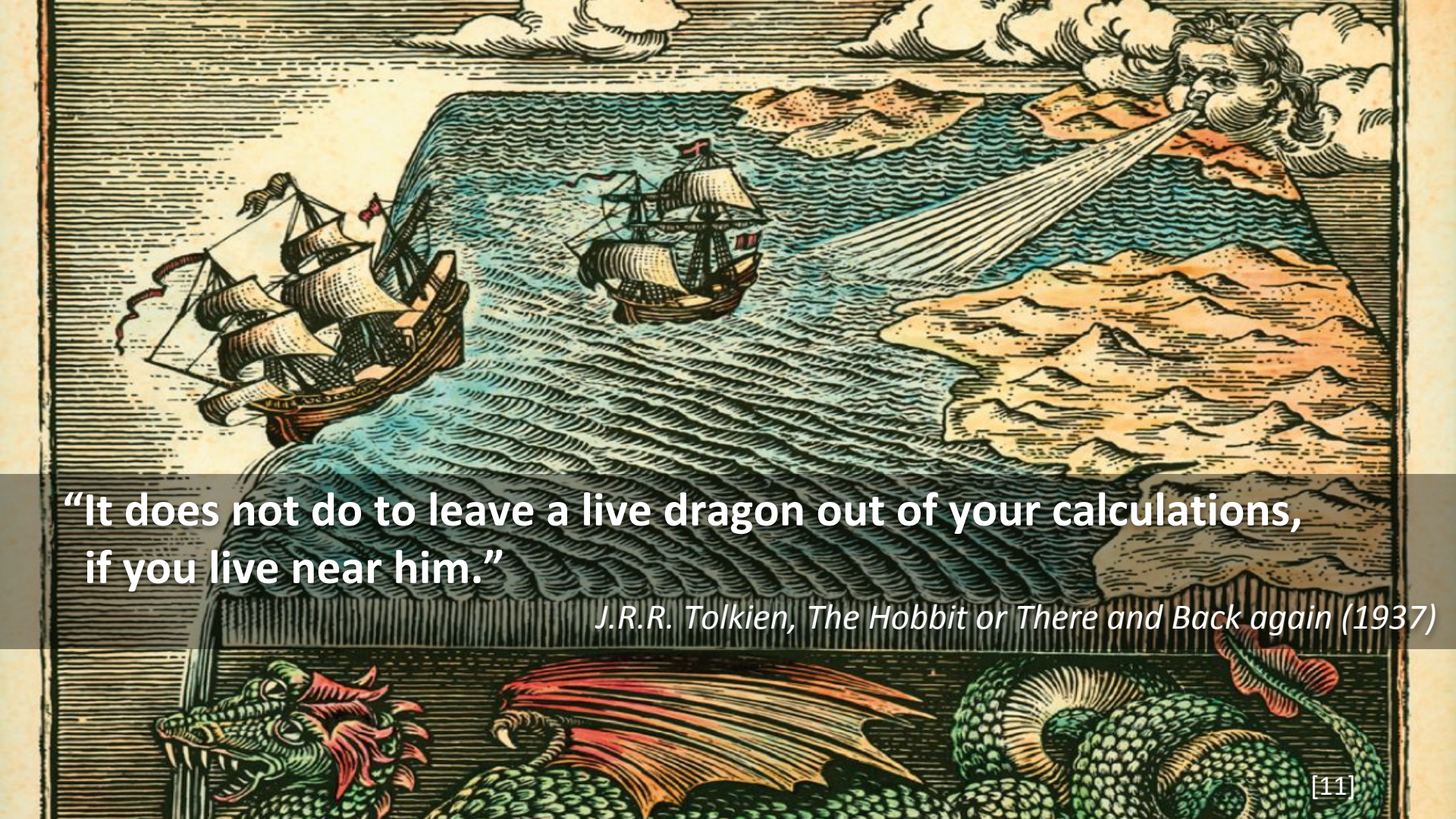
Ontology Types and Categories

according to their level of Semantic Expressivity



(according to Guarino: Formal Ontology in Information Systems, 1998)

(according to Lassila and McGuiness:The Role of Frame-Based Representation on the Semantic Web, 2001



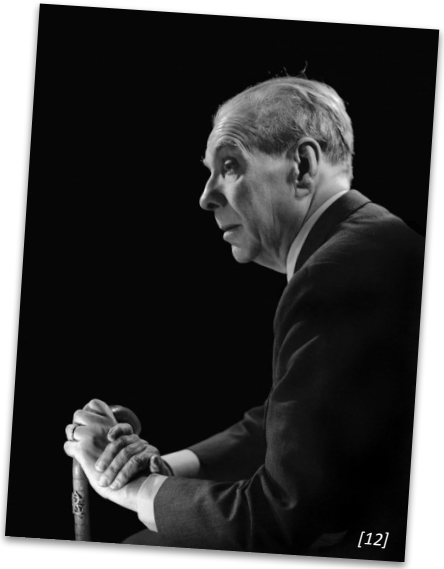
“It does not do to leave a live dragon out of your calculations, if you live near him.”

J.R.R. Tolkien, The Hobbit or There and Back again (1937)

Ontologies as Interpretations of Reality

*Various **categories of animals** from "a certain Chinese encyclopedia"*
according to Jorge Luis Borges:

- Those that belong to the emperor
- Embalmed ones
- Those that are trained
- Suckling pigs
- Mermaids (or Sirens)
- Fabulous ones
- Stray dogs
- Those that are included in this classification
- Those that tremble as if they were mad
- Innumerable ones
- Those drawn with a very fine camel hair brush
- Et cetera
- Those that have just broken the flower vase
- Those that, at a distance, resemble flies



Jorge Luis Borges
(1899-1986)

Jorge Luis Borges: The Analytical Language of John Wilkins (1942)

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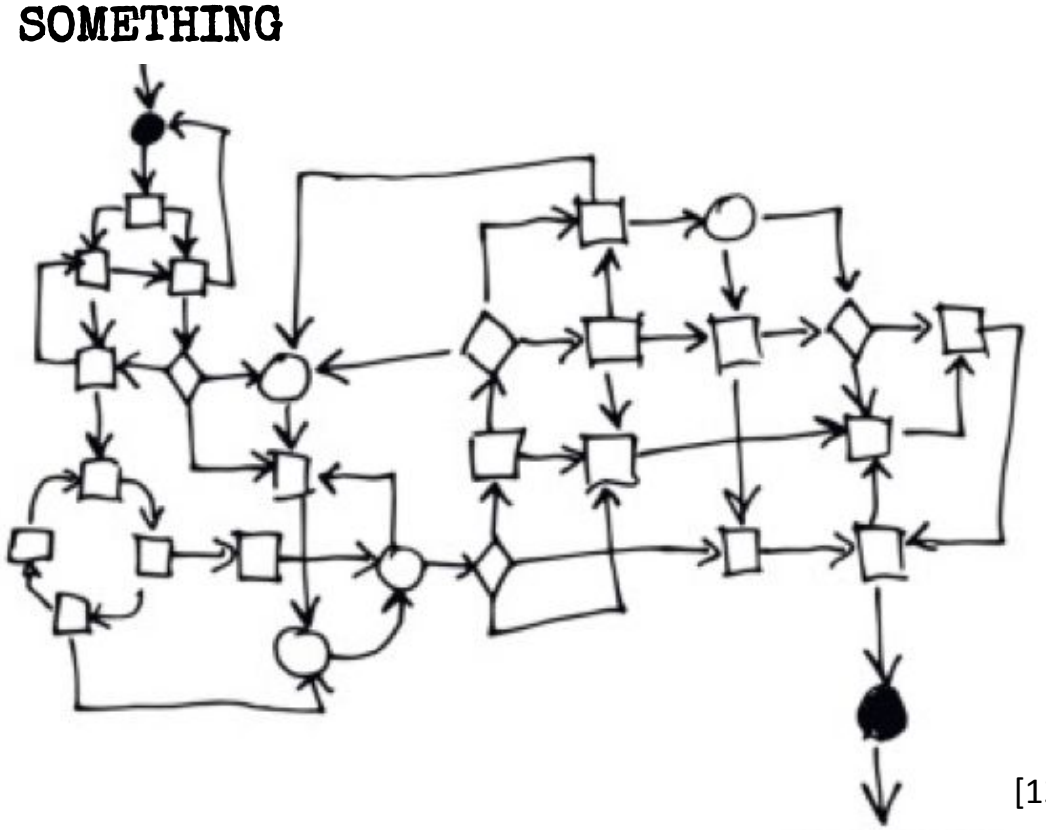
Ontologies and Knowledge Graphs for Research Data Management



[13]

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Ontologies and Knowledge Graphs for Research Data Management

(1) (Raw) Research Data

z/d [1]	Ion density (PIC-ITAP) [10^15 m^(-3)]	Ion density (PIC-INP) [10^15 m^(-3)]
0.0000000e+00	2.1538249e-01	2.2127591e-01
1.0000000e-02	2.2320410e-01	2.2851489e-01
2.0000000e-02	2.3078706e-01	2.3700471e-01
3.0000000e-02	2.3957809e-01	2.4612475e-01
4.0000000e-02	2.4898703e-01	2.5569295e-01
5.0000000e-02	2.5889461e-01	2.6656408e-01
6.0000000e-02	2.7120663e-01	2.7901766e-01
7.0000000e-02	2.8447237e-01	2.9209201e-01
8.0000000e-02	2.9853002e-01	3.0861118e-01
9.0000000e-02	3.1697947e-01	3.2641678e-01
1.0000000e-01	3.3656863e-01	3.4837557e-01
1.1000000e-01	3.6049250e-01	3.7427430e-01
1.2000000e-01	3.8862354e-01	4.0343478e-01
1.3000000e-01	4.2297845e-01	4.3891770e-01
1.4000000e-01	4.6555629e-01	4.8310615e-01
1.5000000e-01	5.1581989e-01	5.3864561e-01
1.6000000e-01	5.7837521e-01	6.0616555e-01
1.7000000e-01	6.4984874e-01	6.8350098e-01
1.8000000e-01	7.3012722e-01	7.6446633e-01
1.9000000e-01	8.1671138e-01	8.5748202e-01
2.0000000e-01	9.0375181e-01	9.4726775e-01

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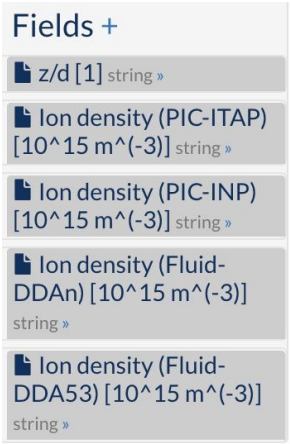
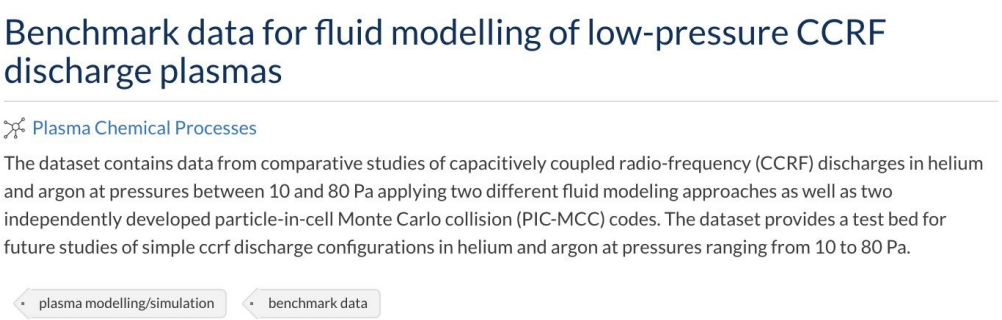
Ontologies and Knowledge Graphs for Research Data Management

(1) (Raw) Research Data

(2) Schema Information



structured information



unstructured information

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Ontologies and Knowledge Graphs for Research Data Management

(1) (Raw) Research Data
(2) Schema Information
(3) Metadata

structured
+
unstructured
Information

Field	Value
Group	Plasma Modelling
Authors	Becker, Markus M. Kählert, Hanno Sun, Anbang Loffhagen, Detlef
Release Date	2019-06-14
Resources	Benchmark data for CCRF discharge plasmas - time averaged ion density (argon, 20 Pa) Benchmark data for CCRF discharge plasmas - time averaged ion density (argon, 40 Pa) Benchmark data for CCRF discharge plasmas - time averaged ion density (argon, 80 Pa) Benchmark data for CCRF discharge plasmas - time averaged ion density (helium, 10 Pa) Benchmark data for CCRF discharge plasmas - time averaged ion density (helium, 20 Pa) Show more
Identifier	60dbcdd4-8be4-4f41-896c-e725bdb37fe2
Permanent Identifier (DOI)	doi:10.34711/inptdat.72
Permanent Identifier (URI)	https://www.inptdat.de/node/72
Is supplementing	M. M. Becker et al., Plasma Sources Sci. Technol. 26 (2017) 044001
Plasma Source Name	CCP
Plasma Source Specification	AC high frequency low pressure non-thermal
Plasma Source Properties	Low-pressure RF plasma between plane electrodes separated by the distance d, driven by a sinusoidal voltage with amplitude V0 and frequency f; d = 2.5 cm (argon) resp. 6.7 cm (helium); V0 = 50-250 V; f = 13.56 MHz; Current density: 10 A/m^2

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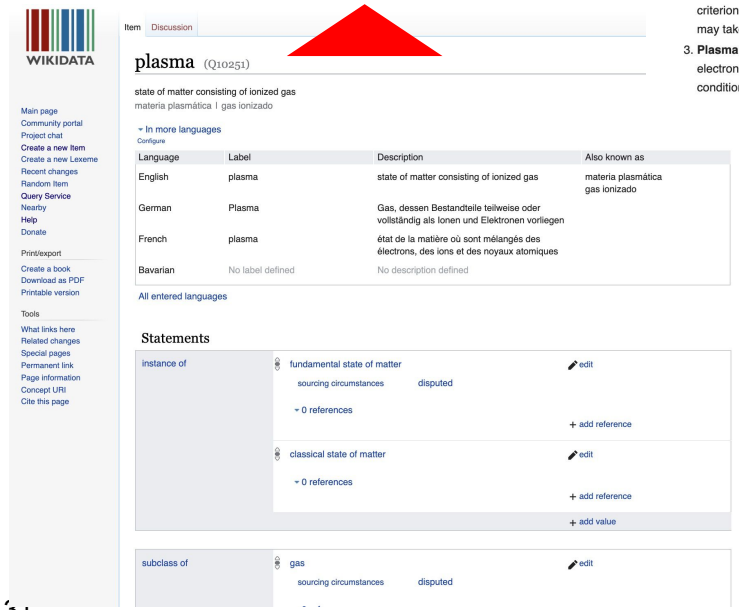
Ontologies and Knowledge Graphs for Research Data Management

(1) (Raw) Research Data
(2) Schema Information
(3) Metadata
(4) External Ressources

semantic information



Properties and parameters

Definition

Plasma is a state of matter in which an ionized gaseous substance becomes highly electrically conductive to the point that long-range electric and magnetic fields dominate the behaviour of the matter.[21][22] The plasma state can be contrasted with the other states: solid, liquid, and gas.

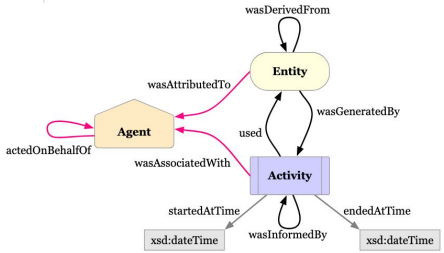
Plasma is an electrically neutral medium of unbound positive and negative particles (i.e. the overall charge of a plasma is roughly zero). Although these particles are unbound, they are not "free" in the sense of not experiencing forces. Moving charged particles generate an electric current within a magnetic field, and any movement of a charged plasma particle affects and is affected by the fields created by the other charges. In turn this governs collective behaviour with many degrees of variation.[10][23] Three factors define a plasma:[24][25]

1. **The plasma approximation**: The plasma approximation applies when the plasma parameter, Λ,[26] representing the number of charge carriers within a sphere (called the Debye sphere whose radius is the Debye screening length) surrounding a given charged particle, is sufficiently high as to shield the electrostatic influence of the particle outside of the sphere.[21][22]
2. **Bulk interactions**: The Debye screening length (defined above) is short compared to the physical size of the plasma. This criterion means that interactions in the bulk of the plasma are more important than those at its edges, where boundary effects may take place. When this criterion is satisfied, the plasma is quasineutral.[27]
3. **Plasma frequency**: The electron plasma frequency (measuring plasma oscillations of the electrons) is large compared to the electron-neutral collision frequency (measuring frequency of collisions between electrons and neutral particles). When this condition is valid, electrostatic interactions dominate over the processes of ordinary gas kinetics.[28]

als Plasma (Physik)
an Plasma (física)
ar بلازما (فيزياء)
arz بلازما (فيزيا)
ast Plasma (estáu de la materia)
as প্লাজমা
azb پلاسما
az Plazma
ba Плазма
be_x_old Плязма
be Плазма
bg Плазма
bn প্লাজমা
bs Plazma (fizika)
ca Plasma (estat de la matèria)
cdo Dĕng-liĕ-cŭ-tâ
chr ᏎᏉ ᎤᏚᏬᏍ
ckb بلازما (فیزیک)
cs Plazma
cv Плазма
cy Plasma (ffiseg)
da Plasma
de Plasma (Physik)
el Πλάσμα (φυσική)
eml Plaśma
en Plasma (physics)
eo Plasmo
es Plasma (estado de la materia)
et Plasma
eu Plasma (fisika)

unstructured information

semantic information



Continuum mechanics

Laws	[show]
Solid mechanics	[show]
Fluid mechanics	[hide]

Fluids
Statics · Dynamics
Archimedes' principle · Bernoulli's principle
Navier–Stokes equations
Poiseuille equation · Pascal's law
Viscosity
(Newtonian · non-Newtonian)
Buoyancy · Mixing · Pressure

Liquids
Surface tension · Capillary action

Gases
Atmosphere · Boyle's law · Charles's law · Gay-Lussac's law · Combined gas law

Plasma

Rheology	[show]
Scientists	[show]

V • T • E

structured information

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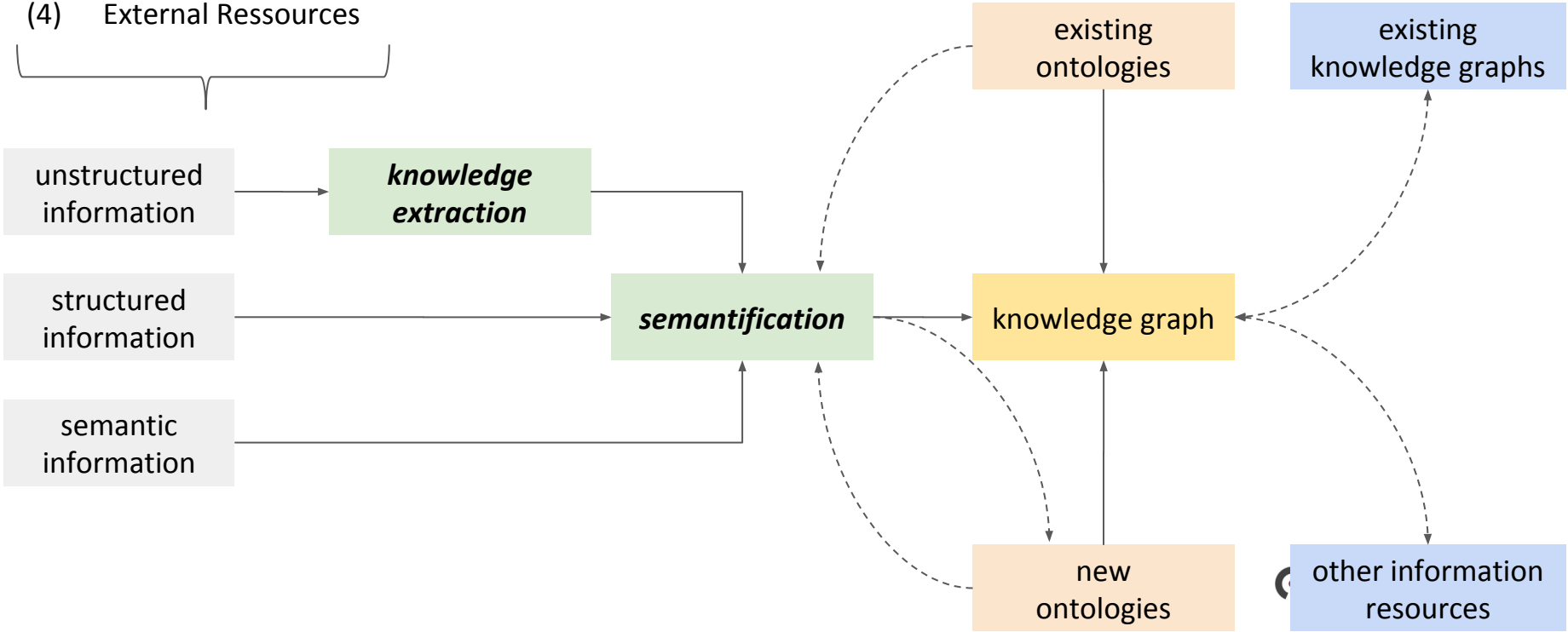
Ontologies and Knowledge Graphs for Research Data Management

(1) (Raw) Research Data
(2) Schema Information
(3) Metadata
(4) External Ressources

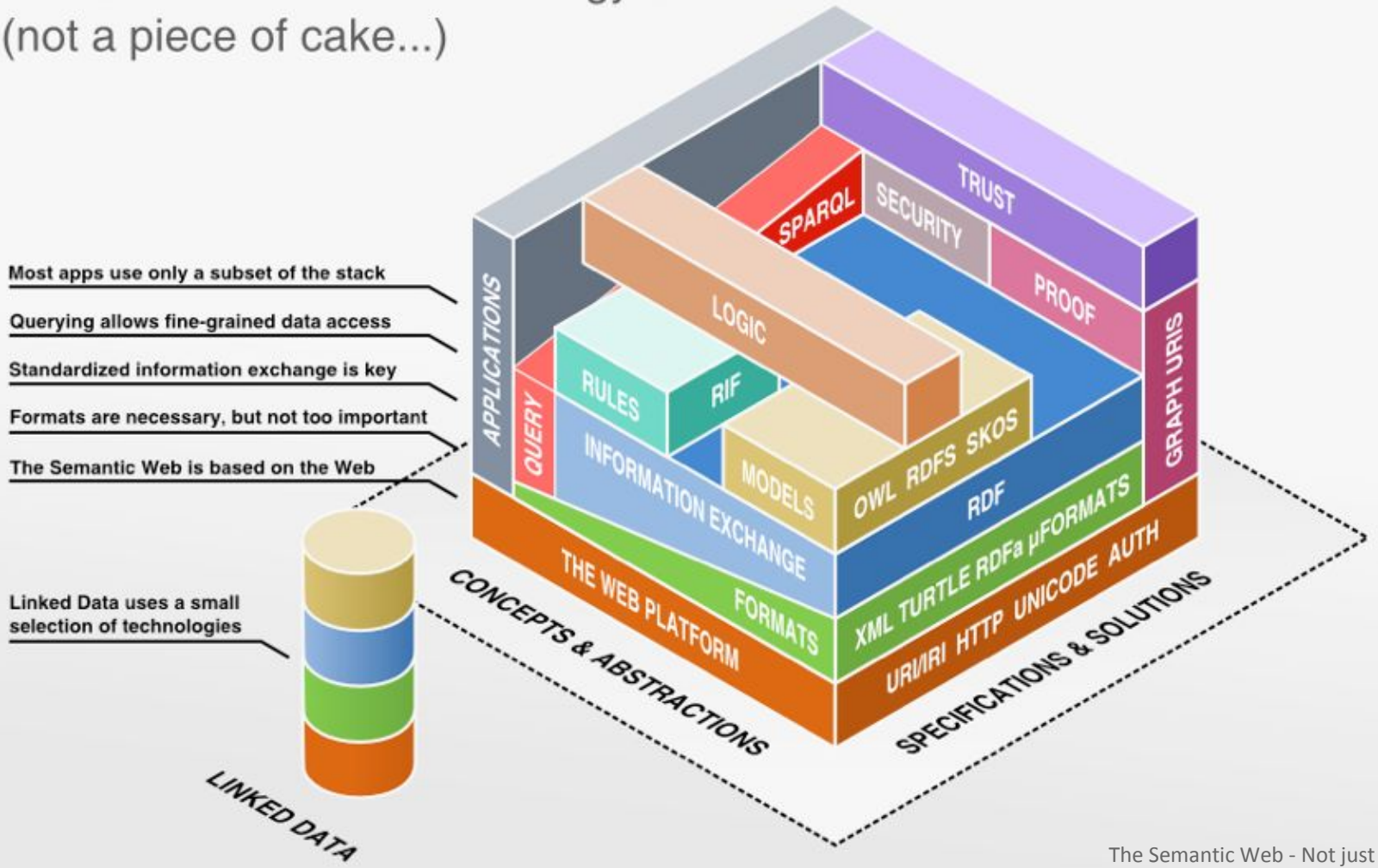


The Liberty Statue, work in progress, 1884 [14]

“Though this be madness, yet there is method in it”

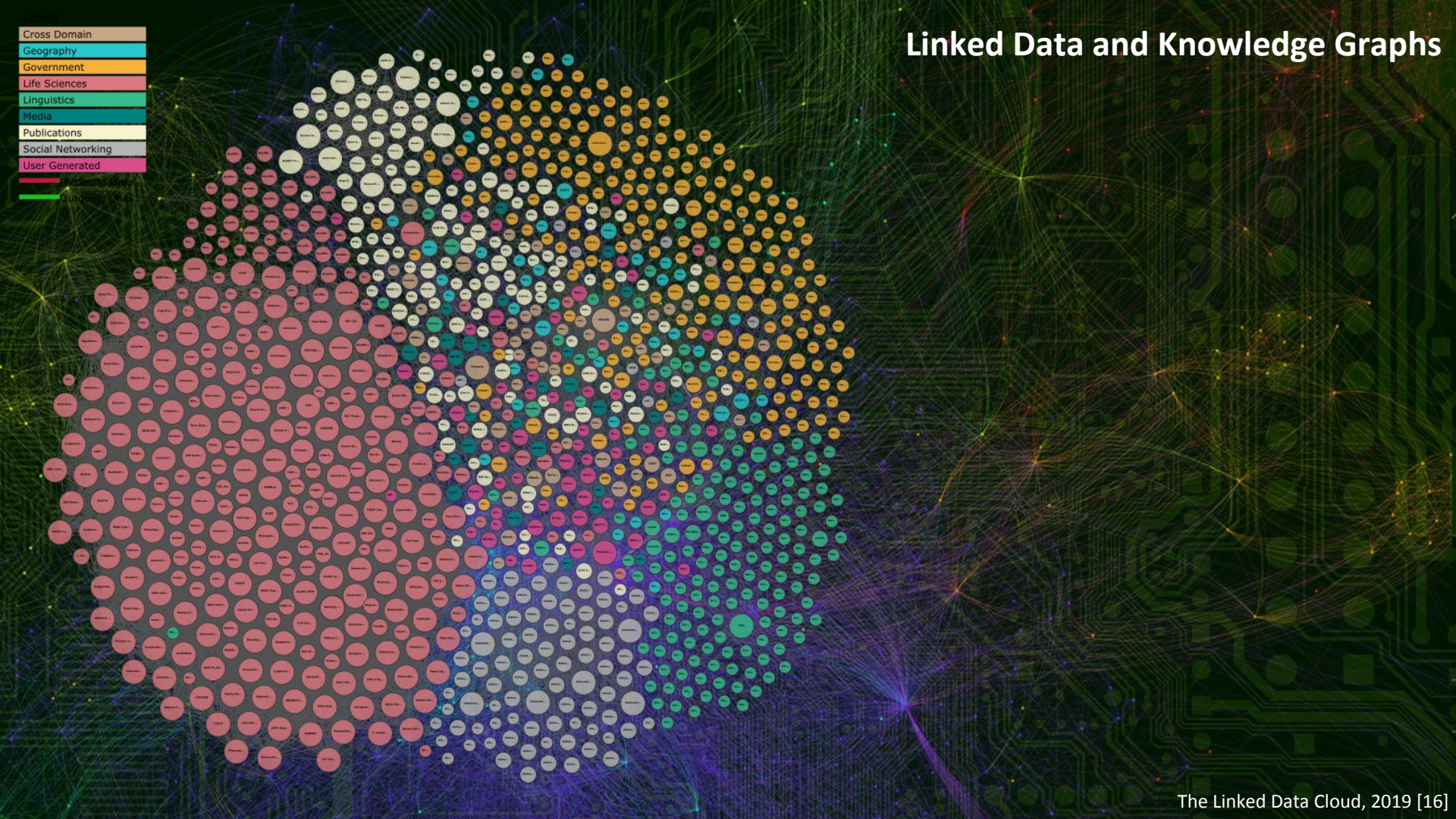
William Shakespeare, Hamlet (1602)

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



The Semantic Web - Not just a piece of cake, [15]

Linked Data and Knowledge Graphs



The Linked Data Cloud, 2019 [16]

Semantic Search & Retrieval

Ontology & Knowledge Graph Applications

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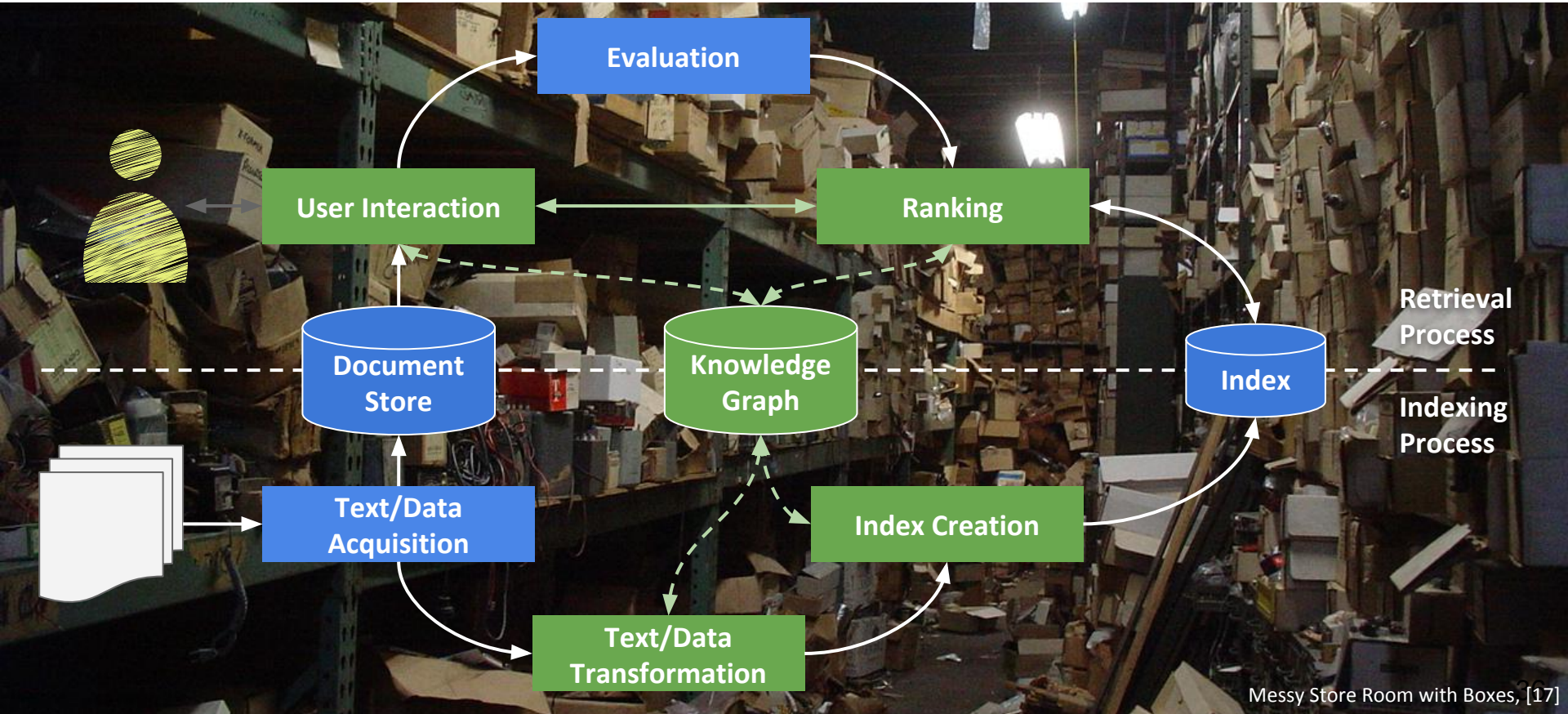
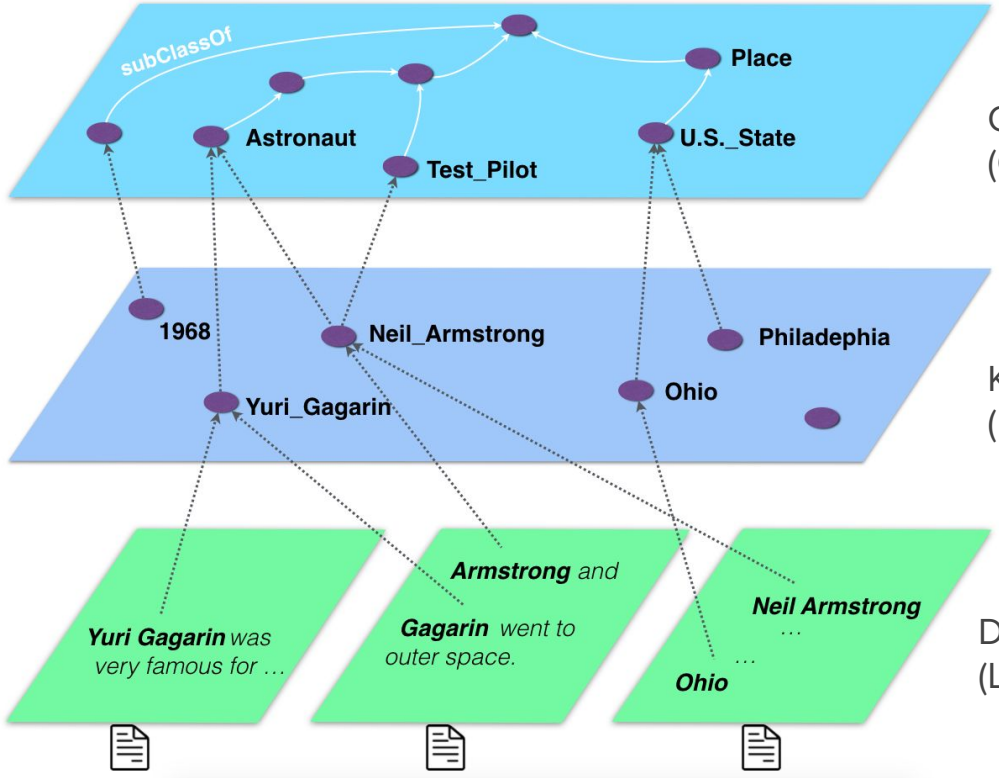


Messy Store Room with Boxes, [17]

Semantic Search & Retrieval

Ontology & Knowledge Graph Applications



Ontology
(Classes & Relations)

Knowledge Graph
(Instances)

Document Text
(Labels)

Jörg Waitelonis, Claudia Exeler, and Harald Sack. **Linked Data enabled Generalized Vector Space Model to improve document retrieval.** In Proc. of NLP & DBpedia 2015 workshop in conjunction with 14th International Semantic Web Conference (ISWC2015), CEUR Workshop Proceedings, Vol1581, pp 33-44, 2015.

Exploration & Recommendation

Ontology & Knowledge Graph Applications

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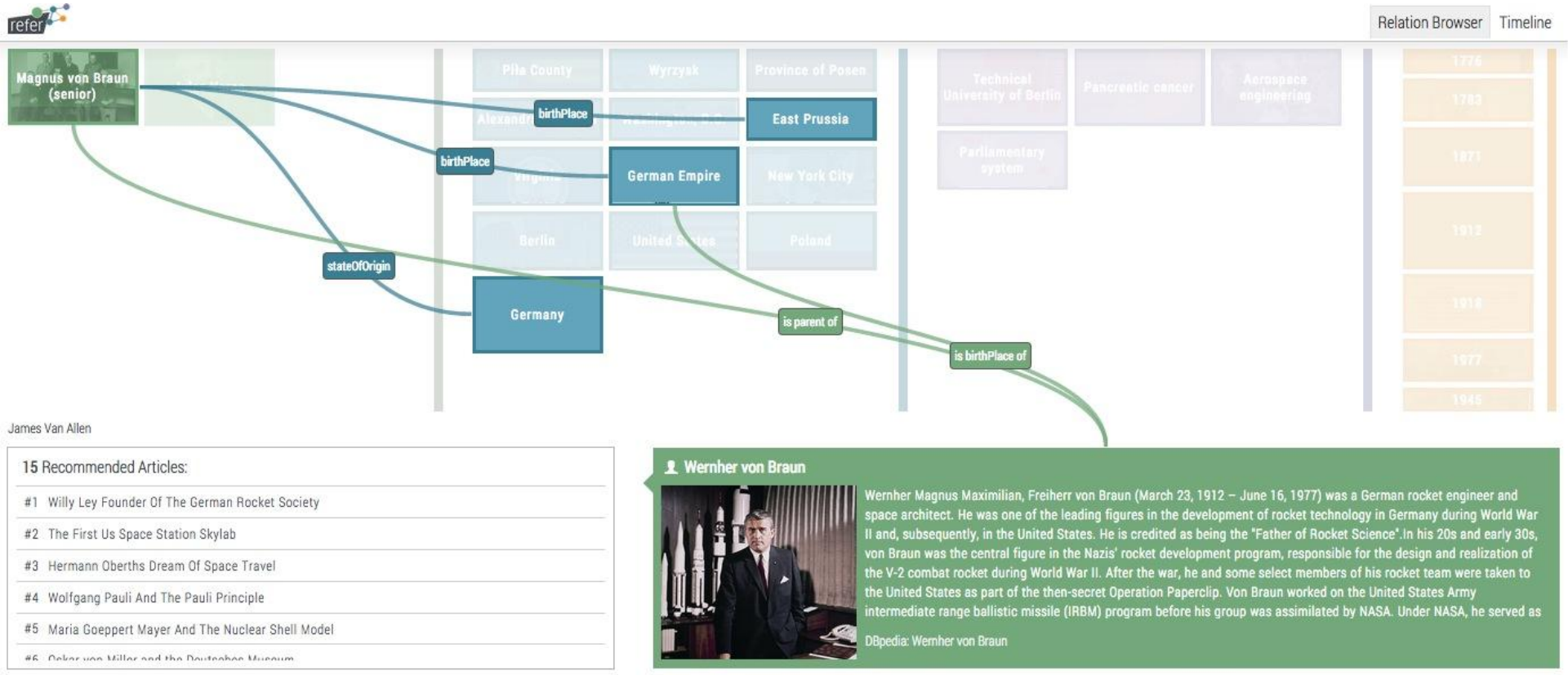

e.g. via refer.cx WordPress PlugIn at http://scihi.org/

An Evolving Knowledge Graph

For Plasma Technology

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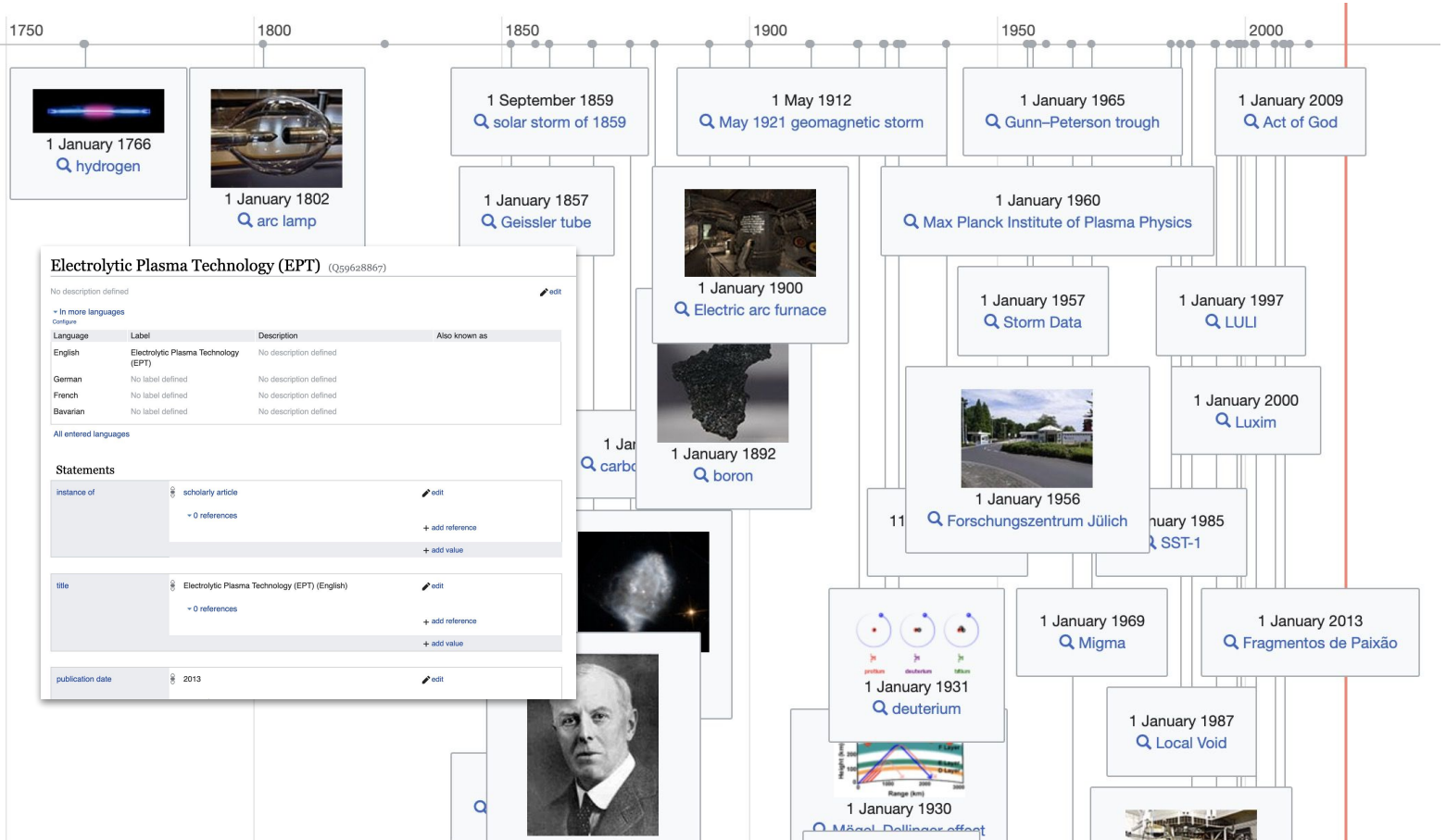

WIKIBASE

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Knowledge Graphs for Research Data Management

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QPTDat Workshop 2020
Karlsruhe, 23. Jan. 2020

QPTDat
Quality | Plasma Technology | Data

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