



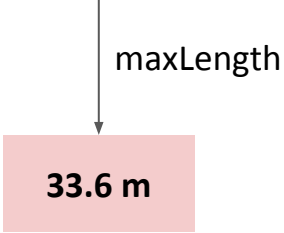
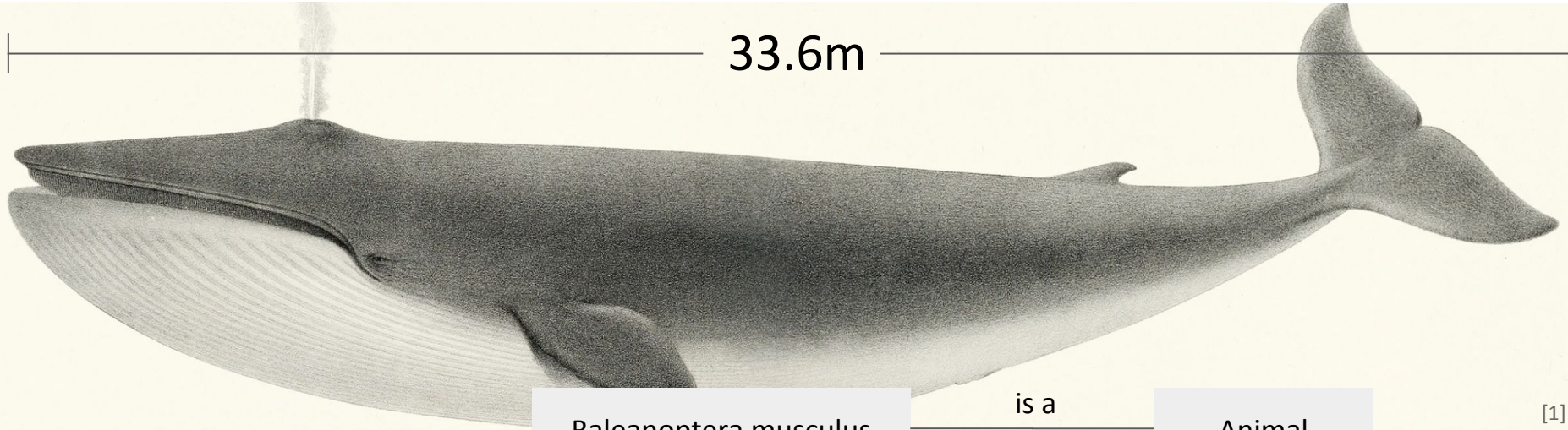
Knowledge Graphs for Research Data Management

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

33.6

33.6 m

From Data to Knowledge



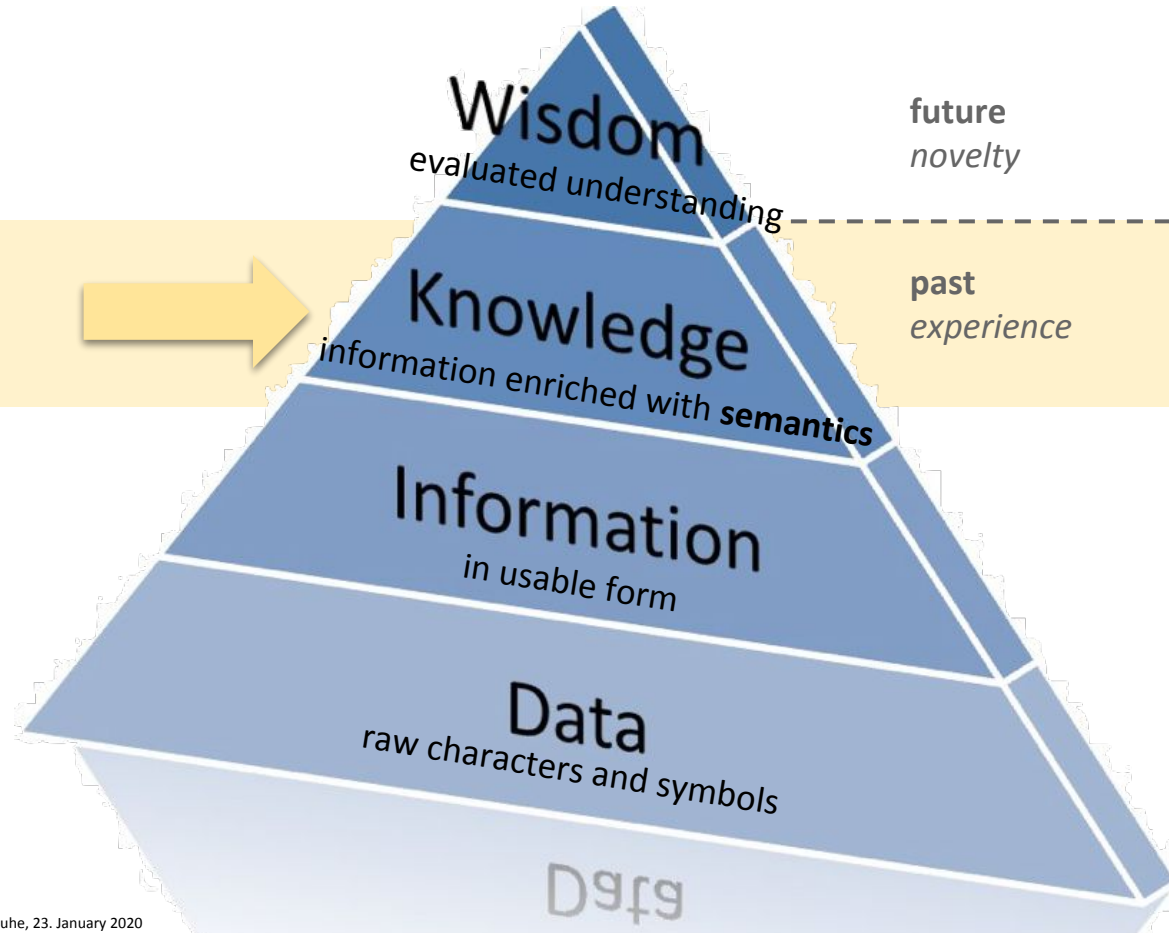
BaleanopteraMusculus \sqsubseteq Animal $\square \nabla$ maxLength. ≤ 33.6

Data



Information

From Data to Knowledge



DIKW Pyramid, *Ackoff 1989*

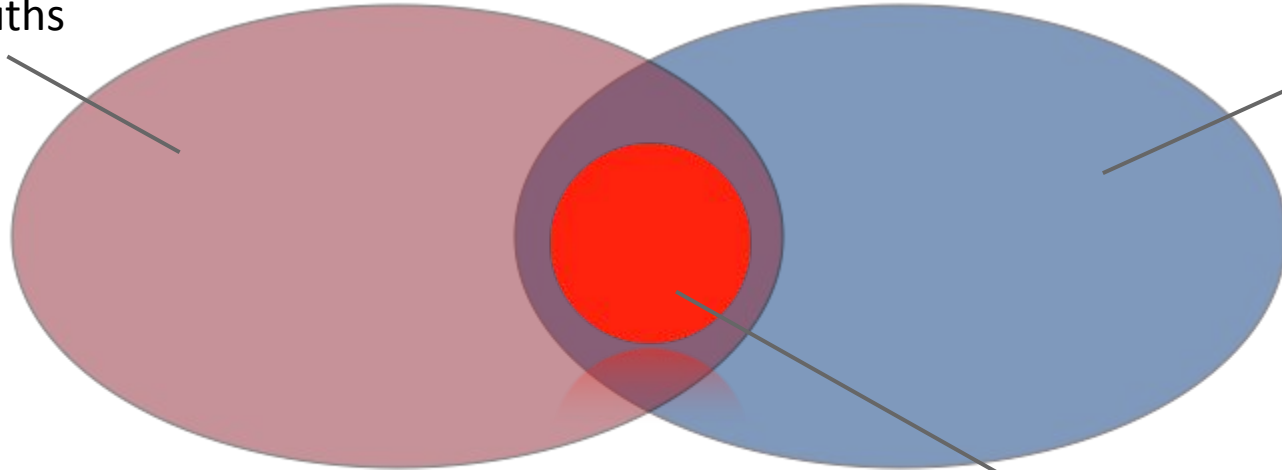


„People can't share knowledge if they don't speak a common language“

Thomas Davenport (1997)

What is Knowledge?

Truths



Beliefs

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**)

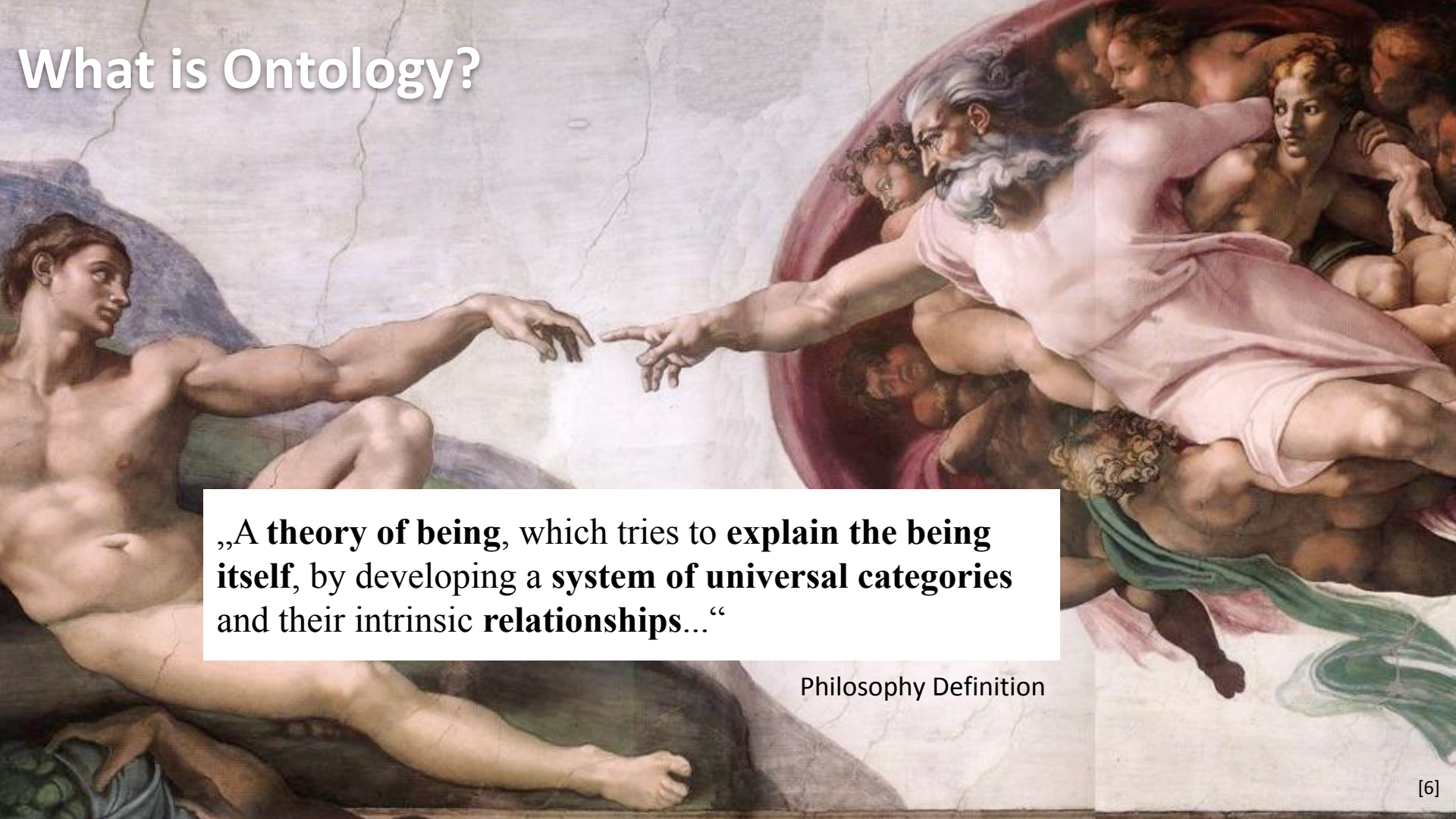
...to speak a common Language:

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Ontologies

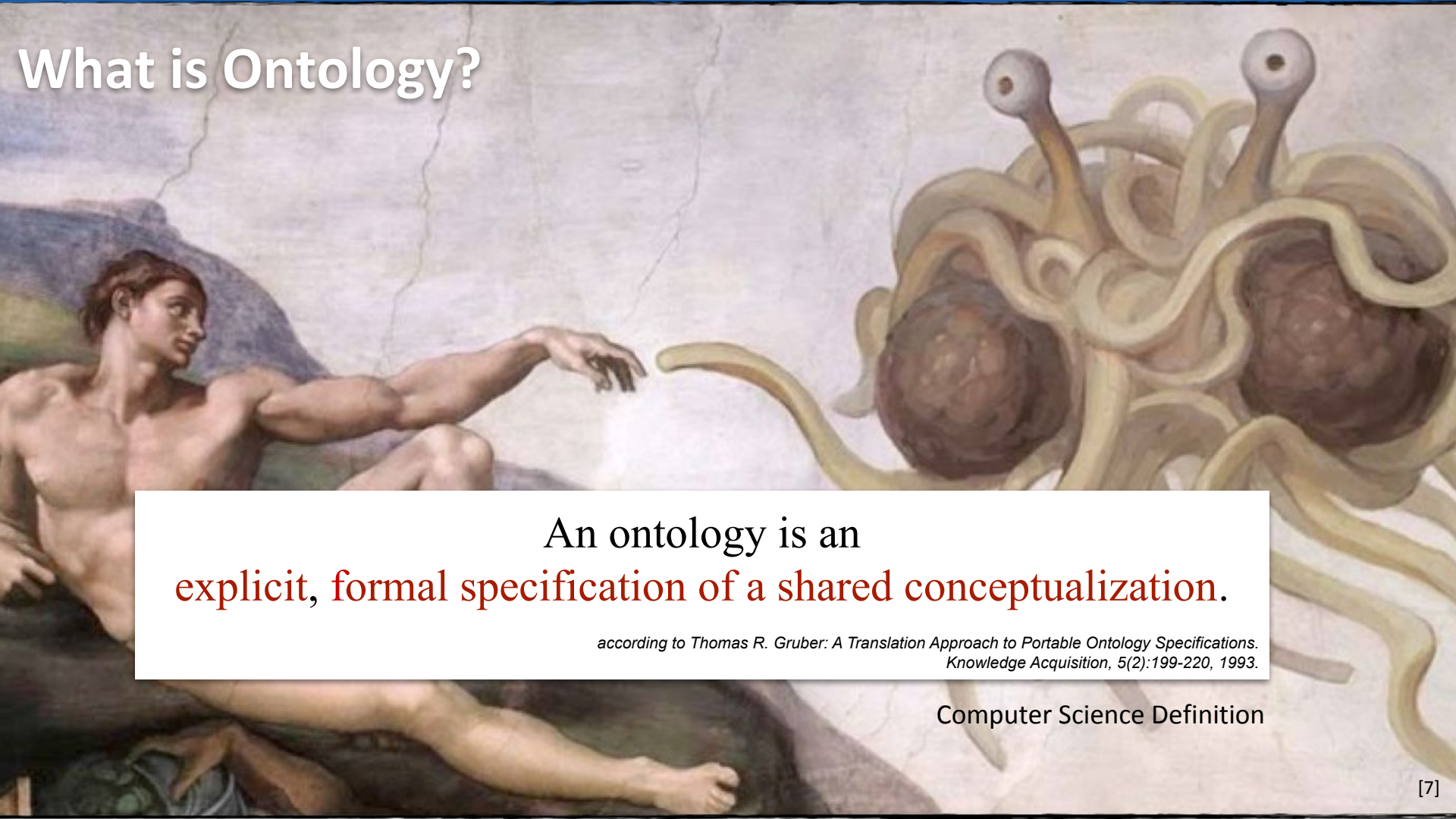
What is Ontology?

The background of the slide is a reproduction of Michelangelo's famous fresco, 'The Creation of Adam'. It depicts Adam on the left, reclining and reaching out with his right hand, and God on the right, reclining and reaching out with his right hand. The two hands are just inches apart, creating a sense of tension and divine spark. The rest of the figures in the fresco are visible in the background, including the Virgin Mary and other figures.

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

Philosophy 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.*

Computer Science Definition

What is Ontology?

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

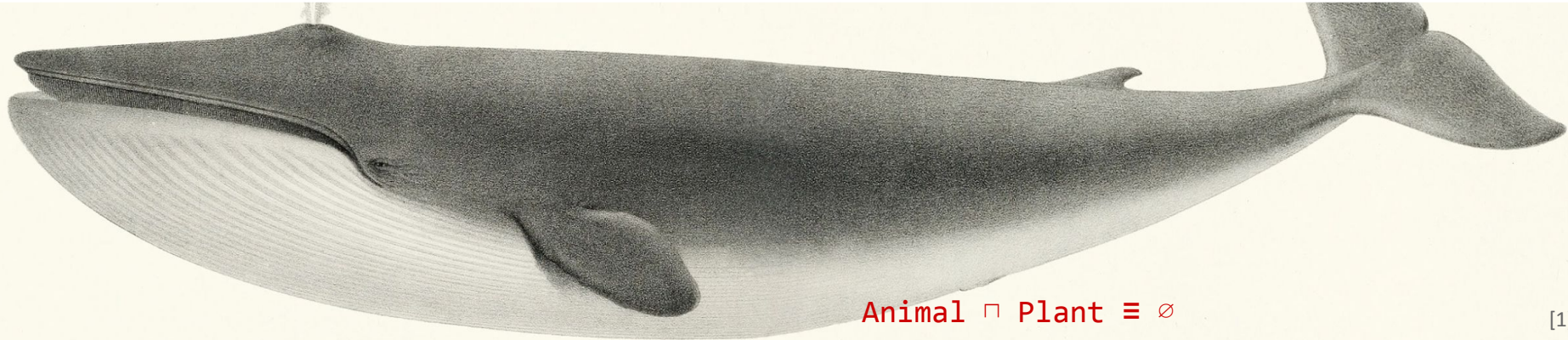
conceptualization:	abstract model (domain, identified relevant concepts, relations)
explicit:	meaning of all concepts must be defined
formal:	machine understandable
shared:	consensus about ontology

P A R E N T A L

ADVISORY

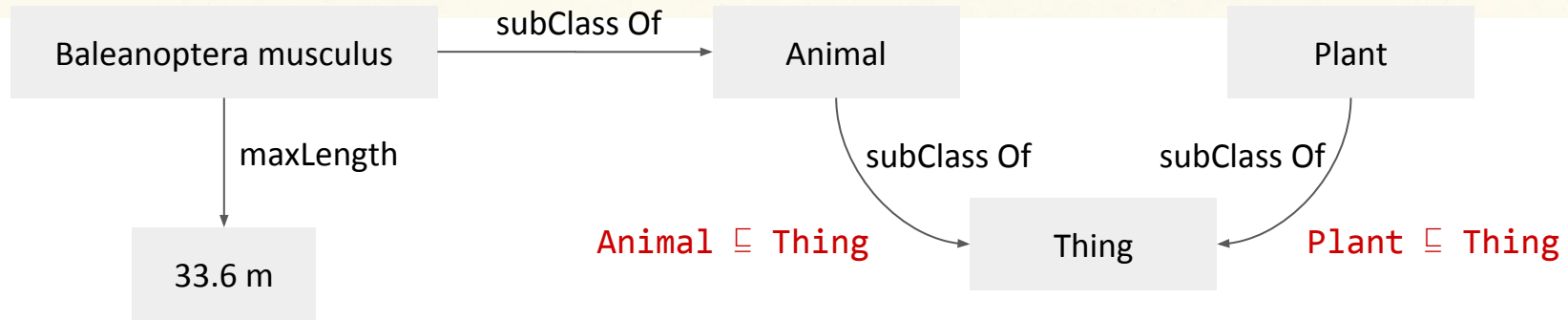
EXPLICIT SEMANTICS

Miniature Example Ontology



$Animal \sqcap Plant \equiv \emptyset$

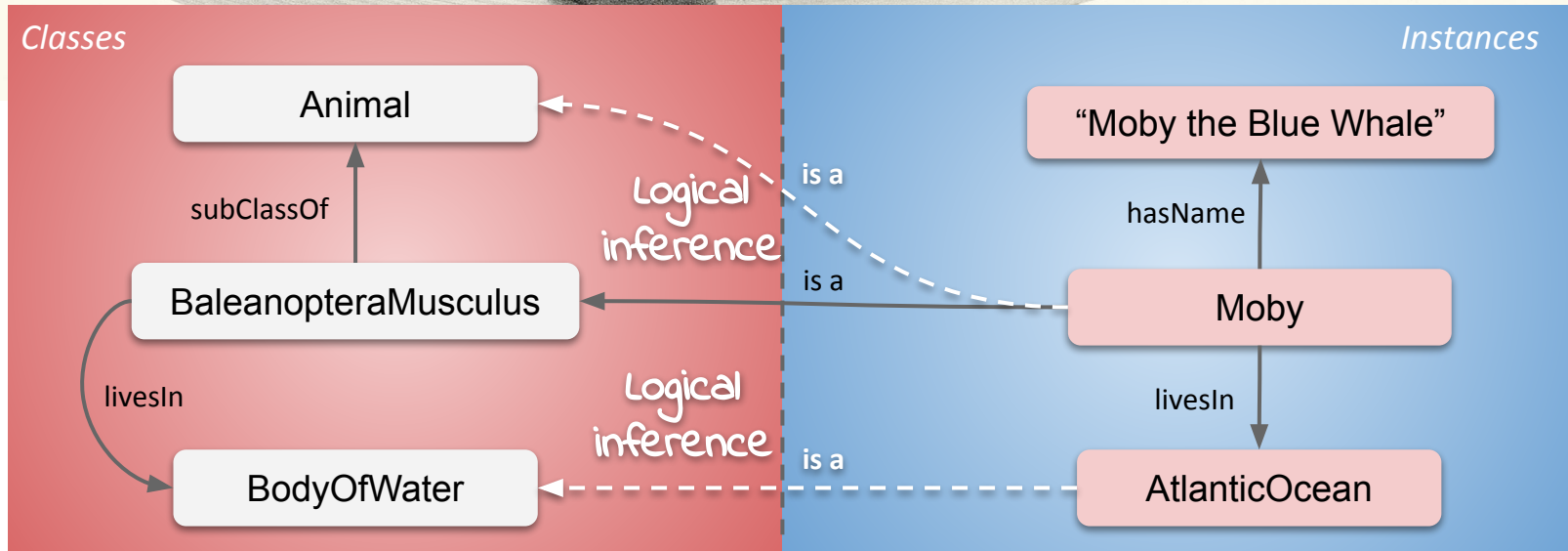
[1]



BaleanopteraMusculus \sqsubseteq **Animal** \sqcap \forall maxLength. ≤ 33.6

Class Class Property Constraint

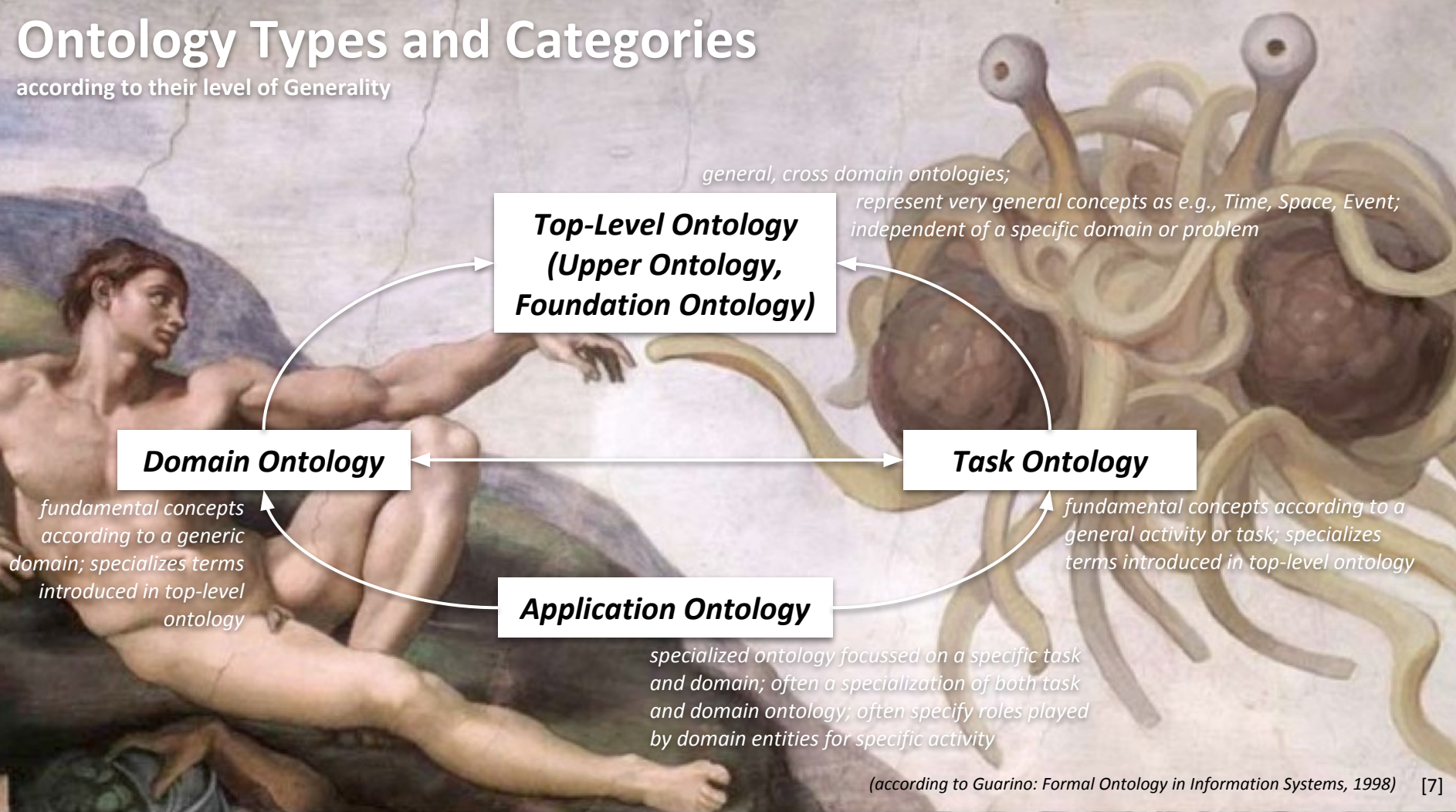
Miniature Example Knowledge Graph



[1]

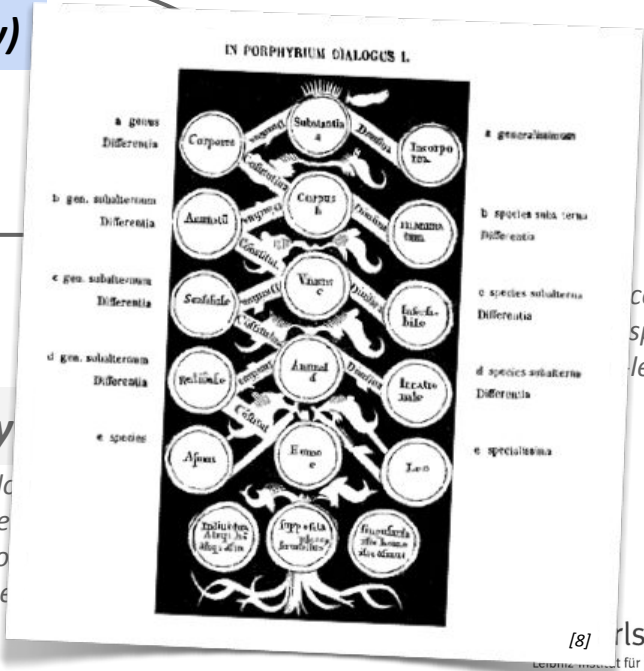
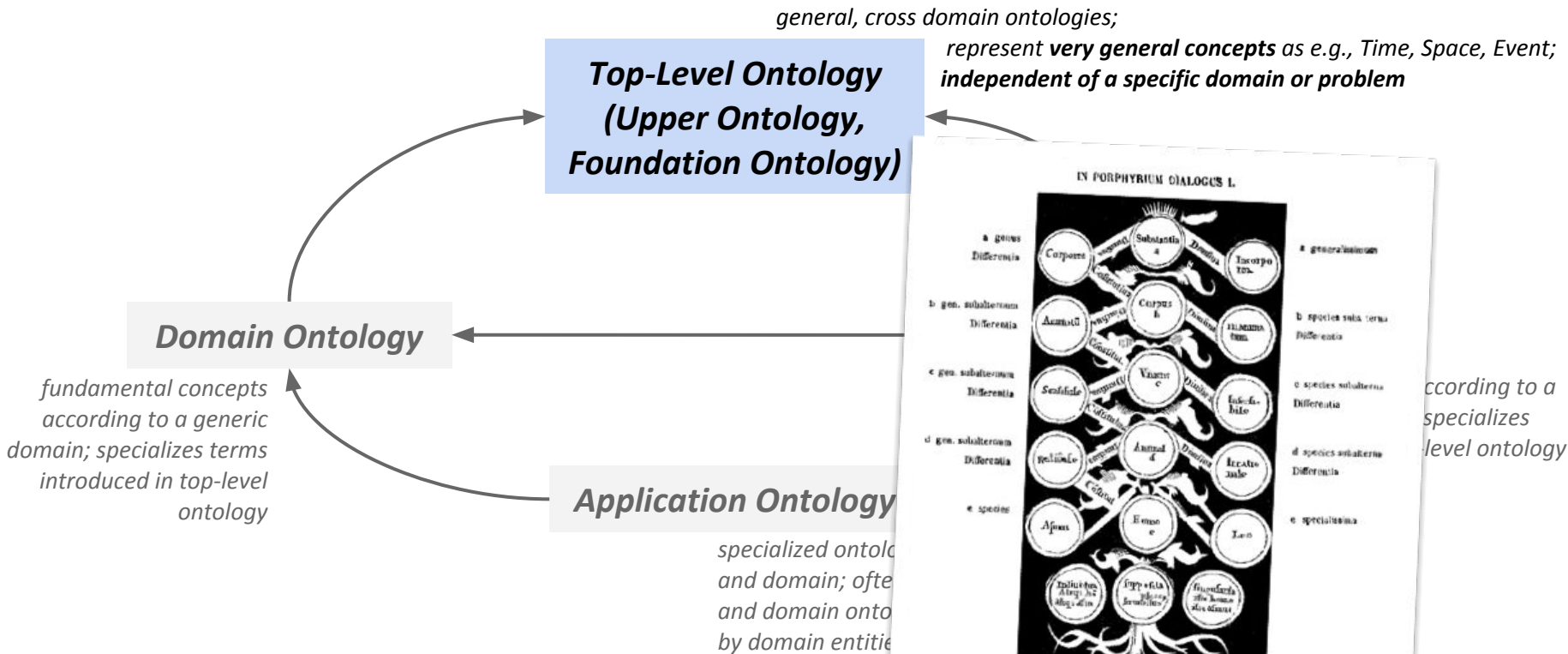
Ontology Types and Categories

according to their level of Generality



Ontology Types and Categories

according to their level of Generality



according to a
specializes
level ontology

Ontology Types and Categories

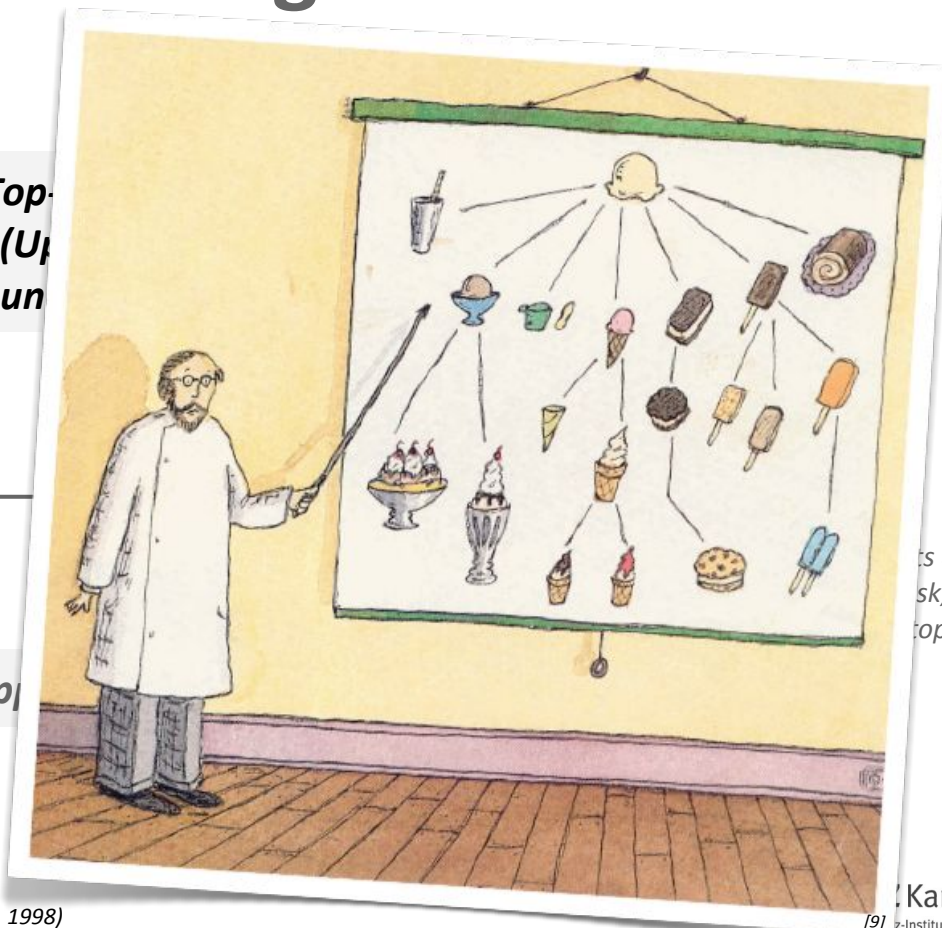
according to their level of Generality

Domain Ontology

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

Top-
(Up
Foun

Ap



Space, Event;

ts according to a
sk; specializes
top-level ontology

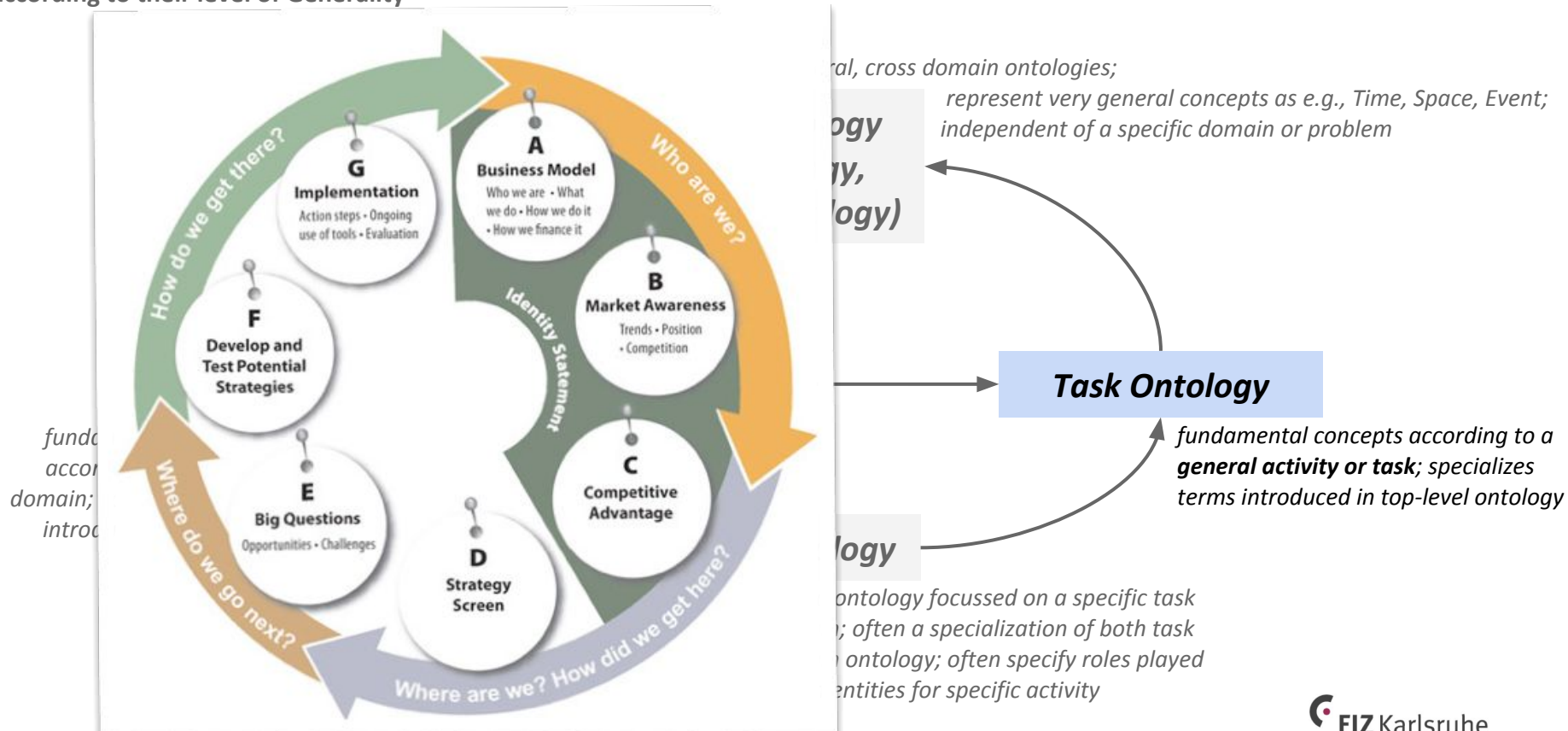
KIT Karlsruhe

[9] z-Institut für Informationsinfrastruktur

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

Ontology Types and Categories

according to their level of Generality



general, cross domain ontologies;

Domain
Ontology,
(Domain
ontology)

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

Task Ontology

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

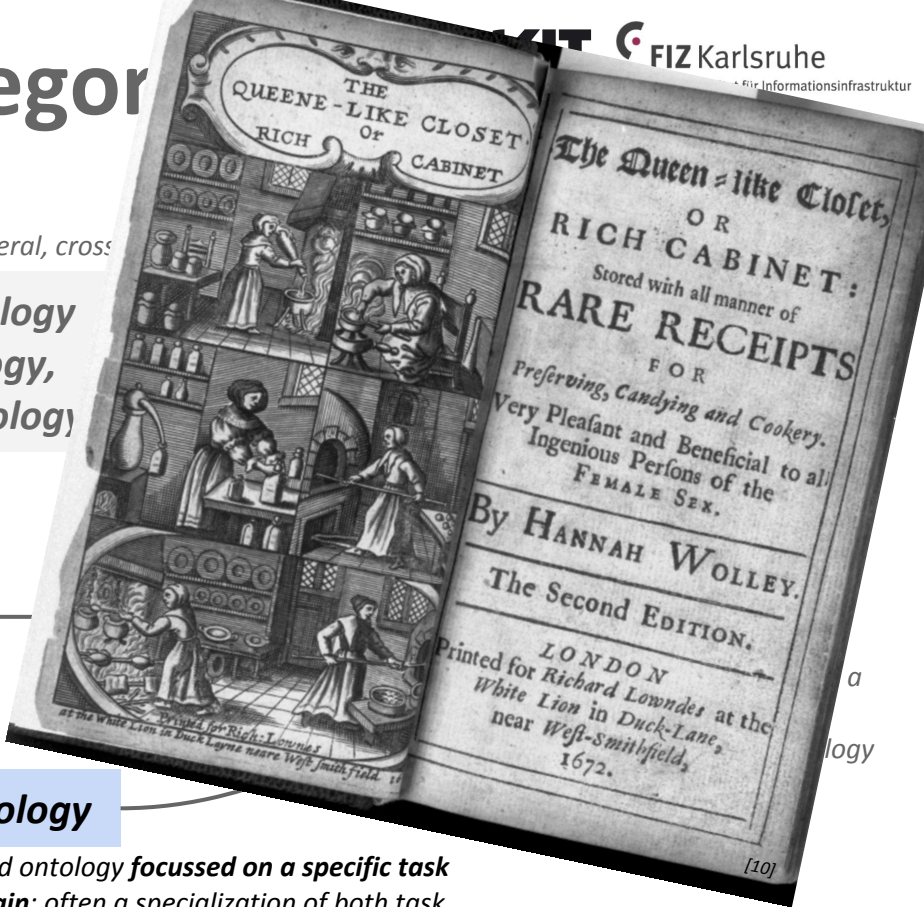
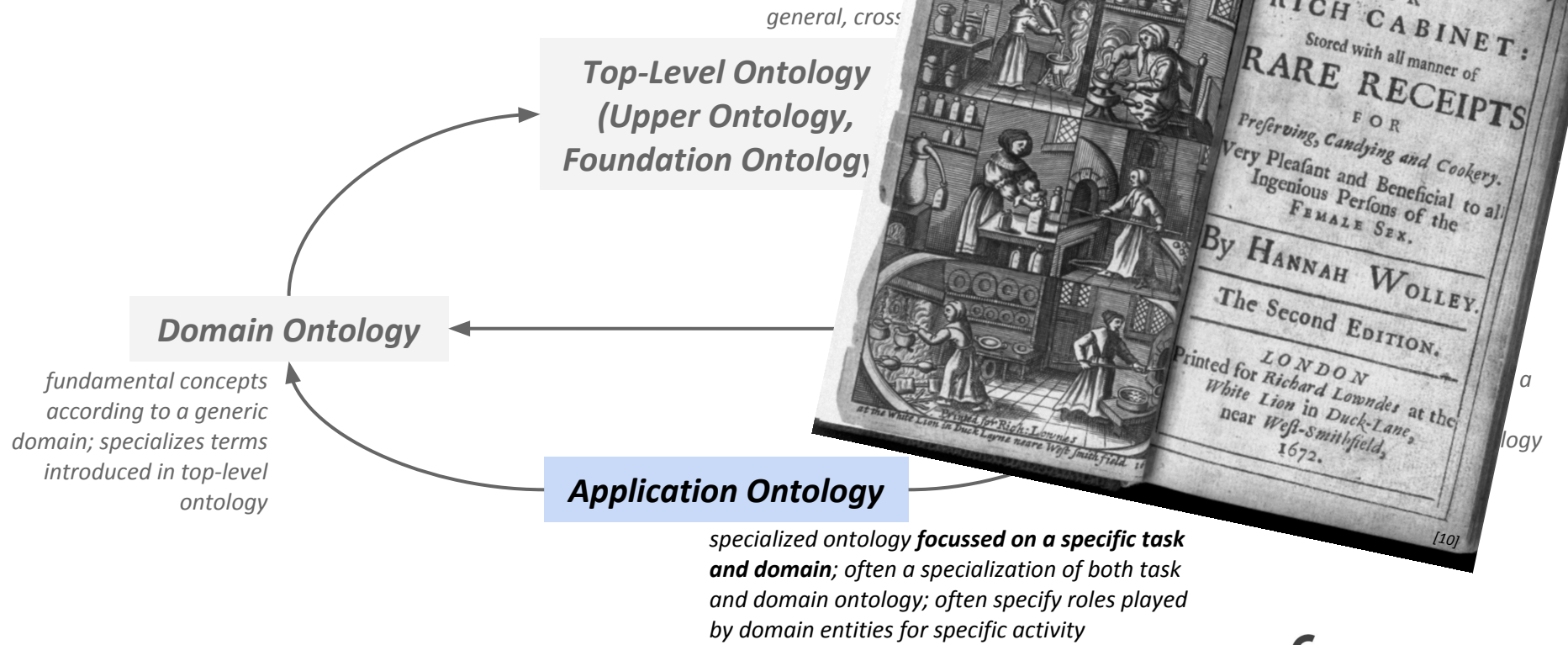
Domain
ontology

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

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

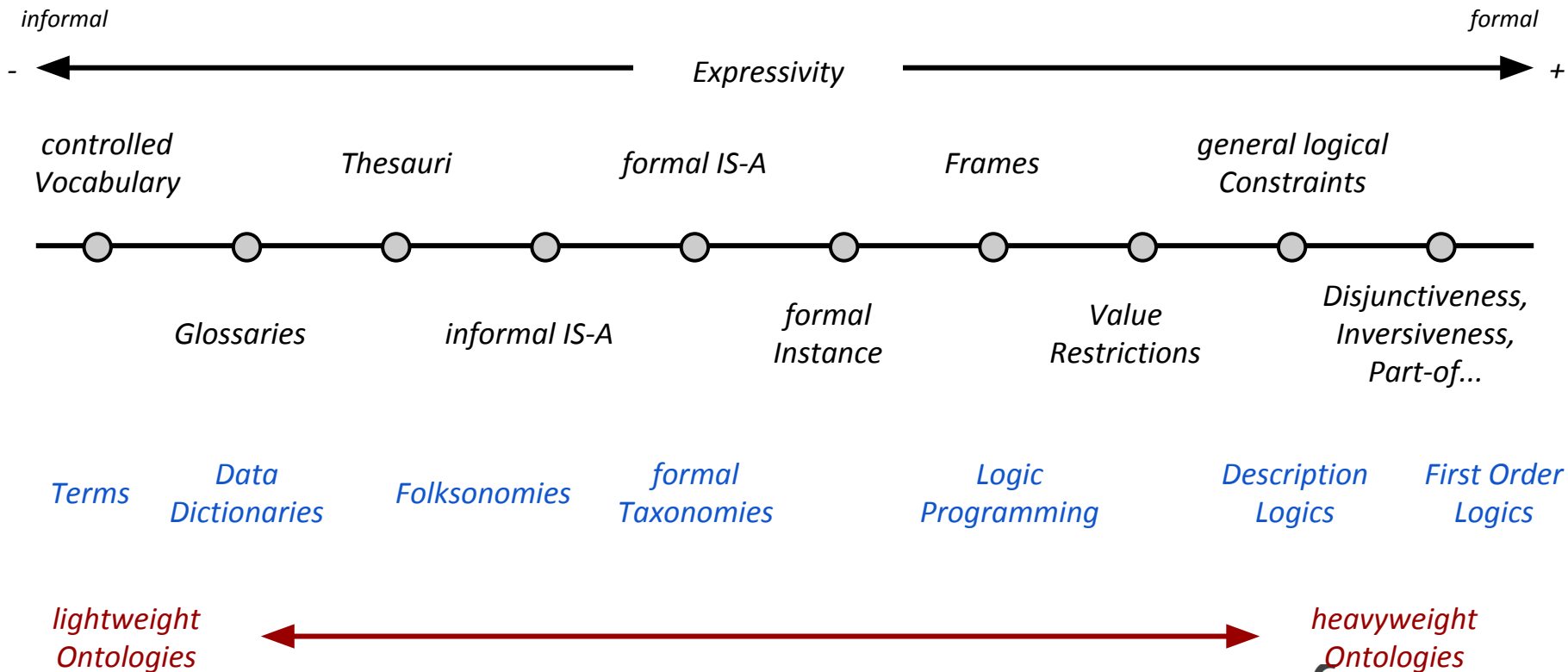
Ontology Types and Categories

according to their level of Generality



Ontology Types and Categories

according to their level of Semantic Expressivity



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

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

A woodcut-style illustration. The top half shows a sea with a human-like face blowing wind across it. Two sailing ships are on the left. The bottom half shows a green dragon with red wings and a red crest. The text is overlaid on the sea.

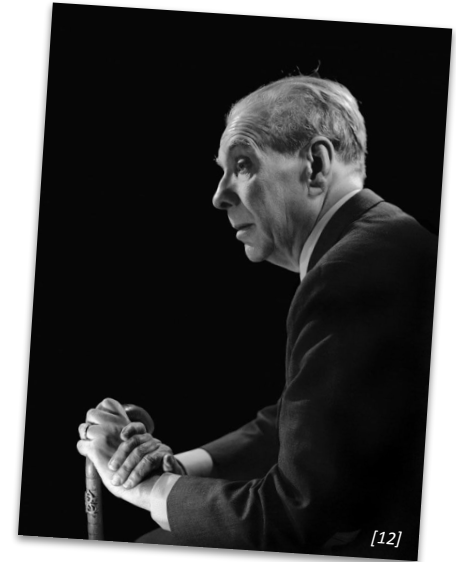
“It does not do to leave a live dragon out of your calculations,
if you live near him.”

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:

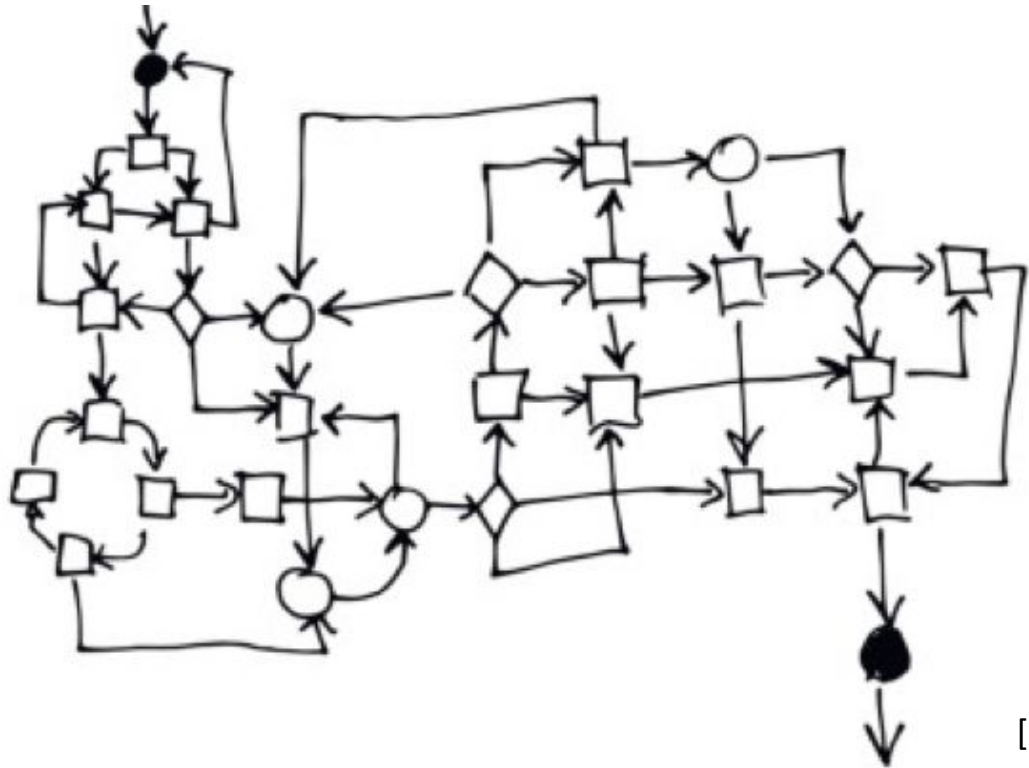
- Those that belong to the emperor
- Embalmed ones
- Those that are trained
- Suckling pigs
- Mermaids (or Sirens)
- Fabulous ones
- Stray dogs
- Those that are included in this classification
- Those that tremble as if they were mad
- Innumerable ones
- Those drawn with a very fine camel hair brush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



Jorge Luis Borges
(1899-1986)

Ontologies and Knowledge Graphs for Research Data Management

SOMETHING



[13]

Great Knowledge Graph

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	9.0275181e-01	9.4776775e-01

Ontologies and Knowledge Graphs for Research Data Management

- (1) (Raw) Research Data
- (2) **Schema Information**

Fields +

- z/d [1] string »
- Ion density (PIC-ITAP) [10¹⁵ m⁽⁻³⁾] string »
- Ion density (PIC-INP) [10¹⁵ m⁽⁻³⁾] string »
- Ion density (Fluid-DDAn) [10¹⁵ m⁽⁻³⁾] string »
- Ion density (Fluid-DDA53) [10¹⁵ m⁽⁻³⁾] string »

structured information

Benchmark data for fluid modelling of low-pressure CCRF discharge plasmas

Plasma Chemical Processes

The dataset contains data from comparative studies of capacitively coupled radio-frequency (CCRF) discharges in helium and argon at pressures between 10 and 80 Pa applying two different fluid modeling approaches as well as two independently developed particle-in-cell Monte Carlo collision (PIC-MCC) codes. The dataset provides a test bed for future studies of simple ccrf discharge configurations in helium and argon at pressures ranging from 10 to 80 Pa.

plasma modelling/simulation benchmark data

unstructured information

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) Benchmark data for CCRF discharge plasmas - time averaged ion density (helium, 40 Pa) Raw benchmark data for CCRF discharge plasmas - time averaged ion density (helium, 80 Pa) Show more
Identifier	60dbccd4-8be4-4f41-896c-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

Ontologies and Knowledge Graphs for Research Data Management

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

semantic information



- Main page
- Community portal
- Project chat
- Create a new item
- Create a new Lexeme
- Recent changes
- Random item
- Query Service
- Nearby
- Help
- Donate
- Print/export
- Create a book
- Download as PDF
- Printable version

Item Discussion

plasma (Q10251)

state of matter consisting of ionized gas
 materia plasmática | gas ionizado

~ In more languages
 Configure

Language	Label	Description	Also known as
English	plasma	state of matter consisting of ionized gas	materia plasmática gas ionizado
German	Plasma	Gas, dessen Bestandteile teilweise oder vollständig als Ionen und Elektronen vorliegen	
French	plasma	état de la matière où sont mélangés des électrons, des ions et des noyaux atomiques	
Bavarian	No label defined	No description defined	

All entered languages

Statements

instance of

- fundamental state of matter edit
 - sourcing circumstances: disputed
 - ~ 0 references
 - + add reference
- classical state of matter edit
 - ~ 0 references
 - + add reference
 - + add value

subclass of

- gas edit
 - sourcing circumstances: disputed

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.

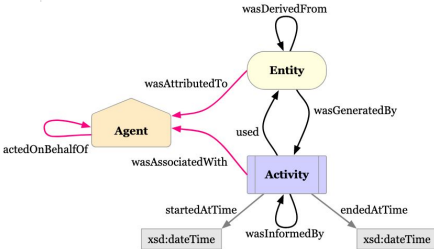
Plasma is an electrically neutral medium of unbound positive and negative particles (i.e. the overall charge of a plasma is roughly zero). Although these particles are unbound, they are not "free" in the sense of not experiencing forces. Moving charged particles generate an electric current within a 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.^{[1][23]} Three factors define a plasma:^{[24][25]}

- The plasma approximation:** The plasma approximation applies when the plasma parameter, $n_e^{[26]}$ 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]}
- 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]
- 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 (فيزياء)
ast	Plasma (estáu de la materia)
as	প্লাজমা
az	Plasma
ba	Плазма
be	Плазма
bg	Плазма
bn	প্লাজমা
bs	Plasma (fizika)
ca	Plasma (estat de la matèria)
ceb	Plasma (fisika)
ckb	پلازما (فیزیک)
cs	Plasma
cv	Плазма
cy	Plasma (ffiseg)
da	Plasma
de	Plasma (Physik)
el	Πλάσμα (φυσική)
eml	Plasma
en	Plasma (physics)
eo	Plasma
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]

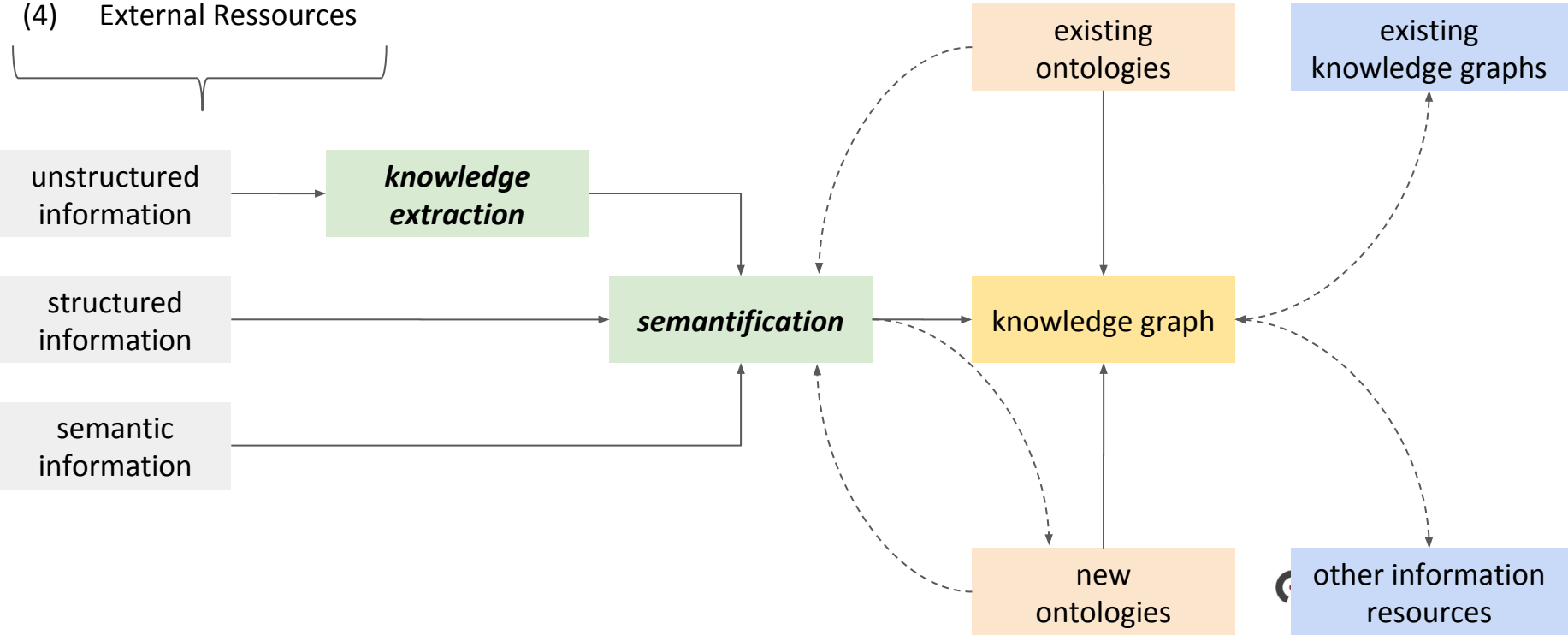
V · T · E

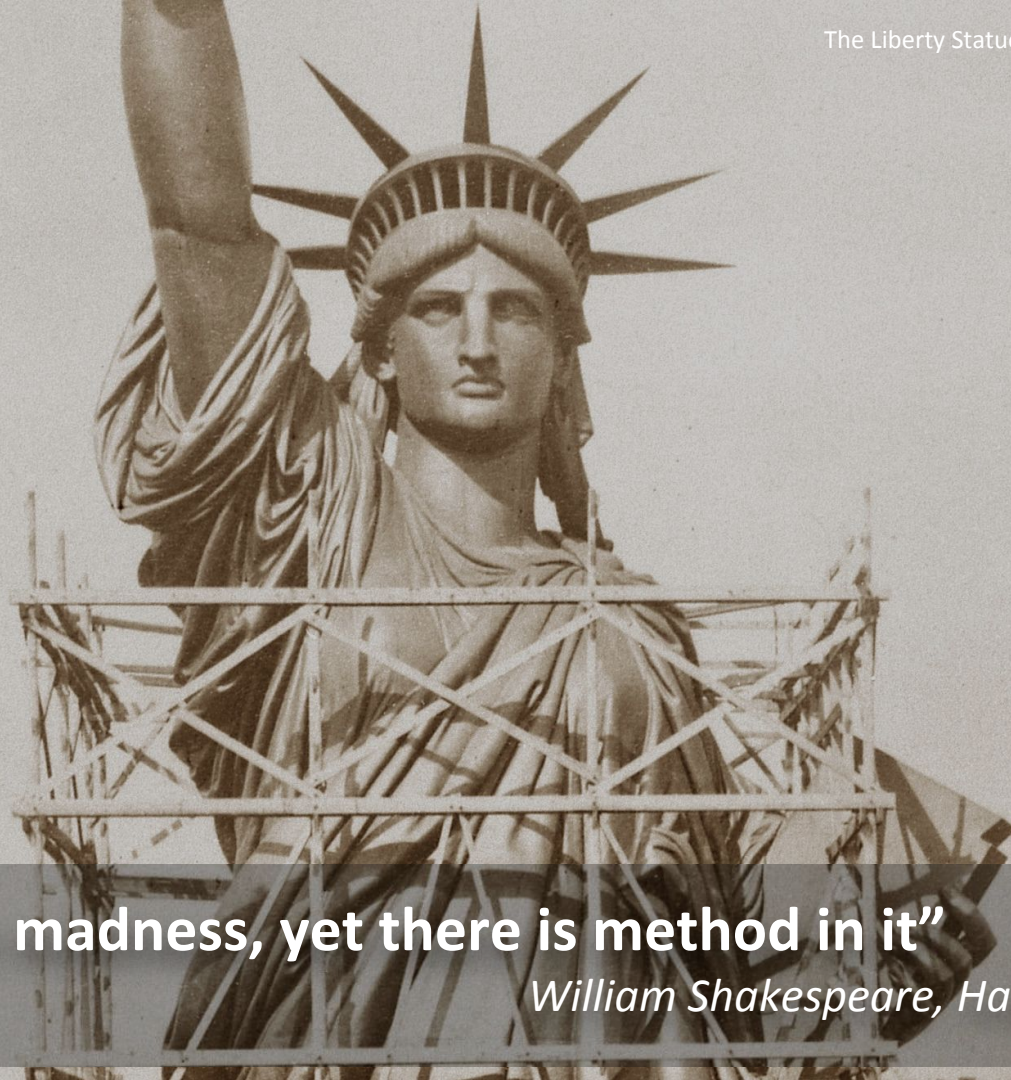
structured information



Ontologies and Knowledge Graphs for Research Data Management

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





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

William Shakespeare, Hamlet (1602)

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

Most apps use only a subset of the stack

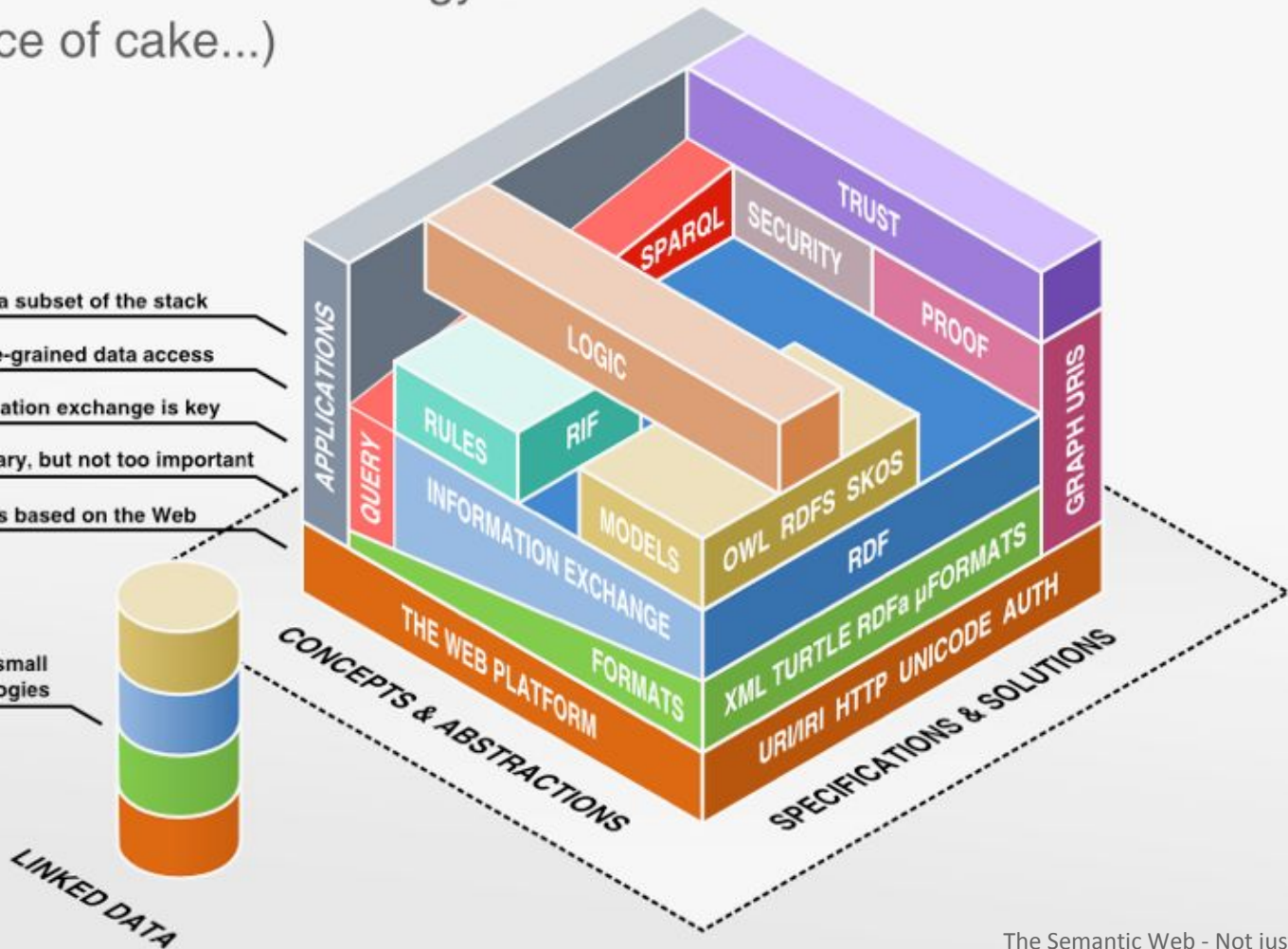
Querying allows fine-grained data access

Standardized information exchange is key

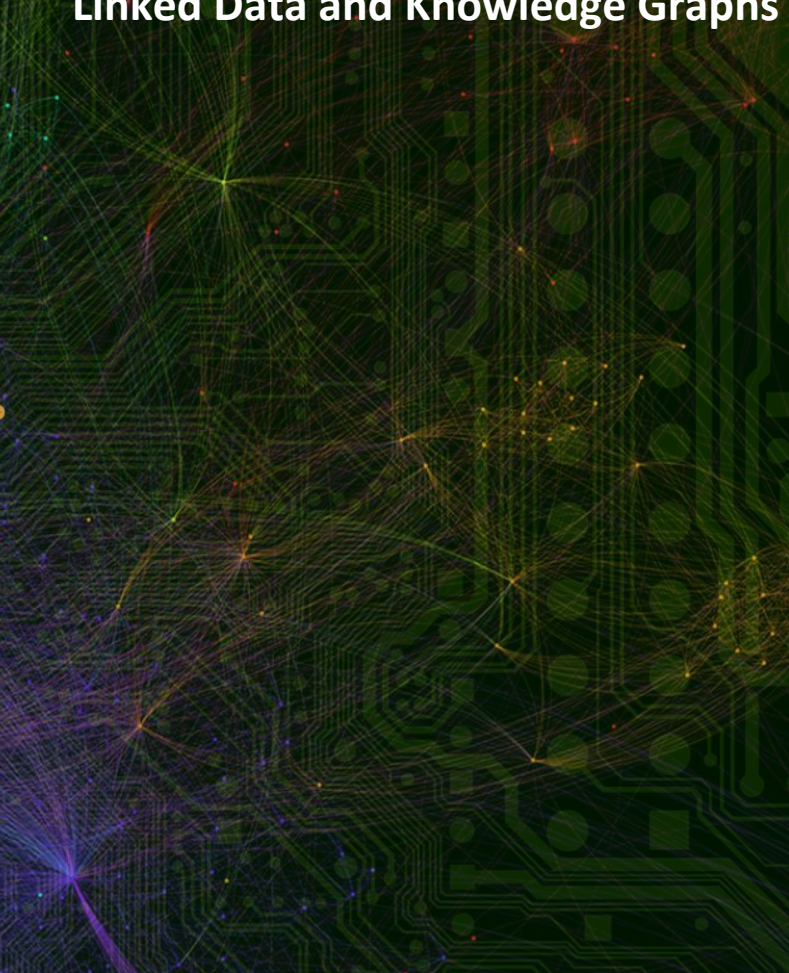
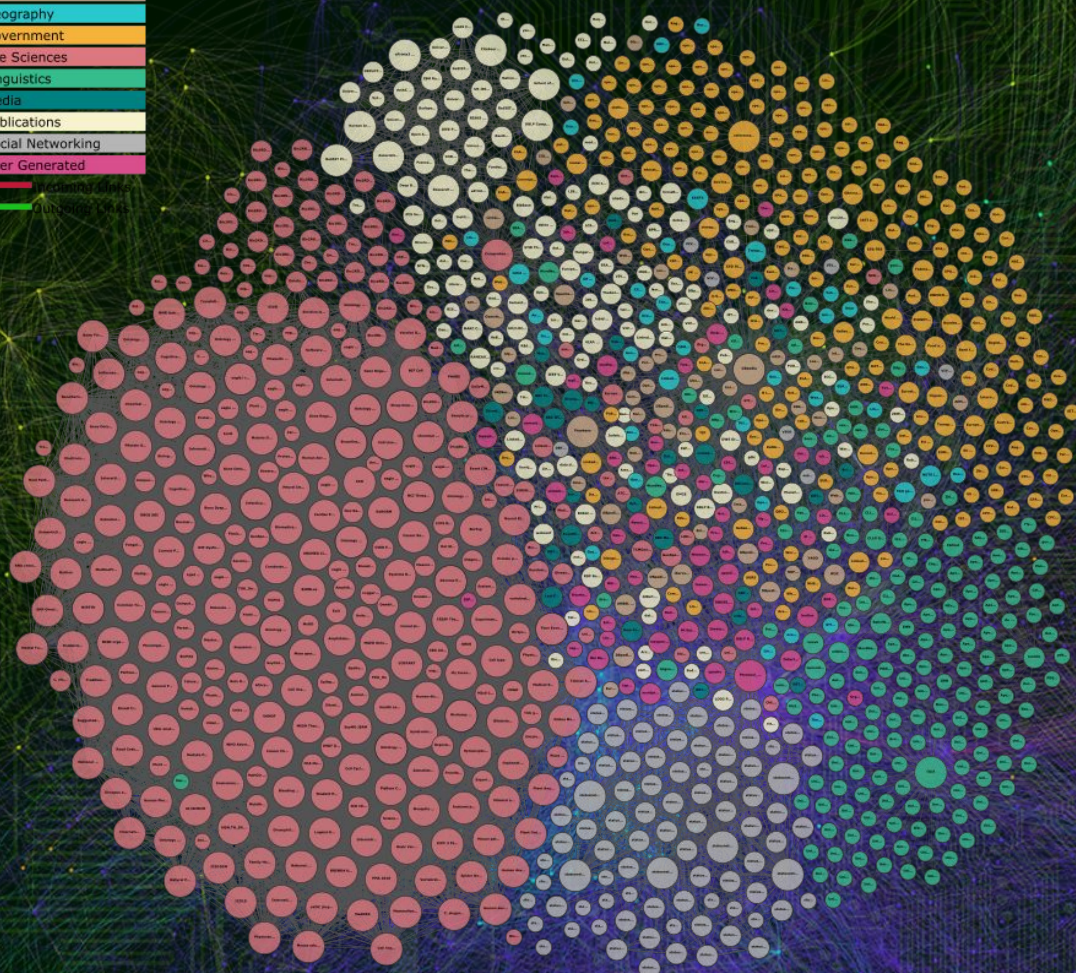
Formats are necessary, but not too important

The Semantic Web is based on the Web

Linked Data uses a small selection of technologies

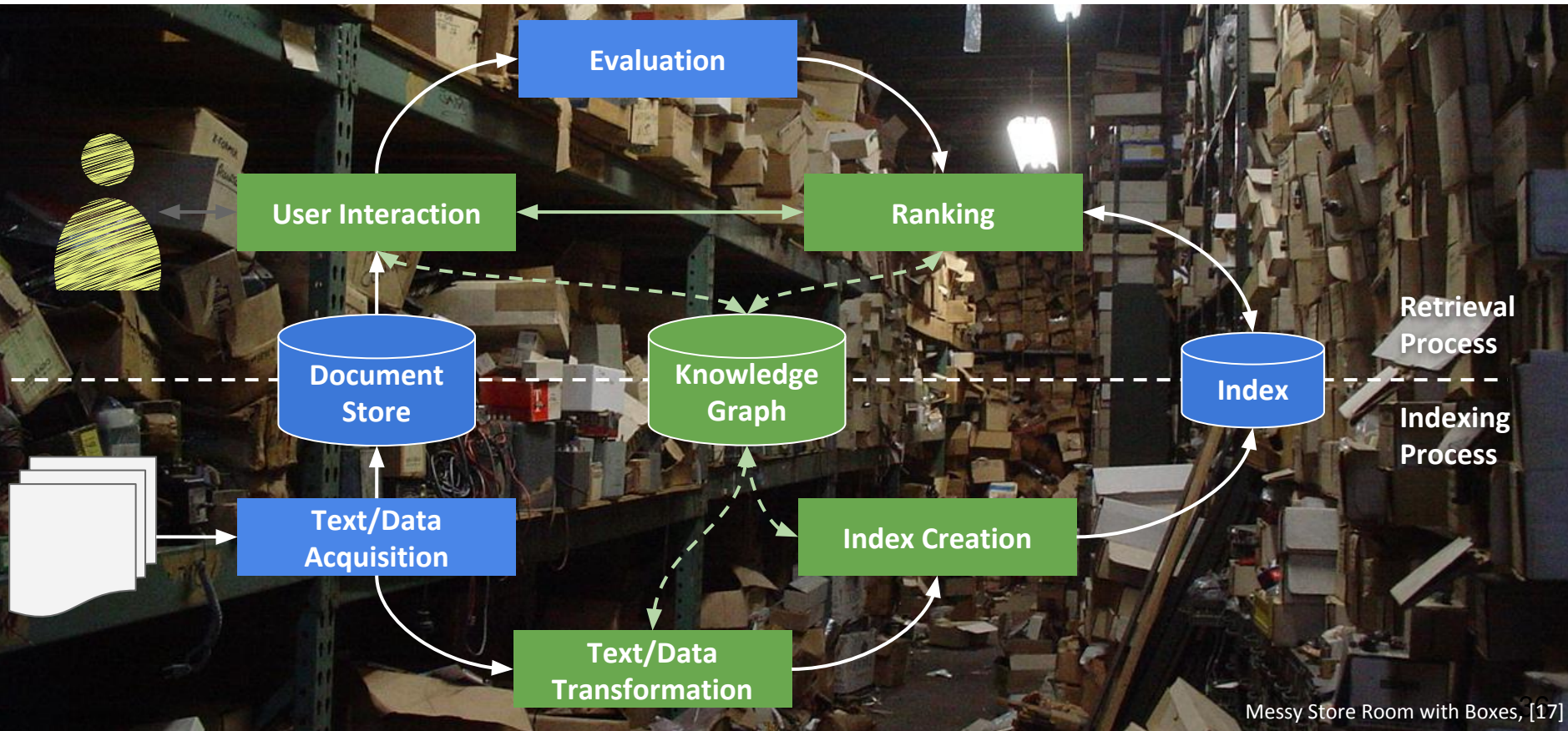


Linked Data and Knowledge Graphs



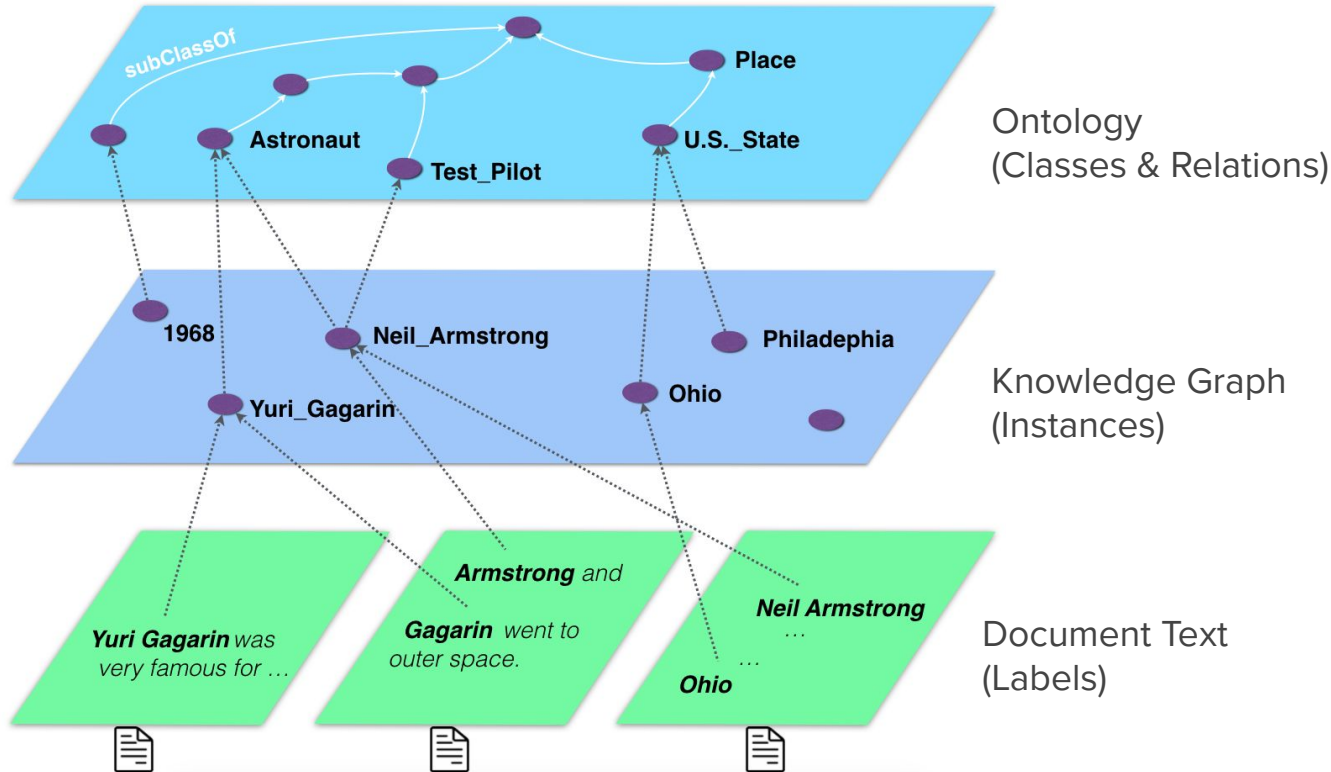
Semantic Search & Retrieval

Ontology & Knowledge Graph Applications



Semantic Search & Retrieval

Ontology & Knowledge Graph Applications



Ontology
(Classes & Relations)

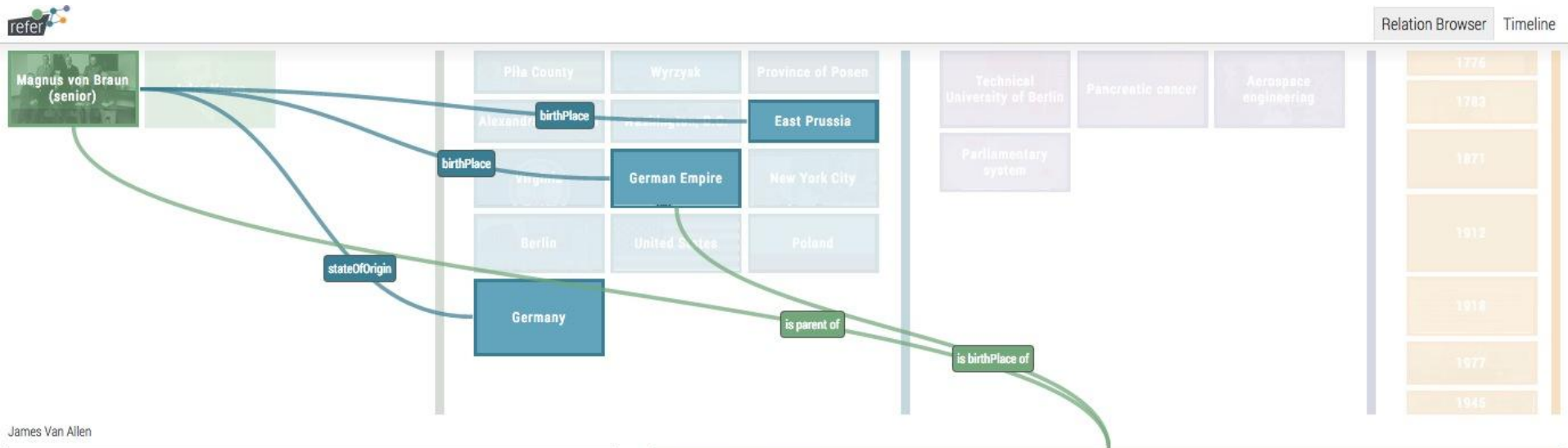
Knowledge Graph
(Instances)

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



James Van Allen

15 Recommended Articles:

- #1 Willy Ley Founder Of The German Rocket Society
- #2 The First Us Space Station Skylab
- #3 Hermann Oberths Dream Of Space Travel
- #4 Wolfgang Pauli And The Pauli Principle
- #5 Maria Goeppert Mayer And The Nuclear Shell Model
- #6 Oskar von Miller and the Deutsches Museum

Wernher von Braun



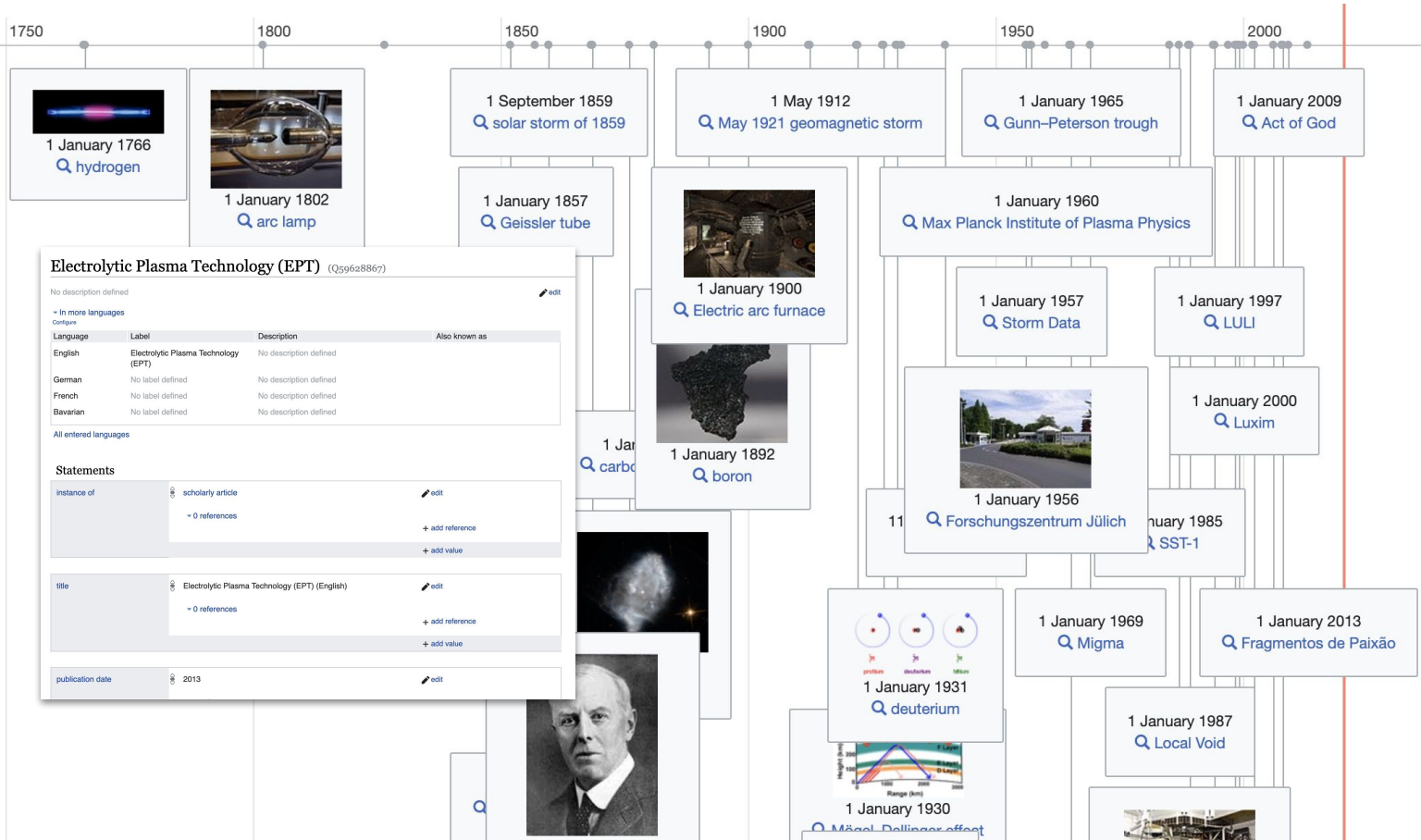
Wernher Magnus Maximilian, Freiherr von Braun (March 23, 1912 – June 16, 1977) was a German rocket engineer and space architect. He was one of the leading figures in the development of rocket technology in Germany during World War II and, subsequently, in the United States. He is credited as being the "Father of Rocket Science". In his 20s and early 30s, von Braun was the central figure in the Nazis' rocket development program, responsible for the design and realization of the V-2 combat rocket during World War II. After the war, he and some select members of his rocket team were taken to the United States as part of the then-secret Operation Paperclip. Von Braun worked on the United States Army intermediate range ballistic missile (IRBM) program before his group was assimilated by NASA. Under NASA, he served as

DBpedia: Wernher von Braun

e.g. via refer.cx WordPress Plugin at <http://scih.org/>

An Evolving Knowledge Graph

For Plasma Technology



Electrolytic Plasma Technology (EPT) (Q59628867)

No description defined edit

[In more languages](#)

Compare

Language	Label	Description	Also known as
English	Electrolytic Plasma Technology (EPT)	No description defined	
German	No label defined	No description defined	
French	No label defined	No description defined	
Bavarian	No label defined	No description defined	

All entered languages

Statements

instance of scholarly article edit
- 0 references + add reference + add value

title Electrolytic Plasma Technology (EPT) (English) edit
- 0 references + add reference + add value

publication date 2013 edit

to be continued...

**“Technology presumes there's just one right way
to do things and there never is”**

Robert M. Pirsig, Zen and the Art of Motorcycle Maintenance (1974)

Prof. Dr. Harald Sack

Knowledge Graphs for Research Data Management

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twitter: [lysander07](https://twitter.com/lysander07)

QPTDat Workshop 2020

Karlsruhe, 23. Jan. 2020

QPTDat 

Quality | Plasma Technology | Data

 **FIZ Karlsruhe**

Leibniz-Institut für Informationsinfrastruktur

Mitglied der

Leibniz
Gemeinschaft

Image References:

- [1] The Sulphurbottom (*Sibbaldius sulfureus*) from Natural history of the cetaceans and other marine mammals of the western coast of North America (1872) by Charles Melville Scammon (1825-1911). <https://www.rawpixel.com/board/328227/charles-melville-scammons-marine-mammals>
- [2] Matrix Computer Screen, <https://pixabay.com/illustrations/matrix-code-computer-pc-data-356024/>
- [3] UBC Library Card Catalog, Paul Joseph, cc-by-2.0, https://commons.wikimedia.org/wiki/File:2009_3544505541_card_catalog.jpg
- [4] Tree of knowledge based on the French Encyclopedie from 1780, https://commons.wikimedia.org/wiki/File:Essai_d%27une_distribution_g%C3%A9n%C3%A9alogique_des_sciences_et_des_arts_principaux_1780.jpg
- [5] Pieter Bruegel the Elder, The Tower of Babel, 1563, [https://commons.wikimedia.org/wiki/File:Pieter_Bruegel_the_Elder_-_The_Tower_of_Babel_\(Vienna\)_-Google_Art_Project_-_edited.jpg](https://commons.wikimedia.org/wiki/File:Pieter_Bruegel_the_Elder_-_The_Tower_of_Babel_(Vienna)_-Google_Art_Project_-_edited.jpg)
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