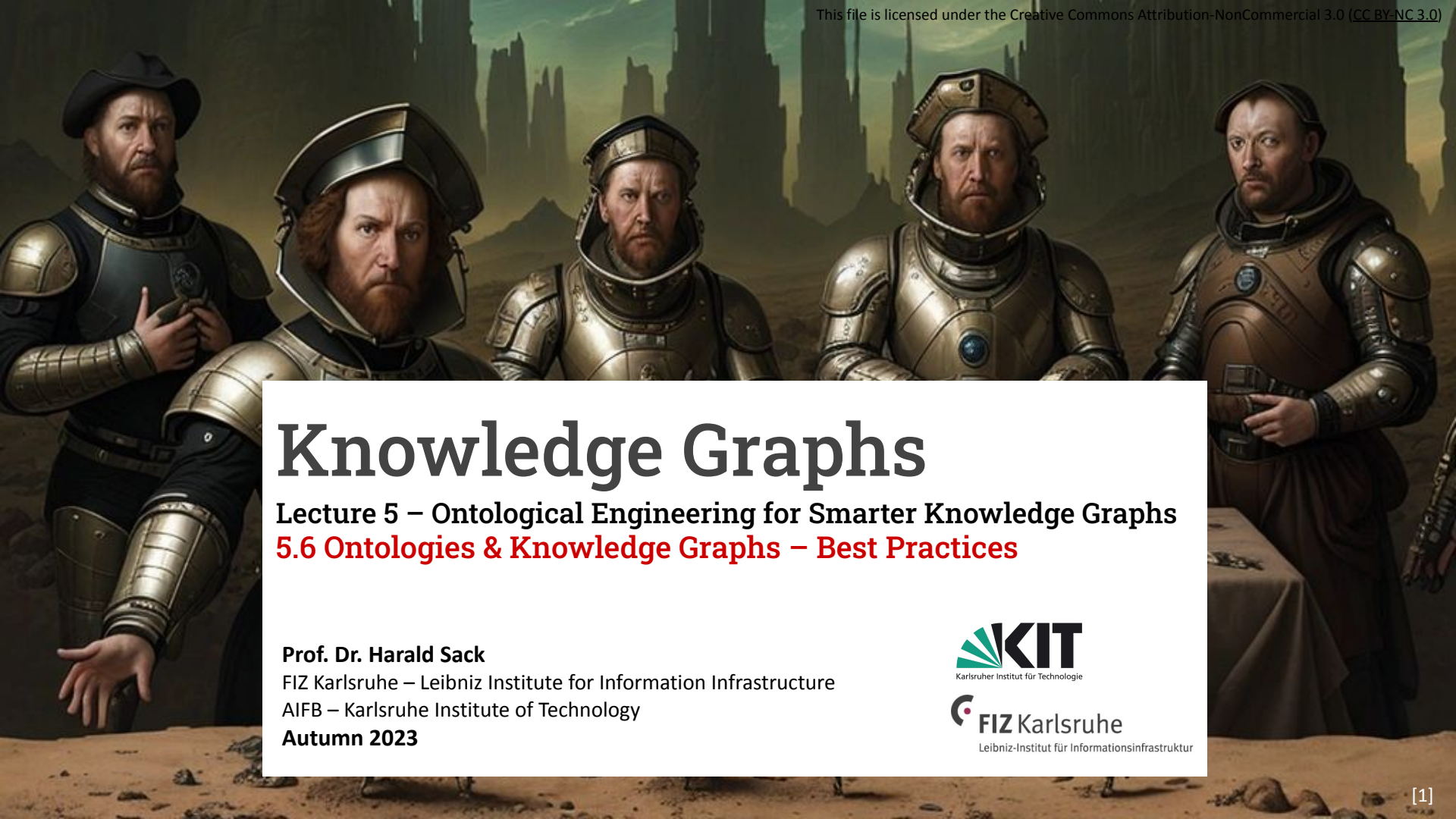

Knowledge Graphs

Lecture 5 – Ontological Engineering for Smarter Knowledge Graphs

5.6 Ontologies & Knowledge Graphs – Best Practices

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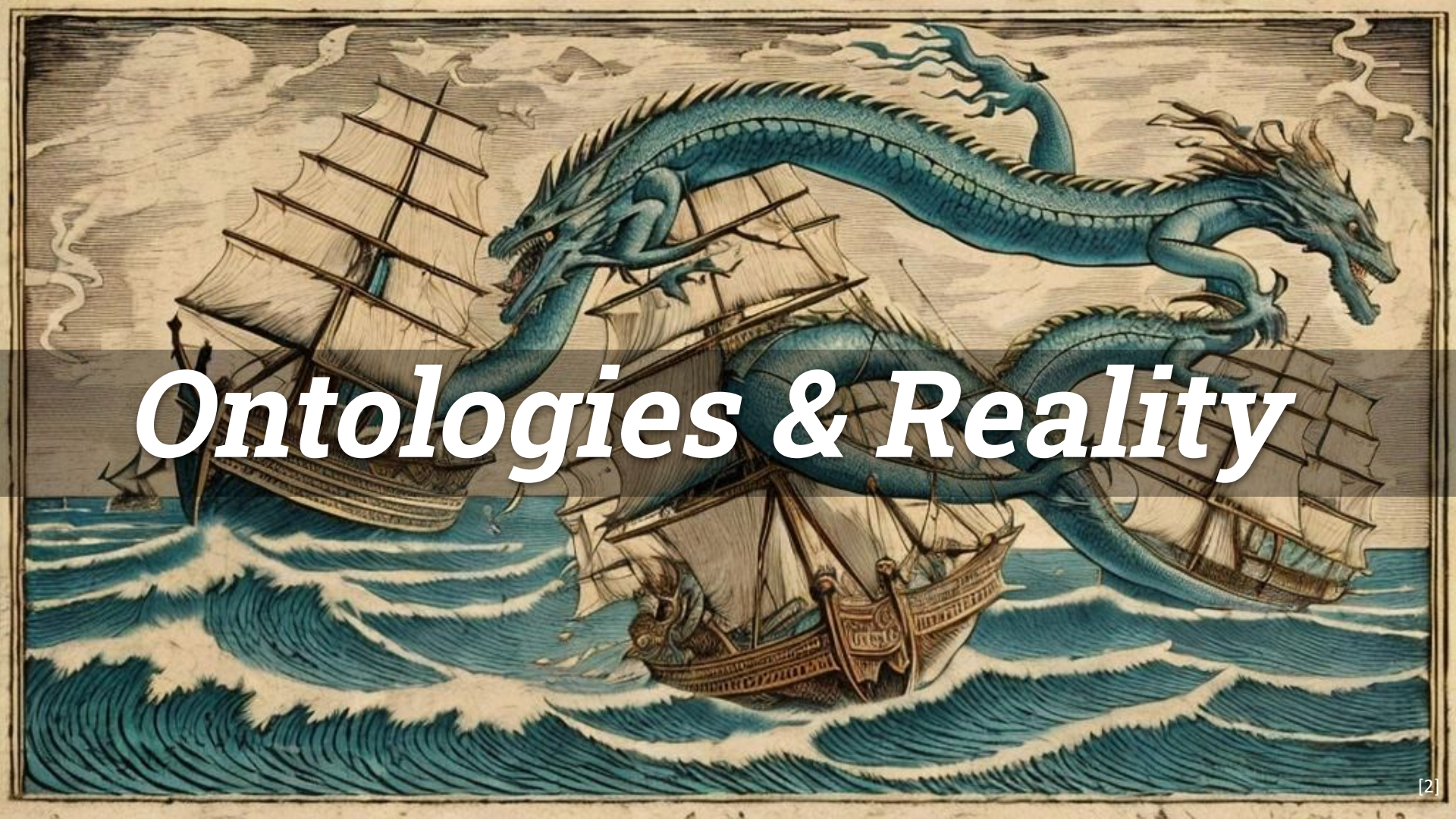
FIZ Karlsruhe – Leibniz Institute for Information Infrastructure
AIFB – Karlsruhe Institute of Technology
Autumn 2023

Knowledge Graphs

Lecture 5: Ontological Engineering for Smarter Knowledge Graphs

Karlsruher Institut für Technologie

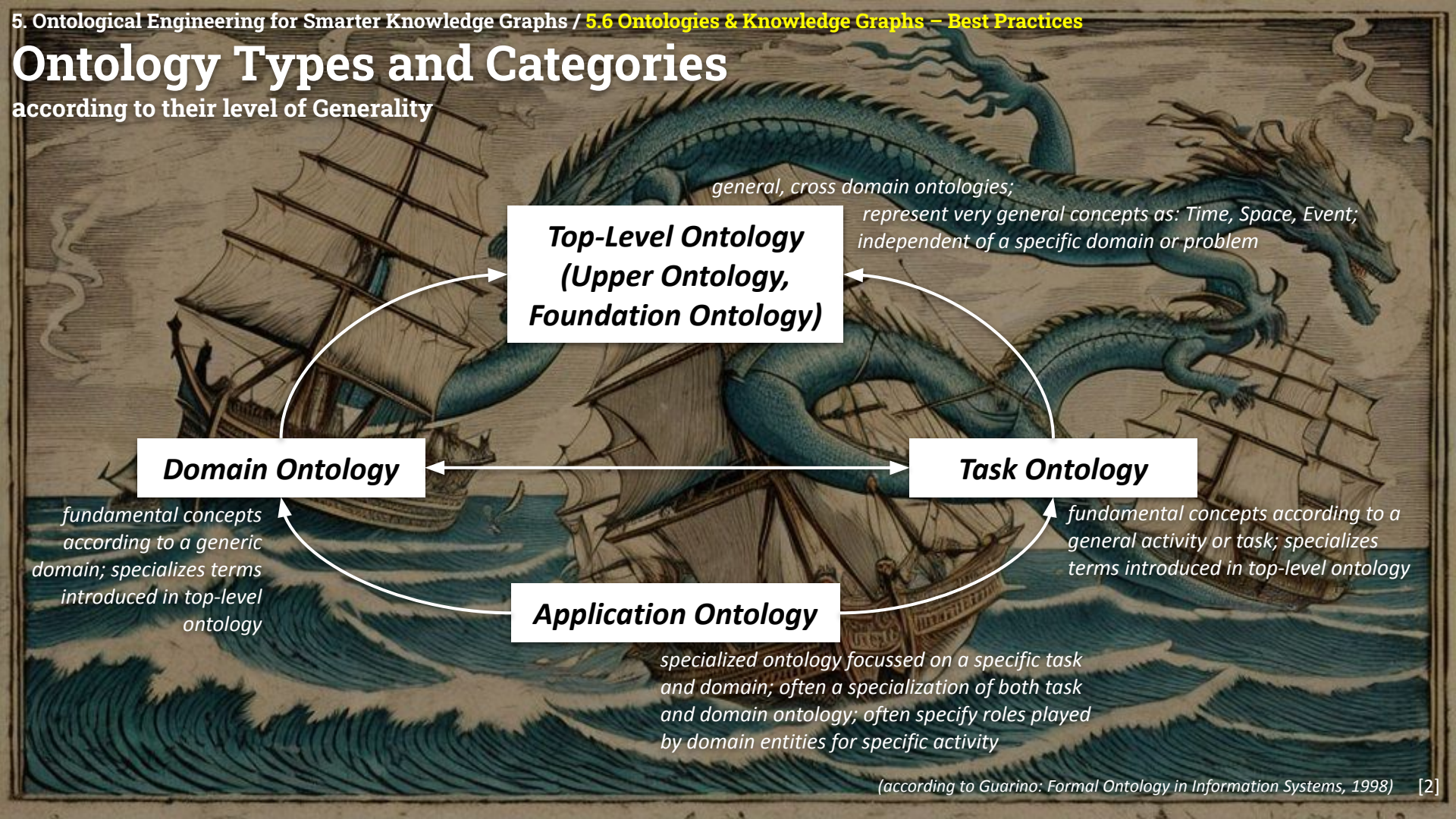
FIZ Karlsruhe
Leibniz Institute for Information Infrastructure



[2]

Ontology Types and Categories

according to their level of Generality

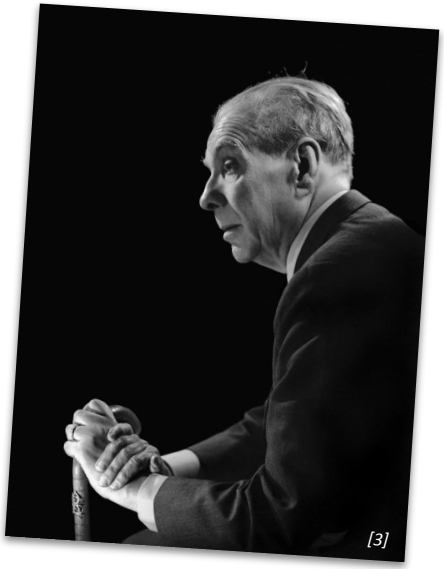


(according to Guarino: Formal Ontology in Information Systems, 1998) [2]

Ontologies as Interpretations of Reality

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

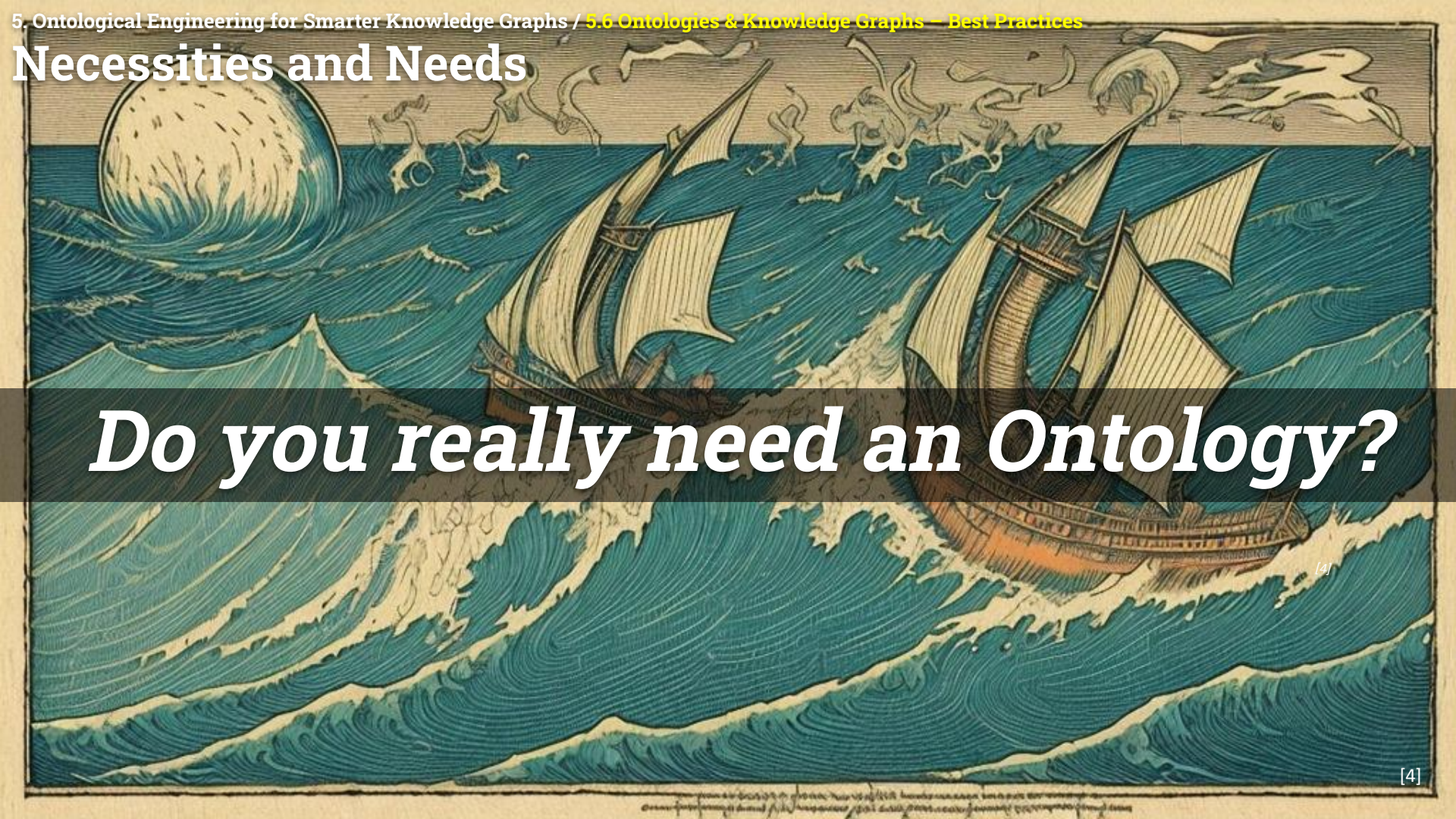
- Those that belong to the emperor
- Embalmed ones
- Those that are trained
- Suckling pigs
- Mermaids (or Sirens)
- Fabulous ones
- Stray dogs
- Those that are included in this classification
- Those that tremble as if they were mad
- Innumerable ones
- Those drawn with a very fine camel hair brush
- 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)

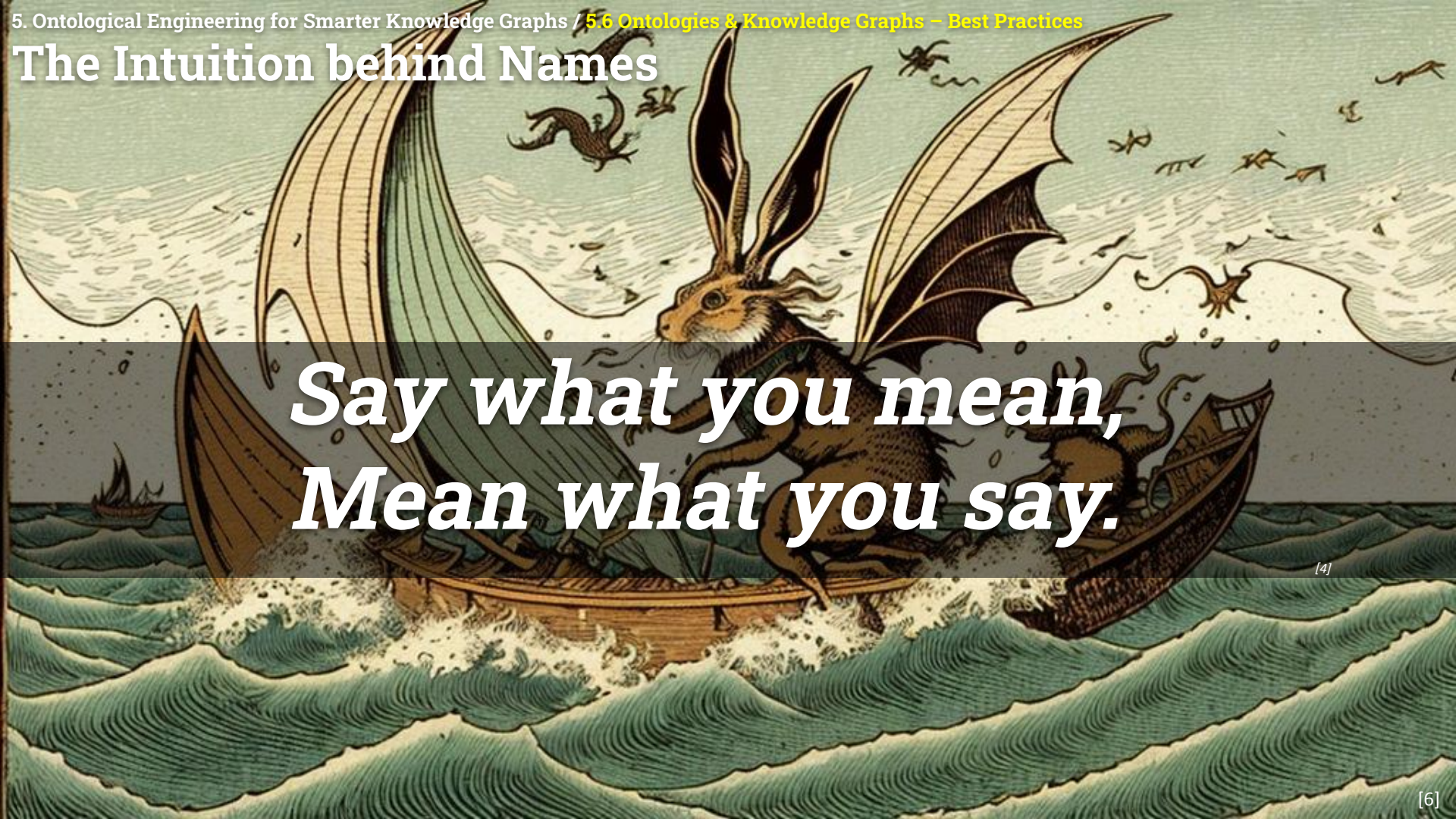
Necessities and Needs



[4]

Take the Pragmatic Approach

The Intuition behind Names

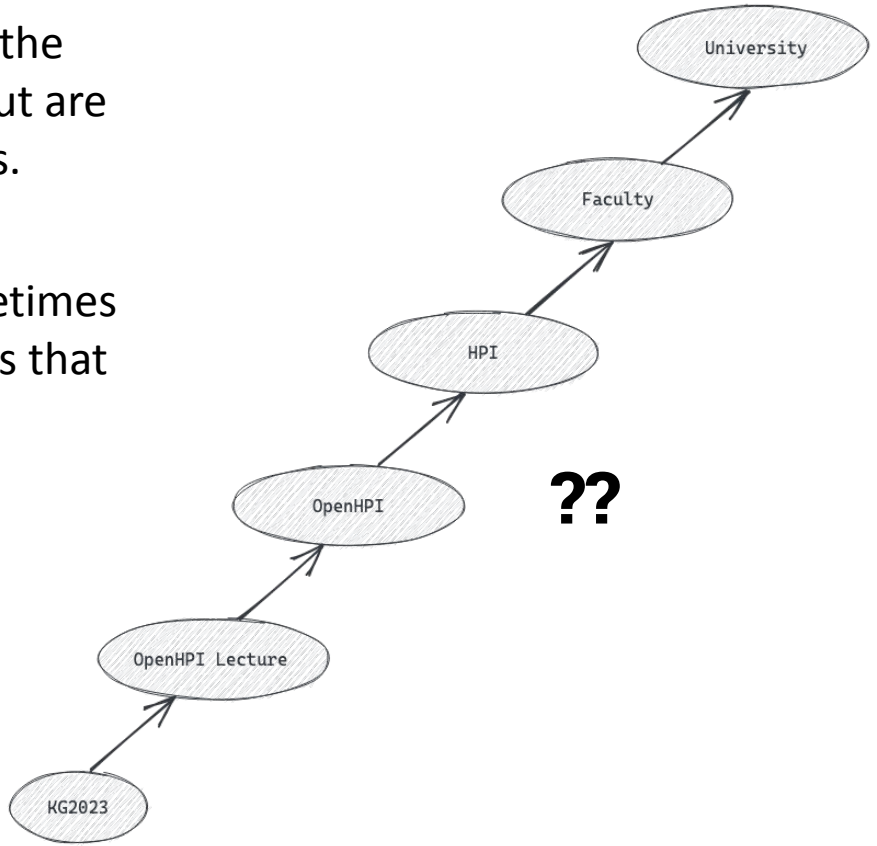


[4]

Correct Taxonomical Structures

- Experienced domain modellers can see the correct way to **structure a taxonomy**, but are typically unable to justify their decisions.
- **Problem:**

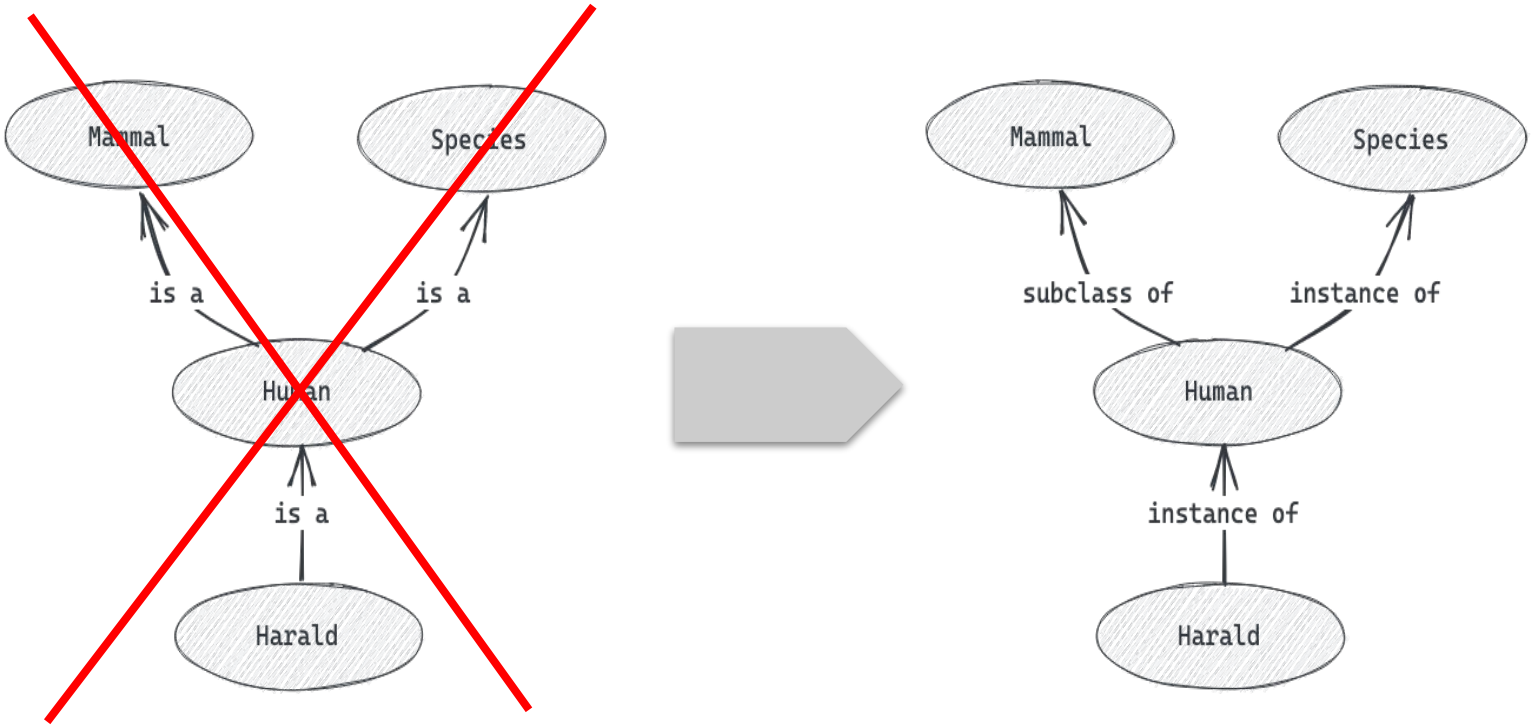
  Subsumption hierarchies are sometimes misused, representing relationships that aren't really subsumptions.



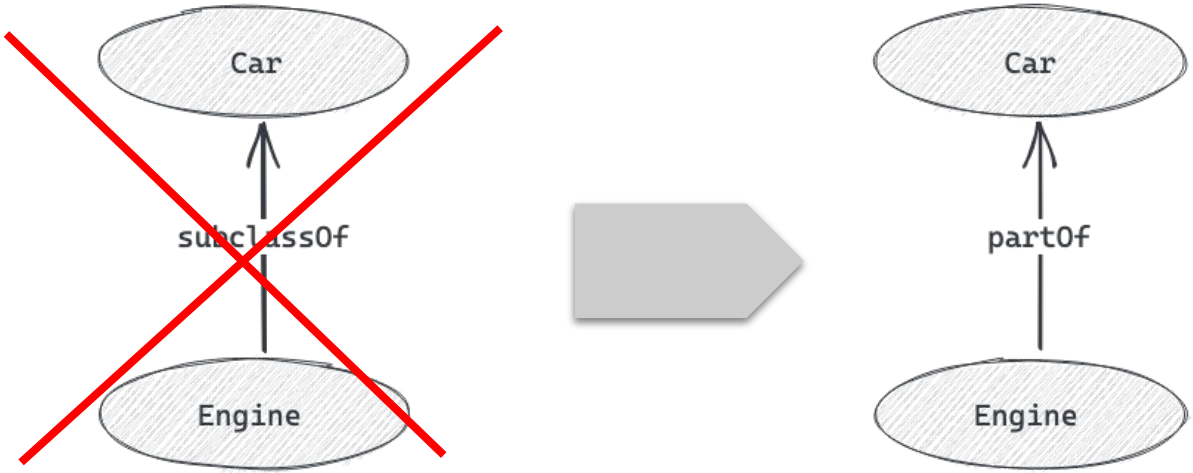
Taxonomies and Subsumption

- **Subsumption** (also *is-a relationship*) is used to construct concept hierarchies
- Formal interpretation:
  - **A subsumes B (B ⊑ A)**
    if all instances of B are necessarily also instances of A
  - attributes, properties, characteristics of a superclass are inherited along the hierarchy to all subclasses
- Unfortunately, the subsumption relation is often misused or confused with other types of relationships

Subsumption confused with Instantiation



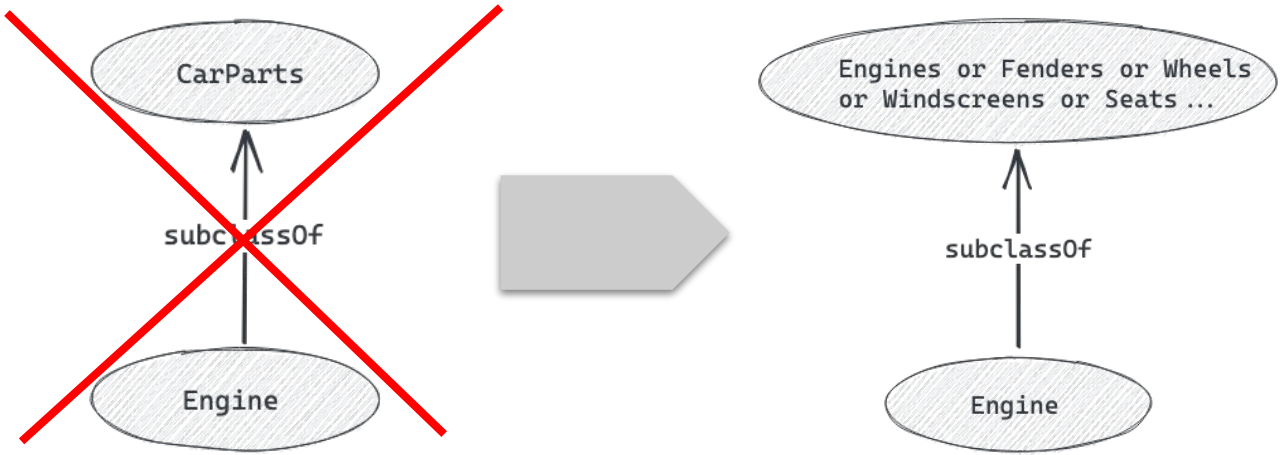
Subsumption confused with Meronomy



- some essential properties of **Car** are functional properties, e.g. *being able to accommodate people*
- **Engine** also has functional properties as essential properties, e.g. *being able to crank and generate a rotational force*

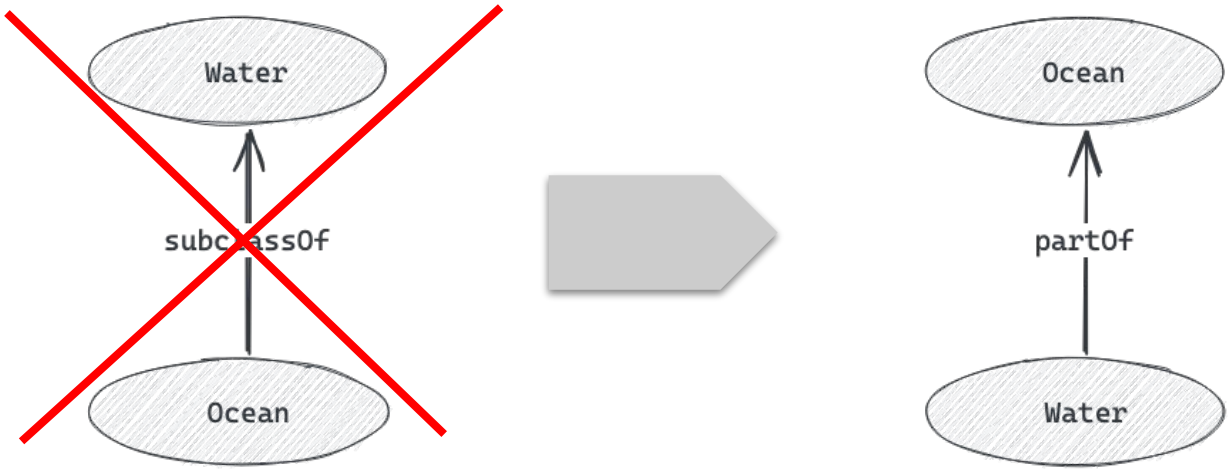
- But: **essential properties of cars do not apply to engines**
- Therefore: **Car** cannot subsume **Engine**

Subsumption confused with Disjunction



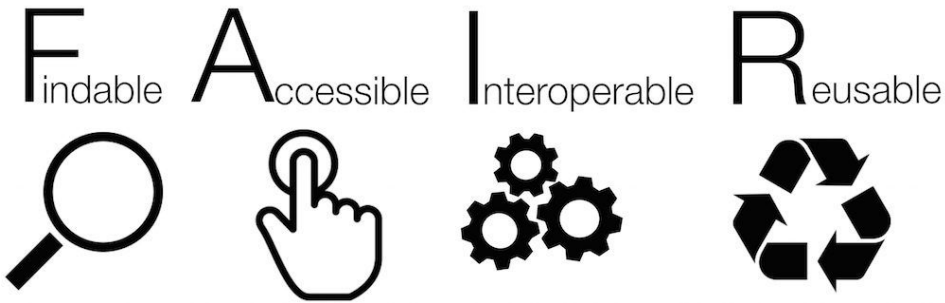
- not all **Engines** are really **Car Parts**, e.g. a boat engine
- Vice versa, Car Parts are a subclass of the class of all Engines, Fenders, Windscreens, Doors, Seats, etc.

Subsumption confused with Constitution



- an instance of **Water** is an amount of water
- an instance of **Ocean** is, e.g., the Pacific Ocean
- **Oceans** are made up of amounts of water

FAIR Principles Revisited

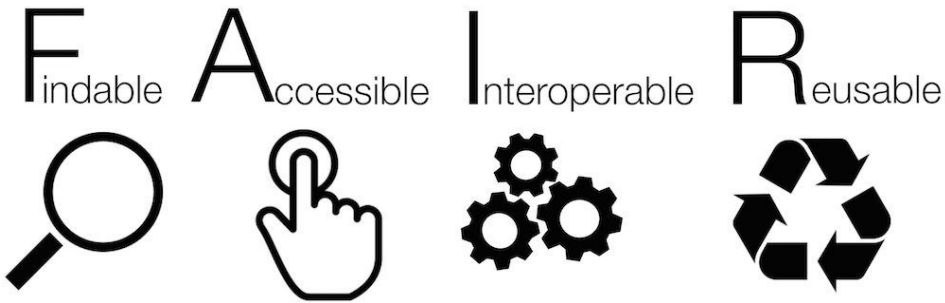


https://www.go-fair.org/fair-principles/

Findable
The first step in (re)using data is to find them. Metadata and data should be easy to find for both humans and computers.

- **F1**: (meta)data are assigned a **globally unique and persistent identifier**
- **F2**: data are described with **rich metadata**
- **F3**: metadata clearly and explicitly **include the identifier** of the data they describe
- **F4**: (meta)data are registered or indexed in a **searchable** resource

FAIR Principles Revisited

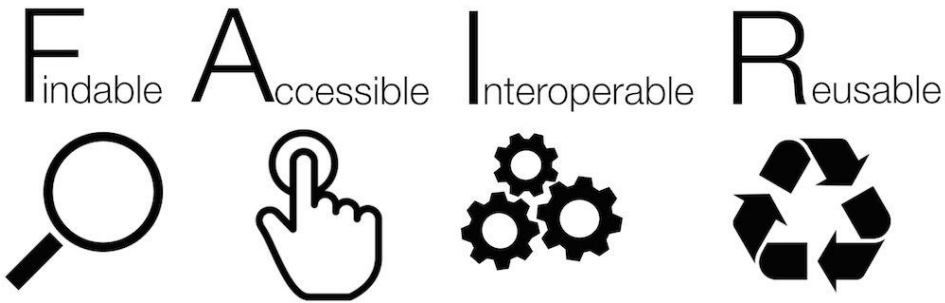


https://www.go-fair.org/fair-principles/

Accessible
Once the user finds the required data, she/he/they need to know how they can be accessed, possibly including authentication and authorisation.

- **A1:** (meta)data are **retrievable** by their identifier using a standard protocol
  - **A1.1**: the protocol is **open**, **free**, and **universally implementable**
  - **A1.2**: the protocol allows for **authentication** and **authorisation**, where necessary
- **A2**: metadata are **accessible**, even when the data are no longer available

FAIR Principles Revisited



https://www.go-fair.org/fair-principles/

Interoperable
The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing.

- **I1**: (meta)data use a **formal, accessible, shared, and broadly applicable language for knowledge representation**
- **I2**: (meta)data use **vocabularies** that follow FAIR principles
- **I3**: (meta)data include **qualified references to other (meta)data**

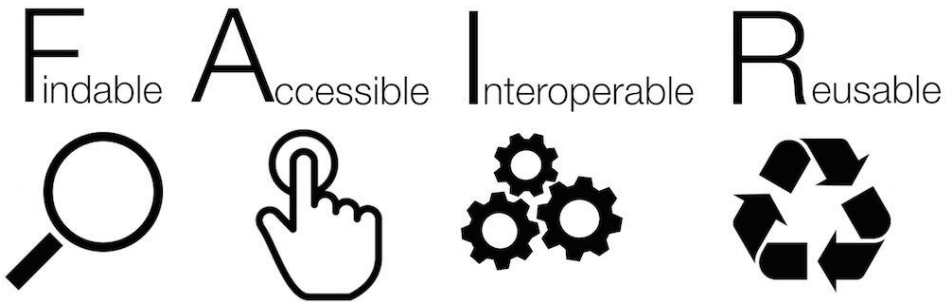
Linked Data Principles Revisited

1. Use **URIs** as names for things.
2. Use **HTTP URIs** so that people can **look up** those names.
3. When someone looks up a URI, provide **useful information**, using the **standards** (RDF, SPARQL).
4. Include **links to other URIs**, so that they can discover more things.

[3]

(Tim Berners-Lee, Linked Data, 2006, http://www.w3.org/DesignIssues/LinkedData.html)

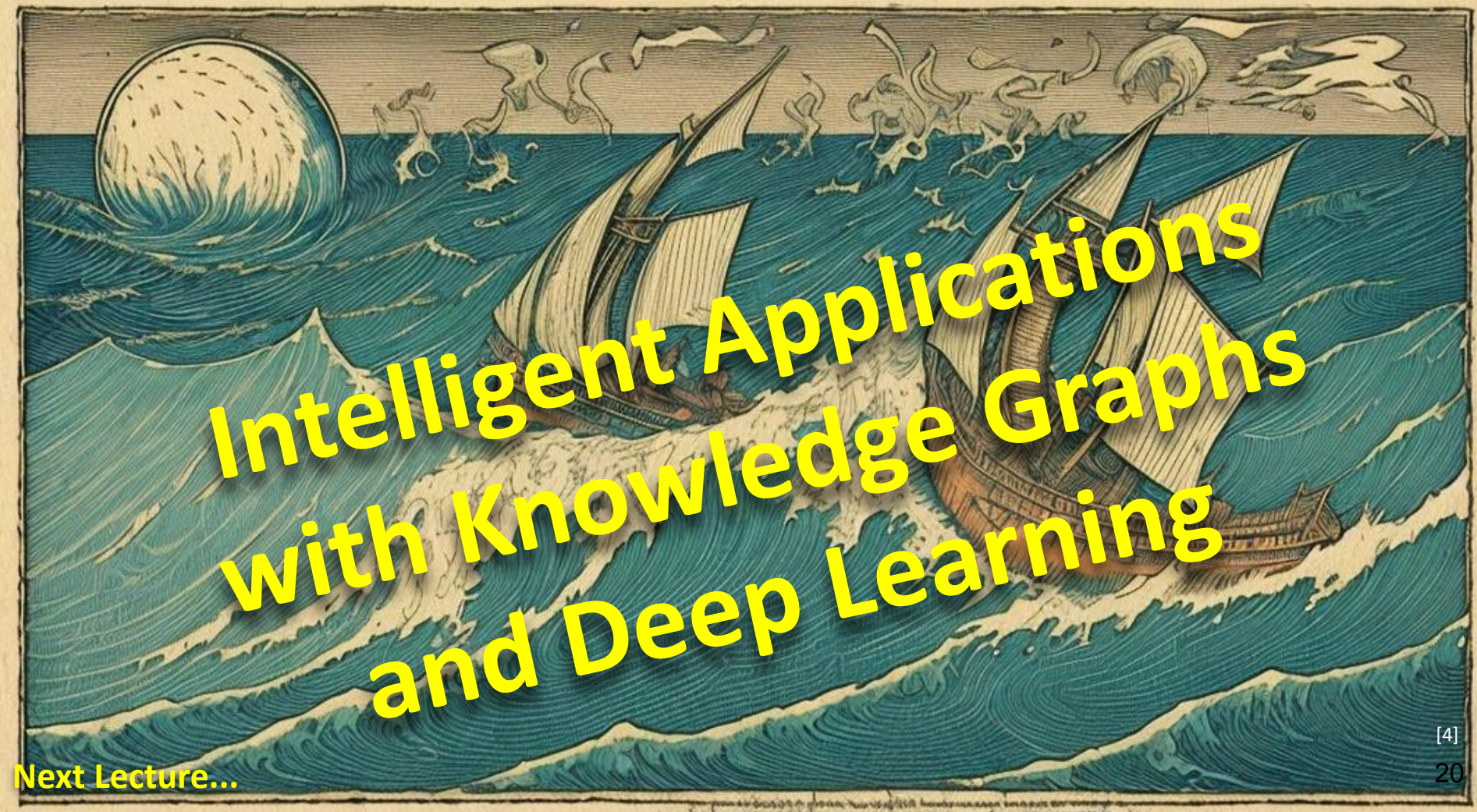
FAIR Principles Revisited



https://www.go-fair.org/fair-principles/

Reusable
The ultimate goal of FAIR is to optimise the reuse of data. To achieve this, metadata and data should be well-described so that they can be replicated and/or combined in different settings.

R1: meta(data) are richly described with a plurality of **accurate and relevant attributes**
- **R1.1** (meta)data are released with a clear and accessible **data usage license**
- **R1.2** (meta)data are associated with **detailed provenance**
- **R1.3** (meta)data meet **domain-relevant community standards**



[4]

Next Lecture...

Bibliographic References:

- Jorge Luis Borges (1942), *The Analytical Language of John Wilkins*, English translation by Lilia Graciela Vázquez @ ALAMUT
- Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. (2016), *The FAIR Guiding Principles for scientific data management and stewardship*. Sci Data 3, 160018 (2016).
- Tim Berners-Lee (2006), Linked Data, 2006, http://www.w3.org/DesignIssues/LinkedData.html
- Aidan Hogan et al. (2021) *Knowledge Graphs*, Synthesis Lectures on Data, Semantics, and Knowledge, No. 22, pp. 1–237, Springer
  9.1 .Best Practices, pp. 65–68.

Picture References:

[1] "On this hyperrealistic scifi movie poster we see the scenery of Hans Holbein the Younger's famous painting "The Ambassadors" set into a postapocalyptic environment on planet Mars showing countless small strange and precious artifacts belonging to the ambassadors..", created via ArtBot, Deliberate, 2023, [CC-BY-4.0], https://tinybots.net/artbot

[2] "On this colorized Renaissance woodcut we see two sailing ships driven towards the edge of flat Earth. Underneath the waves there lures a fierce dragon. The ocean's waters are pouring down from the edge of flat Earth..", created via ArtBot, Deliberate, 2023, [CC-BY-4.0], https://tinybots.net/artbot

[3] Portrait of Jorge Luis Borges, by Annemarie Heinrich, 1967, Annemarie Heinrich, [Public Domain], via WikiCommons, https://upload.wikimedia.org/wikipedia/commons/3/39/Jorge_Luis_Borges_by_Annemarie_Heinrich%2C_1967.jpg

[4] "On this colorized Renaissance woodcut we see two sailing ships driven towards the edge of flat Earth. Underneath the waves there lures a fierce dragon. The ocean's waters are pouring down from the edge of flat Earth..", created via ArtBot, Deliberate, 2023, [CC-BY-4.0], https://tinybots.net/artbot

[5] "On this colorized Renaissance woodcut we see two sailing ships driven towards the edge of flat Earth. Underneath the waves there lures a fierce dragon. The ocean's waters are pouring down from the edge of flat Earth..", created via ArtBot, Deliberate, 2023, [CC-BY-4.0], https://tinybots.net/artbot

[6] "On this colorized woodcut in the style of Albrecht Dürer we see the March Hare on the edge of flat Earth with the ocean's waters pouring down into the vast space of the universe. Underneath the waves there lures a fierce dragon waiting for two sailing ships to fall over the edge and take the March Hare with them.", created via ArtBot, Deliberate, 2023, [CC-BY-4.0], https://tinybots.net/artbot