

Knowledge Graphs

Lecture 1 – Knowledge Representation with Graphs

1.1 From Data to Knowledge

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1.1 From Data to Knowledge

1.2 Knowledge and how to represent it

1.3 The Art of Understanding

1.4 Graphs and Triples

1.5 Knowledge Graphs

1.6 The Semantic Web

1.7 Linked Data and the Web of Data

42



What is 42?



42 is a **number**. It is an integer and a non-negative number. In the decimal system, it is the number following 41 and preceding 43. It is often used as a placeholder for a number or value that is currently unknown or unspecified. The number 42 is also significant in popular culture and has been referenced in many works of fiction, including "The Hitchhiker's Guide to the Galaxy" by Douglas Adams, in which 42 is described as "the answer to the ultimate question of life, the universe, and everything" calculated by an enormous supercomputer named Deep Thought over a period of 7.5 million years.





There are many different interpretations and meanings of the number 42, as it has been referenced in a variety of contexts in different cultures and disciplines. Here are a few examples:



- In the Tarot, the number 42 is associated with the card "The World," which represents completion, wholeness, and the integration of all aspects of the self.
- In numerology, the number 42 is considered to be a highly spiritual number that represents the realization of a higher purpose or goal. It is believed to be a powerful number that can help people overcome challenges and achieve their goals.
- In the Chinese culture, the number 42 is considered to be unlucky because it is a homophone for "death" in Mandarin.
- In the Bible, the number 42 appears several times, including in the story of the Flood, where it is said that the rain lasted for 42 days and 42 nights.
- In sports, the number 42 is retired by Major League Baseball in honor of Jackie Robinson, who was the first African American player to play in the major leagues.



Anything else?



There are many other references and meanings of the number 42 in various fields and disciplines, including:



- In the Maya calendar, the number 42 represents the **end of a cycle, as well as the beginning of a new cycle.**
- In the field of psychology, the number 42 is sometimes used as a **random number** in psychological experiments to control for the effects of extraneous variables.
- In computer science, the number 42 is often used as a **placeholder or default value** in programming, particularly when working with arrays or other data structures.
- In physics, the number 42 is the **atomic number of molybdenum**, a chemical element with the symbol Mo.
- In popular culture, the number 42 has been referenced in a variety of media, including music, film, television, and literature. It is often used as a **symbol of mystery** or as a reference to "The Hitchhiker's Guide to the Galaxy."

- a quantity ?
- a point in time ?
- a time span?
- a length?
- a weight?
- a measurement?
- a code ?
- a character string?

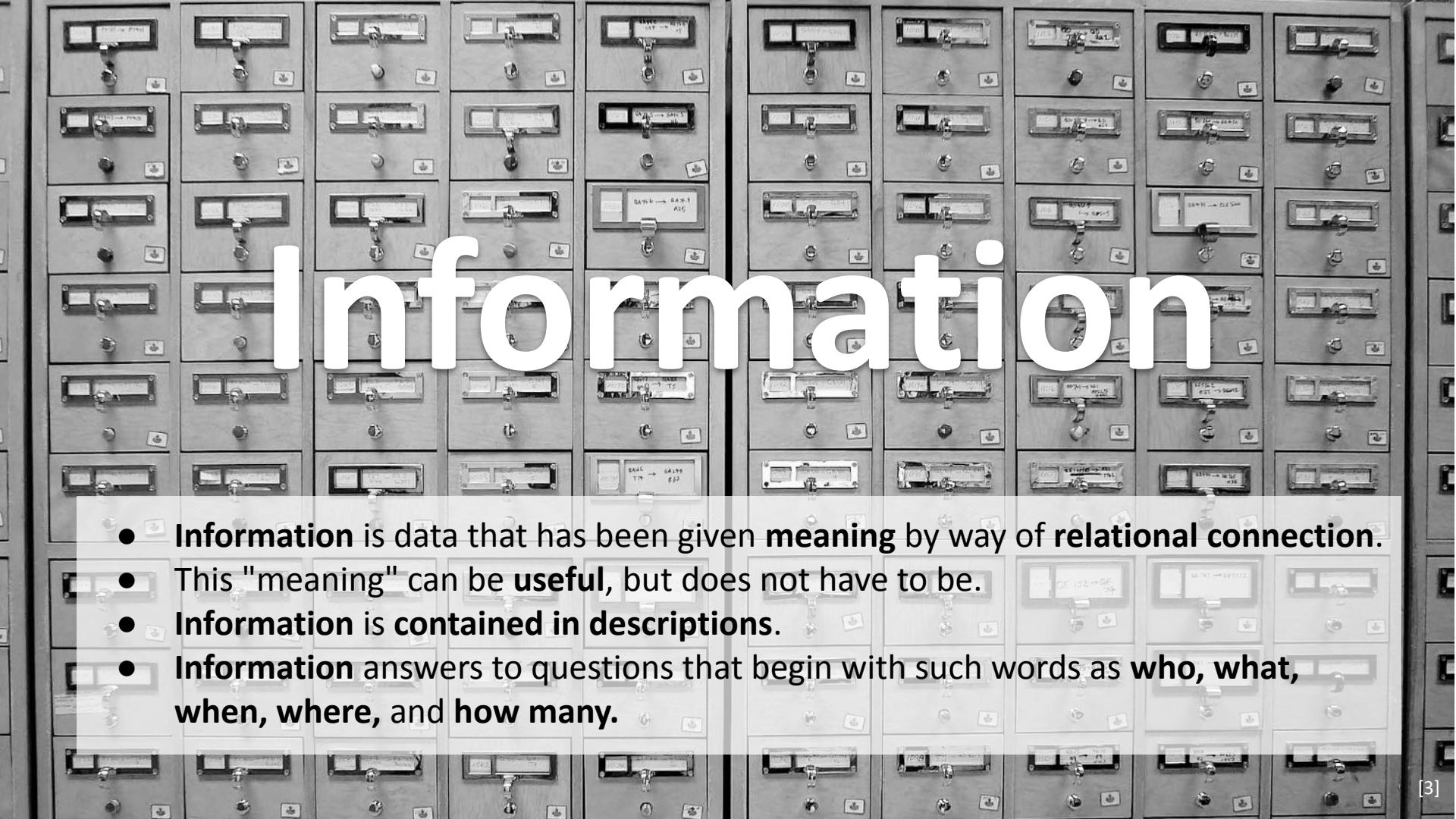
42



We need
more information
to make sense of
the data

Data

- Data is raw.
- It simply exists and has no significance beyond its existence (in and of itself).
- It can exist in any form, usable or not.



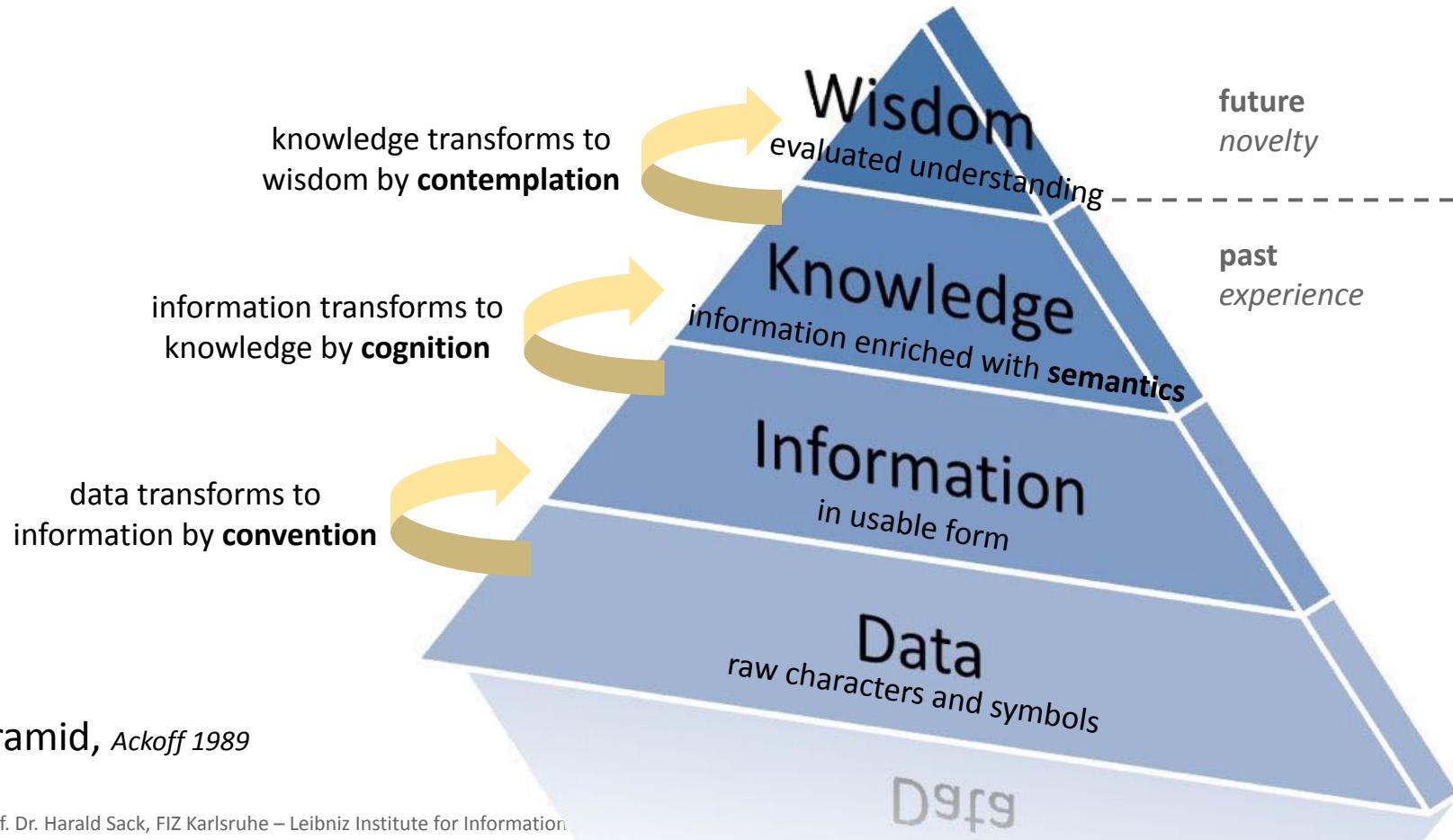
Information

- **Information** is data that has been given **meaning** by way of **relational connection**.
- This "meaning" can be **useful**, but does not have to be.
- **Information is contained in descriptions**.
- **Information** answers to questions that begin with such words as **who, what, when, where, and how many**.

Knowledge

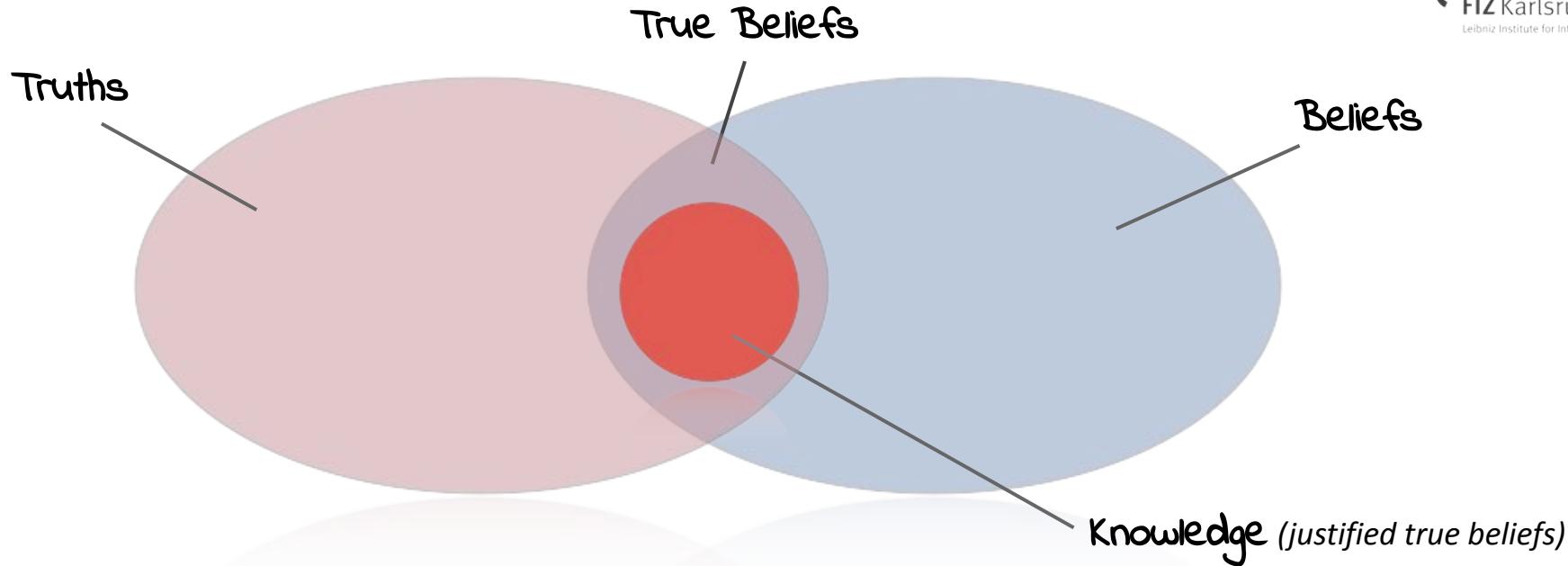
- **Knowledge** is the appropriate collection of information, such that its intent is to be **useful**.
- **Wisdom** is the ability to make **sound judgments and decisions**.
- **Understanding** is a continuum that leads from **data**, through **information** and **knowledge**, and ultimately to **wisdom**.

Data, Information, Knowledge



What is Knowledge?

What is Knowledge?

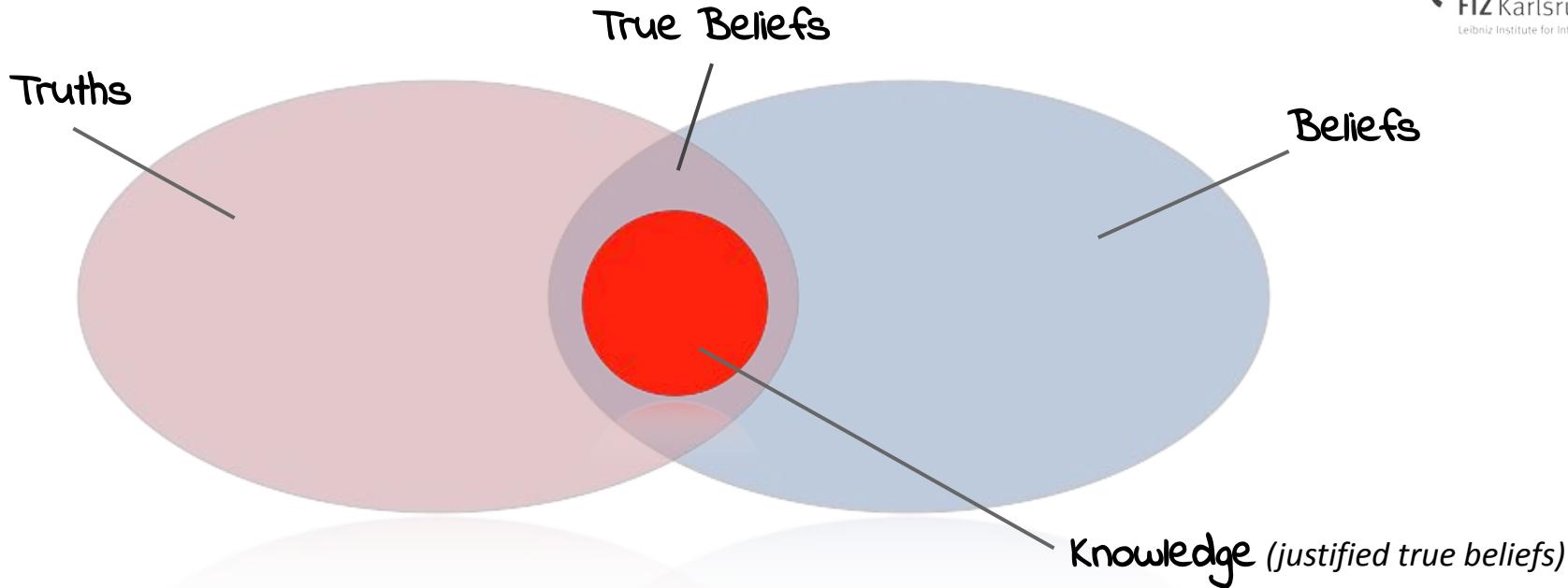


The Tripartite **Analysis of Knowledge**: S knows that p iff

- p is true;
- S believes that p ;
- S is justified in believing that p .

[The Analysis of Knowledge](#), Stanford Encyclopedia of Philosophy, 2001.

What is Knowledge?



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

To represent knowledge, we need a (formal) **knowledge representation**.

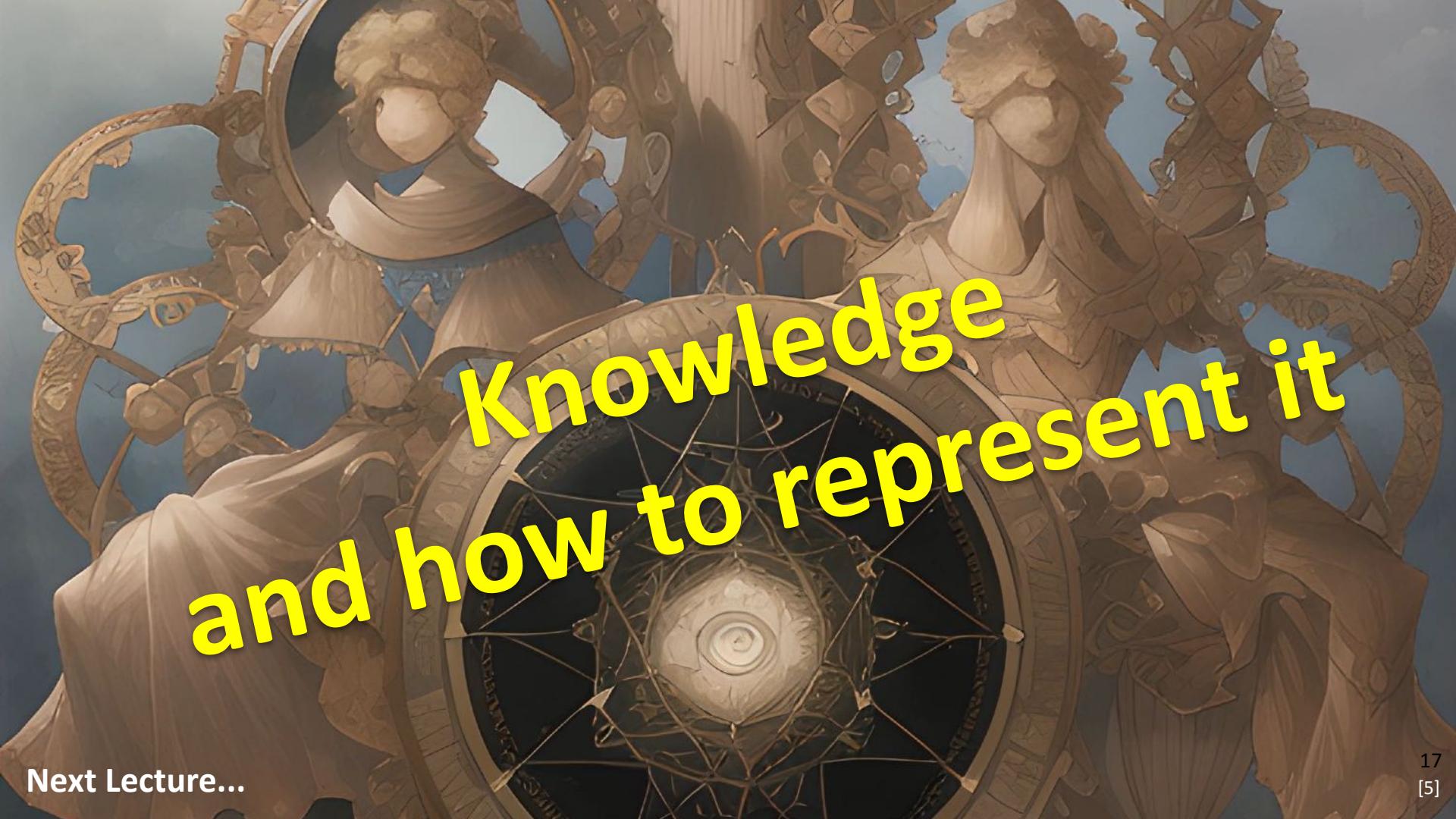


„People can't share knowledge if they don't speak a common language“

Davenport & Prusak, 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**)



Knowledge
and how to represent it

Next Lecture...

Knowledge Graphs

1. Knowledge Representation with Graphs / 1.1 From Data to Knowledge

Bibliographic References:

- OpenAI ChatGPT: <https://chat.openai.com/chat>
- Ackoff, Russell (1989). "[From Data to Wisdom](#)". Journal of Applied Systems Analysis. 16: 3–9.
- Ichikawa, Jonathan & Steup, Matthias (2018). [The Analysis of Knowledge](#). Stanford Encyclopedia of Philosophy.
- Davenport, Thomas H. & Prusak, Laurence (1997). [Working Knowledge: How Organizations Manage What They Know](#). Harvard Business School Press, USA.

Picture References:

- [1] "An image of the Semantic Web which is an extension of the World Wide Web...", created via ArtBot, stable diffusion - generic scifi, 2023, [CC-BY-4.0], <https://tinybots.net/artbot>
- [2] Matrix Computer Screen, [pixabay license], <https://pixabay.com/illustrations/matrix-code-computer-pc-data-356024/>
- [3] UBC Library Card Catalog, Paul Joseph (2009), [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, [public domain]
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), [public domain]
[https://commons.wikimedia.org/wiki/File:Pieter_Bruegel_the_Elder_-_The_Tower_of_Babel_\(Vienna\)_-_Google_Art_Project.jpg](https://commons.wikimedia.org/wiki/File:Pieter_Bruegel_the_Elder_-_The_Tower_of_Babel_(Vienna)_-_Google_Art_Project.jpg)
- [6] "...to speak a common Language: common symbols and concepts (Syntax)...", created via ArtBot, Anything Diffusion - generic scifi, 2023, [CC-BY-4.0], <https://tinybots.net/artbot>