



**FIZ Karlsruhe**

Leibniz-Institut für Informationsinfrastruktur

A large, stylized graphic of an astronaut walking through a landscape of spheres and data-like structures. The astronaut is in the center, wearing a full spacesuit. The ground is covered with various sized spheres, some with grid patterns. The background is filled with abstract, flowing, data-like shapes in shades of gray and white. A large, dark gray 'C' shape is overlaid on the left side of the image, partially obscuring the astronaut's head and the background.

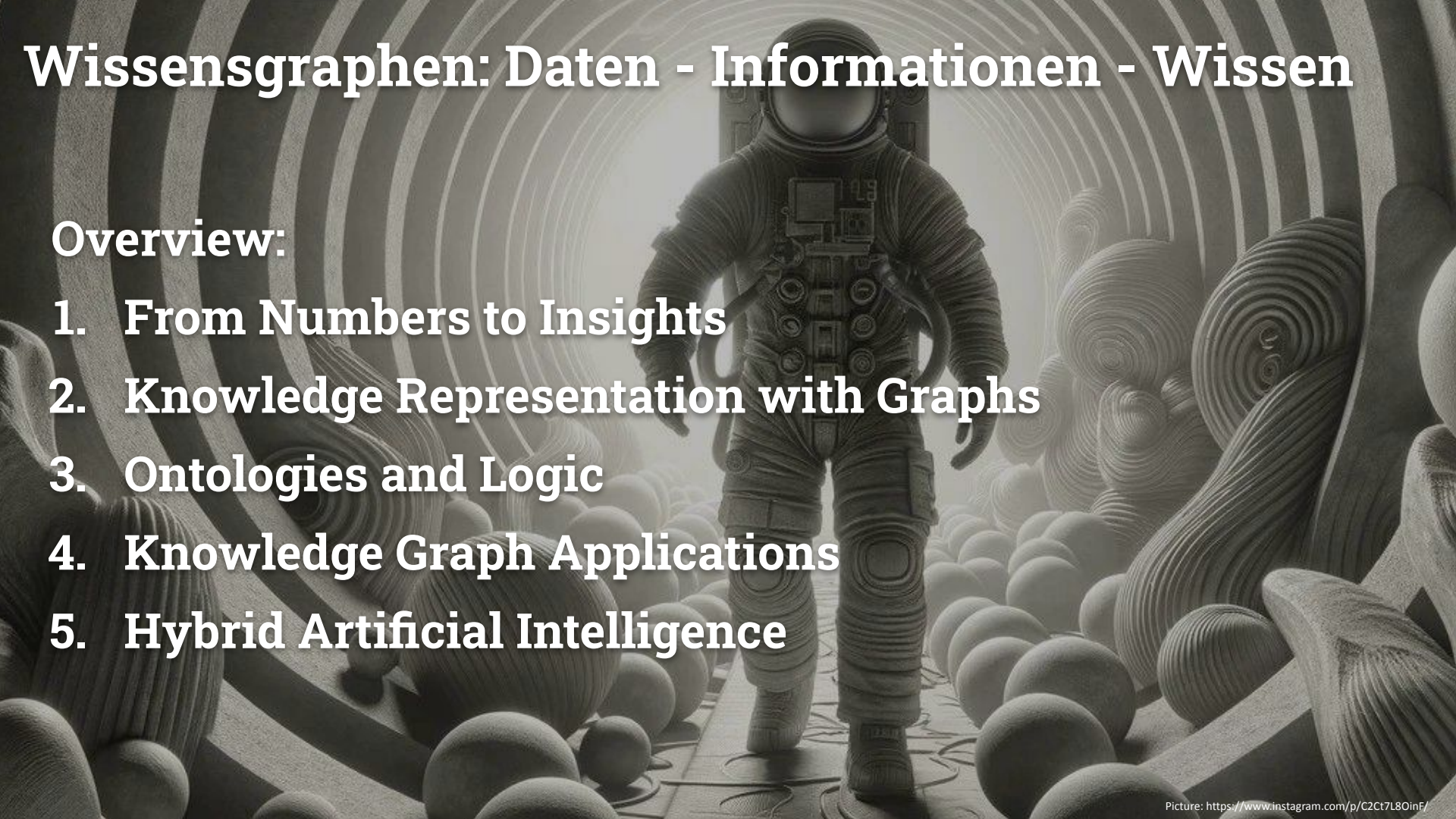
# Wissensgraphen

## Daten - Informationen - Wissen

Prof. Dr. Harald Sack

Studium Generale der Philipps-Universität Marburg  
Marburg, 24.01.2024

# Wissensgraphen: Daten - Informationen - Wissen



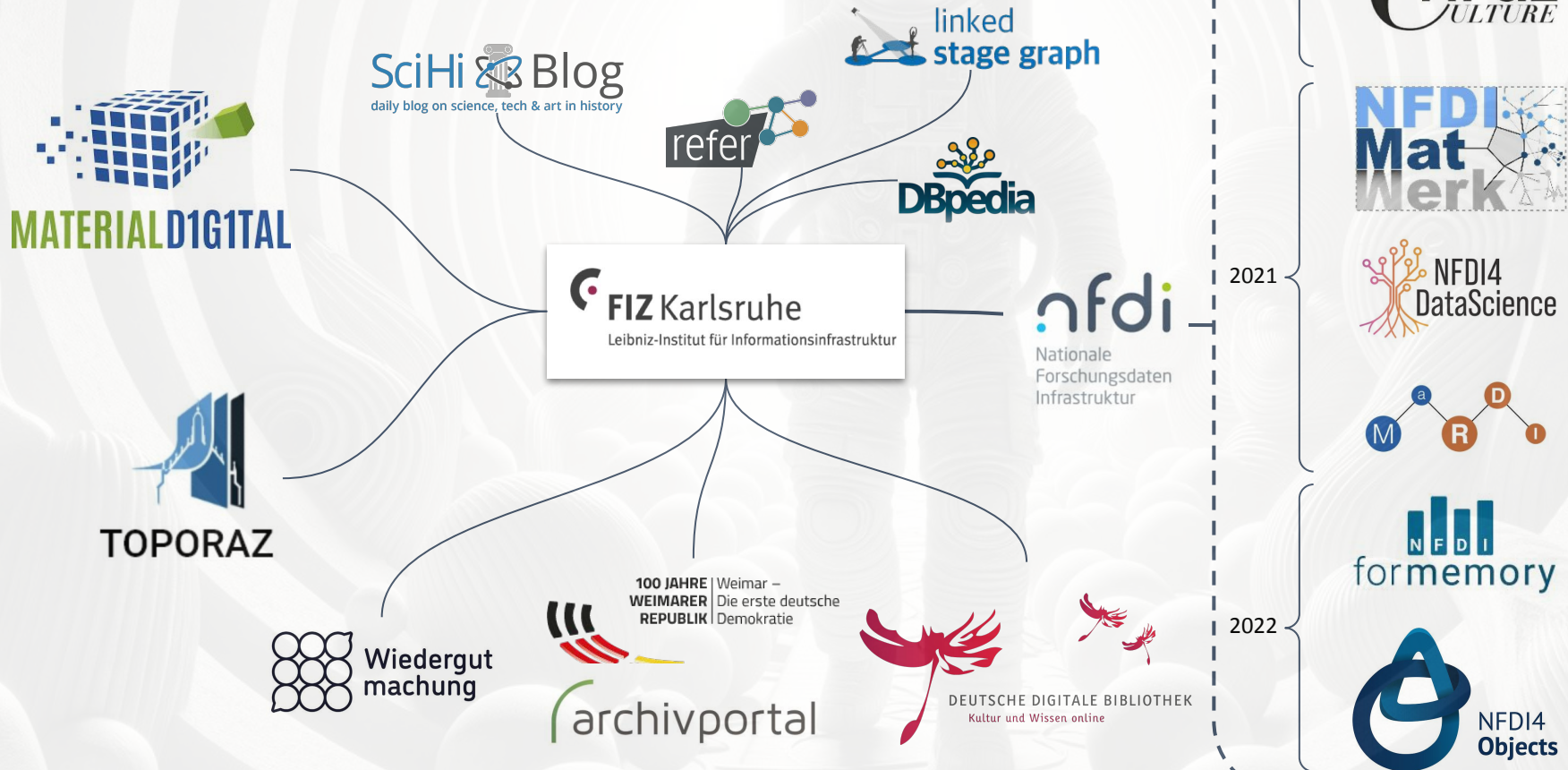
## Overview:

1. From Numbers to Insights
2. Knowledge Representation with Graphs
3. Ontologies and Logic
4. Knowledge Graph Applications
5. Hybrid Artificial Intelligence



# Knowledge Graphs @ FIZ Karlsruhe

Projects, Services & NFDIs





# 1. From Numbers to Insights - Data, Information, and Knowledge



# 42



You

What is 42?



ChatGPT

The **number** 42 is often humorously and philosophically referenced as the **"Answer to the Ultimate Question of Life, the Universe, and Everything"** in Douglas Adams' science fiction series, "The Hitchhiker's Guide to the Galaxy." In the story, a supercomputer named Deep Thought is designed to find the meaning of life, and after much contemplation, it arrives at the cryptic answer: 42. The significance of 42 remains a popular cultural reference and meme.

<https://chat.openai.com/chat>

<https://chat.openai.com/chat>





## ChatGPT

The significance of the number 42 varies in different contexts. Here are a few examples:

### 1. Literary Context:

- In Douglas Adams' "The Hitchhiker's Guide to the Galaxy," the number 42 is humorously presented as the "Answer to the Ultimate Question of Life, the Universe, and Everything." The question itself

### 2. Mathematics:

- In mathematics, 42 is a natural number that fo

### 3. Pop Culture and Internet Memes:

- Due to its association with Douglas Adams' work, 42 is a popular meme on the internet and is sometimes used as an answer to various questions.

### 4. Science and Technology:

- In ASCII code, 42 represents the asterisk (\*) character.

### 5. Age of Wisdom in Some Cultures:

- In Japanese culture, the age of 42 is considered the "Age of Wisdom" in a traditional celebration known as a kanreki.

In Japan, the 60th year of life is called "kanreki" (還暦) and is celebrated as a rebirth or re-entry into childhood. Sixty years is the full cycle of the Chinese zodiac calendar, which was adopted for use in Japan starting in the year 604. 26 May 2020



Seattle Japanese Garden

<https://www.seattlejapanesegarden.org> › blog › kanreki-a... ⋮

“Kanreki” 還暦 –A Red Letter 60th Anniversary for the Garden

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** 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**.



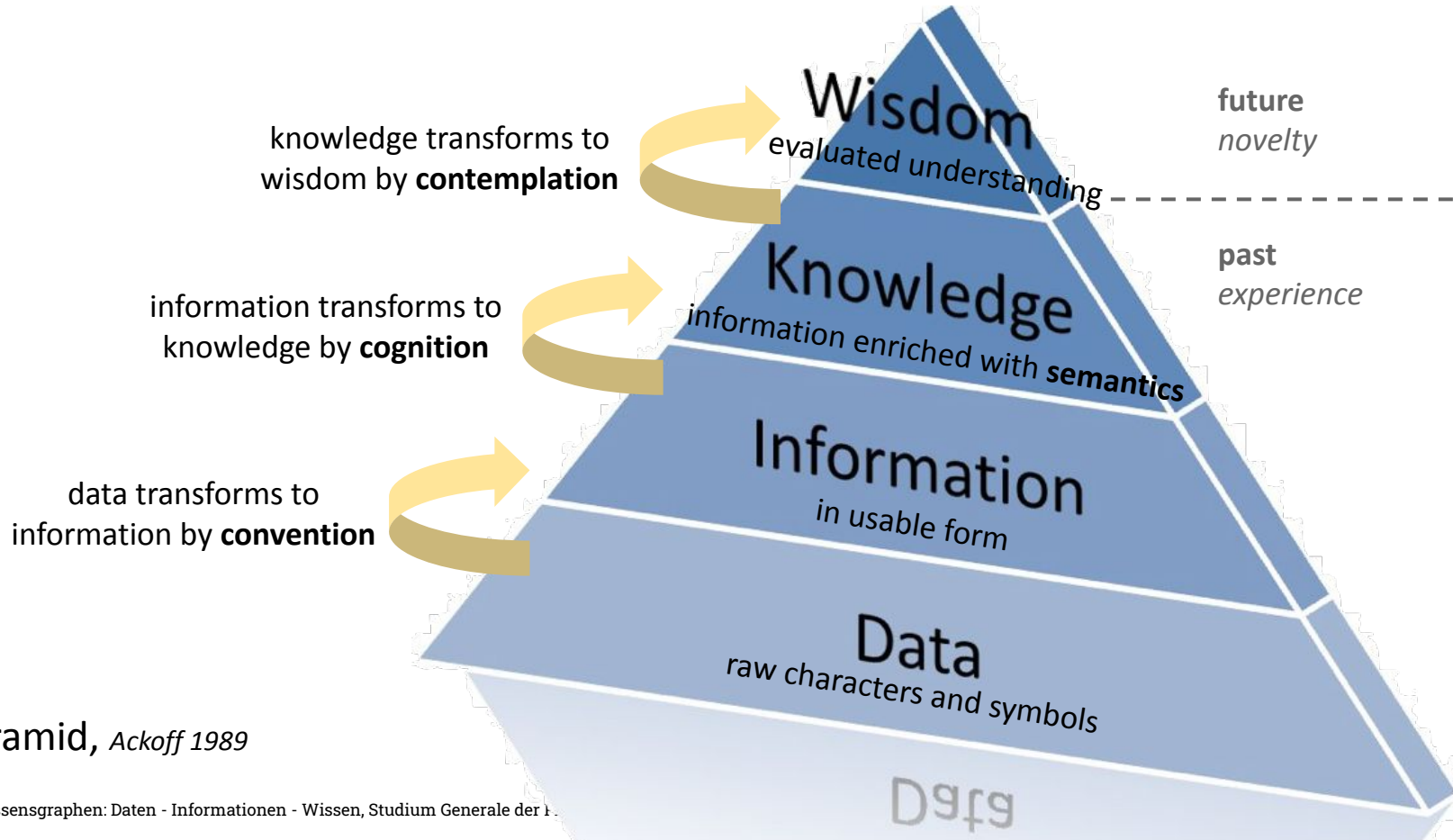


# Wisdom

- **Wisdom is the ability to make sound judgments and decisions.**



# Data, Information, Knowledge



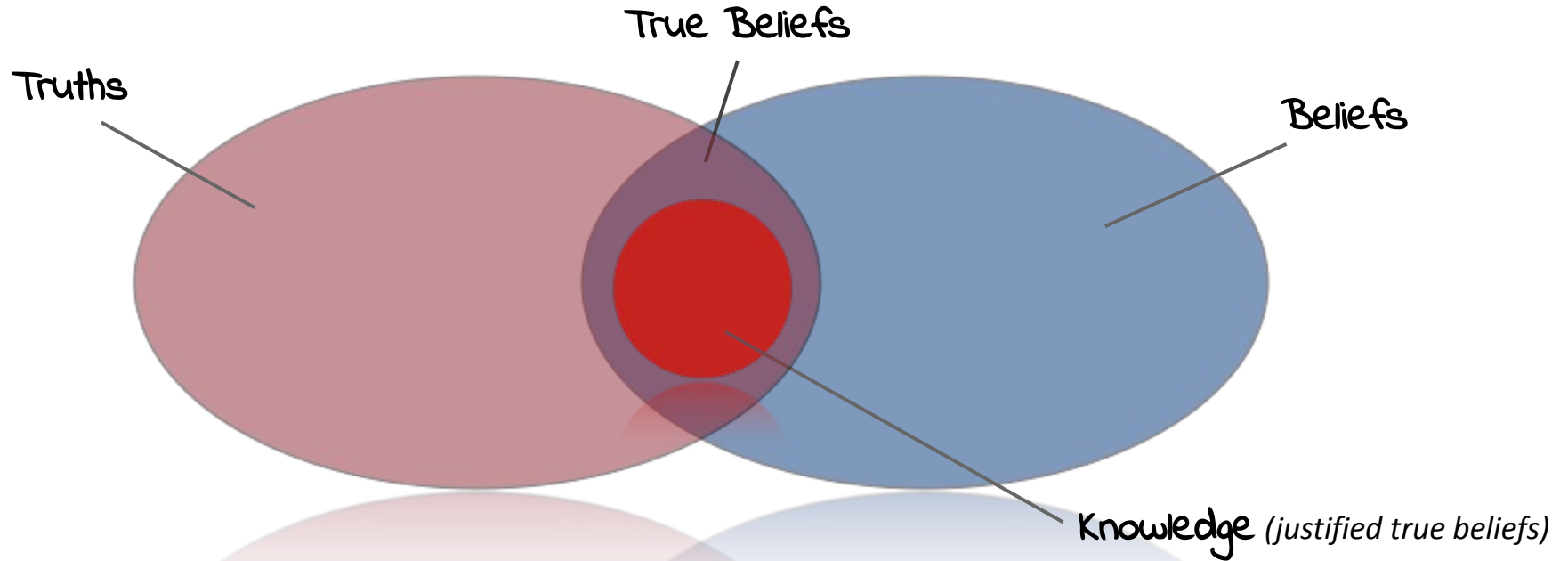
DIKW Pyramid, Ackoff 1989



# What is Knowledge?




# 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“**





## 2. Knowledge Representation with Graphs





I am not Spock

Leonard Nimoy played Spock.  
Spock is a character in Star Trek.  
Leonard Nimoy starred in Star Trek.



# An Intuitive Way to Represent Knowledge

Leonard Nimoy played Spock.

Subject

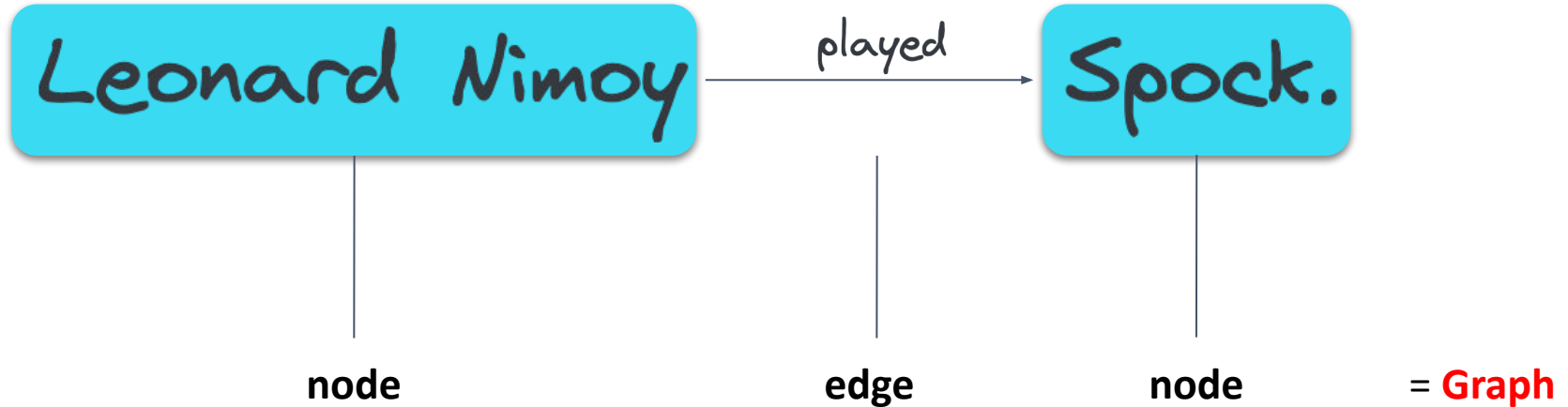
Predicate

Object

= Triple

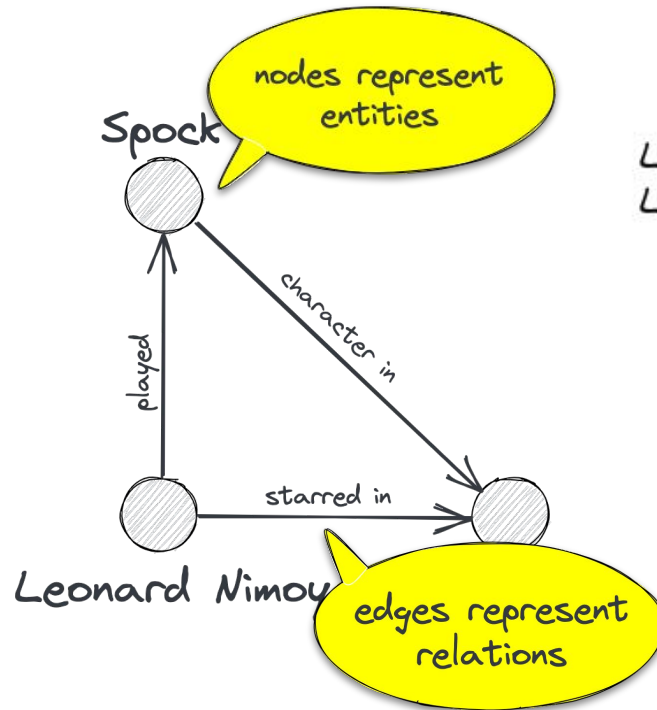
Leonard Nimoy played Spock.  
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# An Intuitive Way to Represent Knowledge





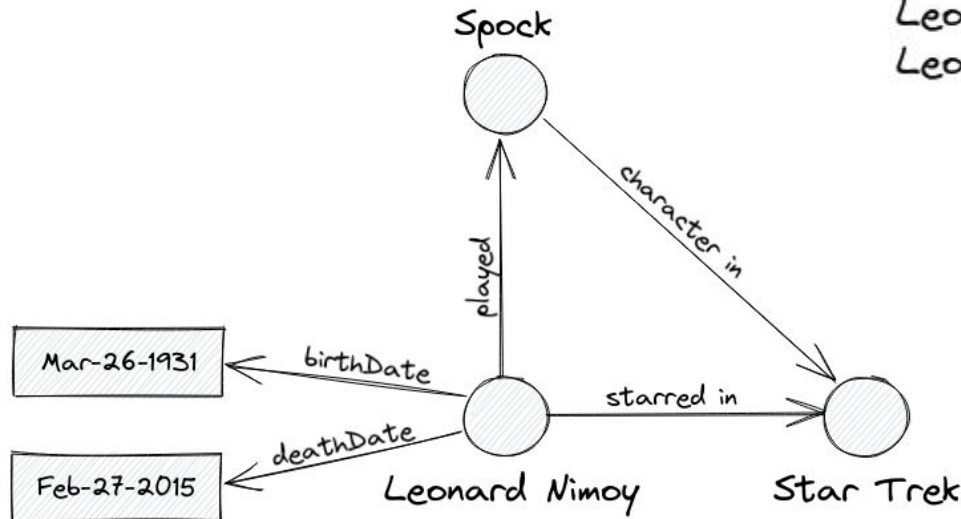
# An Intuitive Way to Represent Knowledge



Leonard Nimoy was born on Mar-26-1931.  
Leonard Nimoy passed away on Feb-27-2015.

Is a date  
an entity?

# Further Refinements

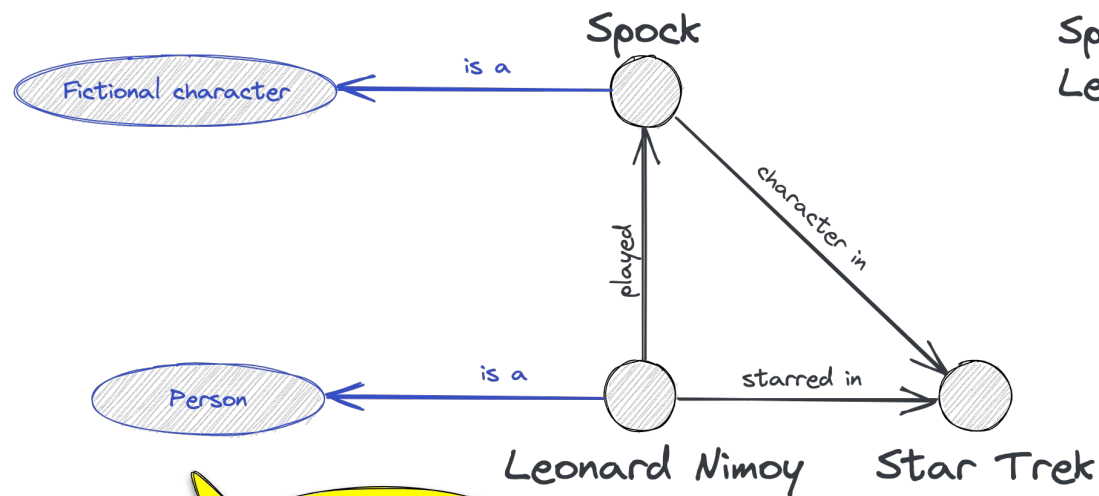


Leonard Nimoy was born on Mar-26-1931.  
Leonard Nimoy passed away on Feb-27-2015.

special vertices  
for literals



# Further Refinements

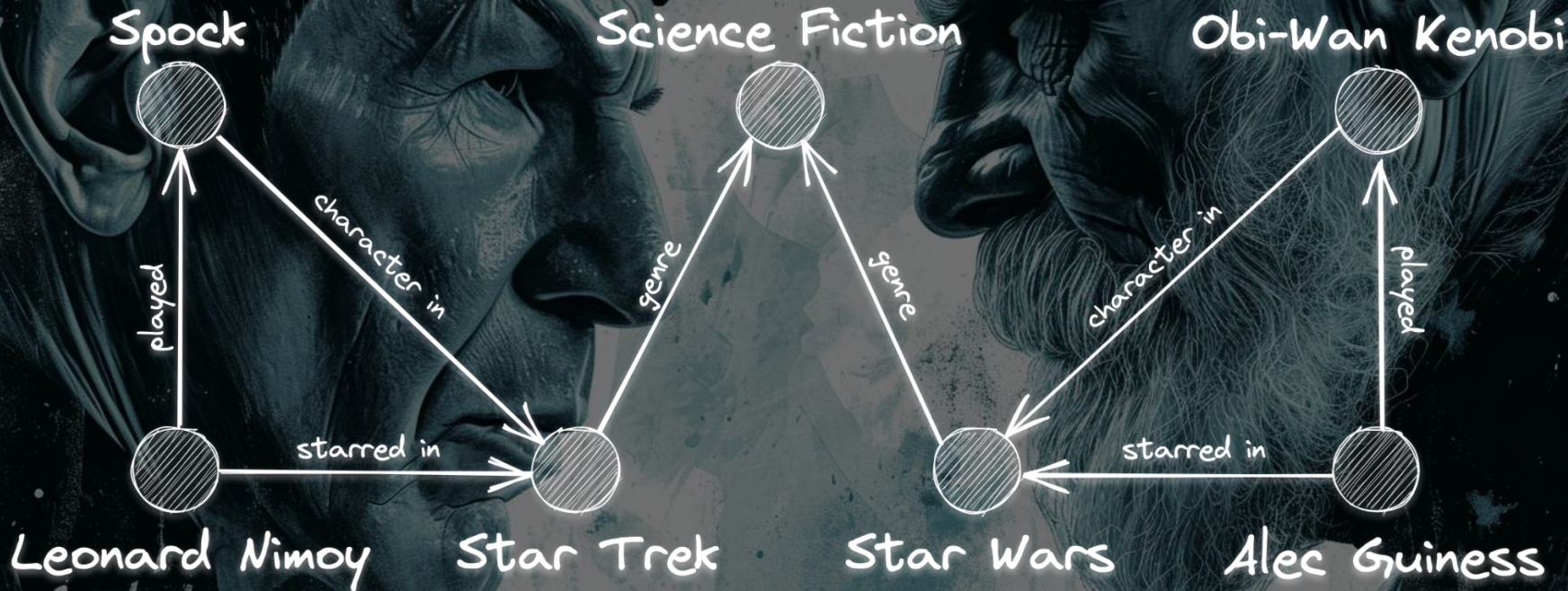


Spock is a fictional character.  
Leonard Nimoy is a person.

individual vs  
aggregation

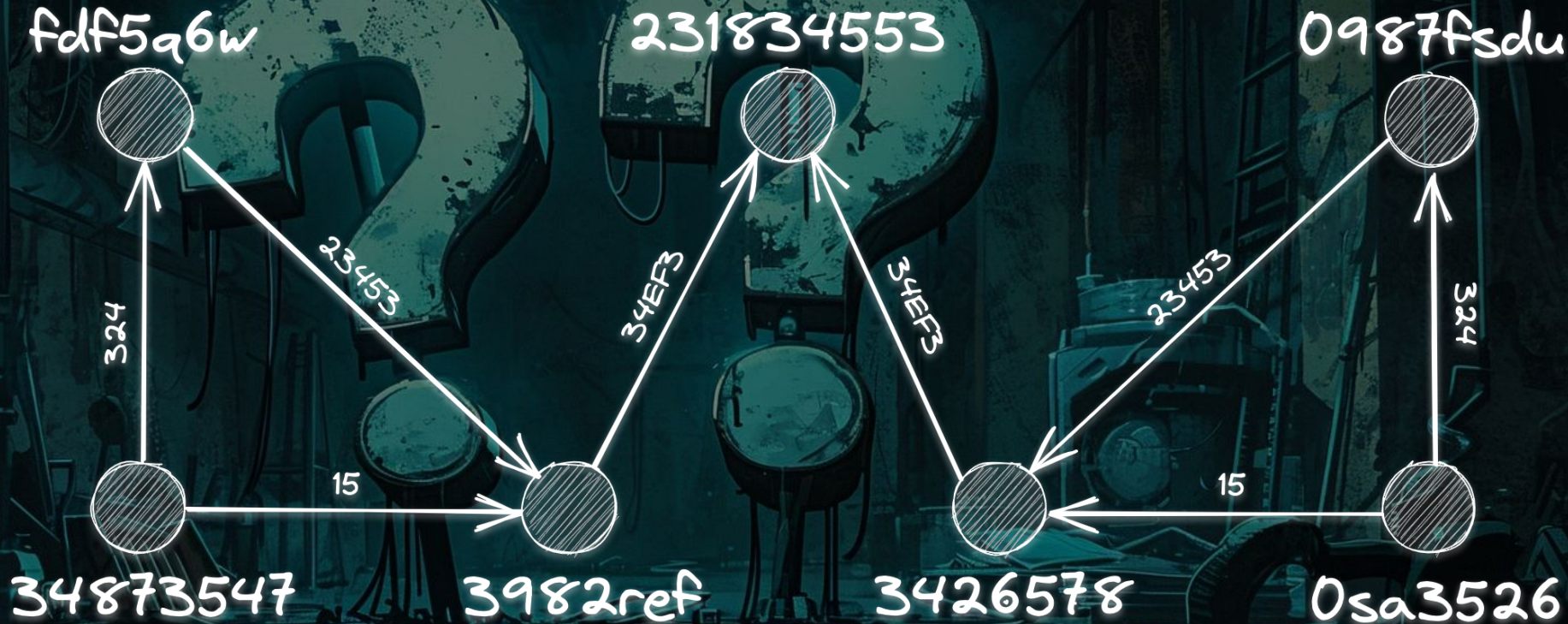
classes are  
special entities

# Knowledge Graphs





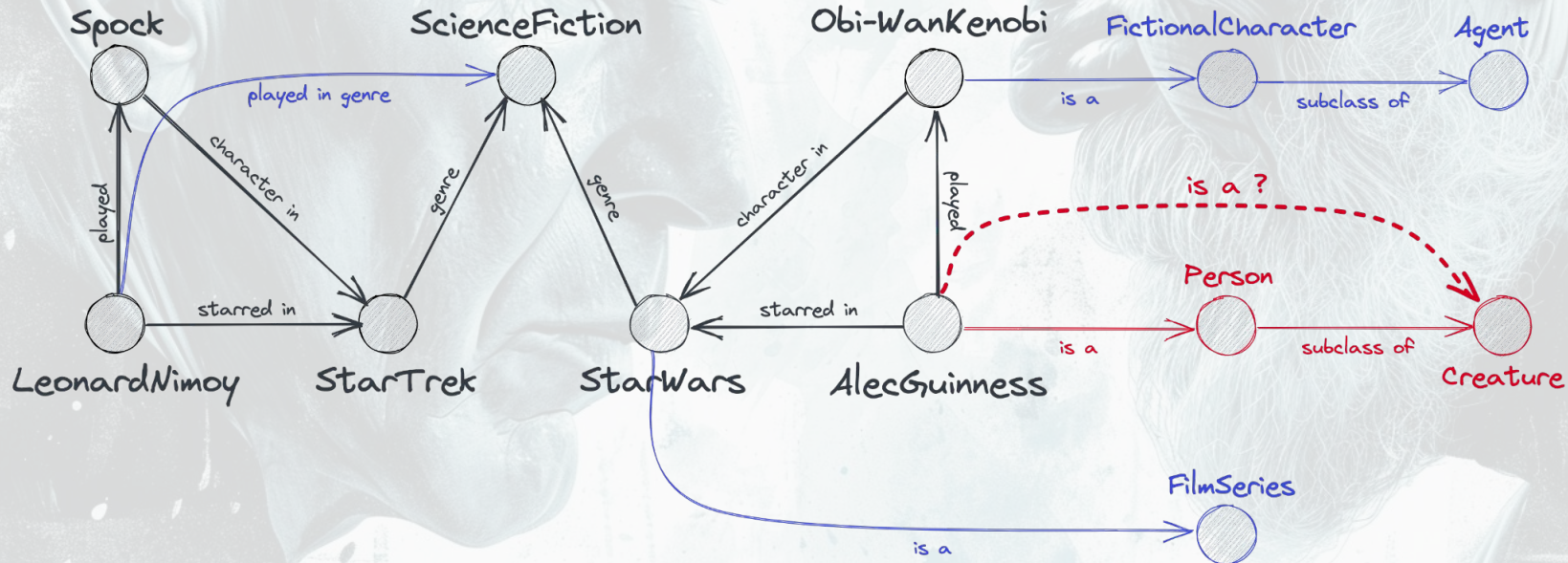
# How does the Computer know the Meaning?



# Can we deduce that Alec Guinness is a "Creature"?

Can be solved via individual software code:

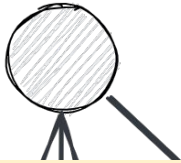
```
IF ((Alec Guinness, is a, Person) AND (Person, subclass of, Creature))  
THEN  
  (Alec Guinness, is a, Creature)
```





# Back to the Start

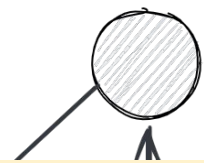
fdf5q6w



231834553



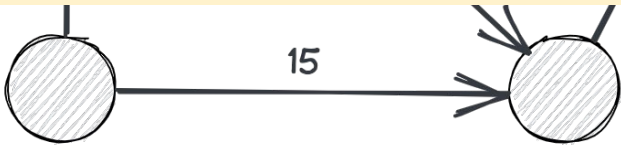
0987fsdu



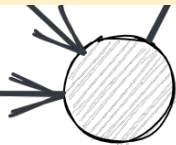
To **represent knowledge explicitly** (and to make use of it), we need a knowledge representation that can be **“understood”** by the computer.

- **Ontologies** based on **Mathematical Logic** as **“formal” Knowledge Representation**.
- **Inference Engine** (Semantic Reasoner) to draw conclusions and inferences.

15



34873547



3982ref

15

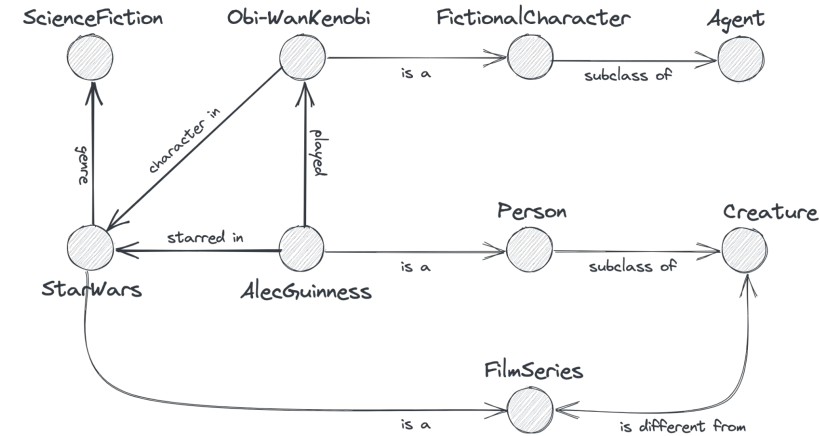


3426578

0sa3526

# A Formal Way to Represent Knowledge

## (Over)Simplified Example



Obi-WanKenobi  $\in$  FictionalCharacter  
 AlecGuinness  $\in$  Person  
 StarWars  $\in$  FilmSeries

FictionalCharacter  $\subseteq$  Agent  
 Person  $\subseteq$  Creature

FilmSeries  $\cap$  Creature =  $\emptyset$

Logical Inference

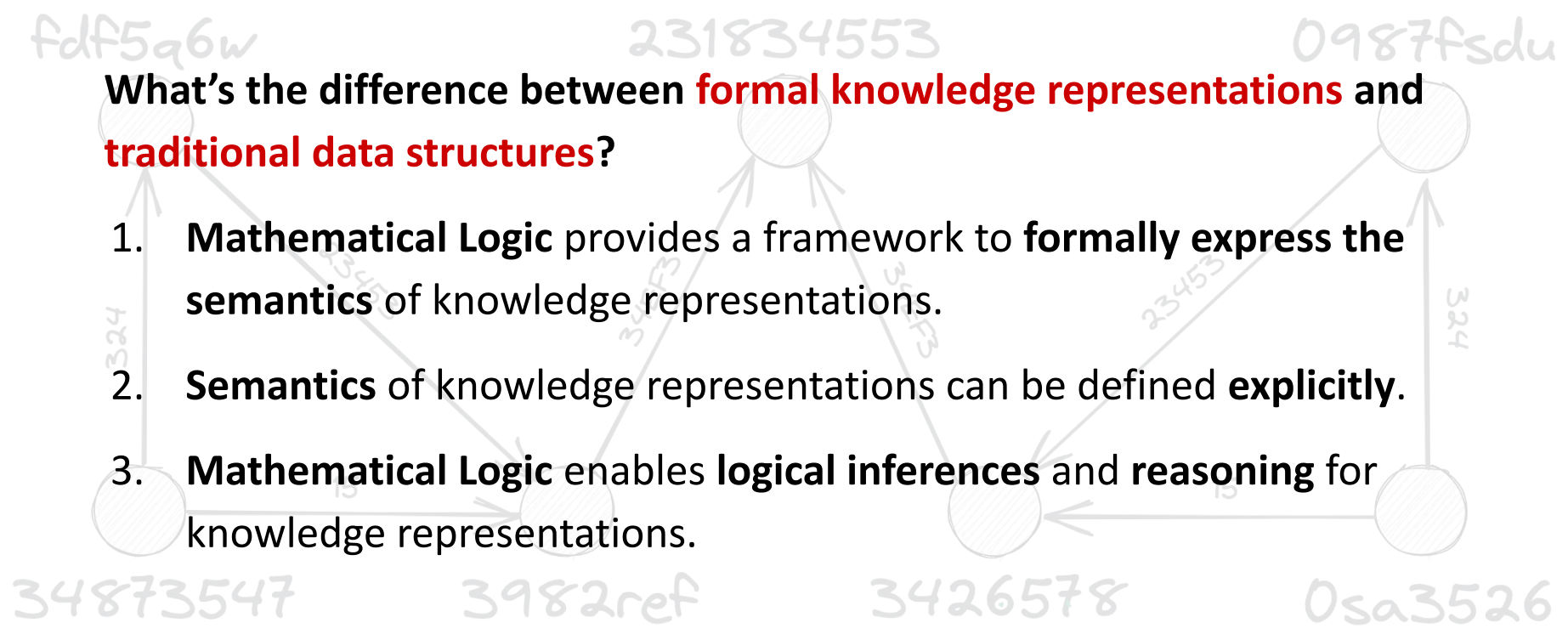
AlecGuinness  $\in$  Creature  
 AlecGuinness  $\notin$  FilmSeries  
 StarWars  $\notin$  Creature



# Formal Knowledge Representations

What's the difference between **formal knowledge representations** and **traditional data structures**?

1. **Mathematical Logic** provides a framework to **formally express the semantics** of knowledge representations.
2. **Semantics** of knowledge representations can be defined **explicitly**.
3. **Mathematical Logic** enables **logical inferences** and **reasoning** for knowledge representations.





# 3. Ontologies and Logic





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

## ...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 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



# What is an Ontology (in Computer Science)?

The background of the slide is a digital artwork. On the left, a woman's head and shoulders are shown in profile, facing right. She has dark hair with pink highlights and is wearing a complex, dark cybernetic headpiece with various sensors and wires. Her skin is a pale, almost greyish tone. On the right, a robotic figure is shown in profile, facing left. The robot has a metallic, textured head with a glowing red eye and a mouth that appears to be a series of mechanical components. The background is a vibrant pink color with a cracked, distressed texture, suggesting a wall or a digital surface. The overall style is a blend of cyberpunk and digital art.

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



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



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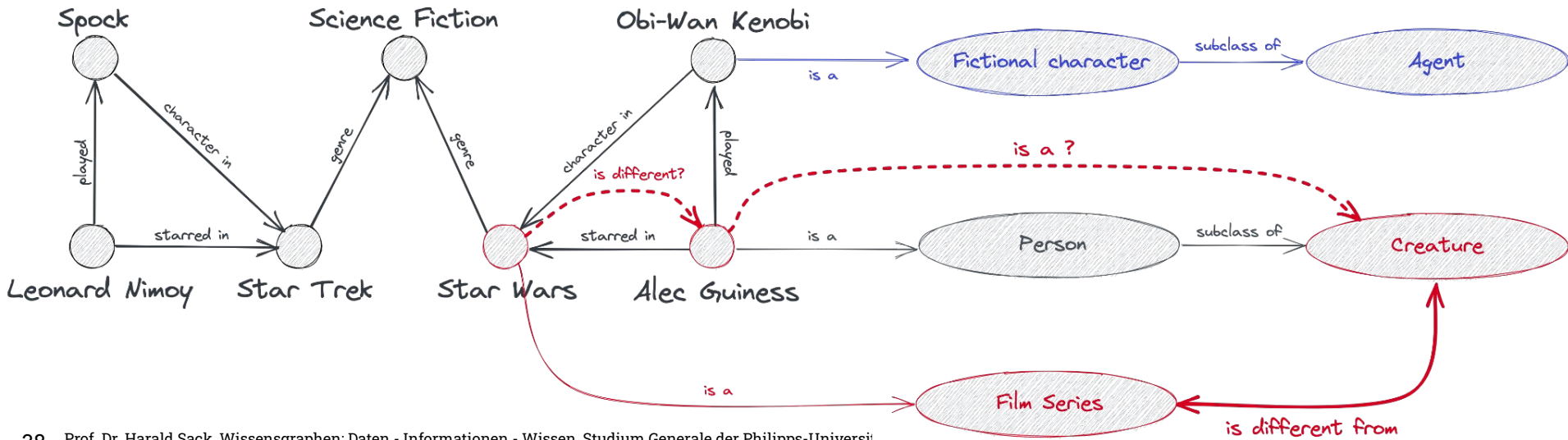


**PARENTAL  
ADVISORY  
EXPLICIT SEMANTICS**

# Knowledge Representation with Ontologies and Knowledge Graphs

Description Logics

$\left. \begin{array}{l} \text{Person}(\text{AlecGuinness}) \\ \text{Person} \sqsubseteq \text{Creature} \end{array} \right\} \Rightarrow \text{Creature}(\text{AlecGuinness})$   
 $\left. \begin{array}{l} \text{FilmSeries}(\text{StarWars}) \\ \text{FilmSeries} \sqcap \text{Creature} \equiv \emptyset \end{array} \right\} \Rightarrow \text{AlecGuinness} \neq \text{StarWars}$



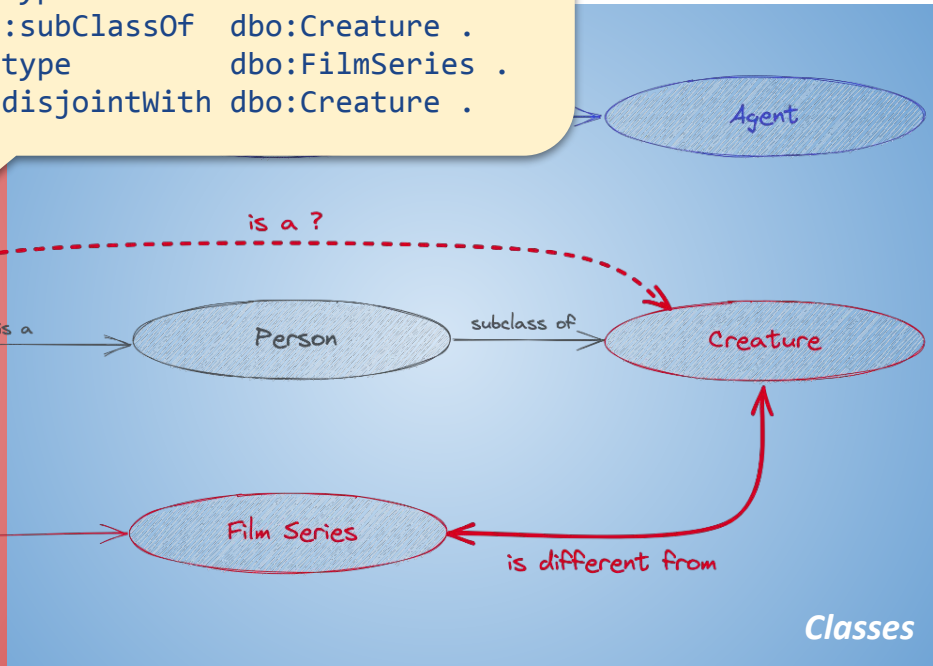
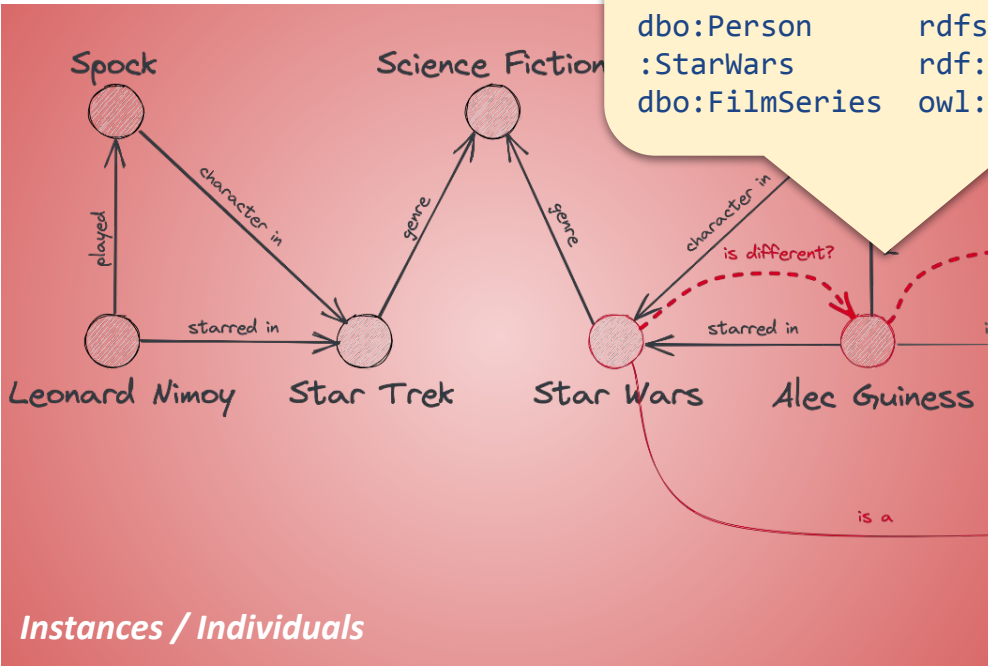


# Knowledge Representation with Ontologies and Knowledge Graphs

Encoded via **RDF(S) & OWL**:

```

:AlecGuinness    rdf:type        dbo:Person .
dbo:Person       rdfs:subClassOf  dbo:Creature .
:StarWars        rdf:type        dbo:FilmSeries .
dbo:FilmSeries   owl:disjointWith  dbo:Creature .
    
```



## Assertional Knowledge

## Terminological Knowledge





## 4. Knowledge Graph Applications

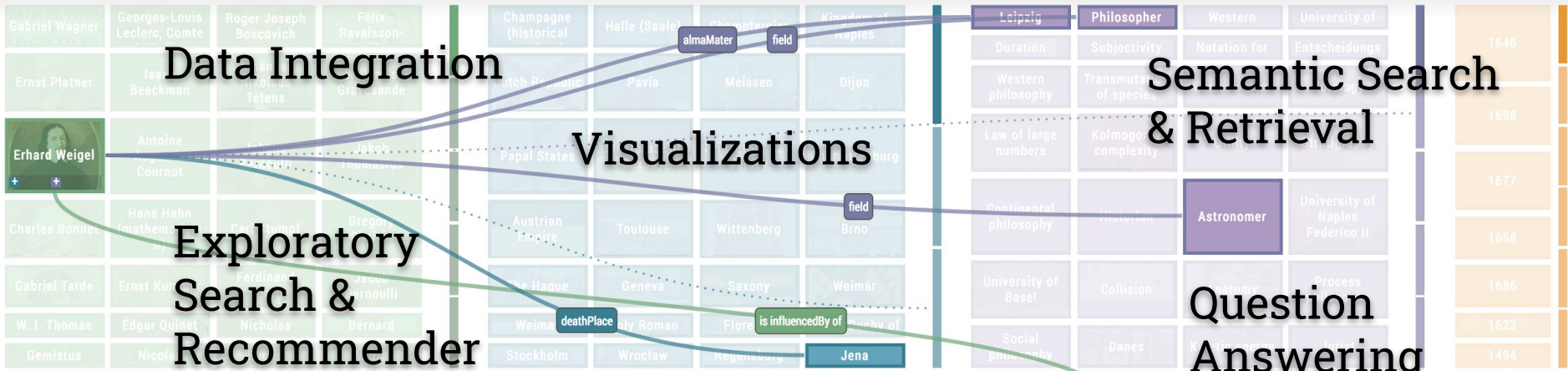


# Knowledge Graph Applications



T. Tietz, J. Jäger, J. Waitelonis, H. Sack, *Semantic Annotation and Information Visualization for Blogposts with refer, (VOILA 2016)*


Relation Browser Timeline



Gottfried Wilhelm Leibniz

- 15 Recommended Articles:
- #1 The Case of J. Robert Oppenheimer
  - #2 Wilhelm Pfeffer and Plant Physiology
  - #3 Karl Pearson and Mathematical Statistics
  - #4 Raphael and the School of Athens
  - #5 Jerzy Neyman – Architect of Modern Theoretical Statistics
  - #6 Christian Gottfried Ehrenberg – Father of Microzoology

**Gottfried Wilhelm Leibniz**



Gottfried Wilhelm von Leibniz (German: [ˈɡɔʦfʁiːt ˈvɪlhɛlm fɔn ˈlaɪbnɪçs] or [ˈlaɪbnɪçs]) (July 1, 1646 – November 14, 1716) was a German mathematician and philosopher. He occupies a prominent place in the history of mathematics and the history of philosophy. Leibniz developed the infinitesimal calculus independently of Isaac Newton, and Leibniz's mathematical notation has been widely used ever since it was published. It was only in the 20th century that his Law of Continuity and Transcendental Law of Homogeneity found mathematical implementation (by means of non-standard analysis). He became one of the most prolific inventors in the field of mechanical calculators. While working on adding automatic multiplication and division to Pascal's calculator, he was the first to describe a pinwheel calculator in 1685 and invented the Leibniz wheel, used

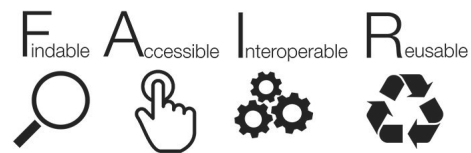
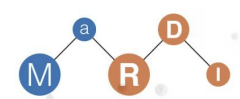
DBpedia: Gottfried Wilhelm Leibniz





# Data Integration





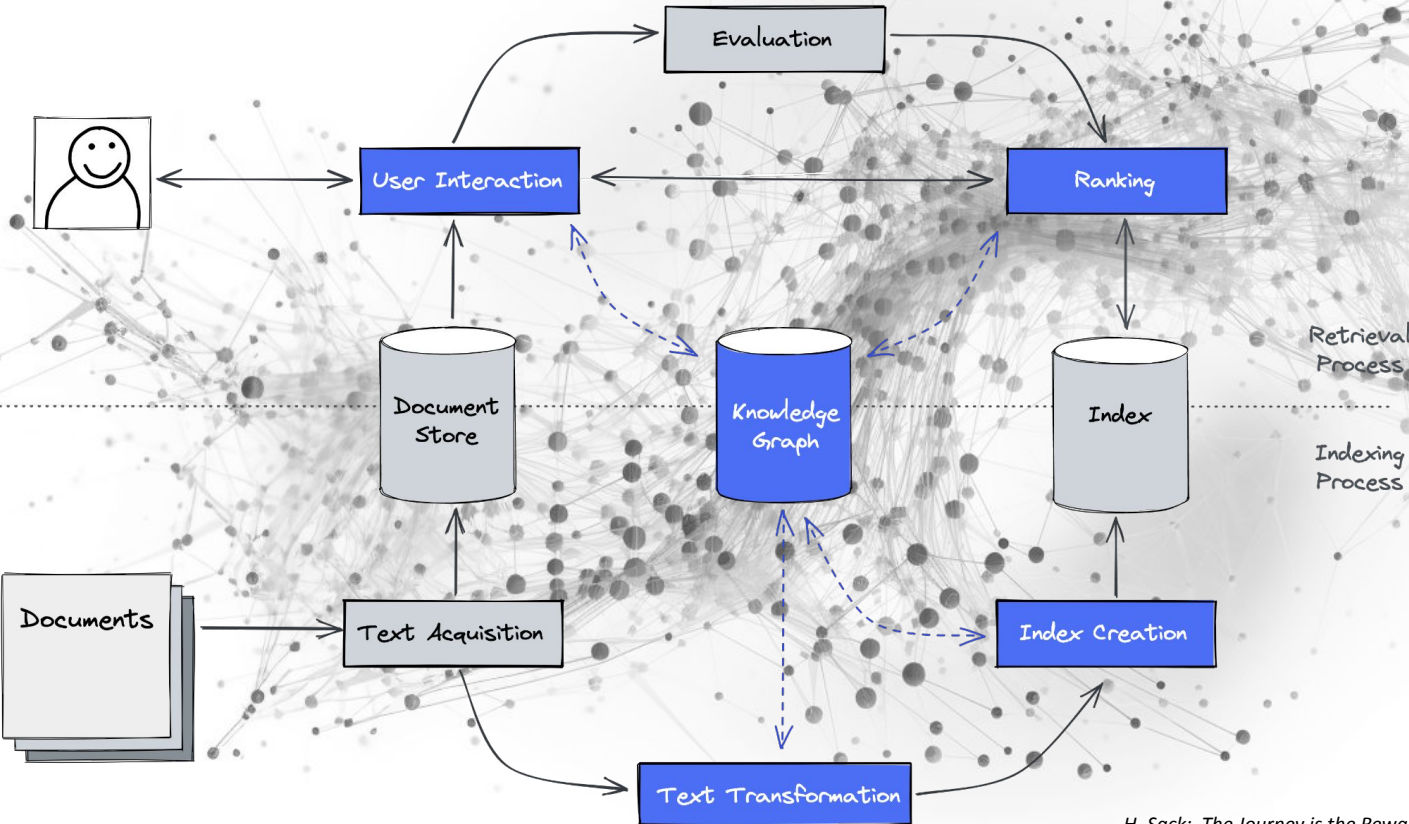


# Semantic Search & Retrieval



# Semantic Search & Retrieval

Things and not Strings



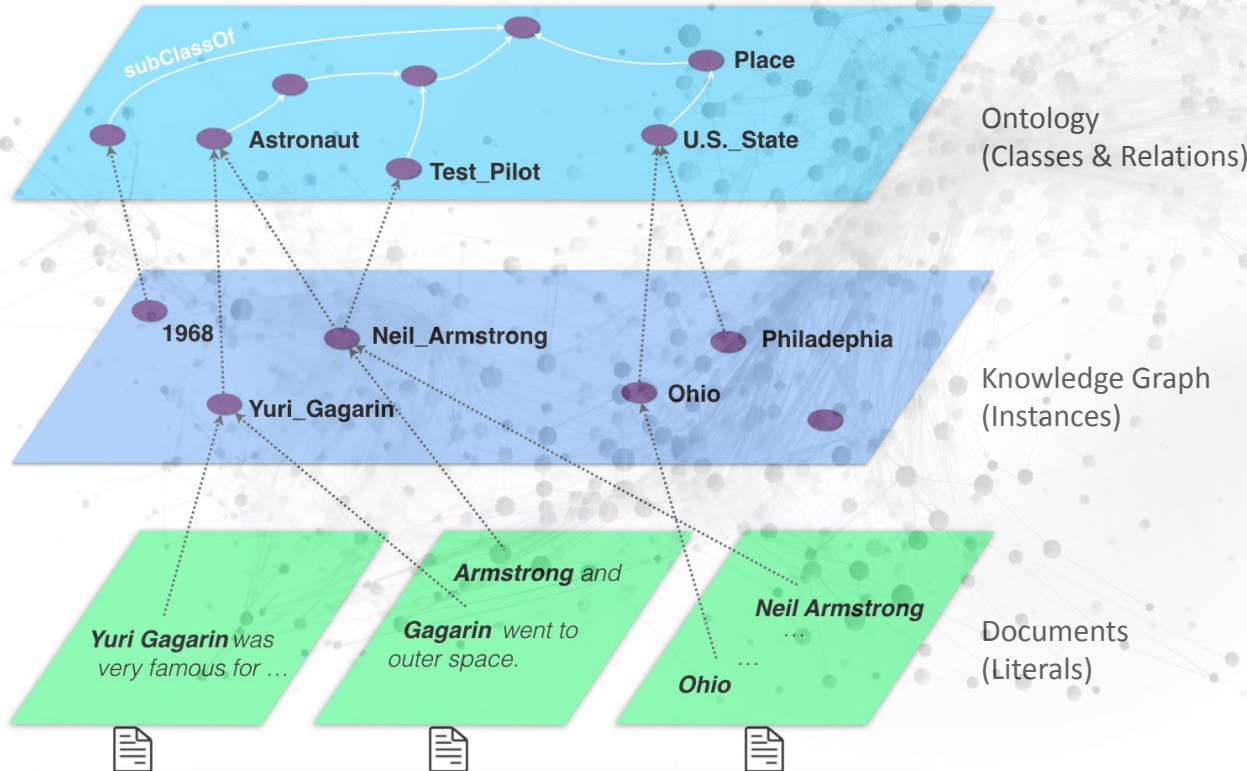
- **Knowledge Graph** as central element of search & retrieval
- KG guides **Index Creation** and **Usage, Ranking** and **User Interaction**
- Enables **Semantic** and **Exploratory Search**

H. Sack: *The Journey is the Reward - Towards New Paradigms in Web Search*, (BIS 2015)

# Semantic Search & Retrieval

## Things and not Strings

J. Waitelonis, C. Exeler and H. Sack: Linked Data Enabled Generalized Vector Space Model To Improve Document Retrieval, (NLP&DBpedia 2015)



### Semantic Search is about

- going **beyond** documents and queries as **bag of words**,
- having a **deeper understanding** of document contents by leveraging **world knowledge** as structured data,
- going **beyond 10 blue links** and providing users with **direct answers** to their (natural language) questions.



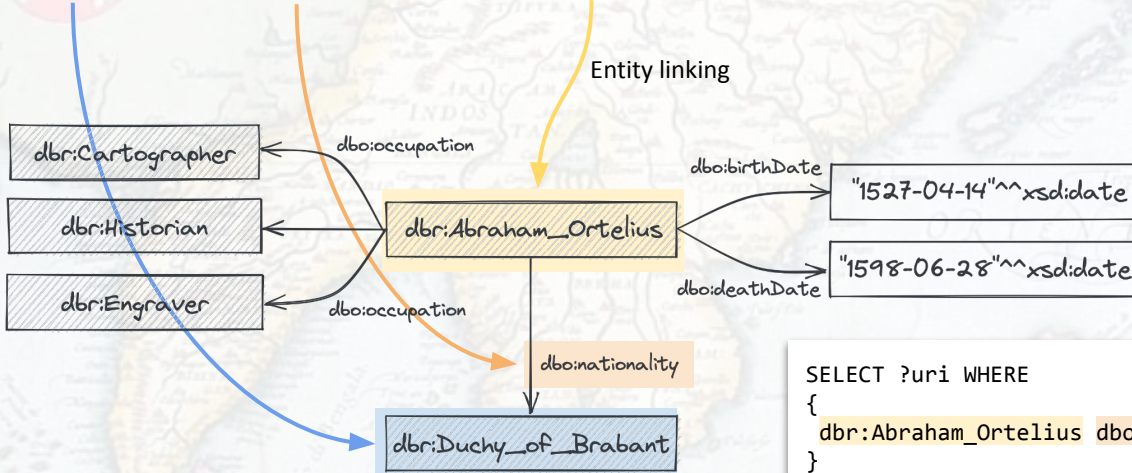


# Question Answering

# Question Answering over Knowledge Graphs

## Factoid Questions

What was the nationality of Abraham Ortelius?



Abraham Ortelius (1527 - 1598)

```
SELECT ?uri WHERE
{
  dbr:Abraham_Ortelius dbo:nationality ?uri.
}
```

- which Popes were in office during the lifetime of Abraham Ortelius?
- which Frisian colleague of Ortelius is considered one of the co-founders of cartography?
- which colleague of Ortelius died of kidney stones?
- which places in Antarctica or the Moon are named after pioneers in cartography?

...



A detailed steampunk illustration in shades of green and black. A woman in a long, dark dress stands on a mechanical ledge, looking out over a complex, industrial landscape filled with gears, pipes, and machinery. The scene is rendered in a sketchy, technical drawing style.

# Exploration & Recommendation

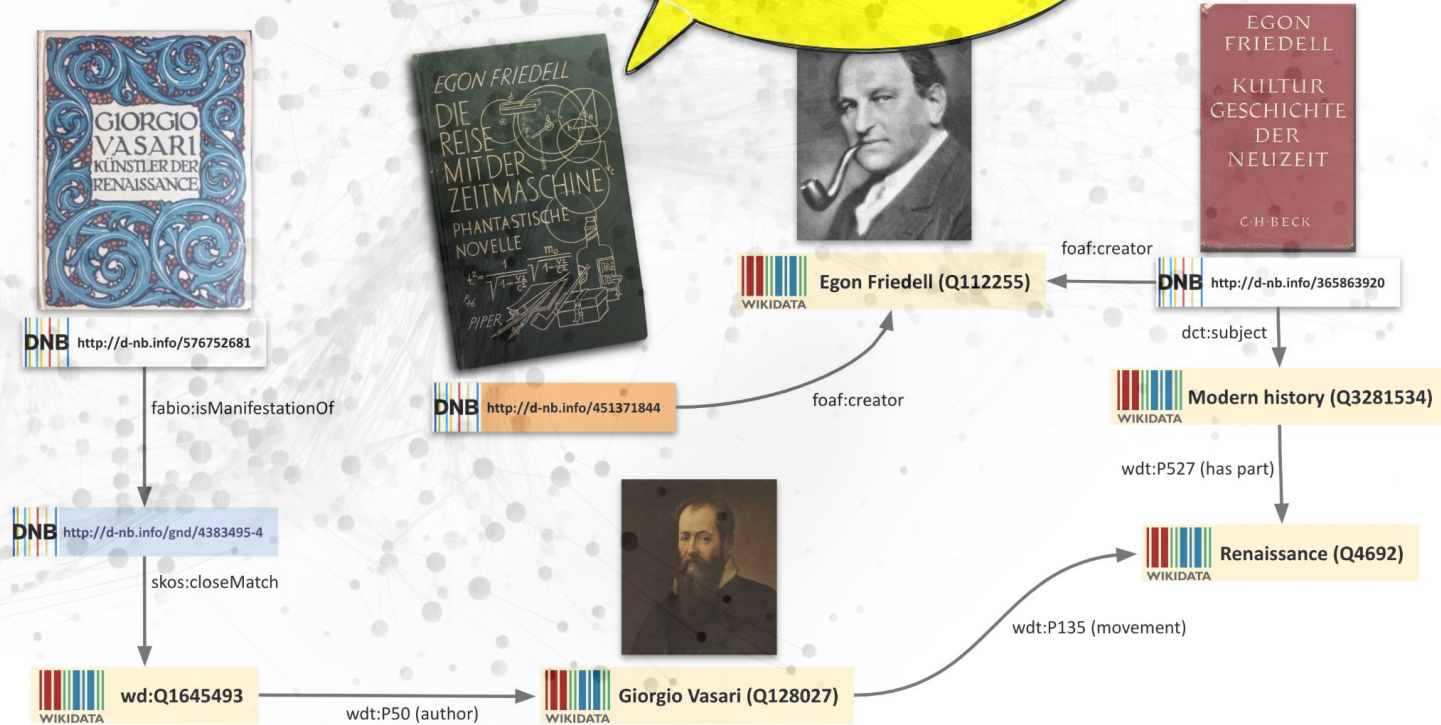
# Exploration & Recommendation

Find what you actually didn't look for in the first place - Serendipity



## Exploratory Search:

- Search in unknown terrain
- unclear search target
- complex information needs
- "Rummaging around" instead of targeted search







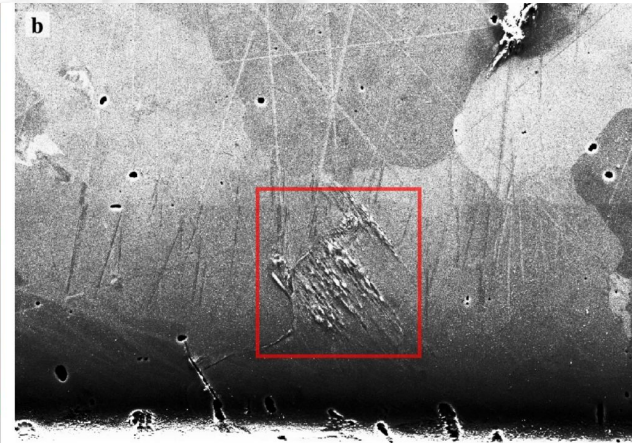
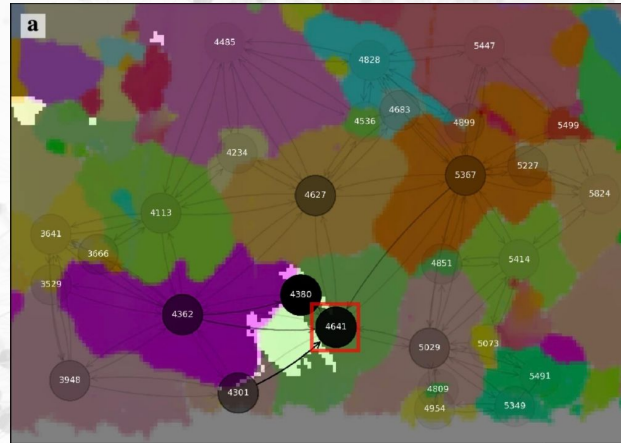
# Explainable AI

# Explainable AI

Why did my Experiment/Simulation/Prediction return this result?

- **Justification** of experimental Results
- Checking for **Plausibility** of experimental Results
- Checking for **Flaws** in your experimental Setup
- Checking for **Flaws** in the **Representation** of your Experiment
- Explain your **Predictions**

Thomas, A., et al. Materials fatigue prediction using graph neural networks on microstructure representations. *Sci Rep* 13, 12562, 2023.



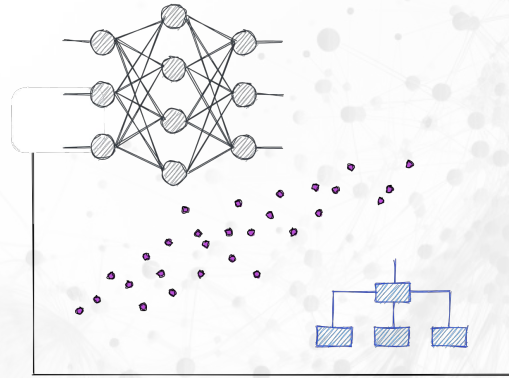




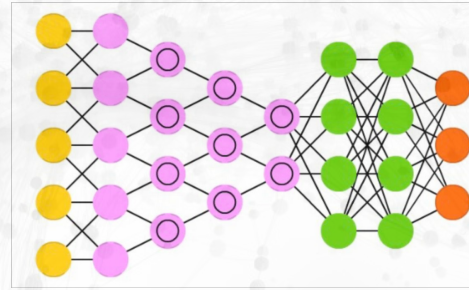
## 5. Hybrid Artificial Intelligence

# 60+ Years of Machine Learning

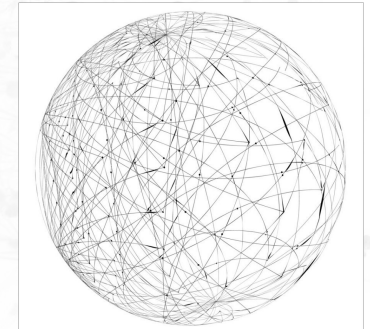
## The Road to Large Language Models



Machine Learning



Deep Learning



Foundation Models

Emergence of ...

“How” (from examples)

“Features” (used for prediction) (advanced) “functionalities”

Homogenization of ...

**Learning Algorithms**  
(as e.g. logistic regression)

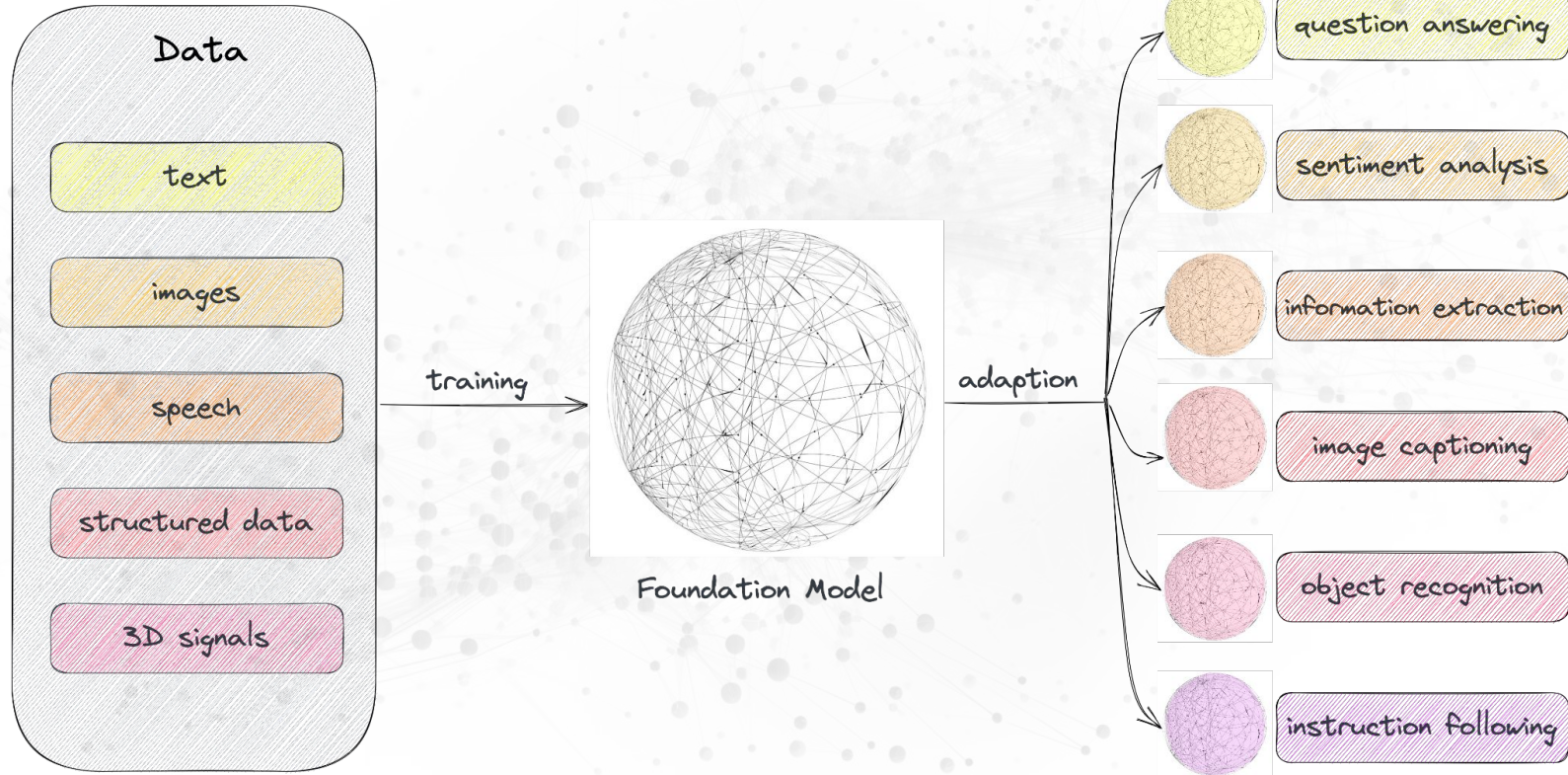
**Model Architectures**  
(as e.g. CNNs)

**Models**  
(as e.g. GPT-4/LLaMA/Mistral)

Bommasani, Rishi, et al., *On the opportunities and risks of foundation models*. arXiv preprint arXiv:2108.07258, 2021.



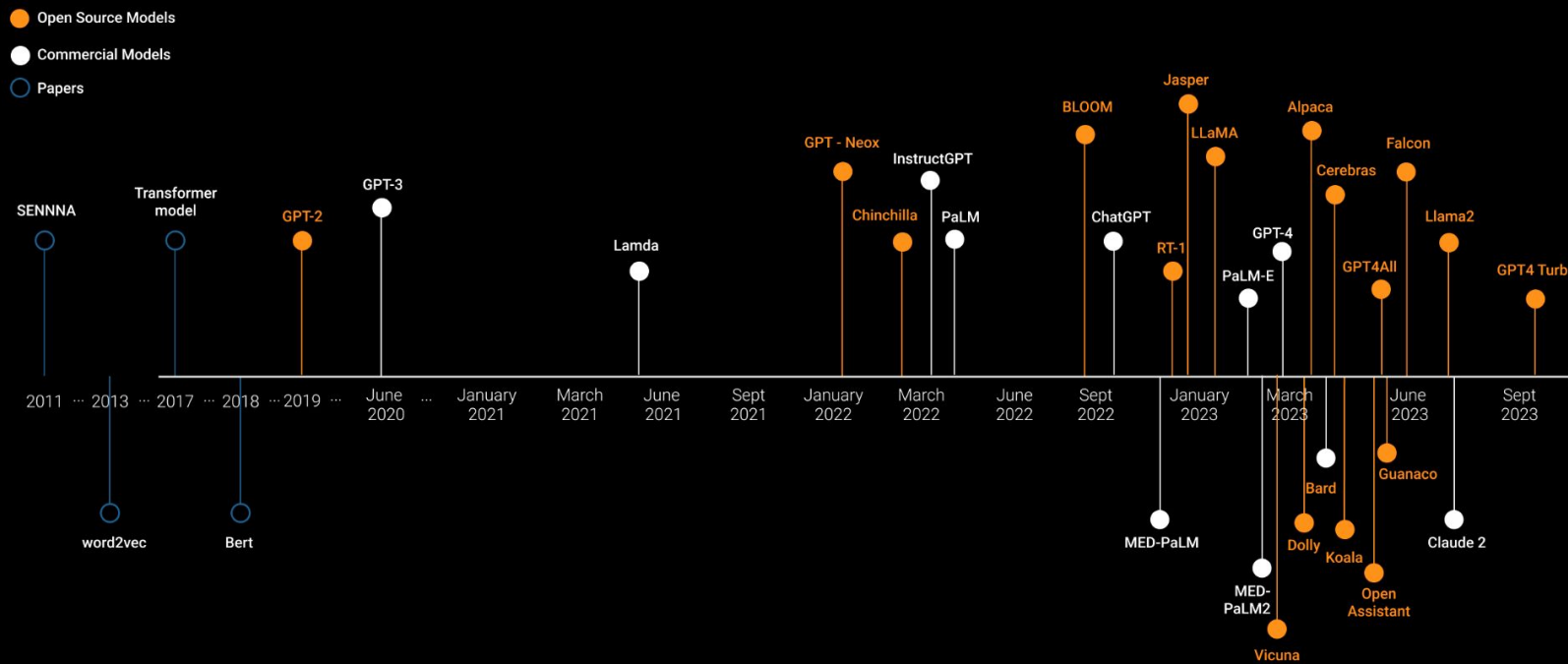
# The Advent of Foundation Models



Bommasani, Rishi, et al., *On the opportunities and risks of foundation models*. arXiv preprint arXiv:2108.07258, 2021.

# The Evolution of Large Language Models

From Basic to Bold in a few Years...





# From Basic to Bold...



# From Basic to Bold in a few Years!

## Example Linked Stage Graph

### Example: Linked Stage Graph Image Annotation

- Knowledge Graph of Archival Documents and Photographies from Stuttgart State theatres 1890 - 1940
- Web page: <https://slod.fiz-karlsruhe.de/>

T. Tietz et al., *Linked Stage Graph*, in Proc. of the 15th Int. Conf. on Semantic Systems, 2019.

T. Tietz et al., *A Data Model for Linked Stage Graph and the Historical Performing Arts Domain*, In Proc. of the Int. Workshop on Semantic Web and Ontology Design for Cultural Heritage (SWODCH), 2023.





# From Basic to Bold in a few Years!

Example Linked Stage Graph

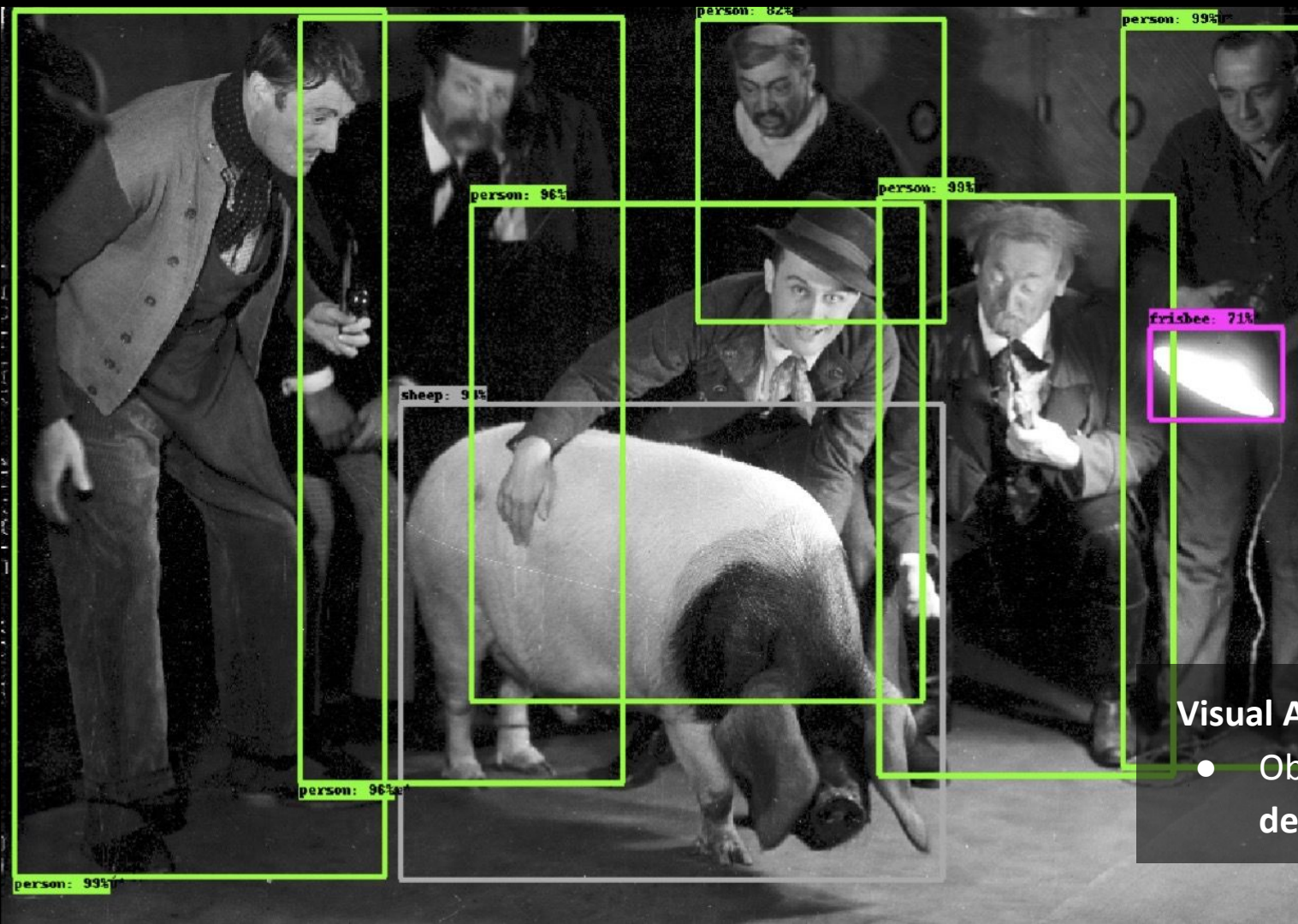


## PROBLEM:

- No content-related Metadata or image descriptions available

## SOLUTION:

- Visual Analysis:
  - Object Identification
  - Image Captioning



### Visual Analysis:

- Object Identification v denseNet-101 (2018)



# From Basic to Bold in a few Years!

Example Linked Stage Graph

## Visual Analysis

- Image Captioning via prompt generation at Midjourney

Midjourney. 2022. Midjourney.com. <https://www.midjourney.com>



Midjourney Bot ✓ BOT

17.11.2023 16:24

1 a man is holding a pig in front of men, in the style of 1920s, spectacular show of ages, zeiss batis 18mm f/2.8, [j. j. grandville](#), lively tableaus, flickr, viennese actionism --ar 128:75

# From Basic to Bold in a few Years!

## Example Linked Stage Graph



### Visual Analysis

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Midjourney. 2022. Midjourney.com. <https://www.midjourney.com>



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17.11.2023 16:24

**1** a man is holding a pig in front of men, in the style of 1920s, spectacular show of ages, zeiss batis 18mm f/2.8, [j. j. grandville](#), lively tableaus, flickr, viennese actionism --ar 128:75

**2** a group of men holding a pig and a camera, in the style of spectacular show of ages, associated press photo, whirly, low speed film, lively tableaus, soft-edged --ar 128:75



# The Ghost in the Machine...



# The Ghost in the Machine

Large Language Models and the Art of Creative Hallucination

# GALACTICA

demo

Try: what is the schrodinger equation

Generate

Explore





**Yann LeCun**

@ylecun



A Large Language Model trained on scientific papers.

Type a text and [galactica.ai](#) will generate a paper with relevant references, formulas, and everything.

Amazing work by [@MetaAI](#) /  
[@paperswithcode](#)



# GALACTICA

demo

Try: what is the schrodinger equation

Generate

Explore



GALACTICA

wiki article on Hanlon's razor



Generated document for query "wiki article on Hanlon's razor"

x not verified

## Hanlon's razor

Hanlon's razor is a psychological tool to help identify the root cause of an event or situation. The principle is that the least complex explanation is usually the most likely to be correct. It was named after its creator, the Canadian psychiatrist Thomas J. Hanlon, who first described it in 1977.

The razor has been described as "a simple heuristic" and as a "useful tool", and has been used to examine various historical events. It has been criticized as "circular reasoning", but has been defended as a "useful tool", and as an example of abductive reasoning.



# Hanlon's razor



From Wikipedia, the free encyclopedia

あ → A

This article **may be expanded with text translated from the corresponding article in French.** [show]

(April 2021) Click [show] for important translation instructions.

**Hanlon's razor** is an **adage** or **rule of thumb** that states "**never attribute to malice that which is adequately explained by stupidity.**"<sup>[1]</sup> Known in several other forms, it is a **philosophical razor** that suggests a way of eliminating unlikely explanations for human behavior. It is probably **named after** Robert J. Hanlon, who submitted the statement to *Murphy's Law Book Two* (1980).<sup>[1]</sup> Similar statements have been recorded since at least the 18th century.

## Contents [hide]

- [Origin](#)
- [Other variations of the idea](#)
- [See also](#)
- [References](#)

## Origin [edit]

A similar quotation appears in **Robert A. Heinlein's** novella *Logic of Empire* (1941).<sup>[2]</sup>

The character "Doc" in Heinlein's story described the "devil theory" fallacy, explaining,

"You have attributed conditions to villainy that simply result from stupidity."<sup>[3]</sup>



*The Court of Foolishness* of [Gerard de Lairesse](#). The accused, pursued by Hatred, is led by Calumny, Envy and Perfidy before a judge with donkey ears, surrounded by Ignorance and Suspicion.

# Hybrid AI



# Symbolic Knowledge Representation to the Rescue

## Limitations

You should be aware of the following limitations when using the model (including the demo on this website):

- **Language Models can Hallucinate.** There are no guarantees for truthful or reliable output from language models, even large ones trained on high-quality data like Galactica. **NEVER FOLLOW ADVICE FROM A LANGUAGE MODEL WITHOUT VERIFICATION.**
- **Language Models are Frequency-Biased.** Galactica is good for generating content about well-cited concepts, but does less well for less-cited concepts and ideas, where hallucination is more likely.
- **Language Models are often Confident But Wrong.** Some of Galactica's generated text may appear very authentic and highly-confident, but might be subtly wrong in important ways. This is particularly the case for highly technical content.

<https://cs.nyu.edu/~davise/papers/ExperimentWithGalactica.html>

## Symbolic AI

- Knowledge Representation
- Reasoning
- Verification

## Subsymbolic AI

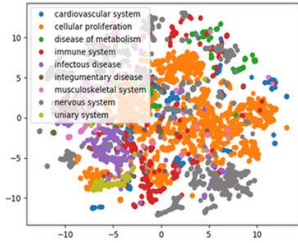
- Neural Networks, Deep Learning & Foundation Models

Hybrid AI  
Models

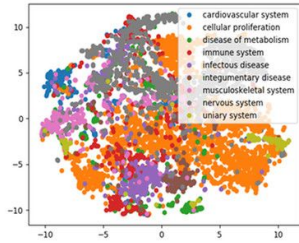
# Hybrid AI - Combining Symbolic and Subsymbolic AI

## Knowledge Graph Embeddings

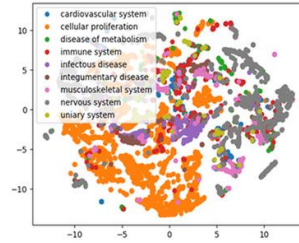
A. Walking\_RDF/OWL



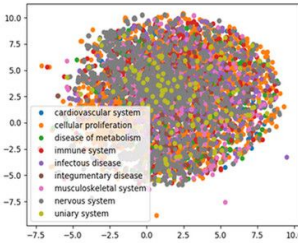
B. TransE embeddings



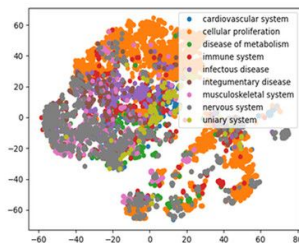
C. Poincare embeddings



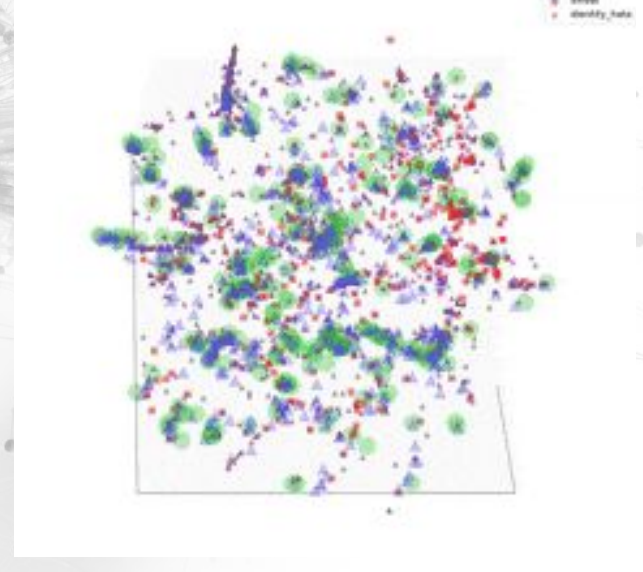
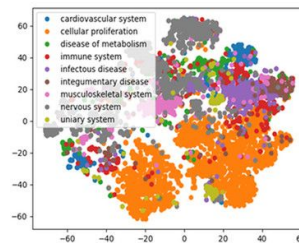
D. Rescal embeddings



E. SimpleE embeddings



F. R-GCN embeddings



- Knowledge Graph Completion
- KGE for Classification Tasks
- Ontology Mapping
- Entity/Knowledge Graph Alignment

R. Biswas et al.: MADLINK: Attentive Multihop and Entity Descriptions for Link Prediction in Knowledge Graphs, Semantic Web Journal, 202

G. A. Gesese et al.: RAILD: Towards Leveraging Relation Features for Inductive Link Prediction, IJCGC 2022

G. A. Gesese et al. A Survey on Knowledge Graph Embeddings with Literals: Which model links better Literal-ly?, Semantic Web Journal, 12(4), 2020

R. Biswas et al.: It's All in the Name: Entity Typing Using Multilingual Language Models, ESWC 2022

Prof. Dr. Harald Sack, Wissensgraphen: Daten - Informationen - Wissen, Studium Generale der Philipps-Universität Marburg, 24.01.2024

<https://peeri.com/articles/cs-341/>



# Hybrid AI - Combining Symbolic and Subsymbolic AI

## Explainability and Fact Checking



Foundation Model



Assertions



knowledge mapping



Knowledge Graph & Ontologies

path discovery  
inconsistency detection  
constraint validation



"verified" assertions

A black and white illustration of an astronaut standing on a lunar surface. The astronaut is wearing a full space suit and is positioned in the center-left of the frame. To the right, a large, curved satellite dish or antenna structure is visible, extending towards the top right corner. The ground is covered in rocks and debris, and the background is a dark, starry sky. The overall scene is rendered in a high-contrast, sketch-like style.

# Example: Iconclass Search & Recommendation



# Iconclass - Iconographic Classification System

Browse [Search](#)

- 0 · Abstract, Non-representational Art
- ▶ 1 · Religion and Magic
- ▶ 2 · Nature
- ▶ 3 · Human Being, Man in General
- ▼ 4 · Society, Civilization, Culture
  - ▶ 41 · material aspects of daily life
  - ▶ 42 · family, descentance
  - ▶ 43 · recreation, amusement
  - ▶ 44 · state; law; political life
  - ▶ 45 · warfare; military affairs
  - ▶ 46 · social and economic life, transport and communication
  - ▶ 47 · crafts and industries
  - ▶ 48 · art
  - ▼ 49 · education, science and learning
    - ▶ 49A · education
    - ▶ 49B · scholastic education, tuition
    - ▶ 49C · aspects of science in general
    - ▶ 49D · mathematics
    - ▶ **49E · science and technology**
    - ▶ 49F · biology
    - ▶ 49G · medicine, medical science
    - ▶ 49H · social sciences
    - ▶ 49I · geography
    - ▶ 49K · historical disciplines; philology
    - ▶ 49L · writing and letters
    - ▶ 49M · production of printed matter, book-production
    - ▶ 49N · reading
  - ▶ 5 · Abstract Ideas and Concepts
  - ▶ 6 · History
  - ▶ 7 · Bible
  - ▶ 8 · Literature
  - ▶ 9 · Classical Mythology and Ancient History

4 · Society, Civilization, Culture

49 · education, science and learning

 **49E**  science and technology

Search with these related keywords:

*civilization, culture, learning, occupations, science, society*

Add more detail:

49E1 · astronomy (and cosmography)

49E2 · physics and mechanics

49E3 · chemistry

49E4 · crystallography

49E5 · geology

49E6 · meteorology

49E7 · technology

49E8 · laboratory

49E9 · experiment, test ~ science and technology

49E(+0) · science and technology (+ variant)

49E(+1) · science and technology (+ scholar, scientist (at work))

49E(+2) · science and technology (+ scholar, scientist in non-work situations)

49E(+3) · science and technology (+ portrait of scholar, scientist)

49E(+4) · science and technology (+ professional clothes of scholar, scientist)

49E(+5) · science and technology (+ scientific research)

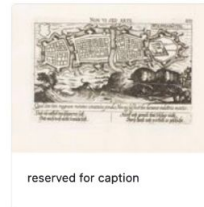
49E(+6) · science and technology (+ divulgation of the results of research)

49E(+7) · science and technology (+ basic phenomena and processes in the natural sciences)

49E(+8) · science and technology (+ plagiarism ~ sciences)

49E(+9) · science and technology (+ counterfeit, fake, forgery ~ sciences)

## 3 sample images



Johann Georg Volckamer



Conrad Gesner

# Traditional Iconclass Search

## Syntactic Text-based Search

Browse

Search

pig

Advanced Search

Include keys (+)

Sort by notation

Found 97 results, searching for *pig*

All 1 2 3 4

- 11H(BLAISE)521 the poor woman brings the pig's head
- 11H(BLAISE)1 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - specific aspects ~ male saint
- 11H(BLAISE)13 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - male saint as patron
- 11H(BLAISE)9 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - portrait of male saint
- 11H(BLAISE)11 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - male saint as patron
- 11H(BLAISE)8 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - post-mortem occurrence
- 11H(BLAISE)4 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - non-miraculous activities and events ~ male saint
- 11H(BLAISE)2 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - early life of male saint
- 11H(BLAISE)0 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed candles, little boy, pig's head, wool-comb - male saint represented in a group
- 11H(BLAISE)83 the martyr Blaise (Blasius), bishop of Sebaste; possible attributes: crossed

1 - Religion and Magic

11 - Christian religion

11H - saints

11H(...) - male saints (with NAME)

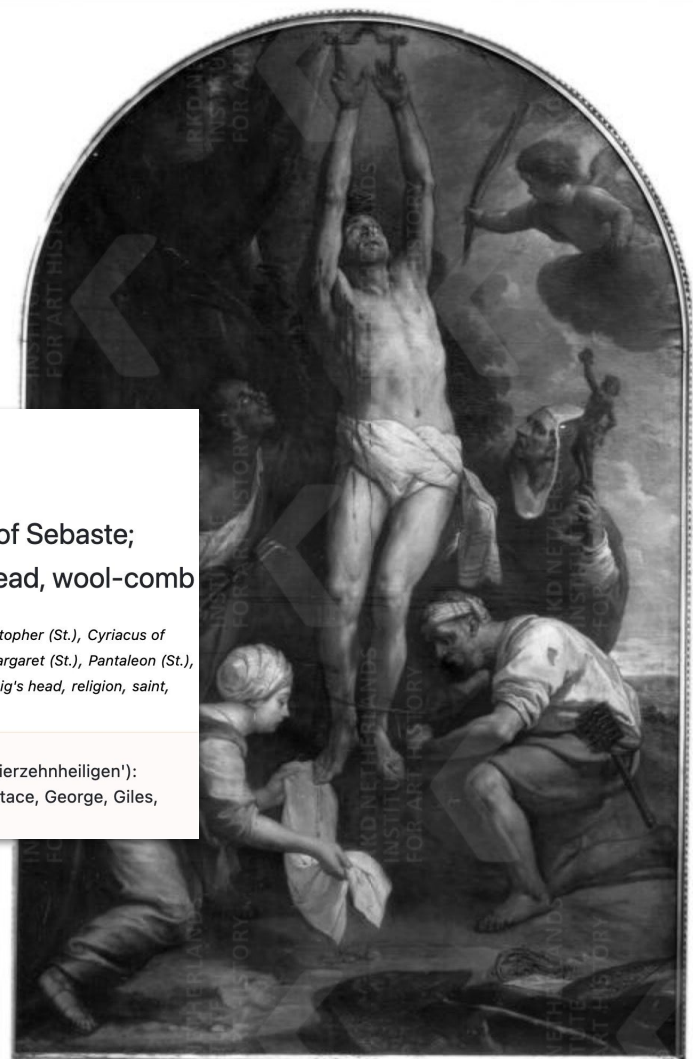
11H(BLAISE) the martyr Blaise (Blasius), bishop of Sebaste;  
possible attributes: crossed candles, little boy, pig's head, wool-comb

Search with these related keywords:

Achatius (St.), Barbara (St.), Blaise (St.), Catherine of Alexandria (St.), Christian religion, Christopher (St.), Cyriacus of Rome (St.), Denis (St.), Erasmus (St.), Eustace (St.), George (St.), Giles (St.), Holy Helpers, Margaret (St.), Pantaleon (St.), Vitus (St.), bishop, boy, candle, comb, crossed candles, fourteen, hackle, help, martyr, pig, pig's head, religion, saint, supernatural

Also see:

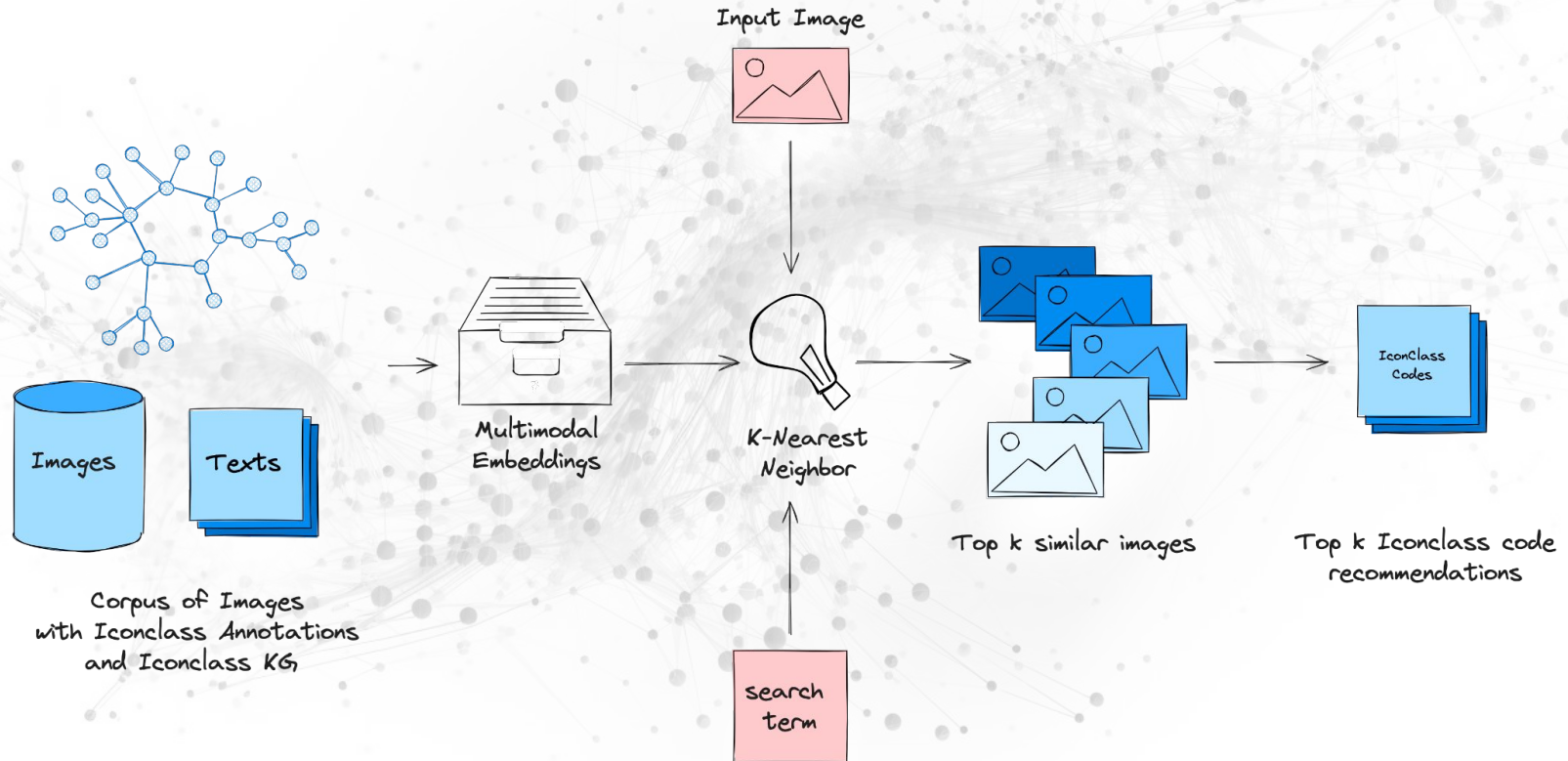
11H(FOURTEEN HOLY HELPERS) - group of fourteen auxiliary saints together ('Vierzehnheiligen'):  
Achatius, Barbara, Blaise, Catherine, Christopher, Cyriacus, Denis, Erasmus, Eustace, George, Giles, Margaret, Pantaleon, Vitus





# Iconclass Image Search and Classification

## Iconclass Multi-Label Multi-Class Classification



# Iconclass Image Search and Classification

## Similarity-based Image Search

Browse

Search

Type some word(s) in English to search for and press 'Enter'...



Advanced Search

Exclude keys (+)

Sort by notation

Found 27 results, searching for *this uploaded image*

- 61B(+55)  historical persons (portraits and scenes from the life) (+ full length portrait)
- 48C24  piece of sculpture, reproduction of a piece of sculpture
- 48C23  portrait, self-portrait of sculptor
- 48B11(+32)  workshop, studio of the artist (in general) (+ sculpture)
- 41D2333  wooden shoes, clogs
- 31A2422  head turned to the right
- 31A231  standing figure
- 25F  animals
- 47I2271  stall, stable
- 47I212  pig
- 41C  nutrition, nourishment
- 34B232  fowl (cock, hen, chicken, etc.)
- 43B7  zoo (as place of recreation)





# Wissensgraphen: Daten - Informationen - Wissen

## Take Home Messages

- To understand data we need context
- Graphs are an intuitive vehicle for knowledge representation
- Ontologies formalize knowledge representation to become machine understandable
- Modern information systems (often) rely on knowledge graphs
- Knowledge Graphs and Deep Learning alone will not lead to robust and reliable AI
- Hybrid AI is a promising solution for more robust and reliable AI

# Thank you very much for your attention!



Picture: <https://www.instagram.com/p/C2Ct7L8OinF/>

## Wissensgraphen

Daten - Informationen - Wissen

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**FIZ Karlsruhe**

Leibniz-Institut für Informationsinfrastruktur





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