Hellooo Computer?
When Large Language Models meet RDF Knowledge Graphs

Hellooo computer?

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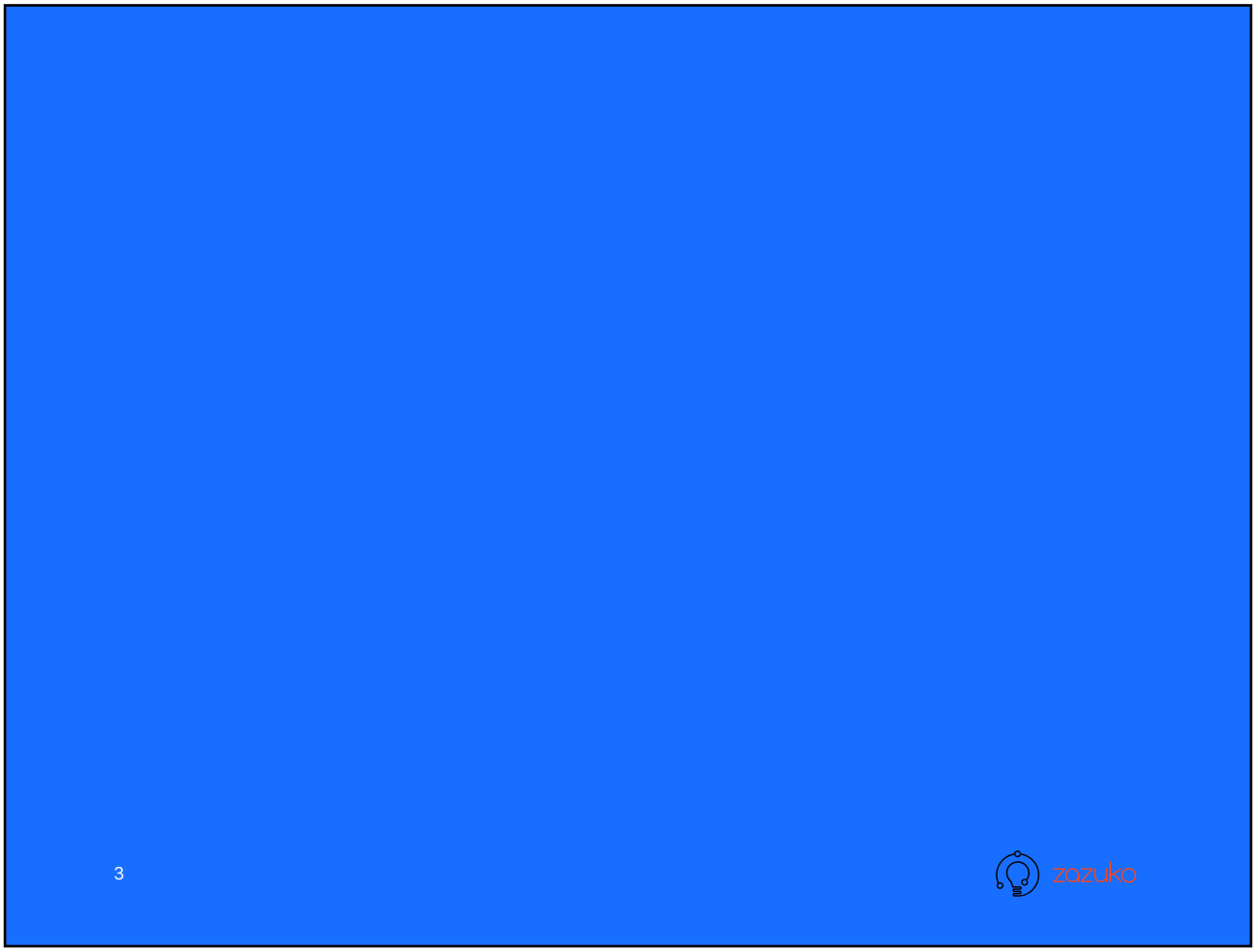
Scotty and the Computer in Star Trek IV

In this memorable scene, Montgomery "Scotty" Scott, the chief engineer from the Starship Enterprise, finds himself in the past, facing a 20th-century computer. Mistaking the mouse for a microphone, he humorously attempts to communicate verbally with it, illustrating the vast differences in technological interaction across eras. This scene playfully highlights the evolution of human-computer interaction and the ever-changing expectations of technology.

This was the Mac model used.



This slide contains the Star Trek sequence mentioned above. You can watch it on YouTube as well.

UNDERSTANDING THE BASICS

LLMs and KGs Unveiled

Understanding the individual strengths and applications of LLMs and KGs sets the stage for their combined potential.

- LLMs: Neural networks for human-like text.
- KGs: Structured knowledge networks.
- Emphasis on RDF KGs and SPARQL.

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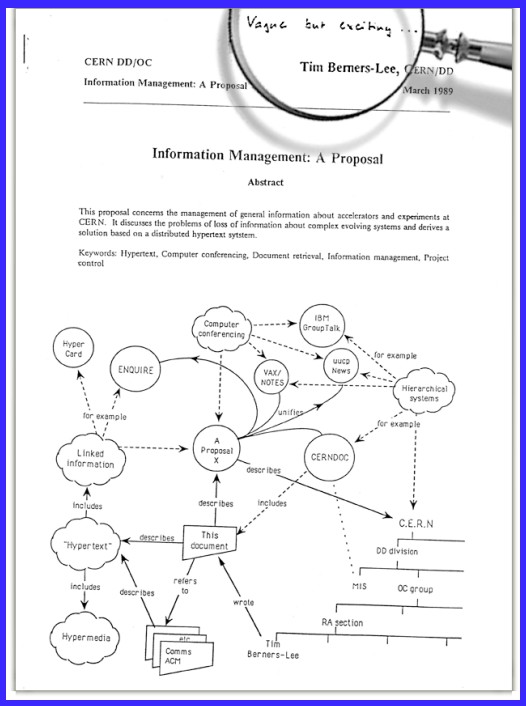
About Zazuko:

- We are a Knowledge Graph & Linked Data consulting company
- Open Source focus
- Remote-first
- Based in Europe & Southeast Asia (Indonesia)
- If you enjoy this tutorial, contact us!

THE SEMANTIC WEB VISION

By Tim Berners-Lee



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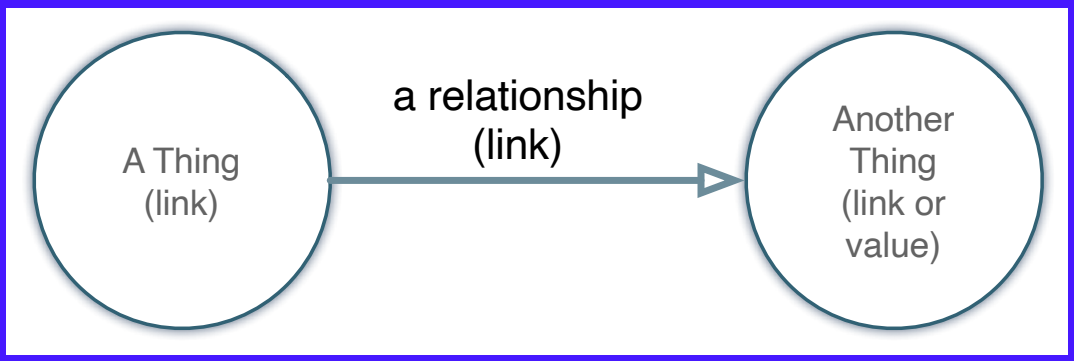
Envisioning a web of data that can be processed by machines and humans alike, aiming for a universal data exchange medium.

– Probably always part of Tims vision, see "the proposal"

RDF

THE BUILDING BLOCK

Resource Description Framework



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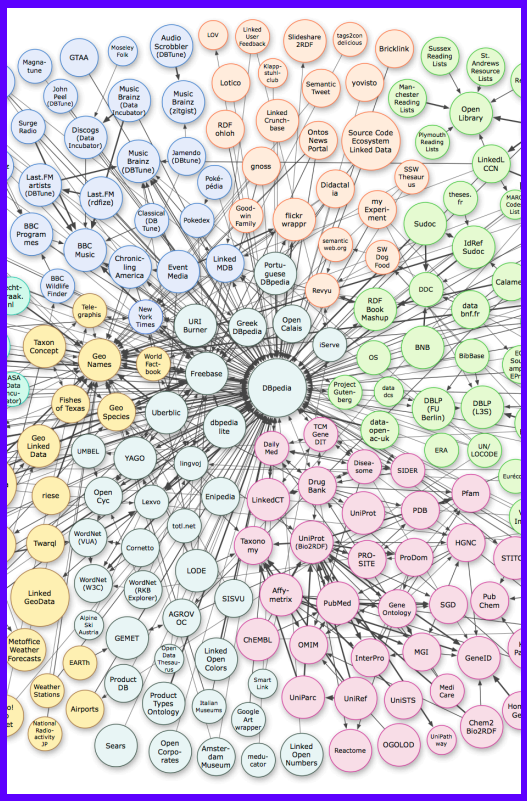
RDF as the foundational model for data interchange on the web, with SPARQL as its standardized query language.

Exploring different formats like Turtle and JSON-LD, designed to make RDF data comprehensible for both humans and machines.

LINKED DATA PRINCIPLES

Connecting the Web, using 5-Star data



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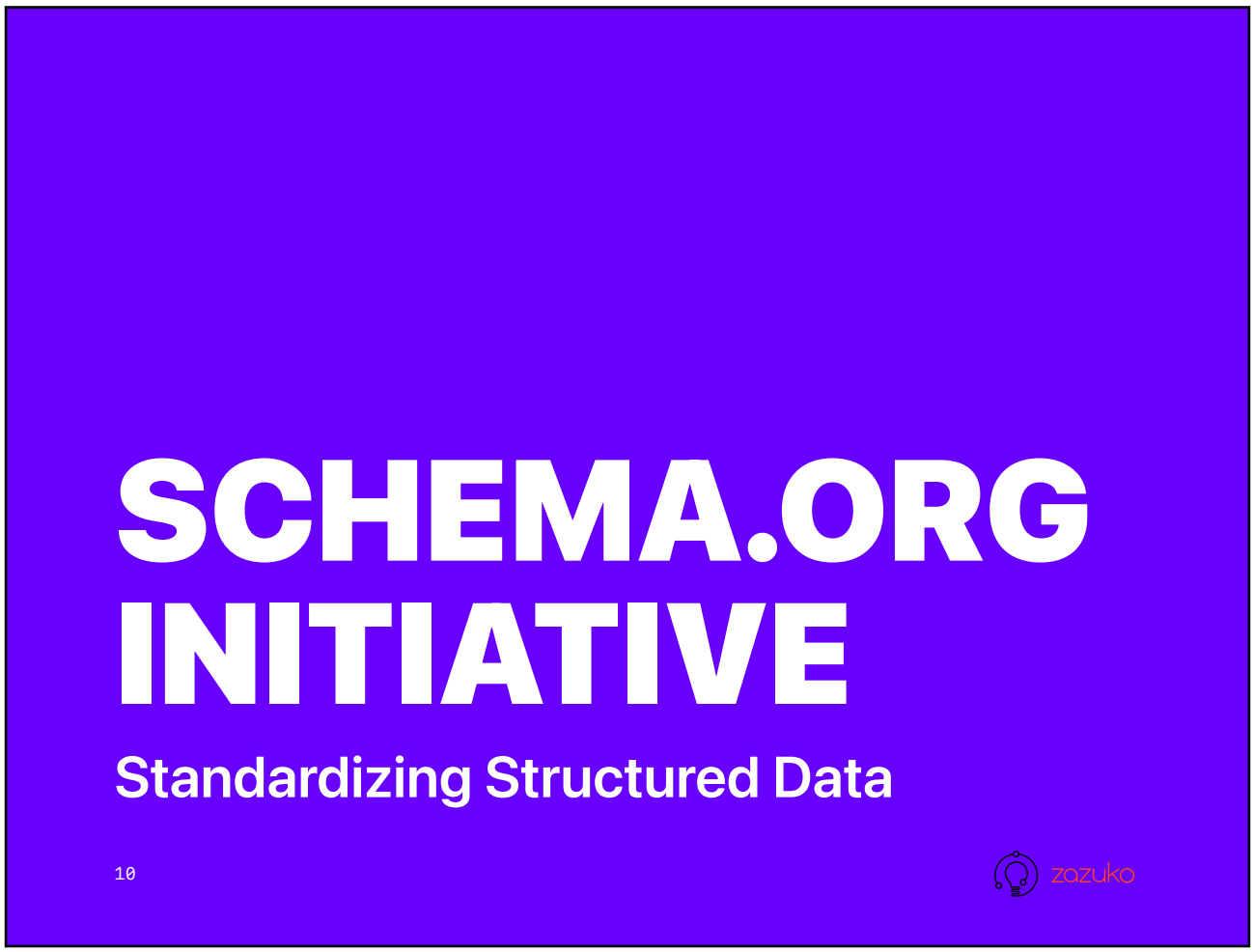
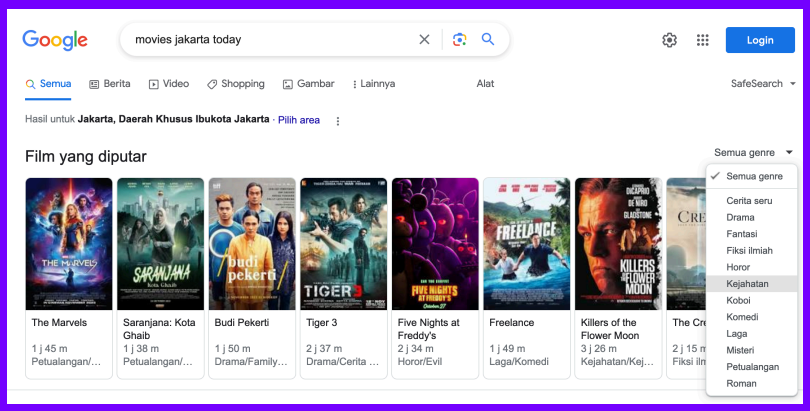
The idea of interlinked data sets across the web, enhancing access and utility of information globally.



Initiated in 2011 by leading search engines, schema.org provides a common vocabulary for structured data on the internet.

GOOGLE'S KNOWLEDGE GRAPH

Revolutionizing Search



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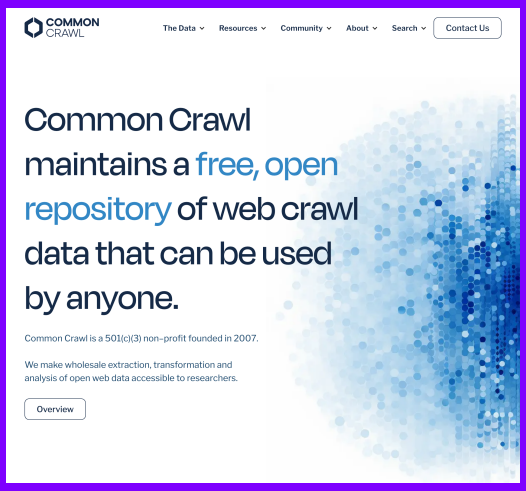
Google's introduction of the term "Knowledge Graph" in 2012 marked a new era in search technology, leveraging interconnected data.

EMBEDDED STRUCTURED DATA



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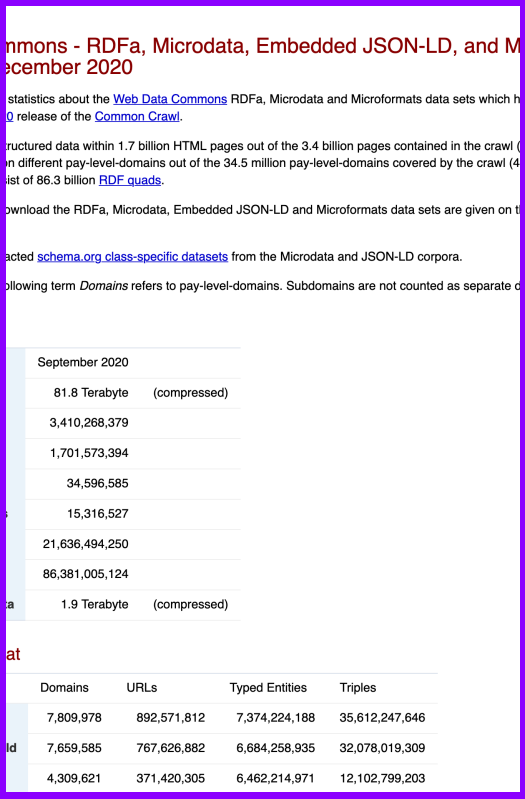
With half of all websites embedding some form of RDF triples, the web is rich with structured, machine-readable data.

- We can't say for sure what the effect of embedded, structured data is for Large Language Models
- But we can assume that is very big for common knowledge

Source

… we found structured data within 1.7 billion HTML pages out of the 3.4 billion pages contained in the crawl (50.0%)



nmons - RDFa, Microdata, Embedded JSON-LD, and M
ecember 2020

statistics about the Web Data Commons RDFa, Microdata and Microformats data sets which h
0 release of the Common Crawl.

ructured data within 1.7 billion HTML pages out of the 3.4 billion pages contained in the crawl (
n different pay-level-domains out of the 34.5 million pay-level-domains covered by the crawl (4
ist of 86.3 billion RDF quads.

ownload the RDFa, Microdata, Embedded JSON-LD and Microformats data sets are given on t

acted schema.org class-specific datasets from the Microdata and JSON-LD corpora.

llowing term *Domains* refers to pay-level-domains. Subdomains are not counted as separate d

	September 2020	
	81.8 Terabyte	(compressed)
	3,410,268,379	
	1,701,573,394	
	34,596,585	
	15,316,527	
	21,636,494,250	
	86,381,005,124	
a	1.9 Terabyte	(compressed)

at

	Domains	URLs	Typed Entities	Triples
	7,809,978	892,571,812	7,374,224,188	35,612,247,646
ld	7,659,585	767,626,882	6,684,258,935	32,078,019,309
	4,309,621	371,420,305	6,462,214,971	12,102,799,203

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Source

RISE OF ENTERPRISE KGS

Beyond Public Data

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The growing trend of implementing Knowledge Graphs in enterprise environments for enhanced internal data analysis and decision-making.

LLMs AND RDF

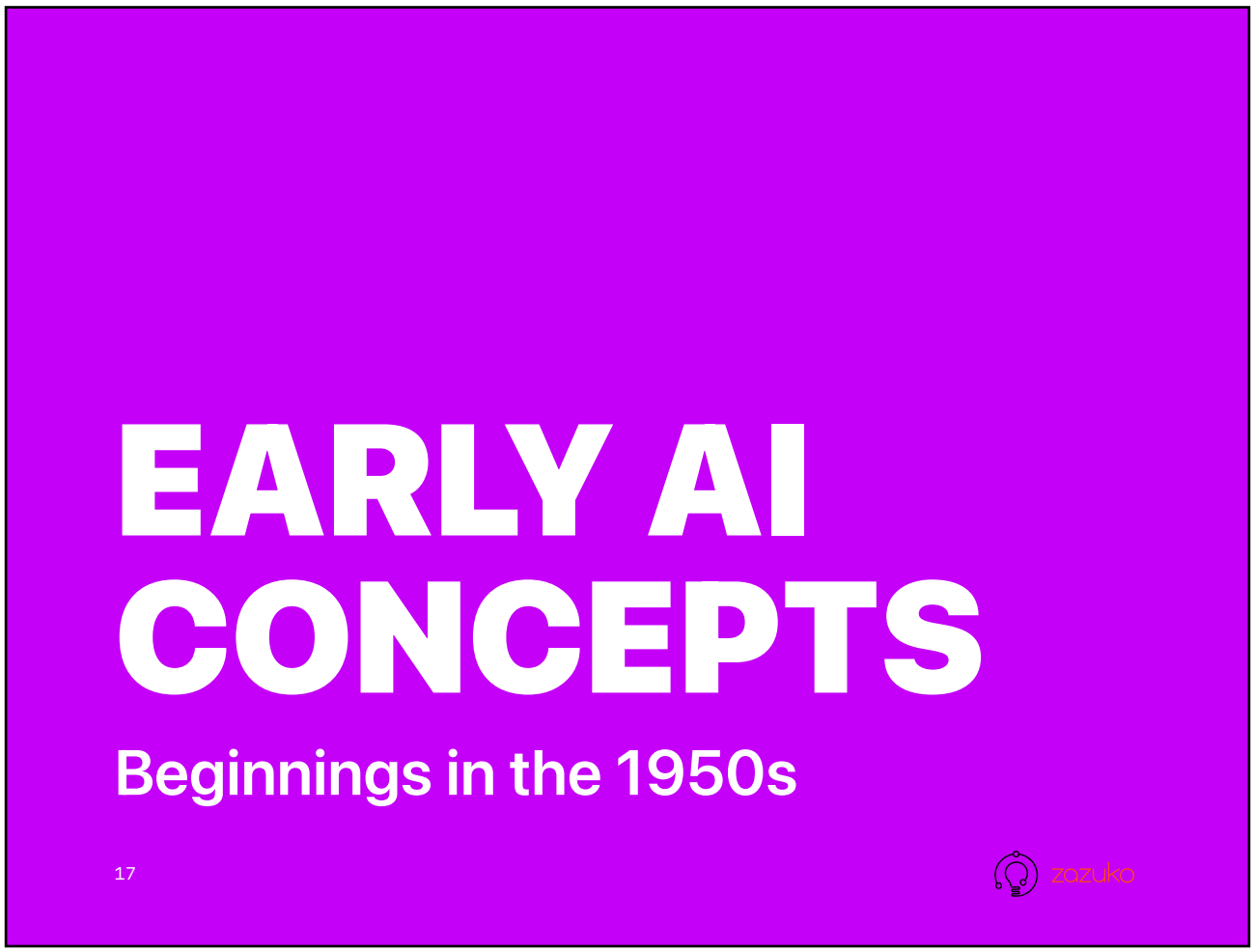
AI's Comprehension of Structured Data

Large Language Models demonstrate an increasing understanding of RDF and its various serializations, thanks to widespread data embedding.

THE EVOLUTION OF AI
Tracing the Journey

Explore the historical development of AI, leading to the creation of LLMs and KGs.

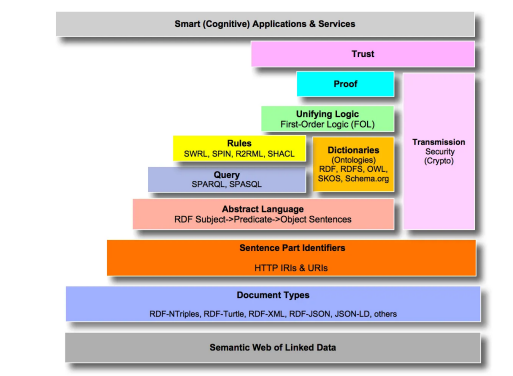
- Key moments in AI history.
- Emergence of LLMs and KGs.



The birth of AI as a scientific discipline, exploring concepts of human-like intelligence in machines.

RULE-BASED AI ERA

Logic and Expert Systems



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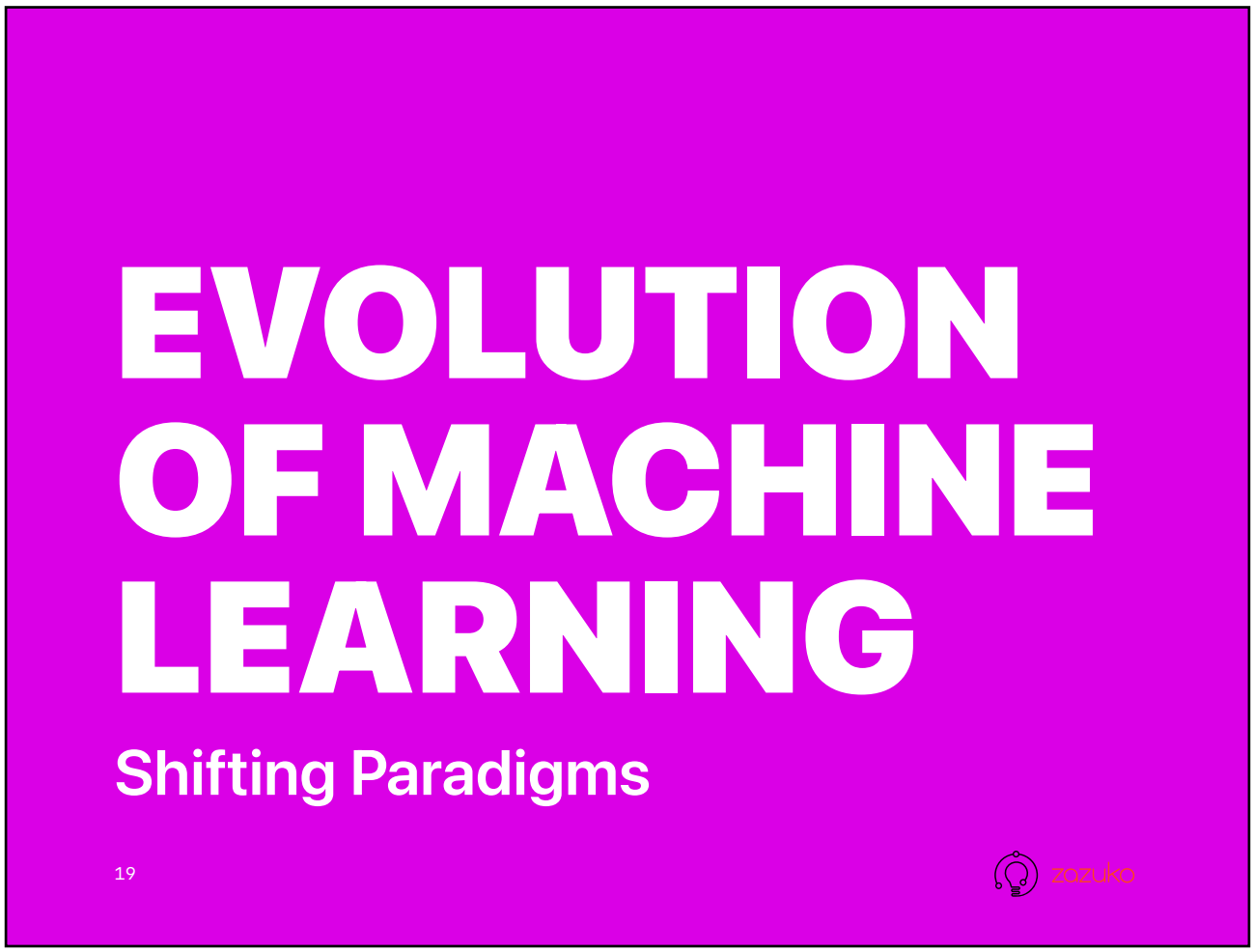
Prominence of rule-based systems in early AI. Systems like Prolog and Datalog exemplified this approach, focusing on logic and structured rules.

- Notation3 is an RDF approach to that. Those with Prolog and Datalog background will feel at home.

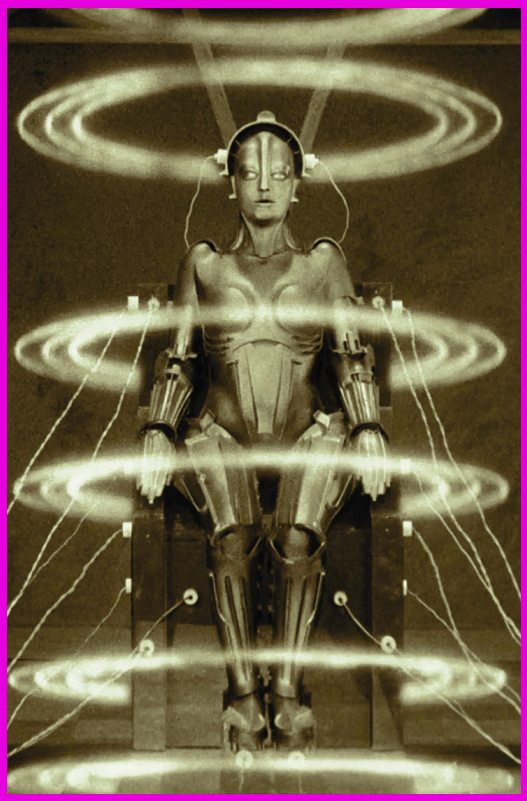
Image credit: Kingsley Uyi Idehen, OpenLink Software



Gradual shift from rule-based systems to machine learning, emphasizing learning from data rather than following hardcoded rules.

RISE OF NEURAL NETWORKS

The Deep Learning Breakthrough



1980s–2015ish: Advancement of neural networks, leading to the current deep learning era, vastly improving AI's capabilities. (Yes, there was a "AI winter" in between).

LARGE LANGUAGE MODELS (LLMS)

Deep Learning in Natural Language Processing

LLMs: The Frontier of NLP

- Advanced application of deep learning for processing language.

Core Functionality:

- Deep neural networks analyzing vast datasets to understand and generate text.

Impact and Capabilities:

- Breakthroughs in text completion, translation, and more.
- Demonstrating a new level of AI's linguistic ability.

Addressing Challenges:

- Ongoing efforts to handle context, reduce biases, and improve reliability.
- Future focus on enhancing transparency and ethical AI.

VECTOR MODELS IN AI

Transforming Language into Mathematics

Essence of Vector Models:

— Turning text data into numerical form using vectors for AI processing.

Importance in NLP:

— Essential for tasks like semantic analysis, where understanding context and meaning is crucial.

How They Work:

— Words, phrases, and even entire documents are mapped to vectors in multi-dimensional space.

Applications:

— From basic similarity checking to complex operations like machine translation and sentiment analysis.

Advancements:

— Continuous evolution with techniques like word embeddings (Word2Vec, GloVe) and transformers.

MODERN AI LANDSCAPE

Diverse Applications

Today's AI: A blend of machine learning, deep learning, and traditional AI methods, applied from natural language processing to complex decision-making.

THE SYNERGY
LLMs and KGs in Collaboration

Uniting LLMs' rapid linguistic analysis with KGs' deep, structured reasoning for enhanced AI capabilities.

LLMs: Masters of Context and Nuance

- Excelling in understanding and generating natural language.
- Quick, intuitive responses akin to human 'System 1' thinking.

KGs: Powerhouses of Depth and Structure

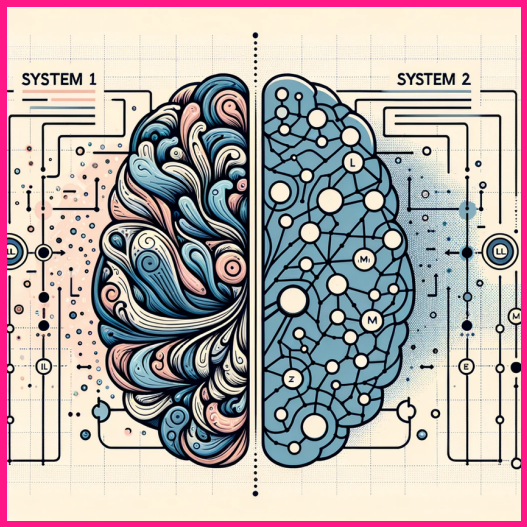
- Providing a rich, interconnected framework for data.
- Methodical and logical, paralleling human 'System 2' thought processes.

Synergistic Strengths and Complementary Weaknesses:

- LLMs bring speed and adaptability, while KGs contribute precision and reliability.
- Addressing the limitations of each through their combined use.

A DUAL MINDSET

Quick Thoughts & Deep Insights



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Delving into how LLMs and KGs complement each other like the two systems of thought.

- System 1: LLMs for intuition.
- System 2: KGs for analysis.

From the book *Thinking, Fast and Slow* by Daniel Kahneman

Credits for KG meets LLM: Tony Seale , KG Engineer at UBS

LLM LIMITATIONS
Addressing the Challenges

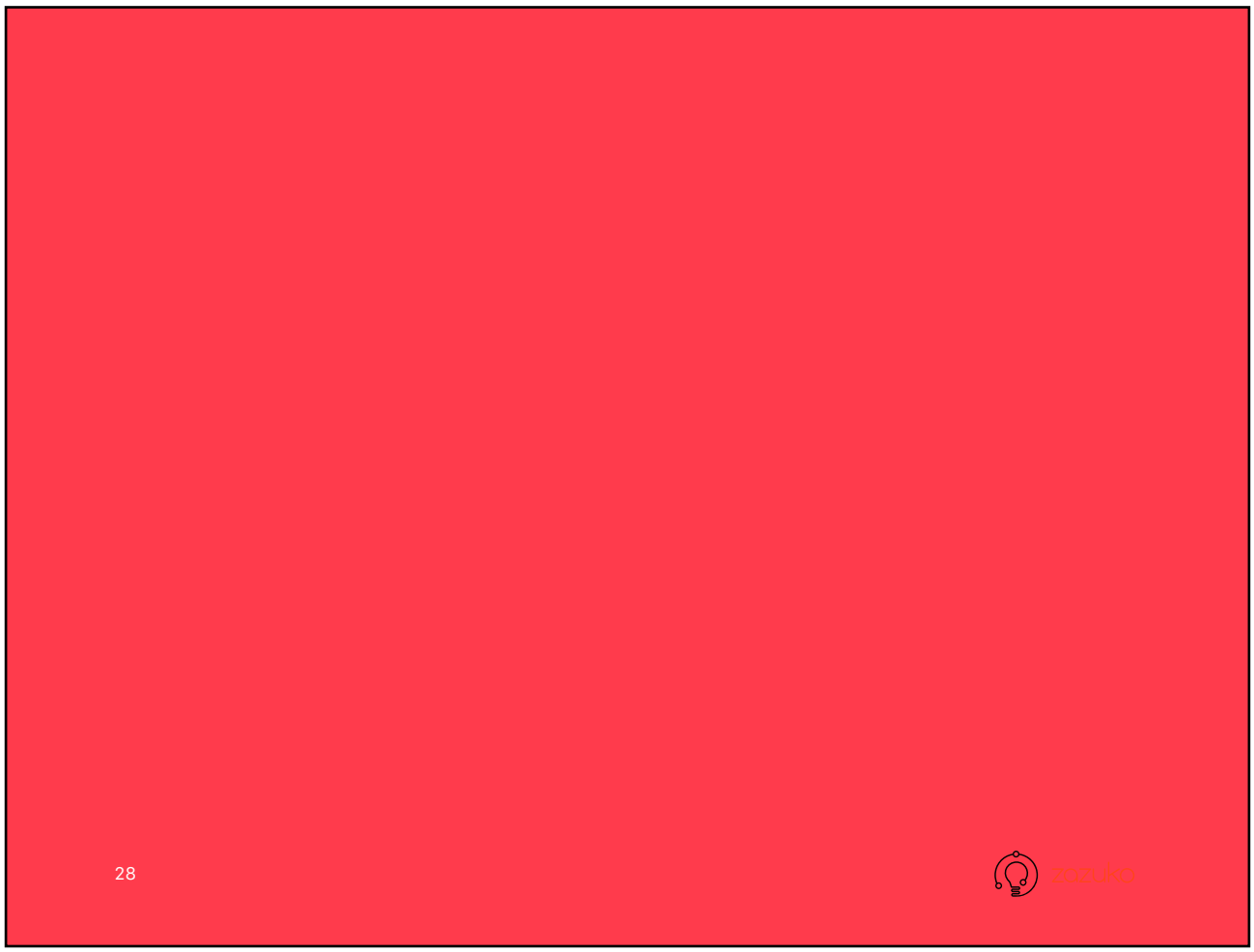
Acknowledging and discussing the current limitations and challenges faced by LLMs.

- Issues with reliability and speed.
- High training and operational costs.
- You cannot really query facts.
- Not trained to your particular problem.

KG ADVANTAGES

Emphasizing Strengths

- Speed and efficiency of KG queries.
- Cost-effectiveness.
- But: No understanding of natural language.



This slide contains a sequence of the science fiction series *The Expanse*, where they interact with a computer with voice and get visualizations on the screen as reaction. It shows well how future interactions with Software could look like if we merge LLMs and KGs.

HANDS-ON EXPERIENCE
Crafting SPARQL Queries with LLMs

Engage in interactive exercises to transform natural language into SPARQL queries.

- Creating queries from scratch.
- Analyzing and refining results.

QUERY 1: INDIVIDUAL FACTS

Create a SPARQL query to find the birthplace of Albert Einstein

Explanation:

- This query tests the AI's ability to extract specific factual data about a well-known individual.

QUERY 2: AUTHOR'S WORKS

Generate a SPARQL query to list all books written by Agatha Christie.

Explanation:

- Challenges the AI to understand relationships between an author and their works.

QUERY 3: FILM GENRES BY DECADE

What's the SPARQL query to find all science fiction films released in the 1990s?

Explanation:

- This query introduces filtering results by genre and time period.

QUERY 4: GEOGRAPHICAL DATA

I need a SPARQL query to list all the capital cities in Europe.

Explanation:

- Geographical queries test the knowledge graph's data richness and the AI's capability in handling spatial information.

QUERY 5: HISTORICAL EVENTS

Can you create a SPARQL query to find the date and location of the signing of the Treaty of Versailles?

Explanation:

- This query combines a historical event with specific details, testing the AI's ability in handling complex historical data queries.

LANGCHAIN LIVE
Demonstrating Integration

Experience Langchain in action, revealing the integration of LLMs with KGs.

- Live Jupyter notebook interaction.
- RDF cube queries and dialogue.

IMAGINING THE FUTURE
Open Source Innovation

Engage in a collaborative session to envision the future of open-source LLM and KG tools.

- Current state of tools.
- Envisioning future enhancements.
- {Interactive brainstorming session.}

THE ROAD AHEAD
From Non-RDF to RDF

Discuss the potential for converting non-RDF data into RDF format using LLMs.

- Challenges in data conversion.
- Role of LLMs in simplification.
- {Talk about automating data transformation.}

WRAP-UP AND Q&A

Reflections and Discussions

Concluding the workshop with reflections on key learnings and an open Q&A session.

- Recap of key points.
- Open floor for questions.