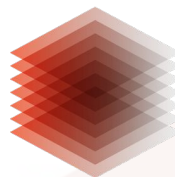


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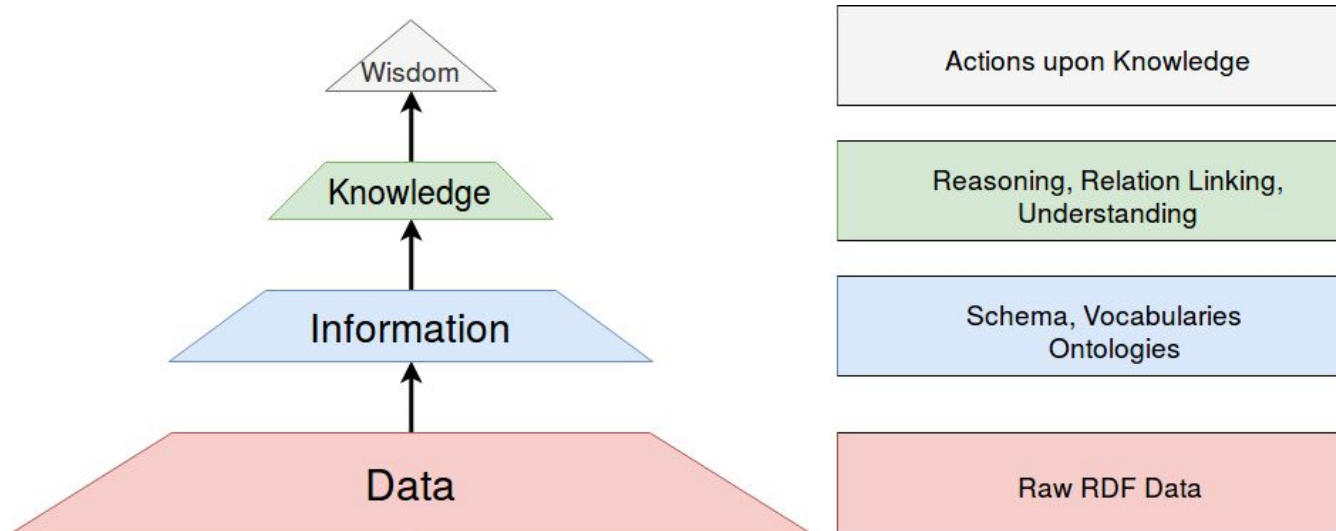
TIB

# Knowledge Graphs - A Visual Exploration

Open Research Knowledge Graph Workshop  
Semantics, Karlsruhe 2019

# Motivation

- We live in the information age
- Every second large collections of data generated
- Structured by ontologies, vocabularies, schema
- Machine readable representations



# Knowledge Graphs

- What are knowledge graphs?
  - “A knowledge graph
    - (i) mainly describes real world entities and their interrelations, organized in a graph,
    - (ii) defines possible classes and relations of entities in a schema,
    - (iii) allows for potentially interrelating arbitrary entities with each other and
    - (iv) covers various topical domains.” Paulheim [1]
  - “Knowledge graphs are large networks of entities, their semantic types, properties, and relationships between entities.” JWS [2]
  - ...

# Knowledge Graphs

Generally, knowledge graphs organize information that is expressed in a machine-readable way as a graph  $G(V,E)$ .

- We consider both A-BOX and T-BOX data.
- Elements of the graph are expressed in a triple format
  - <subject, predicate, object>
- $G(V,E)$ 
  - $V$  : A set of vertices describing (subject or object)
    - Classes, Data Types (T-BOX)
    - Instances, Assertions (A-BOX)
  - $E$  : A set of edges describing (predicate)
    - Relation and axioms between classes and data types (T-BOX)
    - Relations to other instances and value assertions (A-BOX)

# Visualizations

Knowledge graphs have a graph structure

- Directed, Labeled, Cyclic, Multi-Graph

## Directed:

- A predicate creates a connection between resources (subject and object) as a directed link.

## Labeled :

- Resources are labeled (labeled nodes and links)

## Cyclic :

- Connections that create circle can occur

## Multi-Graph:

- Multiple connection between two resources can occur

# Visualizations

- Visualizing this graph structure can be done using graph drawing algorithms.
  - However, A knowledge graph contains a large amount of triples (millions)
    - Hardware limitations for visualization
    - Limitations of human cognition.
- Visualizing a full knowledge graph is not practicable

# Visual Exploration

The information-seeking mantra (Ben Shneiderman)

“Overview first, zoom and filter, then details-on-demand“

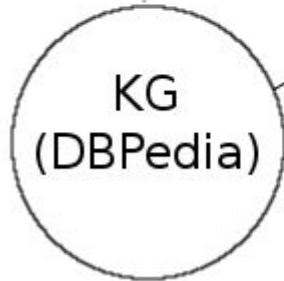
- Overview first → not applicable for KG (too large)
- Zoom and filter → keyword search (SPARQL queries)
  - Predefined set of visual properties that are returned
    - Language and property filter  
(e.g., show for an instance the top five properties )
- Details-On-Demand
  - Interactions for exploration

# Visual Exploration

- Zoom and filter → keyword search (SPARQL queries)

Search:

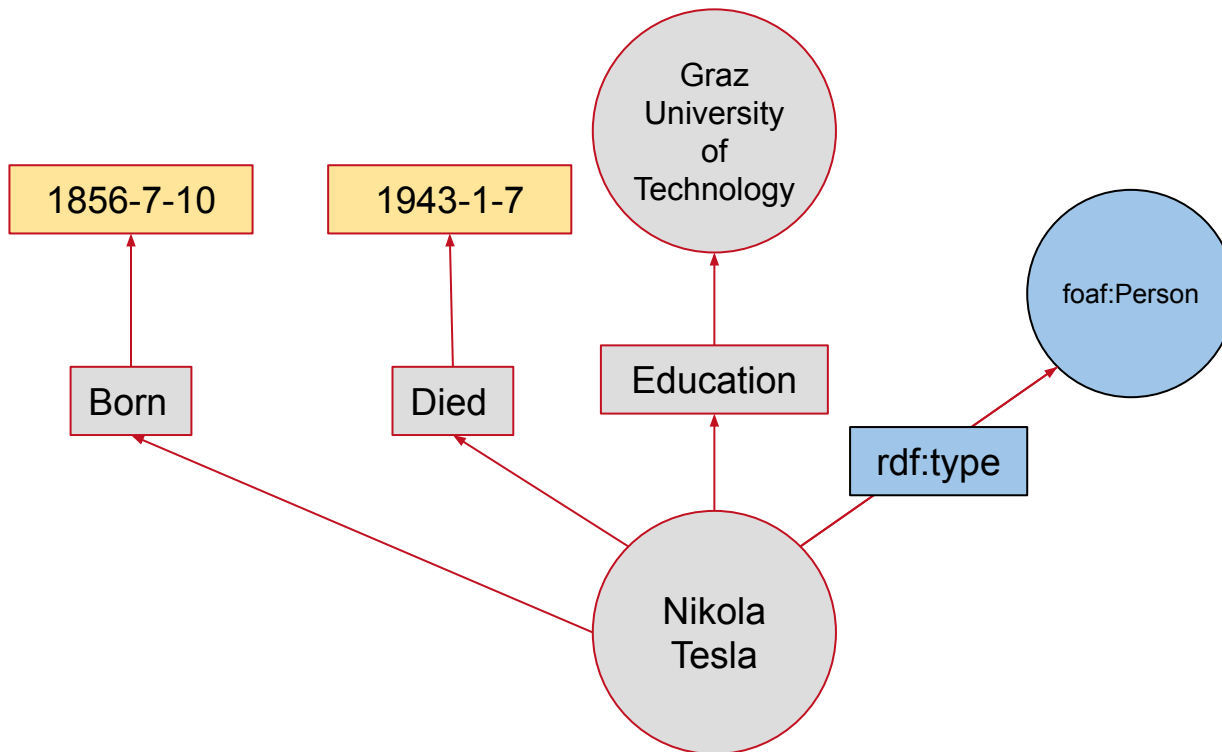
Nikola Tesla|



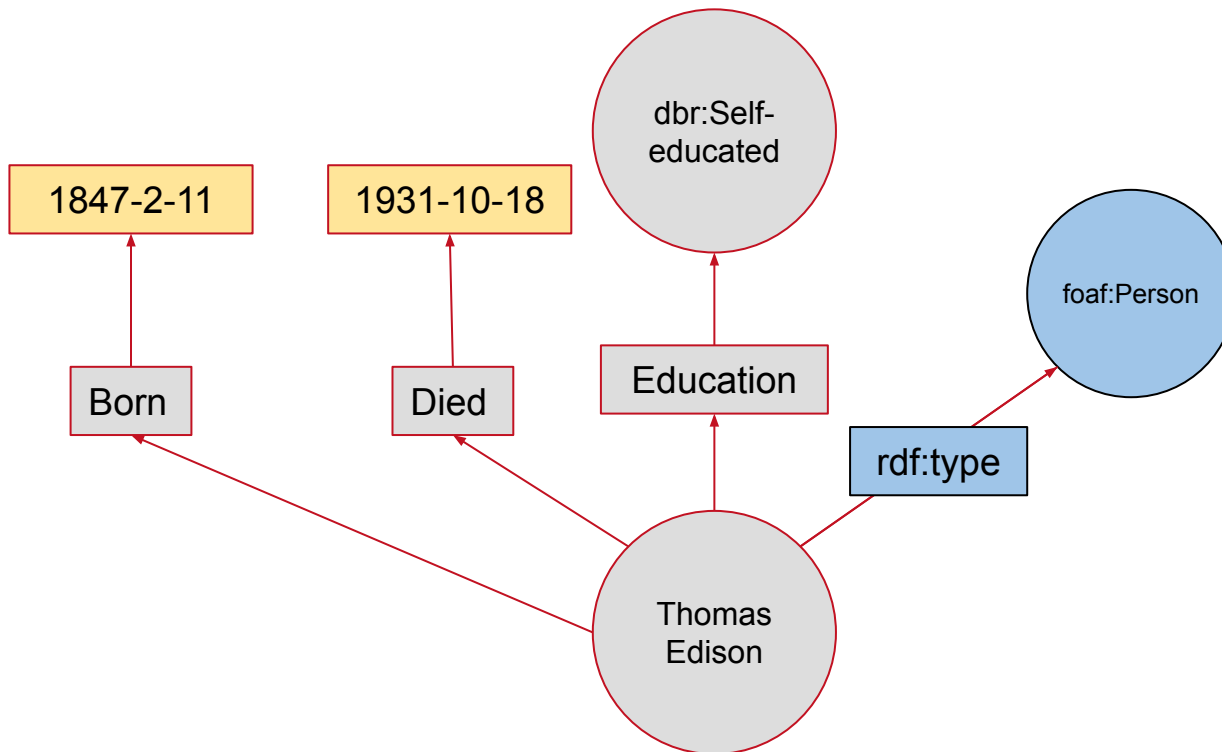
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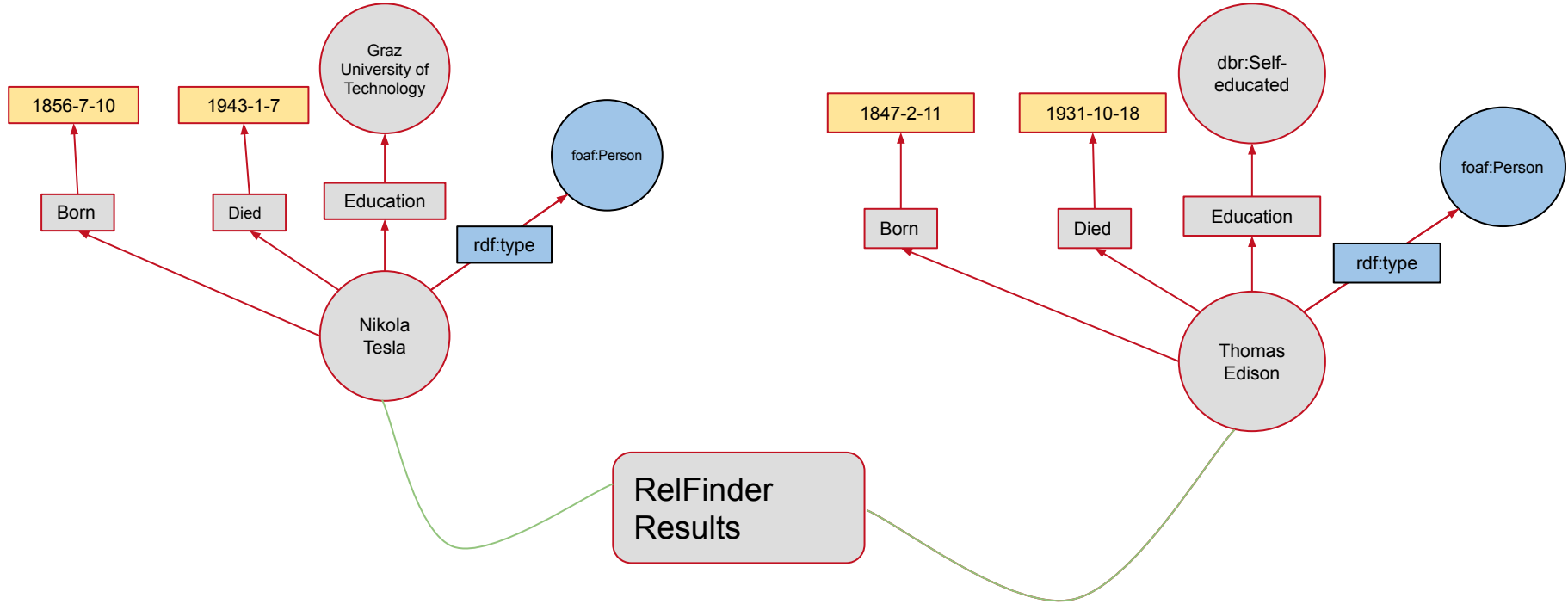
# Visual Exploration



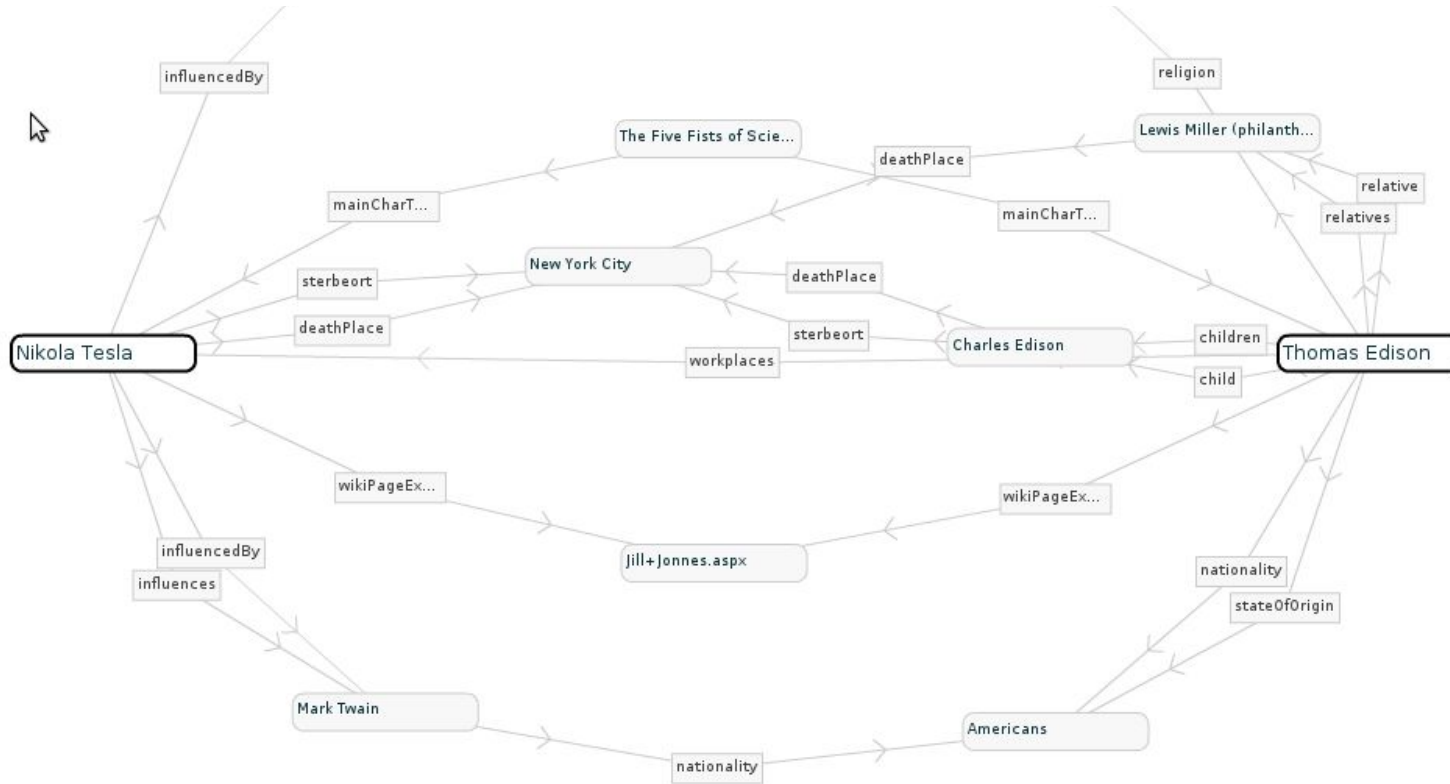
# Visual Exploration



# Visual Exploration



# Visual Exploration



# Visual Exploration

- Details-On-Demand
  - Interactions for exploration
    - Identify relations between entities
    - Explore directly connected resources
    - Filtering of resources of interest
    - Find “distant” relation between entities (RelFinder)

# Visual Exploration

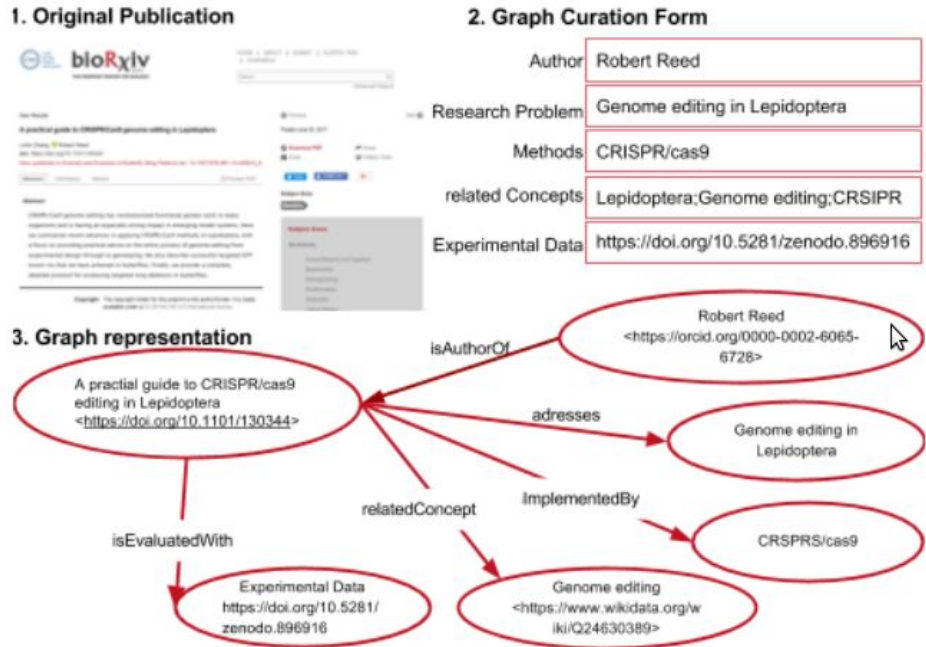
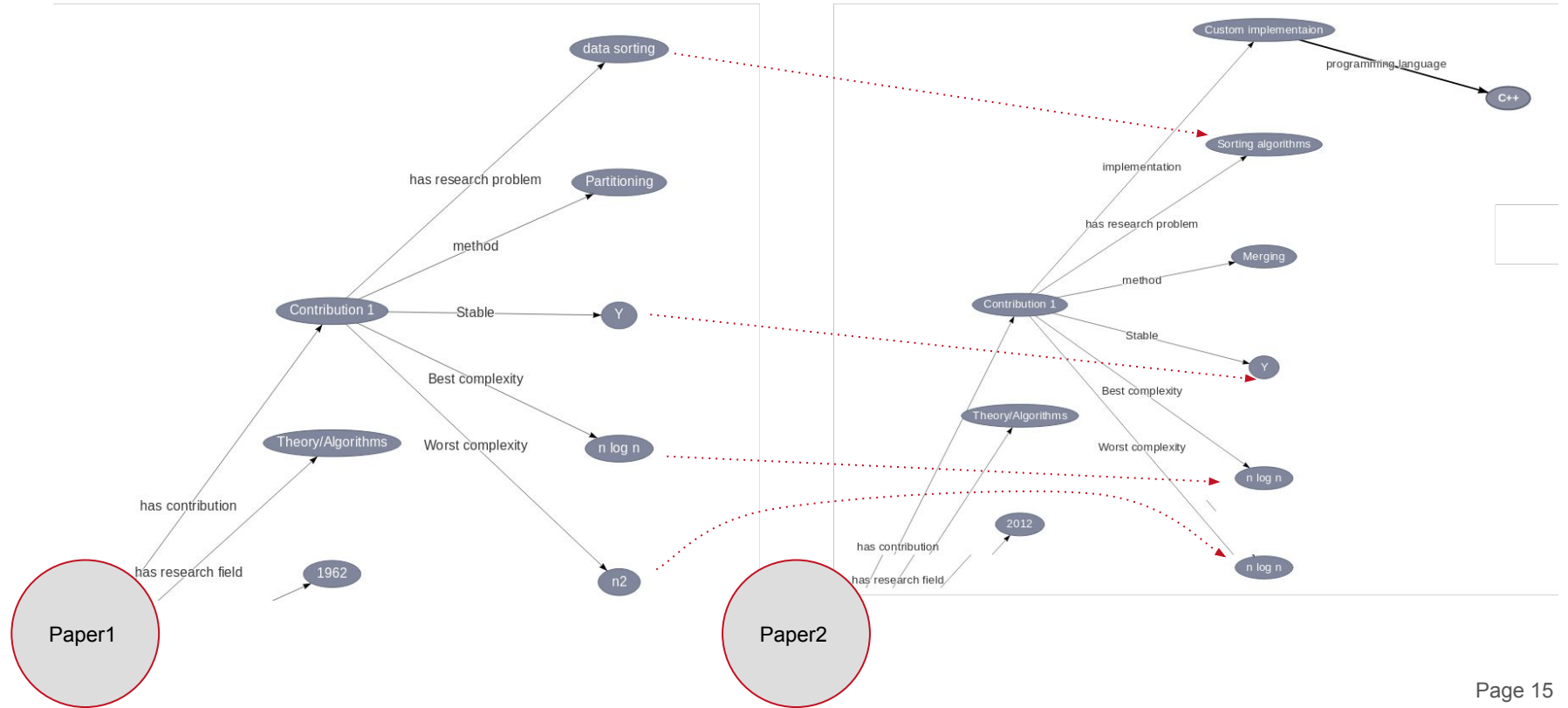


Fig. 5: Acquisition and representation of the CRISPR genome editing method using a knowledge graph.

# Visual Exploration



# Visual Exploration

Contribution comparison

Compare Options ⋮

Properties	Quicksort <small>Contribution 1</small>	Efficient parallel merge sort for fixed and variable length keys <small>Contribution 1</small>
Best complexity	$n \log n$	$n \log n$
Has research problem	data sorting	Sorting algorithms
Method	Partitioning	Merging
Stable	✓	✓
Worst complexity	$n^2$	$n \log n$

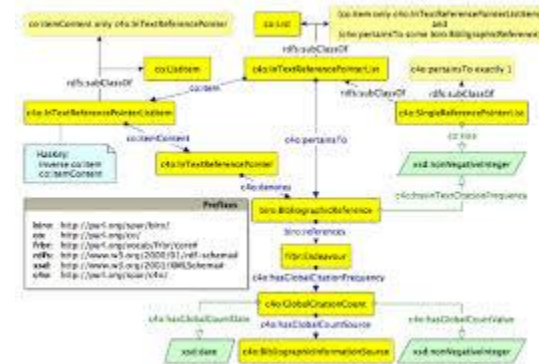
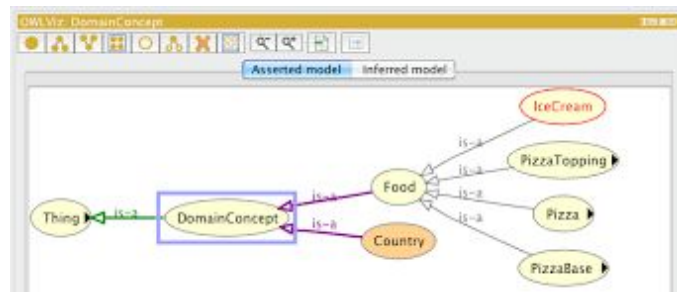
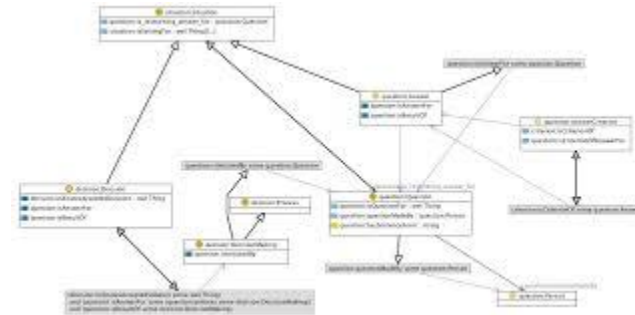
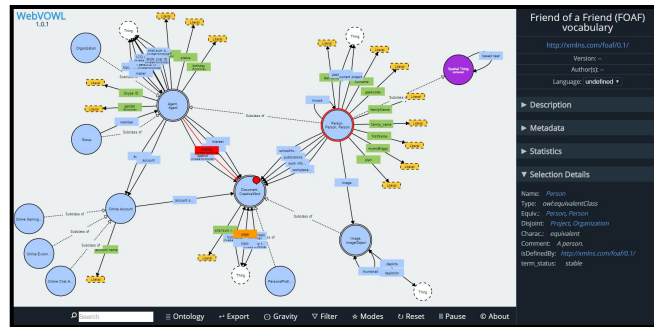
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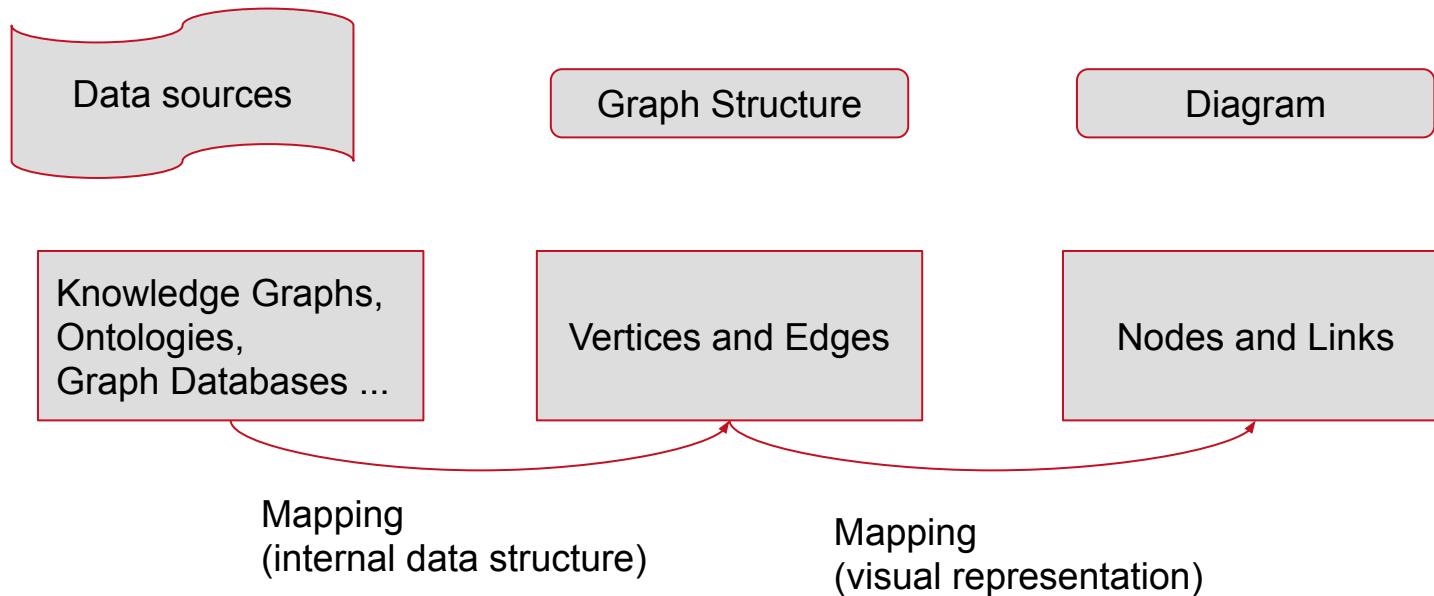
# Visual Mappings

Considering ontologies as a sub-model of a knowledge graph

- Numerous ontology visualizations



# Visual Mappings



# Visual Mappings

