ifis

Institut für Informationssysteme
Technische Universität Braunschweig

Narrative Query Graphs for Entity-Interaction-Aware Document Retrieval

at ICADL2021

Hermann Kroll, Jan Pirklbauer, Jan-Christoph Kalo,
Morris Kunz, Johannes Ruthmann and Wolf-Tilo Balke

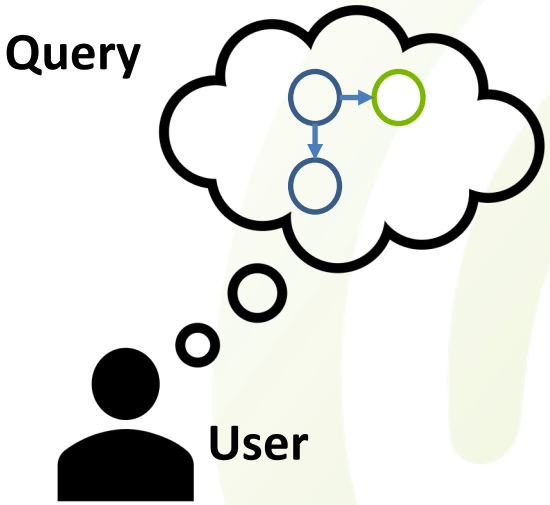
Institut für Informationssysteme

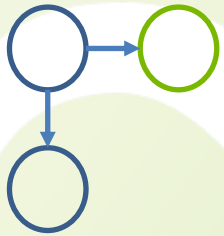
Technische Universität Braunschweig

Why Narrative Query Graphs?

- Limitations of keyword-based retrieval:
  - **Challenging** to specify **interactions** between keywords
  - **Do not feature placeholders/variables**

Keyword-based Retrieval

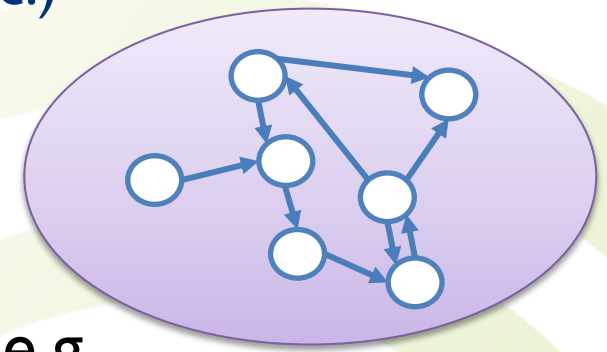




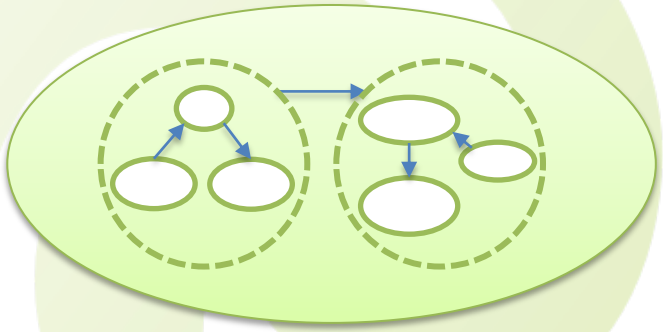
Narrative Query Graphs

Why Not Building Knowledge Graphs?

- Knowledge graphs usually have a different viewpoint:
  - Store structured information about entities (properties, etc.)

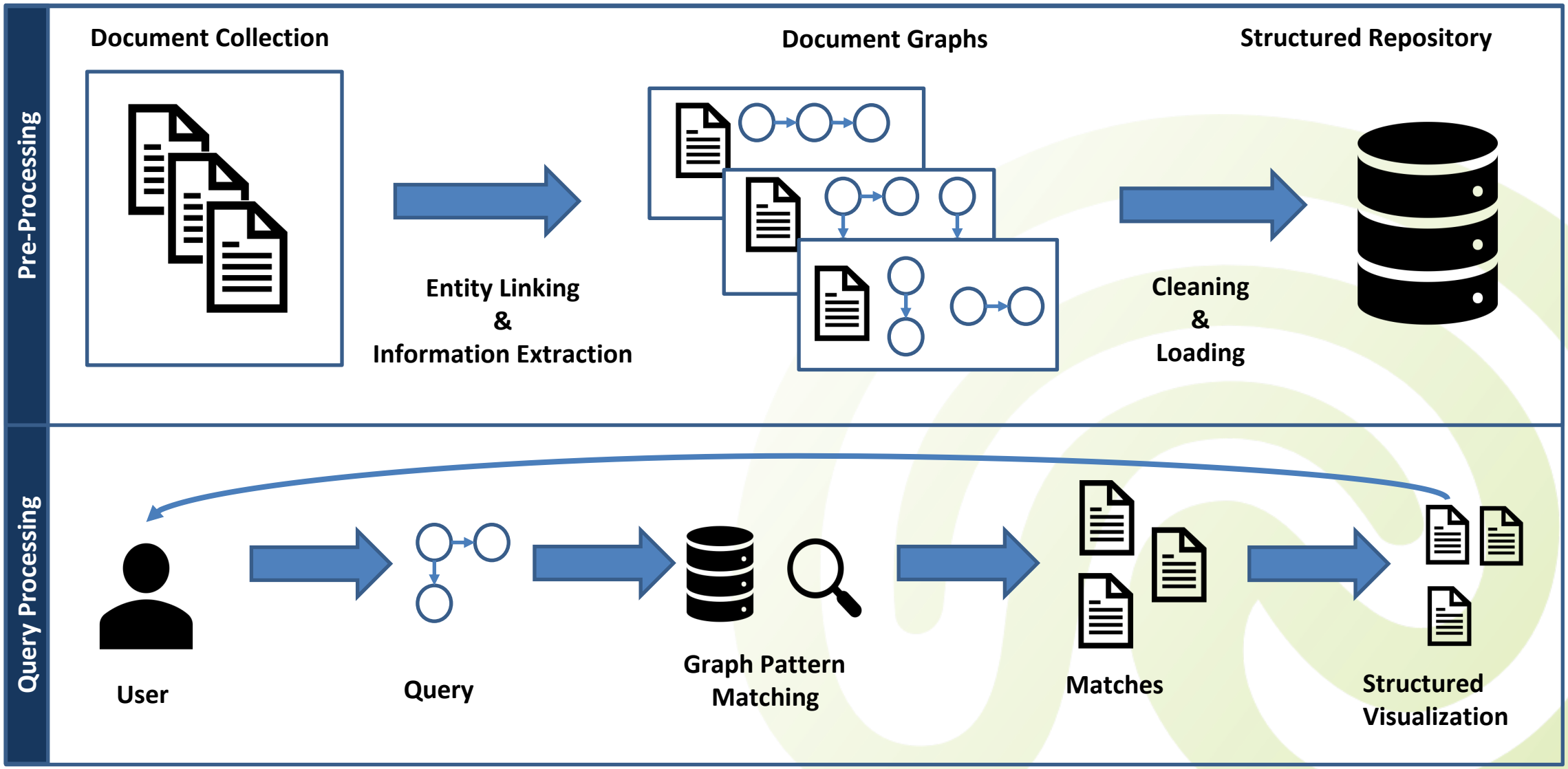


- Expressing **narrative behaviour** is not their focus, e.g.
  - How do entities **interact** within a **line of arguments**?
  - Which **statement** might **lead to** a second **statement**?



- **The connection between statements may simply be lost.**

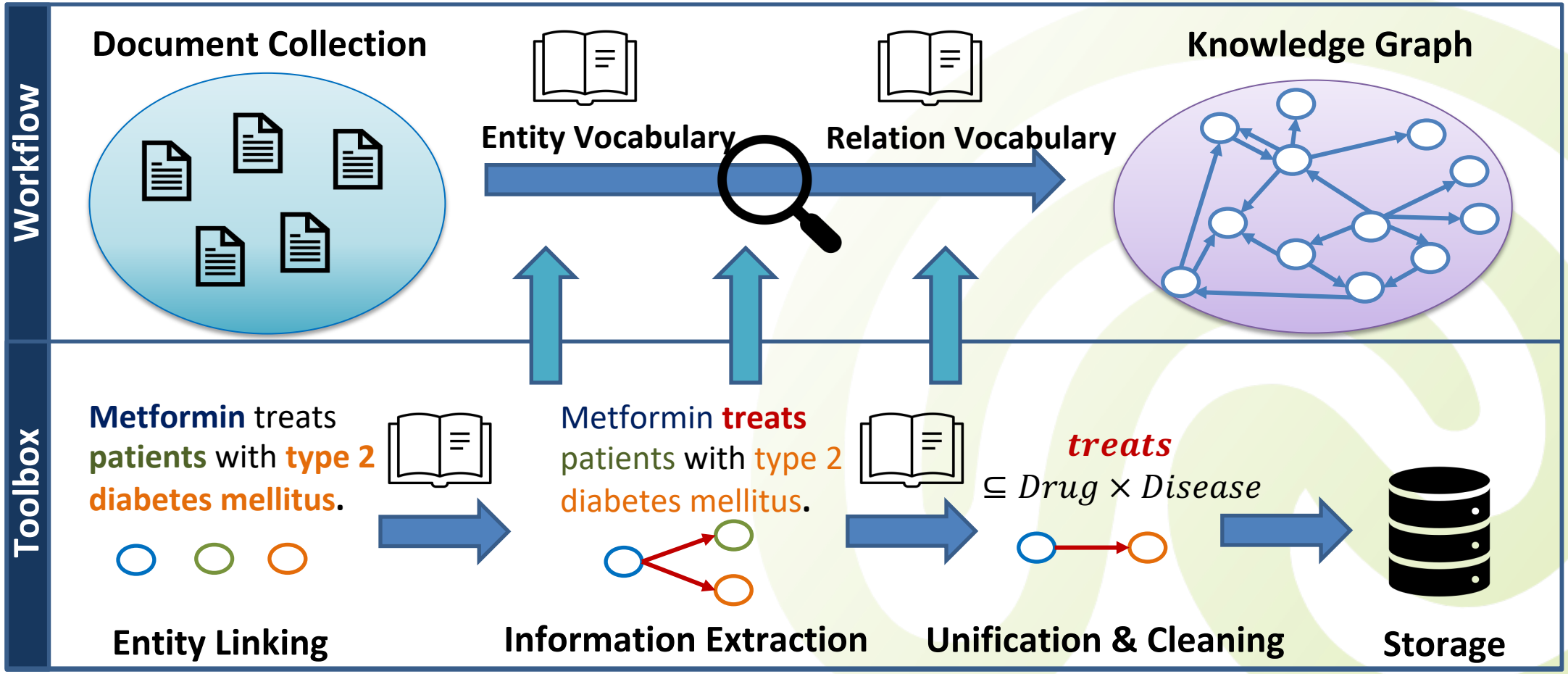
Discovery System Overview



A Nearly-Unsupervised Extraction Toolbox

"A Toolbox for the Nearly-Unsupervised Construction of Digital Library Knowledge Graphs"@JCDL2021

https://github.com/HermannKroll/KGExtractionToolbox



Narrative Prototype Overview

Narrative Prototype Overview

User
Enters Query

Query Builder:

Simvastatin | treats | ?X(Disease) | Add | Search

Substitution-centric Visualization:

225 Documents [?X:= Hypercholesterolemia (Disease MESH:D006937)]

146 Documents [?X:= Diabetes Mellitus (Disease MESH:D003920)]

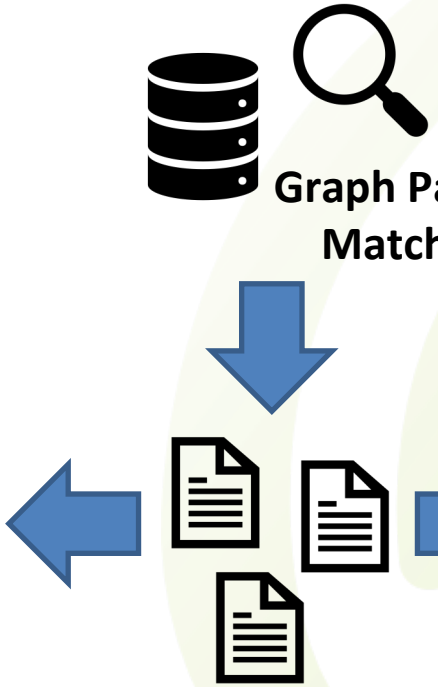
142 Documents [?X:= Coronary Artery Disease (Disease MESH:D003324)]

116 Documents [?X:= Hyperlipoproteinemia Type II (Disease MESH:D006938)]

PubPharm 32800790
Successful pharmacological management of a child with compound heterozygous familial hypercholesterolemia and review of the recent literature.

Provenance

PubPharm 32554834
High cholesterol diet promotes dysfunction of arginase and cholinergic enzymatic



Hierarchical Visualization:

1463 Documents [?X:= C14.Cardiovascular Diseases (Diseases MESH:D002318)]

1114 Documents [?X:= C18.Nutritional and Metabolic Diseases (Diseases MESH:D009750)]

1085 Documents [?X:= C18.452.Metabolic Diseases (Diseases MESH:D008659)]

533 Documents [?X:= C18.452.584.Lipid Metabolism Disorders (Diseases MESH:D052439)]

523 Documents [?X:= C18.452.584.500.Dyslipidemias (Diseases MESH:D050171)]

5 Documents [?X:= C18.452.584.750.Xanthomatosis (Diseases MESH:D014973)]

4 Documents [?X:= C18.452.584.687.Lipidoses (Diseases MESH:D008064)]

PubPharm 15123521
HMG-CoA reductase inhibitor simvastatin profoundly improves survival in a murine model of sepsis.

http://www.pubpharm.de/services/prototypes/narratives/

Quantitative Evaluation

- **Quantitative** Evaluation: 
  - We formulate **six** narrative query graphs and experts manually label 100 abstracts and 50 full texts
  - Our system **is comparable** to a **manual curated** MeSH baseline by achieving high precision and moderate recall

- **Performance** Evaluation: 
  - Queries can be executed within 20ms (1-fact) and 51ms (3-facts)
  - Depends on how general entities/relations/queries are

Qualitative Evaluation

- **Qualitative** Evaluation (**8** biomedical experts):
  - **Think aloud experiments** about literature searches
  - Two **interviews** (one before and one after using the prototype)
  - A closing **questionnaire**

Think Aloud Experiments

- **Recall-oriented** searches:
  - Related work searches such as finding works of author x, finding works about keyword y, going through citation lists etc.

- **Precision-oriented** searches:
  - Verifying a hypothesis, e.g., quickly checking whether some idea has already been investigated in literature

Interview Feedback

- **Drawbacks**:
  - Different and **more complicated** search paradigm
  - Too **cryptic** formulation of variables, e.g. ?X(Drug) vs. Drug
  - **Pre-defined set** of entities and relations (missing entities, etc.)

- **Advantages**:
  - Narrative query graphs retrieve **precise** hits **quickly**
  - Provenance information was considered helpful (why a document matches)
  - **Variables** offer a **novel access path** to the literature

Questionnaire

- Ratings are based on a Likert-Scale
  - (1 disagreement, 5 full agreement)

- **3.5** – "The prototype provides precise results for my questions (I quickly find a relevant match)."
- **3.4** – "When searching for or verifying a hypothesis, I would prefer the prototype to a search using classic search tools (cf. PubPharm, PubMed, etc.)."
  - 2.8 – "When searching for related work, I would prefer the prototype […]"
- **3.9** – "I could imagine using the prototype in my literature research."

Discussion

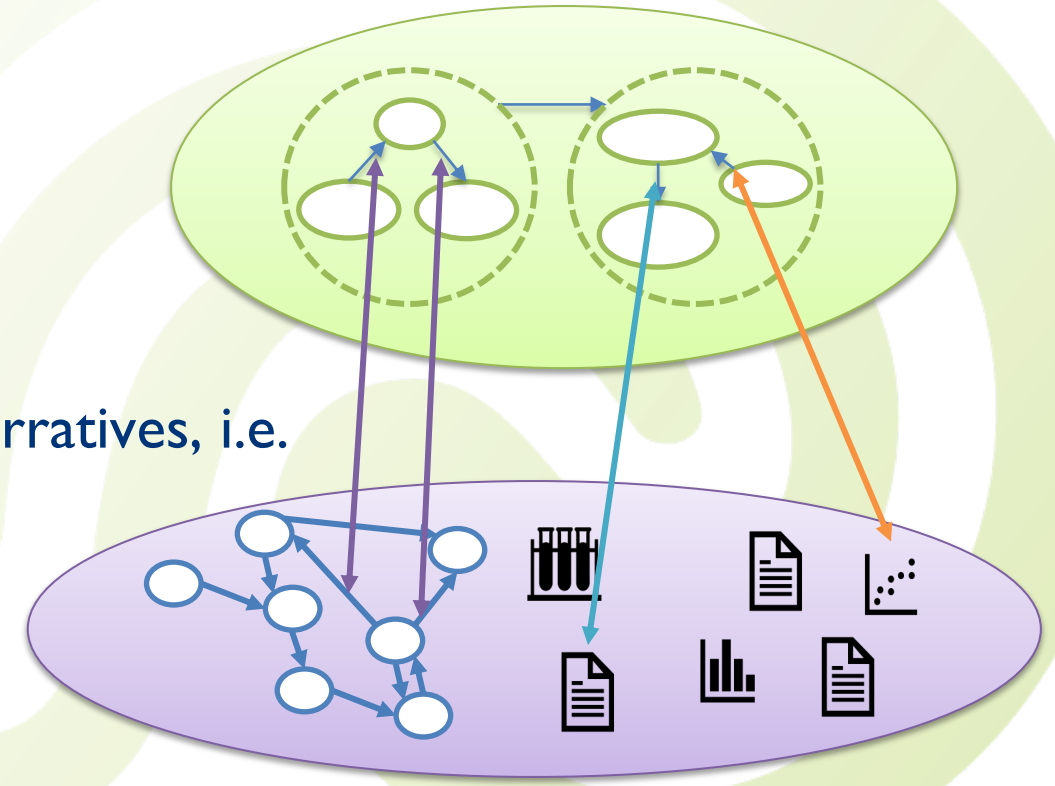
- Narrative query graphs have **limitations:**
  - Are more **complicated** than keyword-based searches
  - Require **intuitive user interfaces**
  - Extraction methods **lack recall** (extractions restricted to sentences, missing entities, errors, etc.)

- But, there is a dire need for **precise document retrieval**:
  - 7 of 8 users agreed that their majority of searches is **precision-oriented** and they **prefer** our **narrative** service for such searches
  - The **verification of a hypothesis** seems to be a real use case

Conclusion

- Narrative query graphs …
  - Offer **precise** and **structured** literature searches
  - Have **use cases** and are **implementable** today
  - But, they **should not replace** traditional discovery systems (e.g. for related work)

- Narrative query graphs are a step towards **narrative information access**
  - Users may formulate their queries as scientific narratives, i.e. they formulate a line of arguments
  - A system then tries to make this narrative query plausible, i.e. by finding evidence



Thank You!

FACHINFORMATIONSDIENST
PHARMAZIE
TU Braunschweig

Technische Universität Braunschweig

If you have any questions, contact me via:

kroll@ifis.cs.tu-bs.de

@HermannKroll

Quantitative Evaluation

Query	Type	PubMed (Keywords)	MeSH Search (hand-crafted)	Narrative QG
Q1	25 Abstracts	P: 0.76 / R: 1.0	P: 0.82 / R: 0.47	P: **1.00** / R: 0.42
Q2	25 Abstracts	P: 0.64 / R: 1.0	P: **0.73** / R: 0.50	P: 0.66 / R: 0.25
Q3	25 Abstracts	P: 0.68 / R: 1.0	P: 0.77 / R: 0.59	P: **1.00** / R: 0.35
Q4	25 Abstracts	P: 0.64 / R: 1.0	P: **0.78** / R: 0.44	P: 0.71 / R: 0.31
Q5	25 Fulltexts	P: 0.25 / R: 1.0	No Hits – 0.0	P: 1.00 / R: 0.17
Q6	25 Fulltexts	P: 0.20 / R: 1.0	No Hits – 0.0	P: 1.00 / R: 0.20

Note: we do not consider a ranking (binary decision)