False, Missing, or Unknown?

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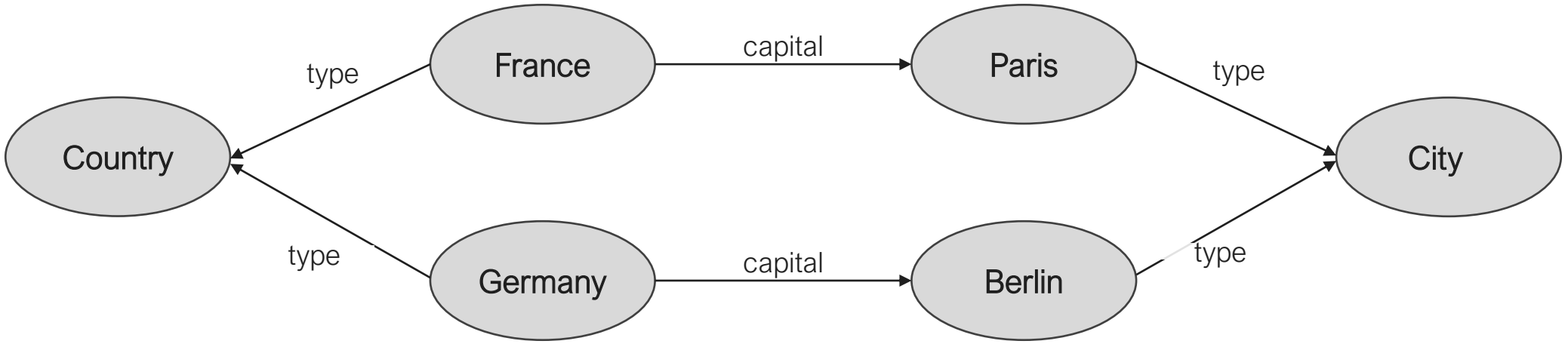
Generating Meaningful Negative Statements for Knowledge Graphs

Knowledge graphs (KGs) capture what is true

They store positive statements as links between entities.



✓ Berlin is the capital of Germany.

What about the links that are not there?

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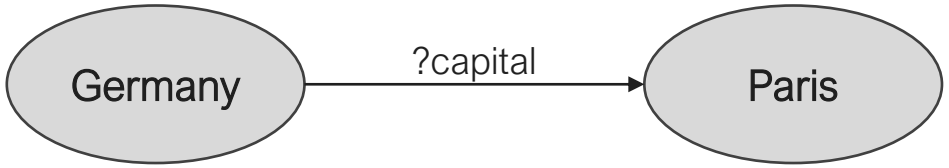
An absent link can have very different meanings



The edge is absent.

× NEGATIVE
The fact is false.

... MISSING
The fact is true, but it was not added.

? UNKNOWN
There is not enough information.

Generating negative statements is a challenging task

A meaningful negative should be plausible enough to be informative.

Positive fact: Germany — capital → Berlin

Candidate negatives:

Germany — capital → Bonn	Historically interesting
Germany — capital → Paris	Plausible
Germany — capital → Banana	Trivial / nonsensical

Research Challenge: generate useful negative statements

Team Project Goals

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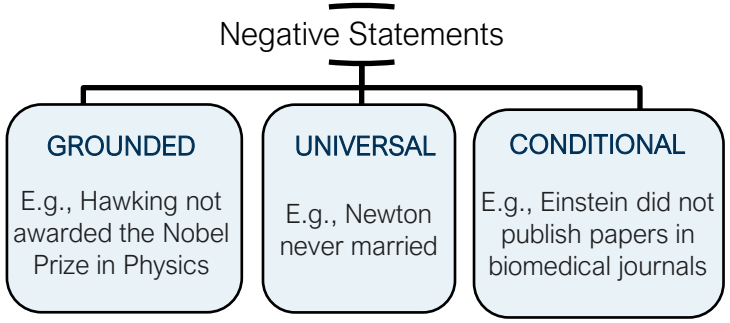
1 Define the space of negative facts

- Grounded vs universal vs conditional
- Trivial vs informative
- Temporal/ outdated



2 Generate the negative facts

- Graph history & edits
  - Deleted/deprecated triples
  - Compare KG versions

  E.g., *Obama presidentOf USA* removed in a later KG version.

- Logic/ontology constraints
  - Disjoint classes
  - Functional properties
  - Domain/range constraints

  E.g., The property *capital* is functional because a country can only have one capital.

- Text + LLM candidates
  - Extract explicit negation from text
  - Prompt LLMs for negative candidates

  E.g., Extract a negative from the sentence “Hawking never received a Nobel.”

3 Validation

- Coverage of positive and negative facts
- Human-in-the-loop review
- Downstream KG tasks (e.g., link prediction, classification)

Where could negative knowledge matter?

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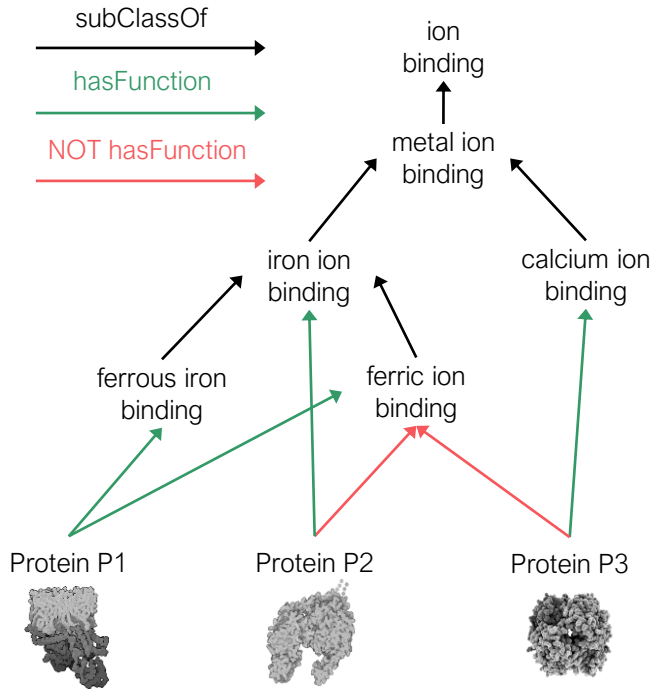
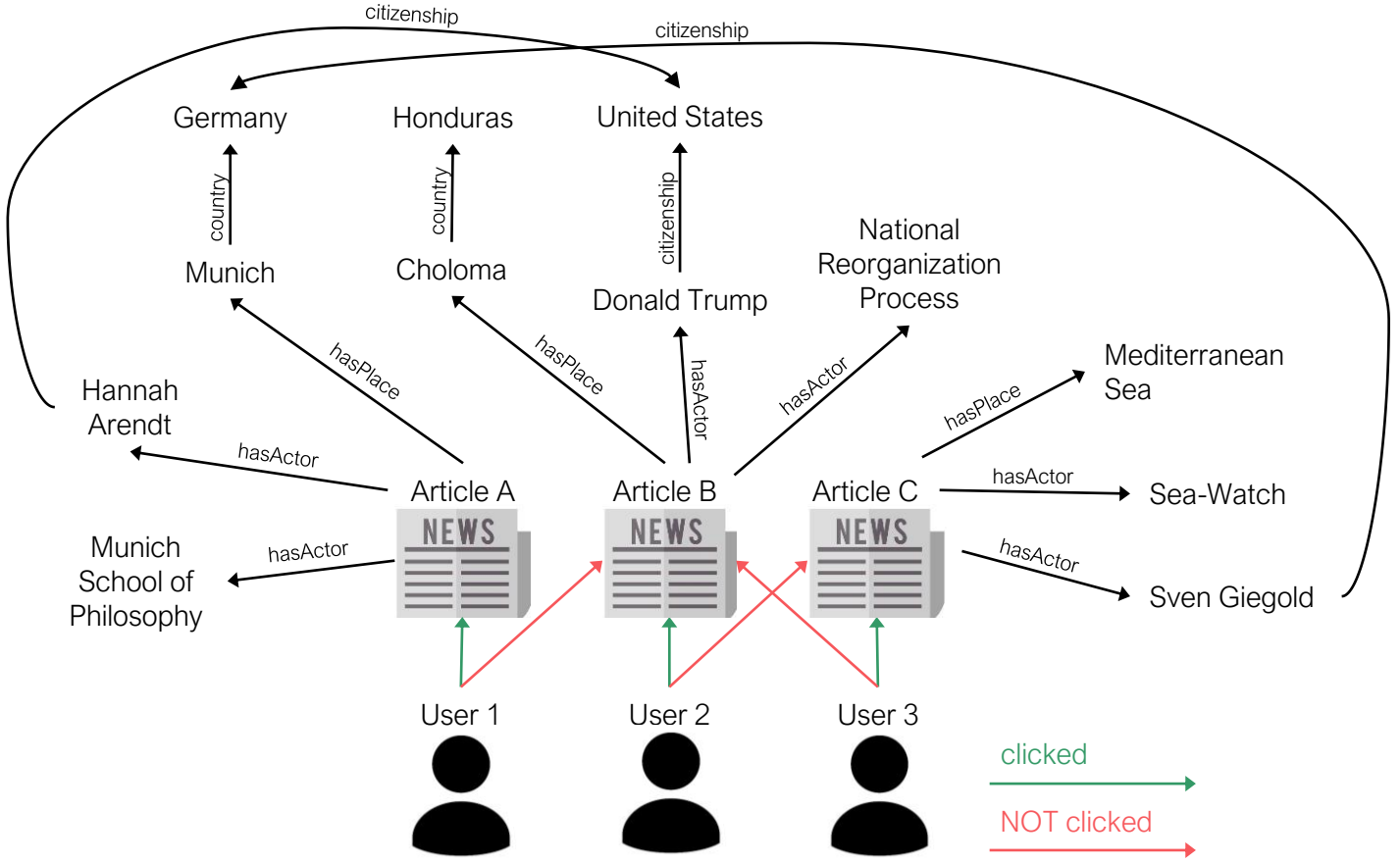
Biomedical Domain



Recommendation Systems



Requirements

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- **Duration:** 6 months
- **Number of participants:** min 2, max 8
  - **Applying as a group** is possible!
- **Prerequisites:**
  - One of Machine Learning, Knowledge Graphs, Data Mining
  - One of Text Analytics, Advanced Methods in Text Analytics
  - Knowledge in Python
- Applicable: Business Informatics and MMDS

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