An FCA Framework for Knowledge Discovery in SPARQL Query Answers

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Introduction

- SPARQL
  - a W3C recommended query language for RDF graphs.
  - query answers can be provided in different formats: TEXT, JSON, HTML, XML, RDF, CSV ...
- Formal Concept Analysis (FCA)
  - used for knowledge discovery within data represented by means of objects and their attributes.
  - concept lattices can reveal hidden relations within data and can be used for organizing, classifying, and even mining data.

Formal Concept Analysis (FCA)

FCA can be used for:

- classification and organization of data, knowledge discovery,
- ontology completion, supporting bottom-up construction of ontologies,
- role assertion analysis,
- computing subsumption hierarchy of least common subsumers,
- exploring finite models,
- discovering formal concepts in the Semantic Web data,
- providing an entry point to a dataset using questions in a way that can be navigated.

FCA – Formal Context

A formal context is (G, M, I) where:

- G – set of objects
- M – set of attributes
- $I \subseteq G \times M$

	m_1	m_2	m_3	m_4
g_1	×			×
g_2			×	×
g_3		×		
g_4			×	×

Table: A formal context.

FCA – Formal Concept

Given $A \subseteq G$ and $B \subseteq M$ of a formal context (G, M, I)

- with a derivation operator $()'$,

$$A' = \{m \in M \mid \forall g \in A, (g, m) \in I\}$$
$$B' = \{g \in G \mid \forall m \in B, (g, m) \in I\}$$

- the pair (A, B) is a formal concept if

$$A' = B \text{ and } B' = A.$$

- a set of concepts ordered with the set inclusion relation form a concept lattice.

FCA – Concept Lattice

	m_1	m_2	m_3	m_4
g_1	×			×
g_2			×	×
g_3		×		
g_4			×	×

Table: A formal context.

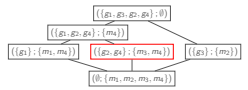


Figure: A concept lattice.

Objective

- organization and classification of SPARQL answers using FCA.
- visualization of SPARQL answers using concept lattices.

Method

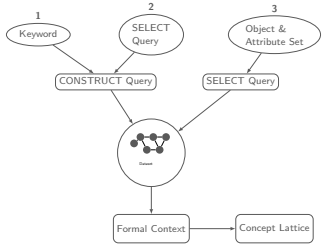
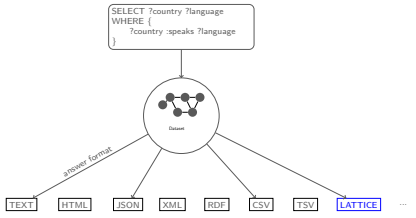
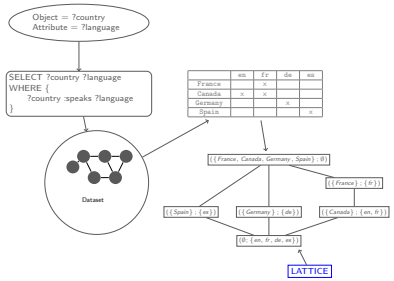


Figure: Architecture of SPARQL query answers organization.

Method



Example

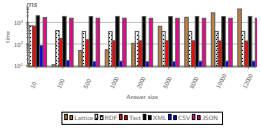


Conclusion

- we provided an organization SPARQL query answers based on a concept lattice, that can be navigated for mining or retrieving specific patterns in query results w.r.t. user constraints.
- this work shows some of the benefits that FCA provides to the semantic web.

Future Directions

- Experimentation: comparison of answer format generations (logarithmic scale).



- To investigate how well this approach scales, given the size of SPARQL query answers over large datasets.

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