Ontology-Based Data Access and OWL 2 QL

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Data access in industry

(from Norwegian Petroleum Directorate's FactPages)

show me the wellbores completed before 2008 where Statoil as a drilling operator sampled less than 10 meters of cores

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5 days later:

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SELECT DISTINCT cores.wlbName, cores.lenghtM, wellbore.wlbDrillingOperator, wellbore.wlbCompletionYear
FROM
     ( (SELECT wlbName, wlbNpdidWellbore, (wlbTotalCoreLength * 0.3048) AS lenghtM
        FROM wellbore_core
        WHERE wlbCoreIntervalUom = '[ft ]' )
       UNION
       (SELECT wlbName, wlbNpdidWellbore, wlbTotalCoreLength AS lenghtM
        FROM wellbore_core
        WHERE wlbCoreIntervalUom = '[m ]' )
     ) as cores,
     ( (SELECT wlbNpdidWellbore, wlbDrillingOperator, wlbCompletionYear
        FROM wellbore_development_all
       UNION
       (SELECT wlbNpdidWellbore, wlbDrillingOperator, wlbCompletionYear
        FROM wellbore_exploration_all )
       UNION
       (SELECT wlbNpdidWellbore, wlbDrillingOperator, wlbCompletionYear
        FROM wellbore_shallow_all )
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WHERE wellbore.wlbNpdidWellbore = cores.wlbNpdidWellbore
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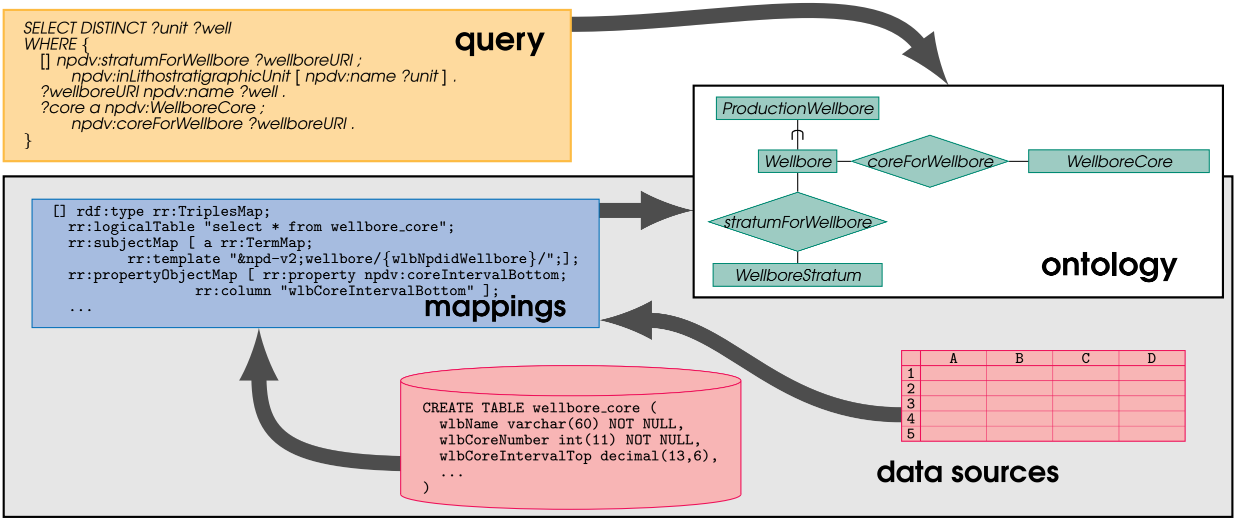
In STATOIL:

1,000 TB of relational data

1,500 tables

30–70% of time on data gathering

Ontology-Based Data Access (OBDA) Poggi et al. (JDS 2008)



ontology

- gives a high-level conceptual view of the data
- provides a convenient & natural vocabulary for user queries
- enriches incomplete data with background knowledge

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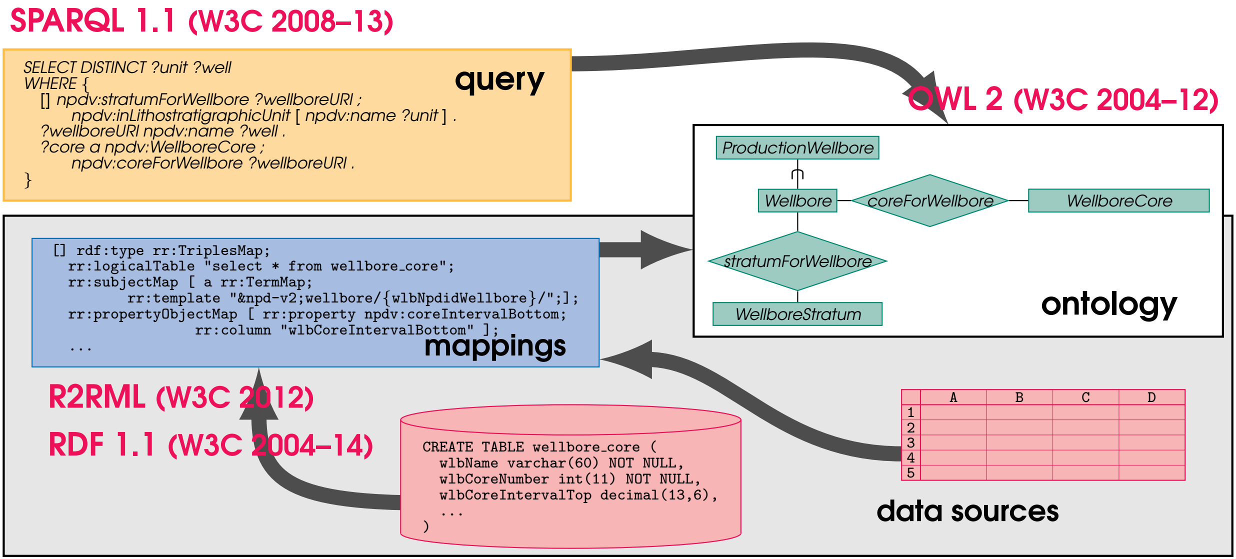

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Materialisation or ETL (Extract, Transform and Load)

translate mappings into rules:

$$\texttt{wellbore\_core}(t_1, t_2, t_3, t_4, t_5, t_6, t_7, t_8, t_9, t_{10}, t_{11}, t_{12}) \rightarrow$$
$$\texttt{npdv:coreIntervalBottom}(\texttt{URI}(\texttt{"\&npdv;wellbore/\{\}/core/\{\}"}, t_9, t_2), t_4)$$

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$\texttt{npdv:production\_wellbore}(x) \rightarrow \texttt{npdv:wellbore}(x)$ `rdfs:subClassOf`

$\texttt{npdv:coreForWellbore}(x, y) \rightarrow \texttt{npdv:WellboreCore}(y)$ `rdfs:range`

`owl:someValuesFrom` (on the left-hand side of $\rightarrow$)

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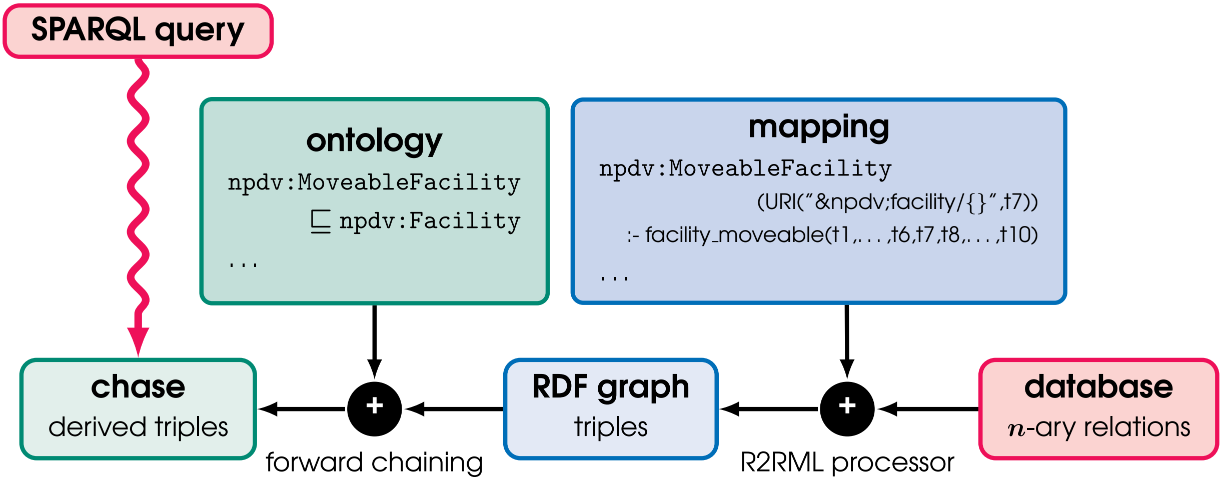
$$\texttt{npdv:StratigraphicUnit}(x) \to$$
$$\texttt{npdv:LithostratigraphicUnit}(x) \lor \texttt{npdv:ChronostratigraphicUnit}(x)$$

`owl:unionOf`

Forward Chaining and OWL 2 RL



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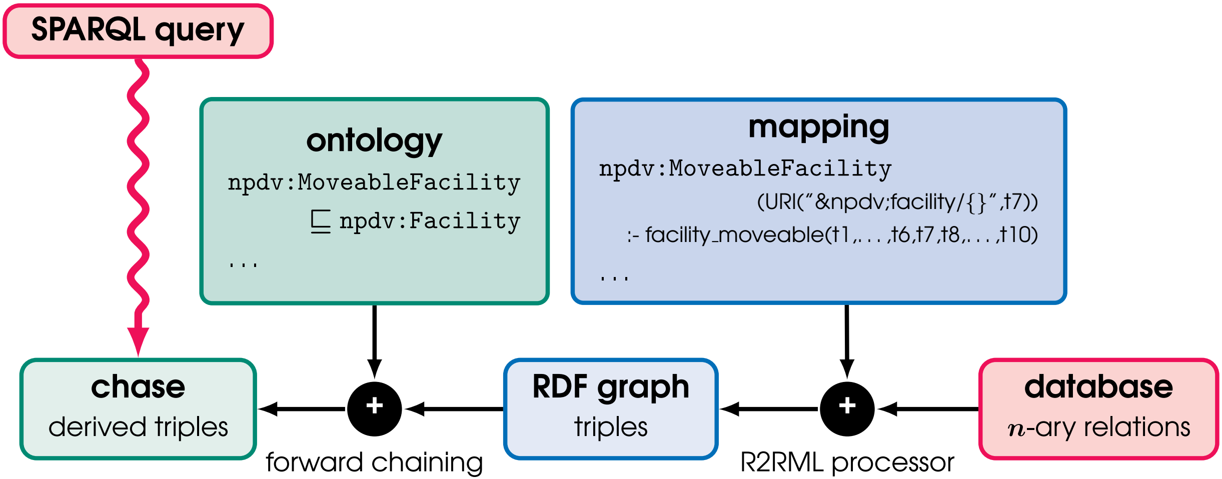

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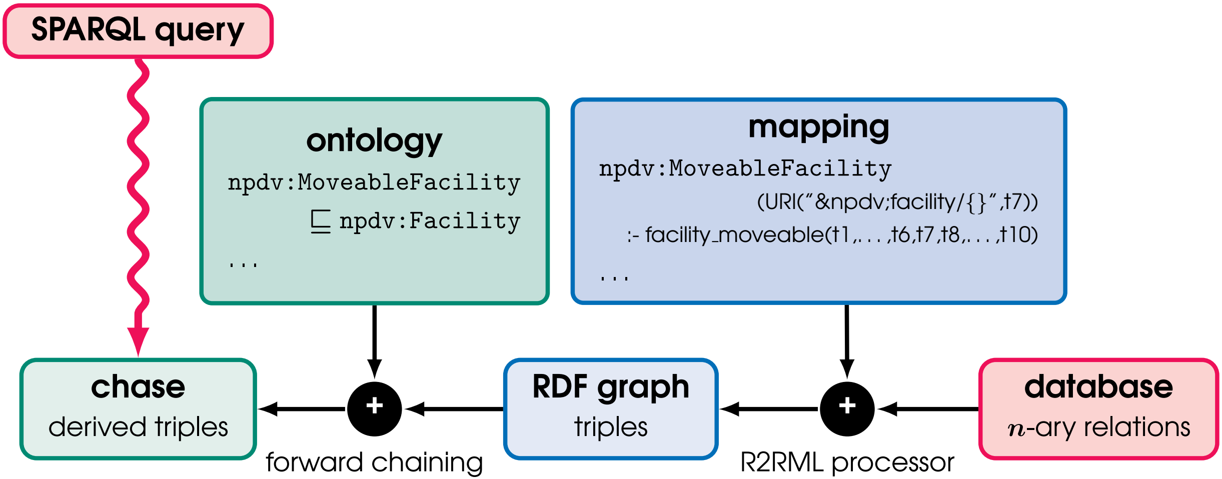

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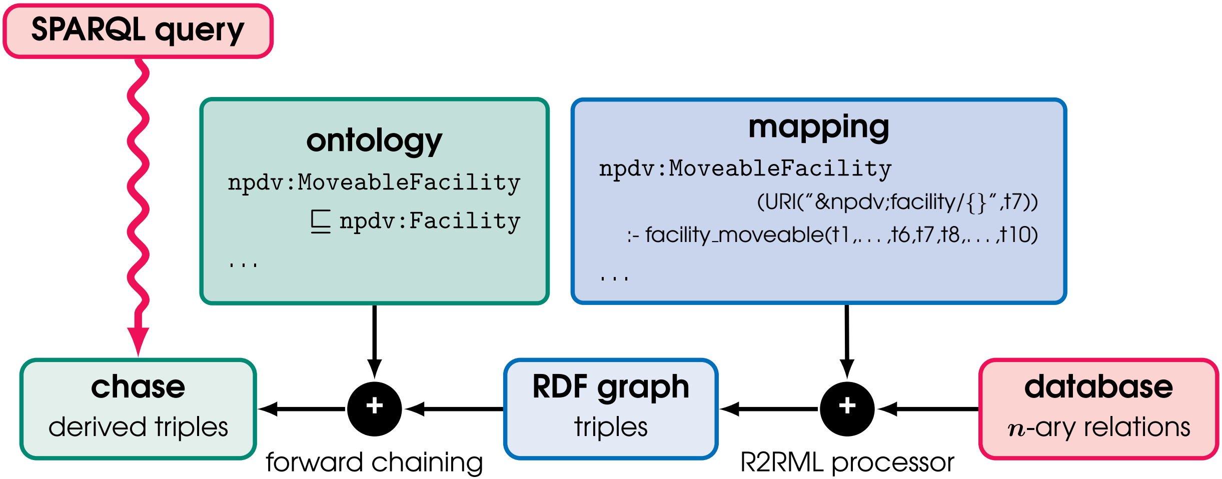

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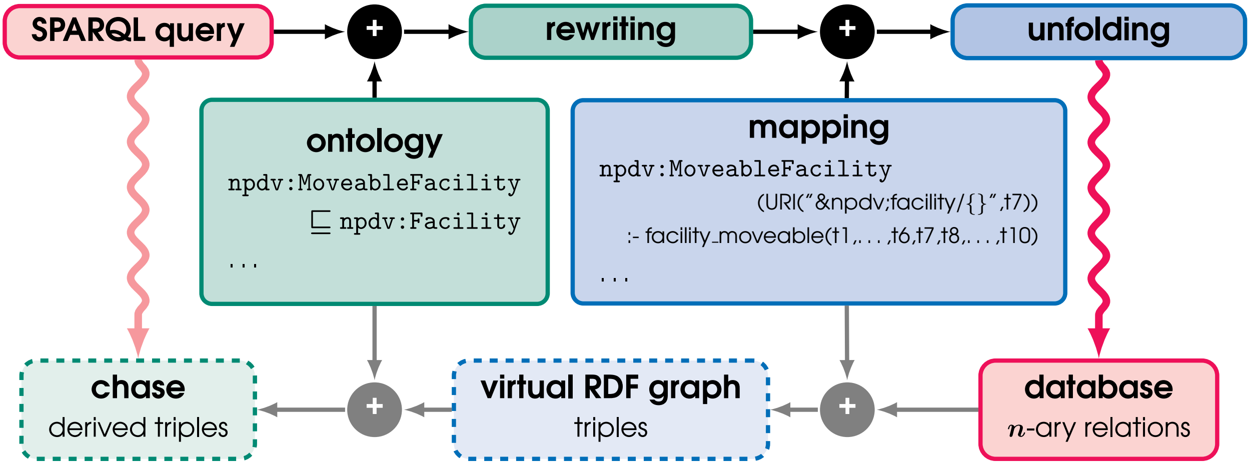
OWL 2 RL is the largest Horn fragment of OWL 2 without value invention

Grosof et al. (WWW 2003), ter Horst (Web Semantics, 2005)

Backward Chaining and OWL 2 QL



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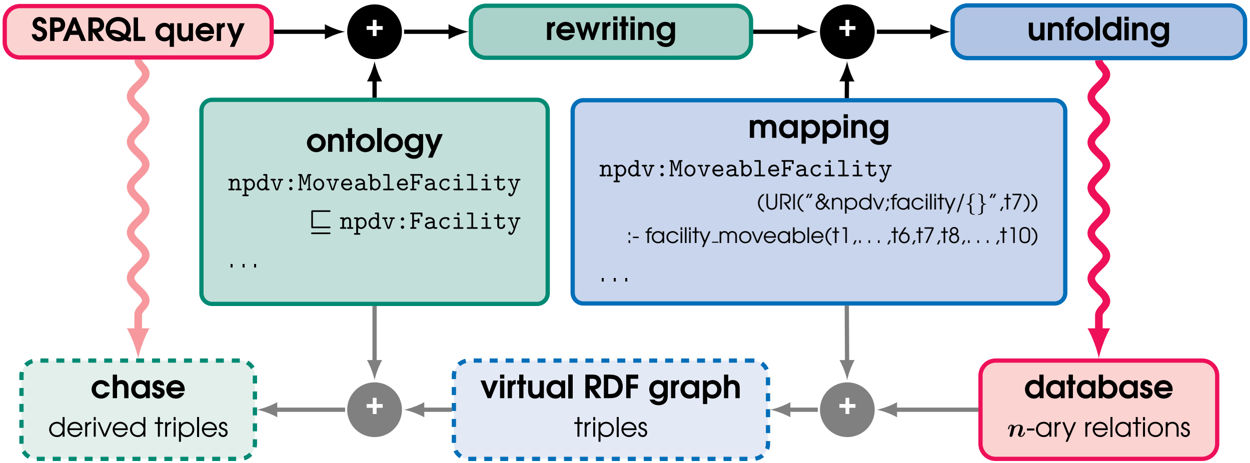

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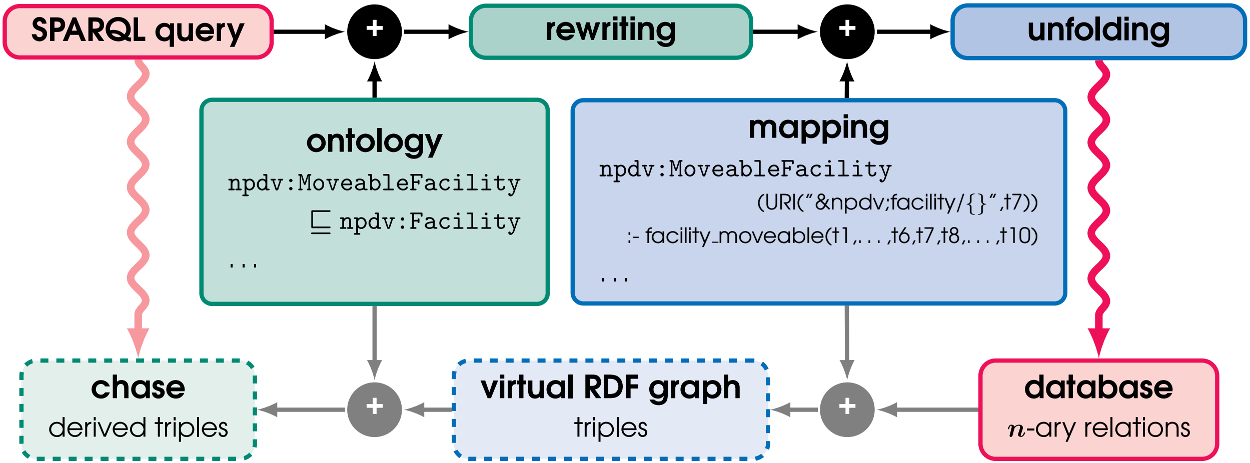

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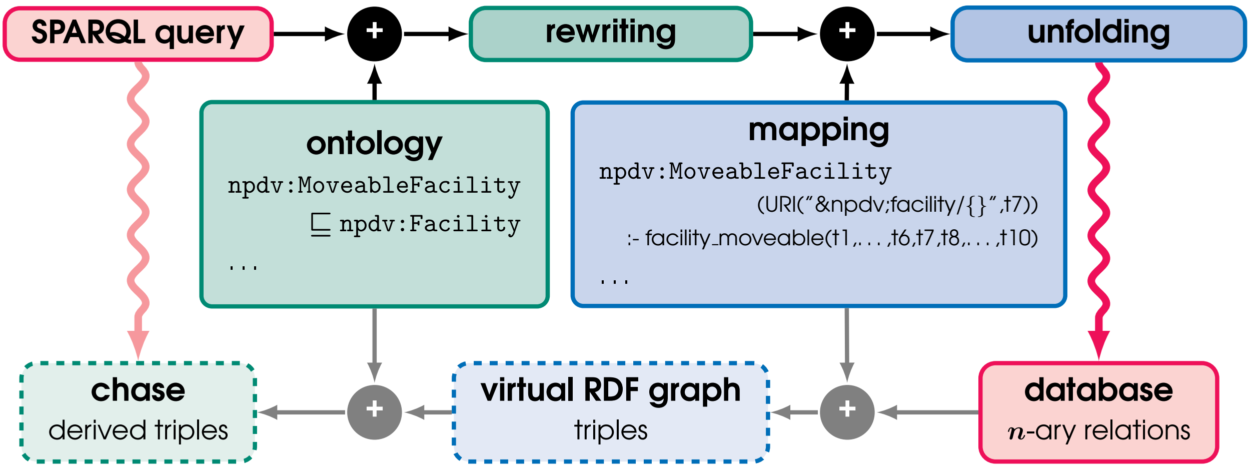

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data complexity of query answering in OWL 2 QL = the data complexity of database query evaluation (AC^0)

+ value invention

– no disjunction, no `owl:someValuesFrom` on the LHS except for `rdfs:domain/range`

Forward v Backward Chaining

ontology: $\texttt{production\_wellbore}(x) \rightarrow \texttt{wellbore}(x)$

data: $\texttt{production\_wellbore}(a42),\ \texttt{wellbore}(a92)$

query: $q(x) \leftarrow \texttt{wellbore}(x)$

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2. use the obtained UCQ to query the original data

Query Rewriting: Theory and Practice

UCQ rewritings are exponential $\Longrightarrow$ **very bad** in practice

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and FO-rewritings are superpolynomial unless $\mathsf{NP/poly} \subseteq \mathsf{NC}^1$

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implemented in ontop framework

Free University of Bozen-Bolzano
with some help from Birkbeck

Calvanese et al. (Semantic Web, 2017), **Rodriguez-Muro et al. (ISWC 2013)**