Model Theory and Calculus for DL-Lite

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Motivation

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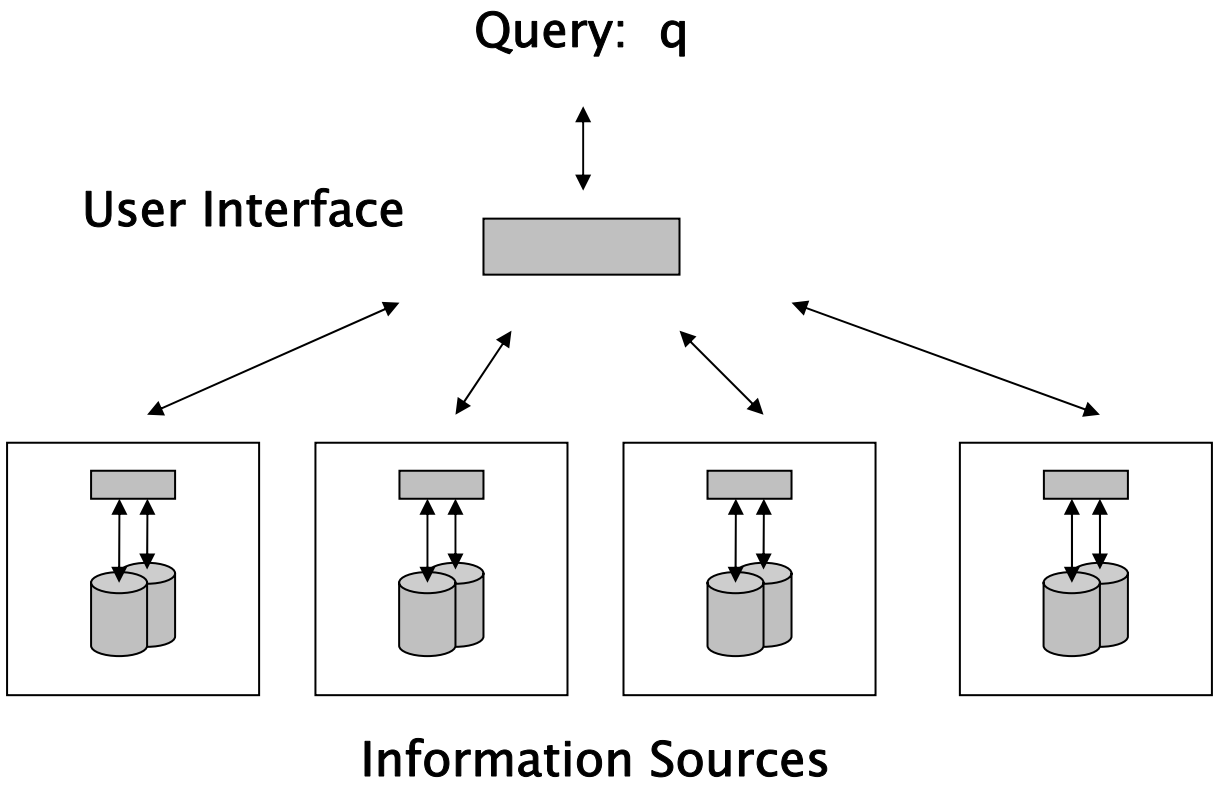
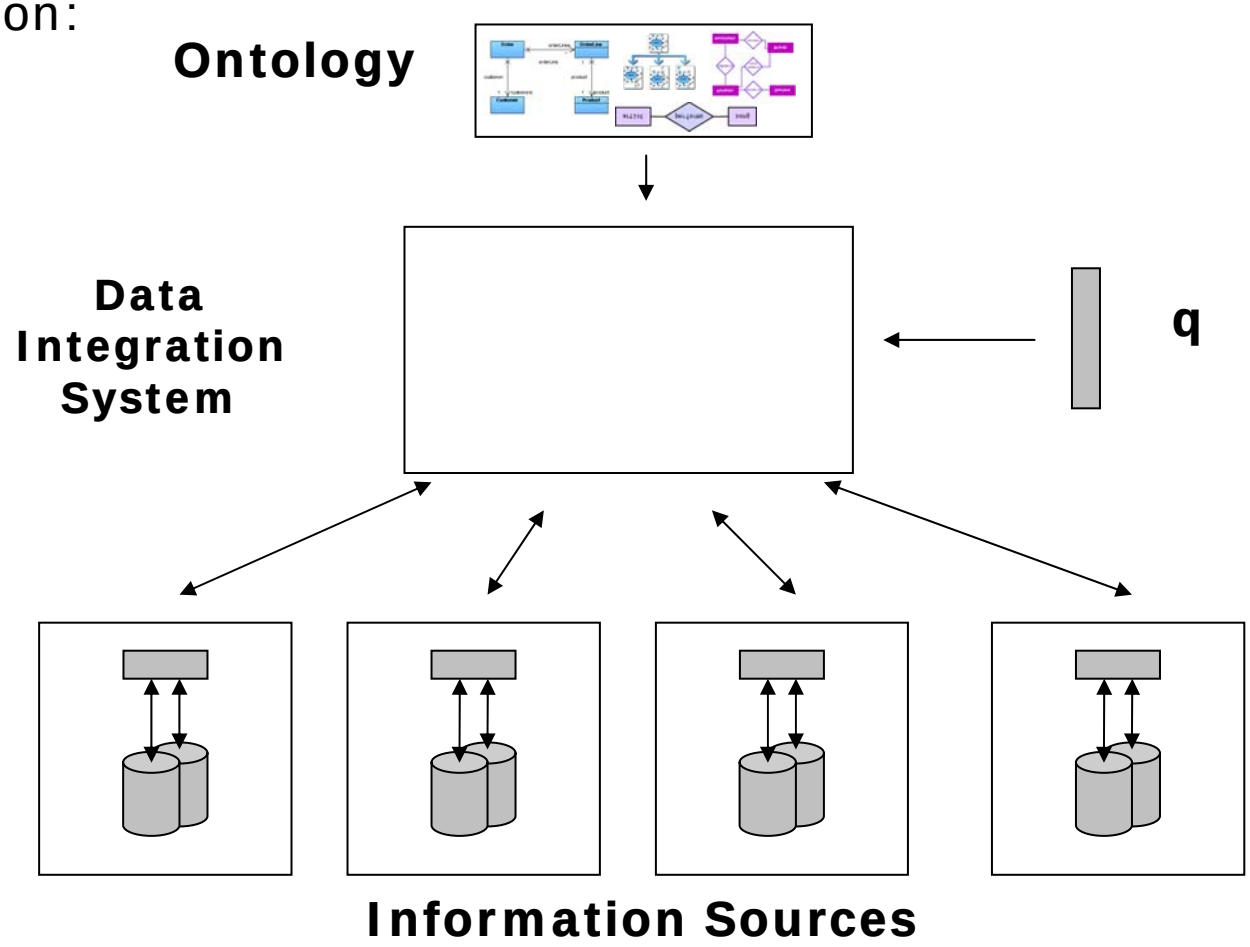
Problem: Data Integration



Motivation

Solution:



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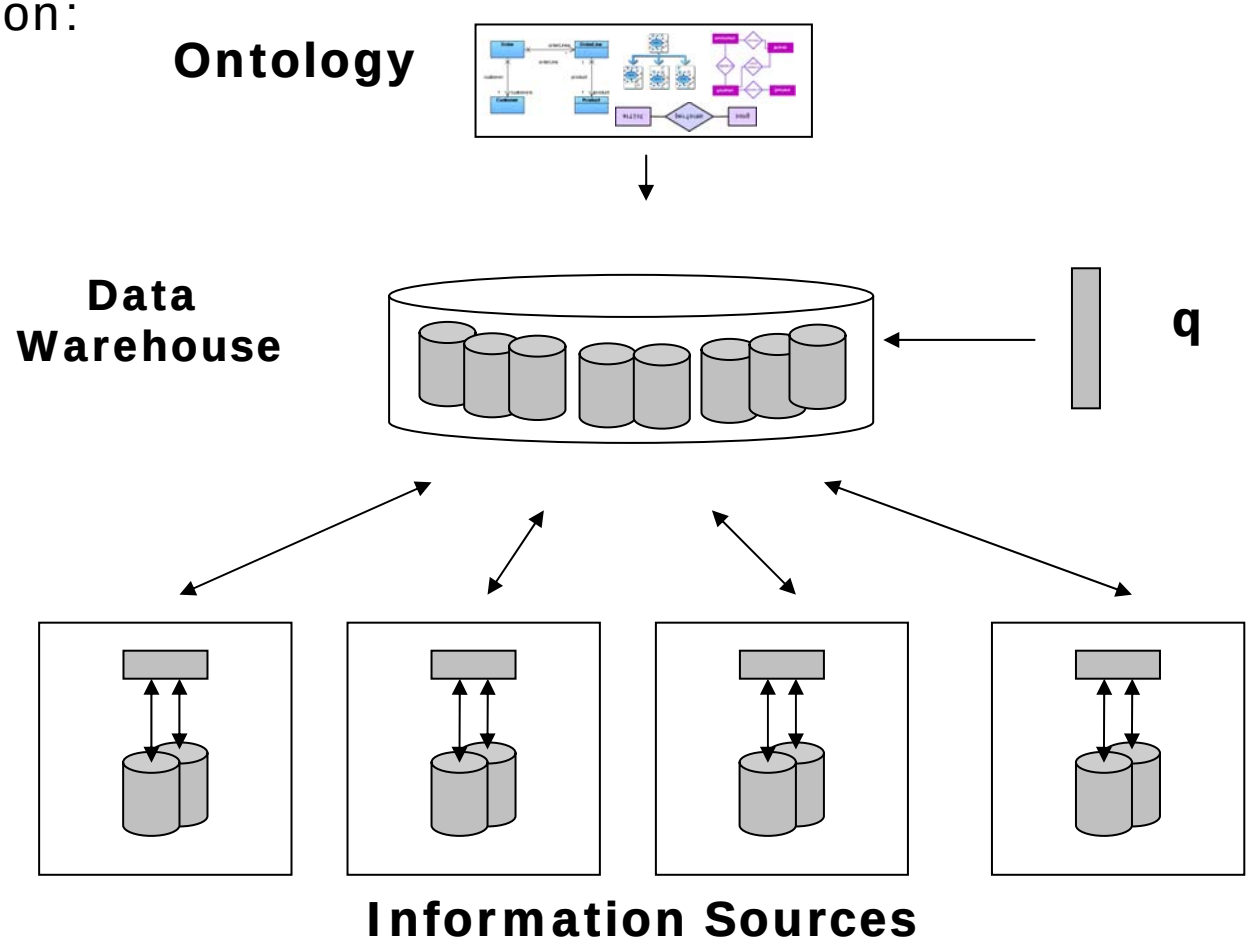
Solution:



Motivation

Pre-process (data from the sources):

Incompleteness of the sources wrt the ontology

- VW is a Car

VW

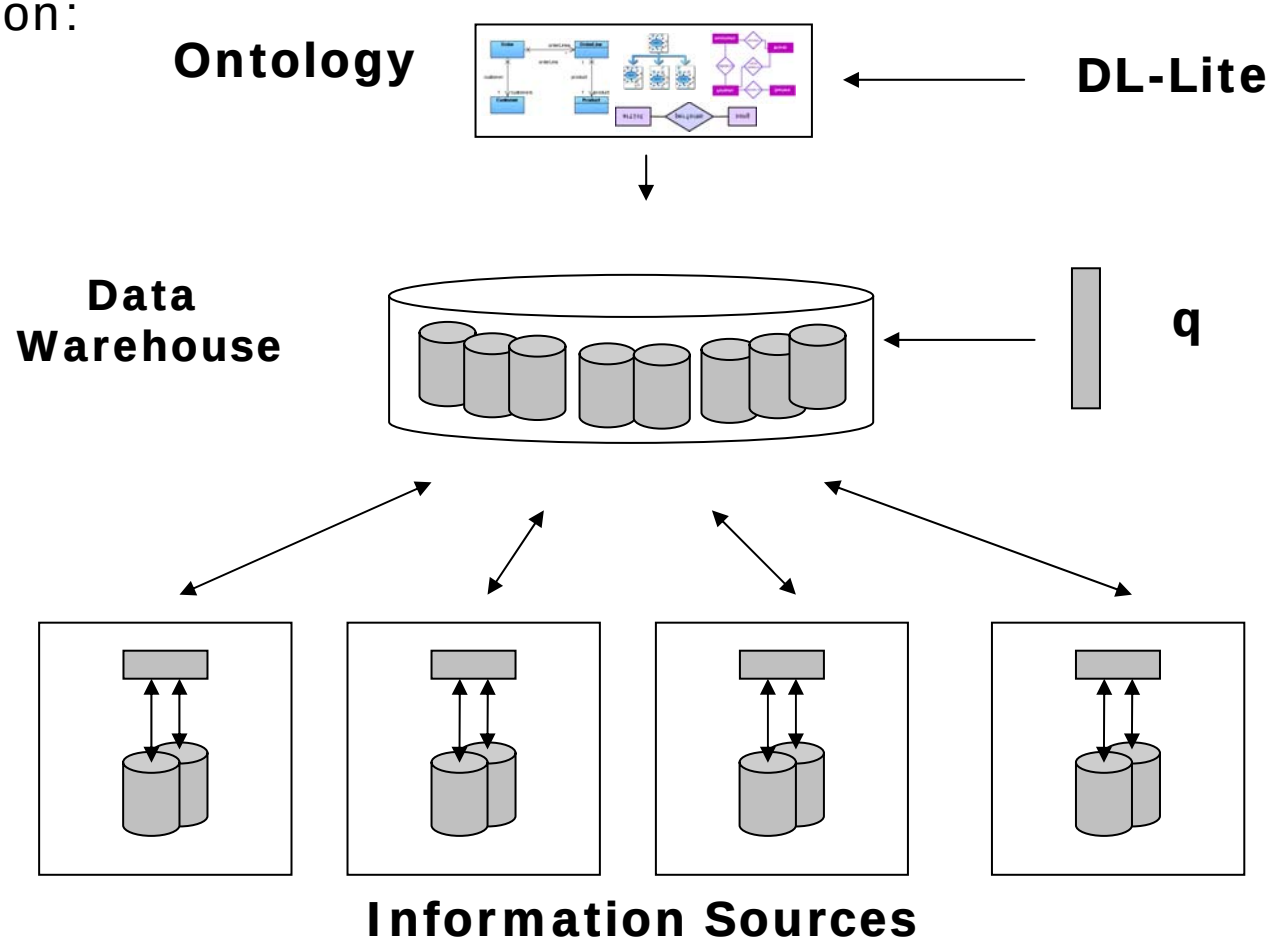
23	Golf	7
	…	

Car

7	Golf	…
	…	

Motivation

Solution:



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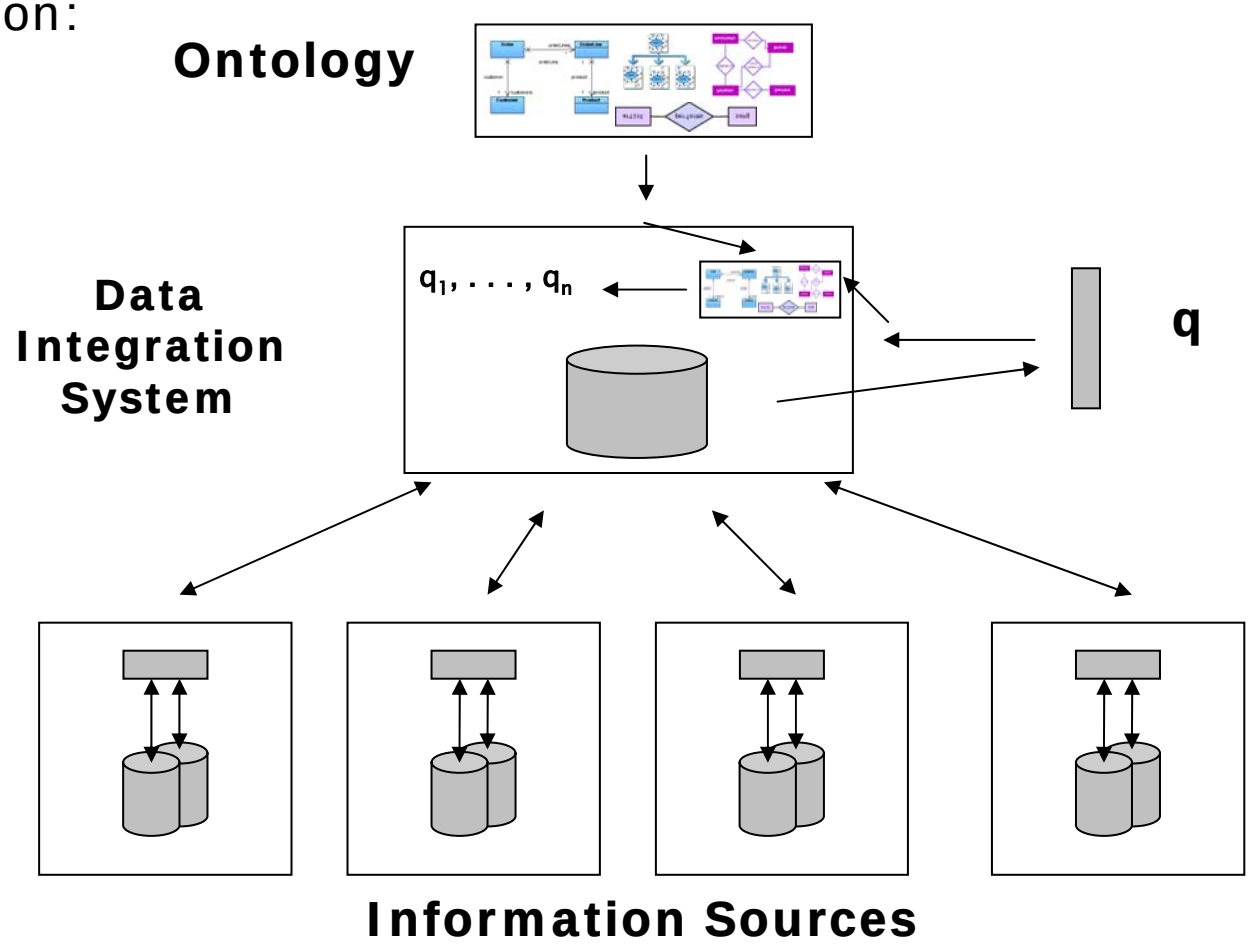
Solution:

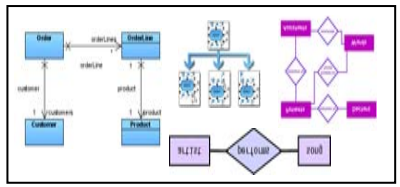


Motivation

Evaluation of Mediators:

- Response time
- Correctness of answers

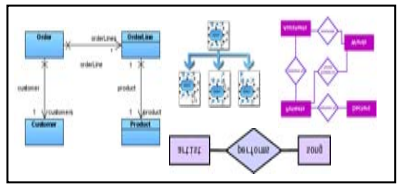
$\mathcal{L}_1$ $\mathcal{L}_2$ $\mathcal{L}_3$

$q \longrightarrow$  $\longrightarrow q_1, \ldots, q_n$

Motivation

Evaluation of Mediators:

CQs DL-Lite UCQs

$q \longrightarrow$  $\longrightarrow q_1, \ldots, q_n$

- Response time ~ LogSpace
- Correctness of answers ~ correct

Problem to be Solved

To understand properties of DL-Lite

- Relationship: ontology - size of the Warehouse
- Relationship: ontology - query answering
  - Response time
  - Correctness of answers

Aim of this Thesis

Better understanding of properties of DL-Lite

DL-Lite

DL-Lite

Vocabulary (of the ontology):

- Classes:
  - Car
  - Elements that participate in a relation:

    A = {x | there is y s.t. Has_engine(x,y)}

    B = {y | there is x s.t. Has_engine(x,y)}

- Relations:

  Has_engine

DL-Lite

Ontology:

- Inclusion dependency:
  - VW IsA Car
  - VW IsA ∃Has_engine
- Disjointness:
  - VW IsA ¬ Mercedes
  - ∃Has_engine IsA ¬ Animal

DL-Lite

Ontology:

- Functional dependency
  - func (Has_id)
  - func (Has_engine)

DL-Lite

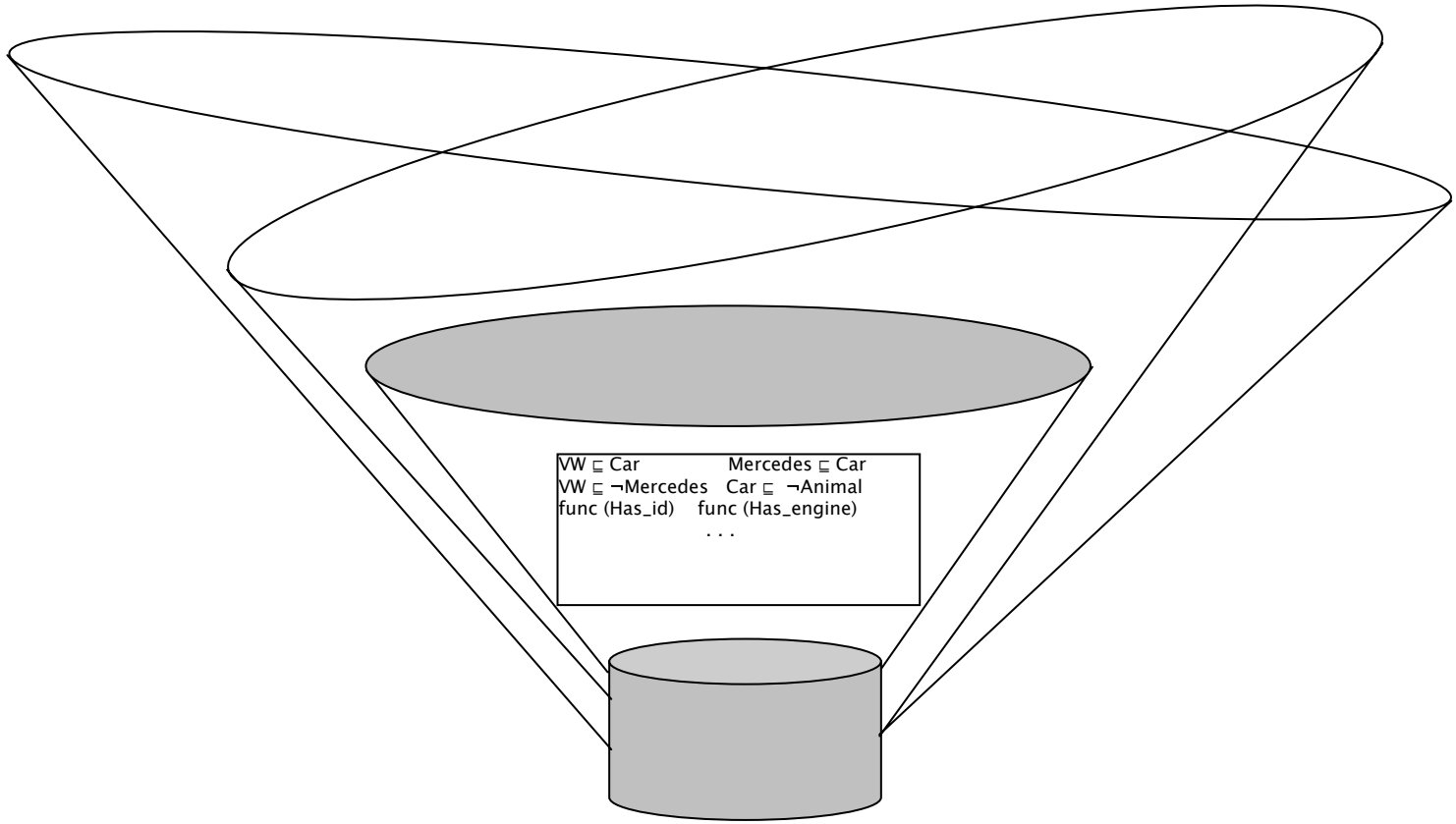
Data (sources):

Car(vw_golf)

Has_engine(vw_golf, td)

Universal Models

Universal Models

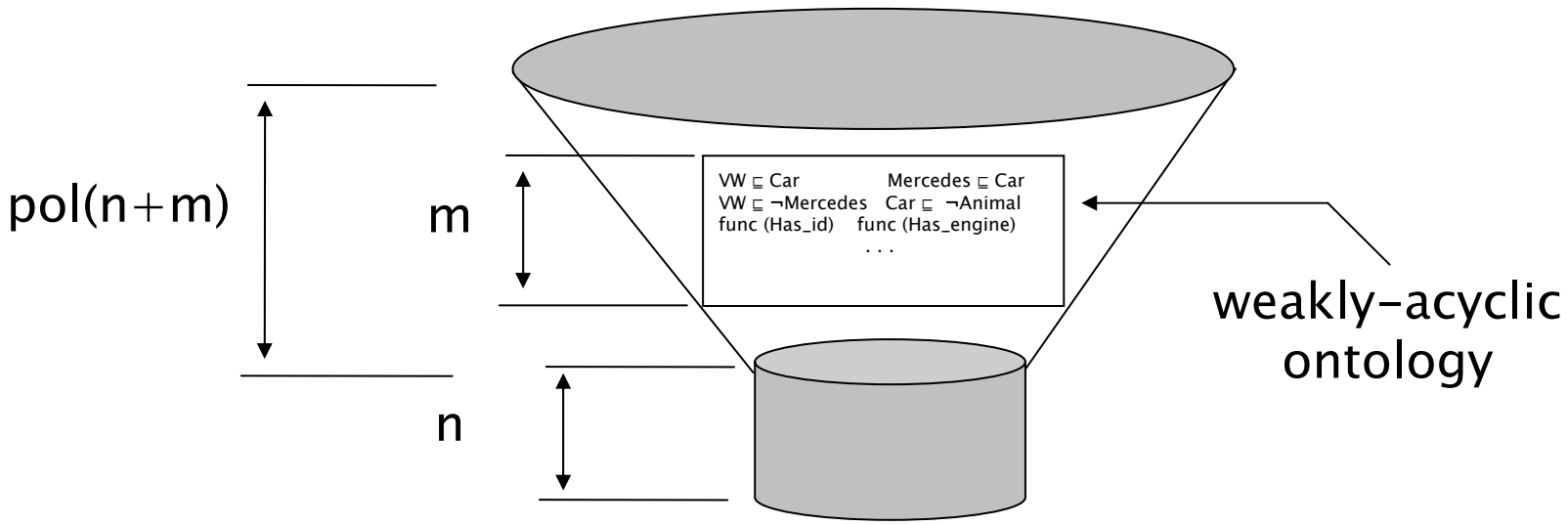


Universal Models

Properties:

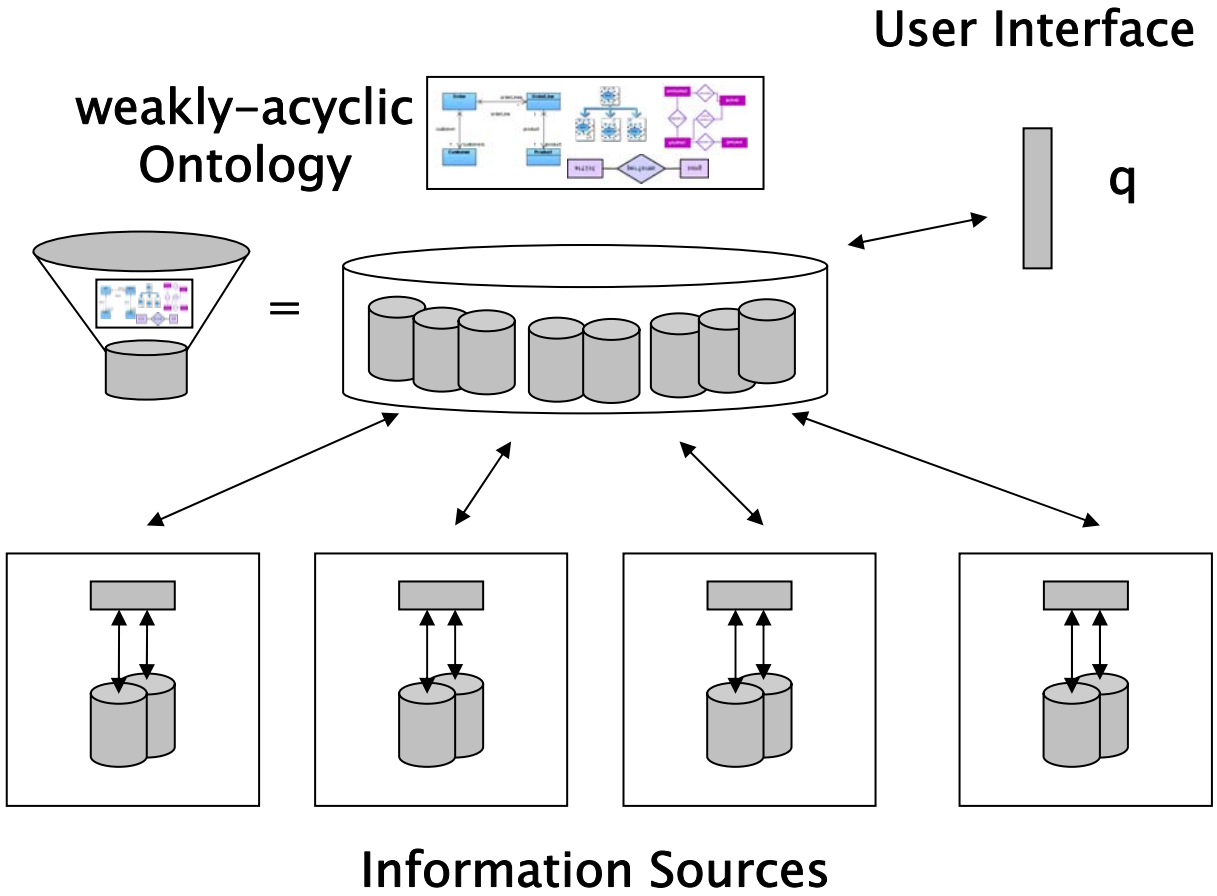
- If there is a completion $\longrightarrow$ UM
- If there is a UM $\longrightarrow$ there is a class of Ums
- Chase of a DB with an Ontology is a UM

Chase of Polynomial Size



Chase of polynomial size:

Chase as Data Warehouse



Results

- Introduced the notion of UM
- Shown that any chase is a UM
- Proposed weakly-acyclic ontologies for which chase is finite and of polynomial size

Deduction as Query Answering

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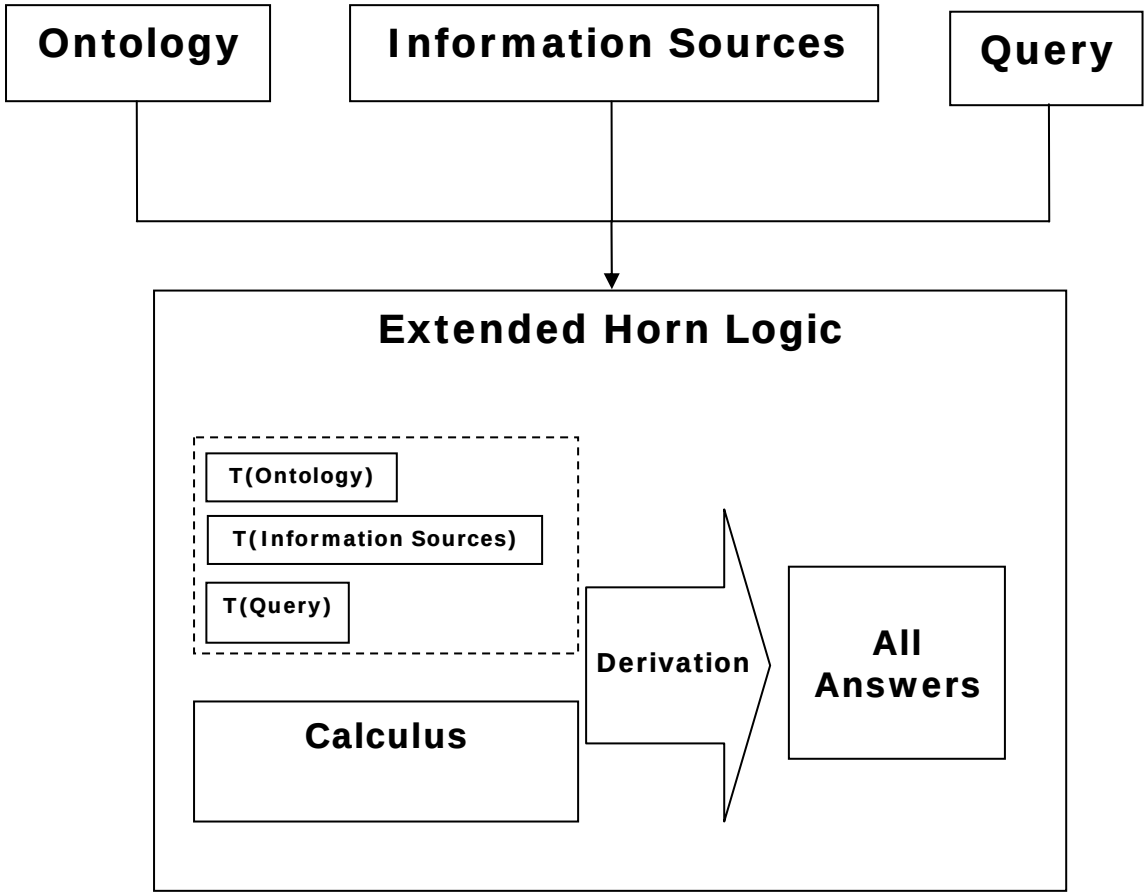

Extended Horn Logic

HL: $\forall X\ \forall Y$ p(X,Y):- q(X,Y), r(Y,Z)

EHL: $\forall X\ \exists Y$ p(X,Y):- q(X,Y), r(Y,Z)

Calculus

Extends Resolution-based calculus with

- Extended resolution
- Query homorphisms

Results

- Introduced EHL
- Defined reduction from DL-Lite to EHL
- Introduced a calculus for EHL
- Shown soundness and completeness of the calculus wrt query answering

$\Rightarrow$ query answering in DL-Lite is reducible to reasoning in EHL

Conclusion

We investigated properties of DL-Lite logic:

- Model theory:
  - Universal models
  - other properties
- Calculus as a tool for query answering

Further work

- Extend query language
- Find good algorithms and optimisations

Thank you