Querying clique guarded existential rules

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Ontology-based Data Access

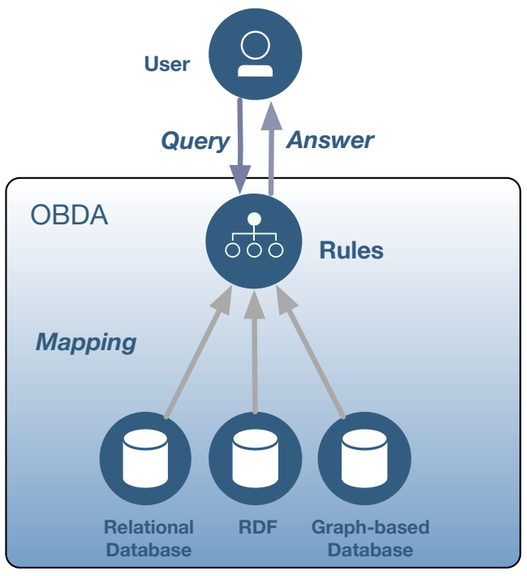

Figure: OBDA Architecture

Industrial applications:

- Optique
- Stardog

Decidable rules are:

- Description logics
- Decidable existential rules

Querying mechanisms are:

- Conjunctive query
- Boolean conjunctive query

Querying via Resolution

Aim: Give a Boolean conjunctive query q, a set of clique guarded existential rules Σ and a set of ground facts $\mathcal{D}$, check whether $\Sigma \cup \mathcal{D} \models q$ (via resolution).

Clique guarded existential rules (CGER):

- Decidable
- Extends (loosely) guarded existential rules
- No practical approach to query CGER yet
- No specific practical approach to decide CGER yet

Boolean conjunctive query (BCQ):

- Returns an yes/no
- Query containment/equivalence/evaluation

Decision Procedures

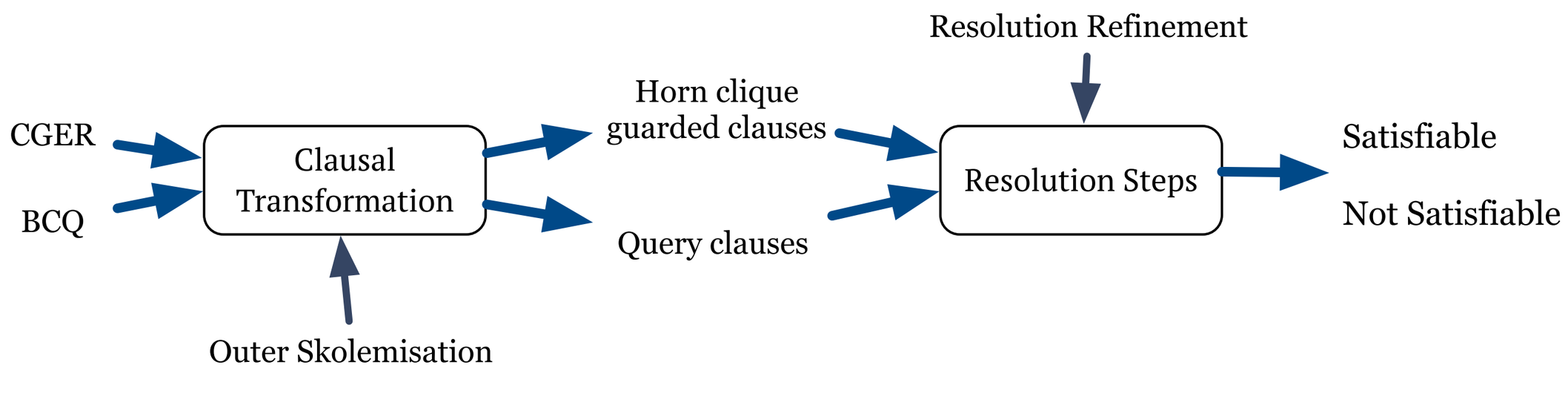

Figure: Overview of the Decision Procedure

Clausal Transformation

Query-Trans:
Simply negate the BCQ.
$\forall xyz(A(x,y) \wedge B(y,z))$ is transformed as $\neg A(x,y) \vee \neg B(y,z)$

CGER-Trans:

- Prenex normal form
- Outer Skolemisation

$\forall xy(A(x,y) \rightarrow \exists w B(x,w))$ is transformed as $\neg A(x,y) \vee B(x,fxy)$.

Clause Defining:

Query clause:

- Flat
- Negative

Horn clique guarded clause (HCGC):

- Simple
- Weakly covering
- There exists a clique in guards
- All non-guard variables are in the clique

Resolution Refinement:

A lexicographic path ordering with a precedence $f > a > p$ and selection:

1. If a clause is flat, select all the negative literals containing top variables.
2. If a clause contains negative non-ground compound literals, select one of them.
3. Else, use the orderings to find the maximal literals.

Top Selection Examples

Example 1

A set of HCGCs:
$C = \neg A_1(x,y) \vee \neg A_2(y,z,v) \vee \neg A_3(z,x) \vee D(z)$
$C_1 = A_1(fx,fx) \vee \neg G_1(x)$ $C_3 = A_3(gx,x) \vee \neg G_3(x)$
$C_2 = A_2(x,gx,x) \vee \neg G_2(x)$

No top selection
The mgu:
$\{x \mapsto fx, y \mapsto fx, z \mapsto gfx, v \mapsto x\}$
The hyper-resolvent is:
$D(gfx) \vee \neg G_1(x) \vee \neg G_2(fx) \vee \neg G_3(fx)$
Contains a deeper term.
Not a query clause/HCGC.

Top selection
Top variable: z,
Select A_2 and A_3,
The hyper-resolvent is:
$\neg A_1(x,x) \vee \neg G_2(x) \vee \neg G_3(x) \vee D(gx)$
It is a HCGC.
(Use a proper precedence.)

Example 2

A query clause and a set of HCGCs:
$Q = \neg A_1(x,y) \vee \neg A_2(y,z)$
$C_1 = A_1(fxy,x) \vee \neg G_1(x,y)$
$C_2 = A_2(gxy,x) \vee \neg G_2(x,y)$

No top selection
The mgu:
$\{x \mapsto f(gxy,y'), y \mapsto gxy, z \mapsto x\}$
The hyper-resolvent is:
$\neg G_1(gxy,y') \vee \neg G_2(x,y)$
Not weakly covering.
Not a query clause/HCGC.

Top selection
Top variable: x,
Select A_1,
The resolvent is:
$\neg A_2(x,z) \vee \neg G_1(x,y)$
It is a query clause.
(Requires another premise.)