Rel. Algebra: polynomial
$\hat{=}$ SQL

Relational Calculus ?

subset of FOL

" FOL undecidable "

↳ Satisfiability of FOL formulas is undecidable
i.e. in any structure

~ Reasoning

here: Query Answering in a given DB (structure)

⇒ Subfunctionality of Things that could be done in FOL.

⇒ for this subfunctionality: polynomial

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S. 436 : Test Safety of a {Formula / Query} $F(\bar{X})$

- Rewrite Formula in a Normal Form (equivalent)
- Simpler Proof/Check for NF Formulas

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example for 3)

(3) $rr = \{x, y\}$

$F = \underbrace{p(\underset{rr\,(1)}{x}, \underset{rr\,(1')}{y})} \wedge \underbrace{\neg q(x)}_{\text{not } rr}$

consider SQL:
evaluate $p(x,y)$
and lookup $\neg q(x)$ via an index

Outlook

no directly equivalent exp in the Rel. Algebra

⇝ minus

$xy - xy$

$p(x,y) - (p(x,y) \bowtie q(x))$

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exaple 4)

$cons(N, \text{"D"}, \underset{rr}{P}, A) \wedge P = Q$

also rr

$cons(N, \text{'D'}, P, A) \wedge \underset{?}{C} = \underset{?}{D} \wedge p(C, D)$

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- Query answering
  - bottomup: Algebra on DB
  - use a Reasoner on

    $F(X,Y) \wedge$ all predicate atoms that are in the DB

    $\wedge$ not anything else!

    $\Rightarrow$ conclude the answer

    $\Rightarrow$ expensive
    undecidable
  - translate query into rel. Alg and

äquivalent

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Closed World (= DB with implicit negation)
vs
Open World

$F(X)$:- $\overset{\text{Icode}}{\text{country}}(N, X, P, A) \wedge$
$\neg$ borders$(X, \text{"D"})$

DB: expect e.g. X/"BR", X/"P", ...

Conc: Mondial $\models$ country$(N, X, P, A) \wedge \neg$borders$(X, \text{"D"})$

$\Leftrightarrow \emptyset \models_\beta$ conj-of-all-ground-facts
$\wedge$ country$(N, X, P, A) \wedge \neg$borders$(X, \text{"D"})$

$\beta(X)$?

$\wedge$ conjunction with a lot of negated atoms

$\Rightarrow$ DB actually does not contain any negative facts!

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$F = F_1 \wedge F_2 \wedge \ldots\ldots \wedge F_k$

$t(x)$ $u(z)$

not free$(F_k) = m (\neq \emptyset)$

e.g. $F_k = \underbrace{\neg p(x)}_{m = \emptyset}$

we know

$m \supseteq \{x, y, z\}$

$\Rightarrow$ some $F_1 \ldots F_{k-1}$ wishes

y and z m

e.g. $F_k = p(x,y) \wedge q(y,z)$

free $= \{x, y, z\}$

$m = \{y\}$

free $= m$ $\quad \underline{t(x) \wedge q(y,z)} \vee \underline{u(z) \wedge p(x,y)}$ free $= m$

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