Sl 551:

Database point of view

- start with φ = db state $\hat{=} T_P^1(\emptyset)$
- set of true rules $H \leftarrow B_1, \dots, B_n$

~~Def~~ Slide 551:
but is equivalent

Sl 551 = Prolog-style definition:

start with $\emptyset$

Program P: • ground facts $p(a,b,c).$
• rules $q(X) :- p(X,\_,\_).$

$I_0 = \emptyset = T_P^0(\emptyset)$
$I_1 = T_P(\emptyset)$
– rules: don't do anything
– gnd facts: $\hat{=}$ rules $p(a,b,c) :- .$
"from nothing, we can derive $p(a,b,c)$"

DB state $\varphi \hat{=} T_P^1(\emptyset) = T_P(\emptyset) \Longleftarrow$ all these gnd facts

… $T_P^2(\emptyset)$
⋮
$T_P^3(\emptyset) = T(T_P^2(\emptyset))$
⋮
$T_P^{1000}(\emptyset)$ ⇝ take the union (infinite(?))
↓
$T_P^\omega(\emptyset)$

Consider (Prolog!) there is a rule (using a fct. symbol f)

$$P = \{ \; person(father(X)) \leftarrow person(X). \quad person(john). \; \}$$

$T_P^0(\emptyset) = \emptyset$

$T_P^1(\emptyset) = T_P(\emptyset) = \{person(john)\}$

$T_P^2(\emptyset) = \{person(john), person(father(john))\}$

$T_P^3(\emptyset) = \{person(john), person(father(john)), p(f(f(j)))\}$

⋮ by induction

$T_P^i(\emptyset) = \{ \; person(f^j(john)) \mid j = 0 \dots i-1 \}$

$\Rightarrow \bigcup_{i=0..\infty}^{i} T_P^i(\emptyset)$ is infinite! $= \underbrace{\{ p(f^i(john)) \mid i = 0..\infty \}}_{\mathcal{M} :=}$

$\Rightarrow$ this is an infinite FOL interpretation / infinite Herbrand structure, which can be finitely described

Prolog
- bottom-up characterization infinite / purely theoretical
- top-down use

?- p(f(f(f(f(j))))).

yes.

↑ uses the proof-theoretic semantics

?- person(father(mary))

No. cannot prove it.

$\mathcal{M}$ is a Herbrand interpretation

= set of ground atoms.

$\mathcal{M} \models P$?

- $\mathcal{M} \models person(john)$ yes: $person(john) \in \mathcal{M}$
- $\mathcal{M} \models \forall x: person(x) \rightarrow person(father(x))$

  whenever $person(t) \in \mathcal{M}$, t ground term, then also $person(father(t)) \in \mathcal{M}$

$\Rightarrow$ yes, $\mathcal{M} \models P$.

- $\mathcal{M}$ is the smallest model of P

  foreach $\mathcal{M}' \subsetneq \mathcal{M}$ then $\mathcal{M}' \not\models P$

- there are many $\mathcal{M}'' \supsetneq \mathcal{M}$ such that

  $\mathcal{M}'' \models P$

  e.g. take $\mathcal{M}'' := \mathcal{M} \cup \{person(mary), person(father(mary)), \dots\dots person(f^i(mary)) \mid i = 0..\infty\}$

  $\mathcal{M}'''' := \mathcal{M} \cup \{country(ger), cap(ger, bln), pres(ger, fwsteinmeier)\}$

  $\mathcal{M}^5 := \mathcal{M}'''' \cup \{person(fwsteinmeier), person(father^i(fwsteinmeier)) \mid i = 0..\infty\}$

SS55 basic Knowledge K_1

basic Knowledge $K_2 \supseteq K_1$

derivable conclusions: $K_i \models_{calc} \varphi$?

Holds whenever $K_1 \models_{calc} \varphi$, then also $K_2 \models \varphi$

if yes: "calc is monotonous"

FOL is monotonous.

Consider

tweety is a bird.
Usually birds fly.
penguins are birds.
penguins do not fly.

$\left.\right\} K_1 \vdash_{\text{human calc}}$ tweety flies (we assume "usually")

$K_2 = K_1 + \{$tweety is a penguin$\}$

$K_2 \vdash_{\text{human calc}}$ tweety does definitely not fly!

$\Rightarrow$ human reasoning is nonmonotonic!

$\Rightarrow$ to do <u>belief revision</u> if necessary!

SQL queries:

select name from country c
where <u>not</u> exists (select *
from ismember i
where i.country = c.code
and i.org = 'EU')

$\mathcal{D}_1 \models$

name
USA
R
UA
KOS
⋮

update: $\mathcal{D}_2 = \mathcal{D}_1 \cup \{$ismember('UA', 'EU', 'member')$\}$.

$\mathcal{D}_2 \supsetneq \mathcal{D}_1$, but

answer to same query:

name
USA
R
~~UA~~
KOS
⋮

answers($\mathcal{D}_2$) $\not\supseteq$ answers($\mathcal{D}_1$)

$\rightarrow$ SQL is nonmonotonic.