until now:

- Relational Calculus
- First-Order logic
  - Semantics: FO Model Theory
  - Reasoning ... Tableau Reasoning

Classical logic

FOL is not monotonous

Datalog:

based on Relational Calculus

different model theory!

Algorithms for computing answers (instead of Reasoning)

$\Rightarrow T_P$ is monotonous

Jan 8-10:08

Human Reasoning

~~FOL~~ is not monotonous:

- (usually) birds fly
- Penguins are birds
- Penguins don't fly
- Tweety is a bird

Knowledge K1

Knowledge K2 $= K1 \cup \{$Tweety is a penguin$\}$

Tweety can fly

Tweety does not fly

this conclusion does not hold any more

Human: "usually" + exceptions

$\Rightarrow$ reasoning with incomplete knowledge

$\dashrightarrow$ withdraw old conclusion upon learning more things

Jan 8-10:51

Same in FOL:

$F = (\forall x : penguin(x) \rightarrow \neg fly(x)) \wedge$
$bird(tweety) \wedge$
$(\forall x : penguin(X) \rightarrow bird(X)) \wedge$
$(\forall x : bird(x) \wedge \neg penguin(X) \rightarrow fly(x))$

What about tweety?

$F \models fly(tweety)$?

No, not sure, but maybe!

$F \wedge fly(tweety)$ is consistent

but also $F \wedge \neg fly(tweety)$ is also consistent

$\Rightarrow$ no answer in FOL about tweety!

Jan 8-10:57

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$$P = \begin{cases} q(X) :- p(X). \\ r(X) :- q(X). \\ p(a) :- true. \end{cases}$$

(1): $\emptyset$ (2): $q(a)$ 3: $q(a)$ 4: $q(a)$
(1): $\emptyset$ (2): $\emptyset$ 3: $r(a)$ 4: $r(a)$
(1) $p(a)$ (2): $p(a)$ (3): $p(a)$ (4): $p(a)$

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

$T_P^1(\emptyset) = \{p(a)\}$

$T_P^2(\emptyset) = T_P(T_P^1(\emptyset)) = T_P(\{p(a)\})$
$= \{q(a), p(a)\}$

$T_P^3(\emptyset) = T_P(T_P^2(\emptyset)) = \{q(a), r(a), p(a)\}$

$T_P^4(\emptyset) = \ldots = \{ \text{"} \} = T_P^3(\emptyset) = T_P^\omega(\emptyset)$

Jan 8-11:19