

A GRAMMAR FOR FIRST-ORDER LOGIC

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Sentence → AtomicSentence | ComplexSentence
AtomicSentence → Predicate | Predicate(Term, ...) | Term * Term
ComplexSentence → ( Sentence ) | [ Sentence ]
               | ~ Sentence
               | Sentence & Sentence
               | Sentence ∨ Sentence
               | Sentence ⇒ Sentence
               | Quantifier Variable, ... Sentence

Term → Function(Term, ...)
      | Constant
      | Variable

Quantifier → ∀ | ∃
Constant → a | x1 | John | ...
Variable → x | y | z | ...
Predicate → True | False | After | Loves | Running | ...
Function → Mother | LeftLeg | ...
    
```

12 first order logic

generalize propositional logic by adding :

构件 {

 objects (terms)

 relations and quantifiers (量词)

 [predicates (断言, 谓词)] → some, all, every ...

 { true

 subset of a term

 functions

 variables
 }

atom : predicate symbol + list of terms

e.g. brother (Richard, John)

model : domain + interpretive mapping

$$\neg \forall x \phi \equiv \exists x \neg \phi$$

$$\neg \exists x \phi \equiv \forall x \neg \phi$$

term equality : Father (John) \equiv Henry

example : A natural number is prime
 if there does not exist any other natural number
 rather than it self
 or one-evenly divided evenly

$$\forall n [\text{Natural}(n) \wedge (\neg \exists x (x \neq n \wedge x \neq 1 \wedge \text{DivideEven}(n, x)))] \Rightarrow \text{Prime}(n)$$

assumptions : (unique-names)

{ close - world
domain - closure

inference $\alpha \models \beta$?

infinite domains : model checking not enough

semi-decidable { if subset is unsatisfiable, the unsatisfiable
But, if $\alpha \not\models \beta$, 无法证明

{ universal instantiation \forall (因为反query)(可以证实, 无法证伪)
existential instantiation \exists (证伪)

Skolem constant / skolem function / Skolemized

not logically equivalent, but inferentially equivalent

propositionalization

FOL KB $\xrightarrow{\text{instantiation}}$ Propositional Logic KB

try: generates all terms at depth 0, 1, 2...
until find the proof

Conclusion, inference

option 1 : propositionalization + ~~the~~ interactive deepening

option 2 : "Lifting" inference to work directly in the FOL theory.