

First-Order Logic

- ▶ First-Order Predicate Calculus
- ▶ Predicate Calculus
- ▶ FOL
- ▶ FOPC

Makes a stronger set of ontological commitments than propositional logic.

*The world consists of **objects** that is thinks with individual identities and **properties** that distinguish them from other objects.*

***relations** between objects.*

functions

First-Order Logic

- ▶ **Objects:** people, houses, colors, numbers
- ▶ **Relations:** brother of, bigger than, part of, has color, owned.
- ▶ **Properties:** red, round, prime
- ▶ **Functions:** father of, best friend.

First-Order Logic

- ▶ **Term:** A Logical Expression that refers to an object.

john

fatherof(john)

- ▶ **Atomic Sentences:**

brother(john, richard)

married(fatherof(richard), motherof(john))

- ▶ **Complex Sentences:**

brother(richard, john) \wedge brother(john, richard)

First-Order Logic

Quantifiers, Variables

► **Universal Quantification:** \forall

$$\forall x \text{ cat}(x) \rightarrow \text{mammal}(x)$$

$$\forall x \text{ man}(x) \rightarrow \text{mortal}(x)$$

► **Existential Quantification:** \exists

$$\exists x \text{ sister}(x, \text{spot}) \wedge \text{cat}(x)$$

► **terms:**

$$a, \text{fatherof}(a), x$$

► **ground terms:**

$$a, \text{fatherof}(a)$$

First-Order Logic

Syntax

$Atomic_Sentence \Rightarrow Predicate(term_1 \dots)$
| $term = term$

$term \Rightarrow Function(term_1 \dots)$
| $constant$ | $variable$

$Sentence \Rightarrow Atomic_Sentence$
| $Sentence$ $Connective$ $Sentence$
| $Quantifier$ $Variable$ $Sentence$
| \neg $Sentence$
| $(Sentence)$

First-Order Logic

Syntax

Connective $\Rightarrow \wedge \mid \vee \mid \equiv$

Quantifier $\Rightarrow \forall \mid \exists$

Constant $\Rightarrow a \mid john \mid \dots$

Variable $\Rightarrow x \mid s \mid \dots$

Predicate $\Rightarrow before \mid hascolor \mid \dots$

Function $\Rightarrow mother \mid leftlegof \mid \dots$

Application

Temporal Reasoning

- ▶ TMM – Time Map Manager (Brown, Yale, Honeywell, Nasa)
- ▶ Specialized Temporal Reasoning System
- ▶ Reasoning about the ordering an extent of events and the resulting changes in the state of the world.
- ▶ Applied to very large problems – 10,000 activities.
- ▶ Scheduling for a circuit board manufacturing plant, science modules on Space Shuttle.

Application

Semantic Web

- ▶ Syntactic Web vs Semantic Web
- ▶ HTML, XML
- ▶ Ontologies, Description Logics
- ▶ Web Search, Electronic Commerce
- ▶ Web Services
- ▶ <http://www.semanticweb.org>