

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.

2 / 1

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*

1 / 1

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:**
 - $a, \text{fatherof}(a)$

4 / 1

First-Order Logic

- ▶ **Term:** A Logical Expression that refers to an object.
 - $john$
 - $\text{fatherof}(john)$
- ▶ **Atomic Sentences:**
 - $\text{brother}(john, richard)$
 - $\text{married}(\text{fatherof}(richard), \text{motherof}(john))$
- ▶ **Complex Sentences:**
 - $\text{brother}(richard, john) \wedge \text{brother}(john, richard)$

3 / 1

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

6/1

Application

Semantic Web

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

8/1

First-Order Logic

Syntax

Atomic sentence $\Rightarrow Predicate(term_1 \dots)$
 | $term = term$
term $\Rightarrow Function(term_1 \dots)$
 | $constant \mid variable$
Sentence $\Rightarrow Atomic\ sentence$
 | $Sentence\ Connective\ Sentence$
 | $Quantifier\ Variable\ Sentence$
 | $\neg Sentence$
 | $(Sentence)$

5/1

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.

7/1