

# Lecture 13

## LCD 306: Semantics & Pragmatics

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# Outline

- 1 Administrativa
- 2 Predicate Logic
  - Meaning
  - Propositional Logic
  - Constants and Variables
  - Predicates
  - Quantifiers

# Table of Contents

## 1 Administrativa

## 2 Predicate Logic

- Meaning
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# Quiz

- Review Grade
- Bimodal distribution with a large number of high marks and a decent amount of par marks

# Calendar

- 26 March: *PC and Entailments*
- 31 March: *Quantifiers*
- 2 April: **Group presentations**

# Calendar

- 5 April: Post-presentation write-up
- 7 April: Spring Break
- 9 April: Spring Break
- 13 April: Exam II and mid-term course assessment
- 14 April: Class resumes

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# Meaning

We have been talking about what it means to *mean* something at the following levels

- Proposition
- Word

# Predicate Logic

How do we deal with *meaning* at the level of...

- **Proposition**: Propositional Logic
  - Truth: True or False
- **Word**: Sense and Reference
  - Sets of real world entities

# Predicate Logic

How do we handle the meaning of lexemes other than concrete nouns

- Adjectives?
  - Properties of an entity
- Verbs?
  - Properties of an entity
  - Relation between entities

# Predicate Logic

Properties of an entity & relation between entities are formalized and conceptualized using **sets**

# Predicate Logic

We can talk about meaning in terms of **sets**

- Using set theory,
- Propositional logic, and
- **Predicate Logic...**
- We can discuss compositional meaning

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# Predicate Logic

- We begin with Propositional Logic

# Predicate Logic

Predicate logic is an enrichment of propositional logic

- the logical connectives

$\neg, \vee, \wedge, \rightarrow, \leftrightarrow$

- the brackets ‘(’ and ‘)’

# Well-formed formulae

The set of wff (aka grammatical sentences) in Predicate Logic is defined recursively as follows:

- If  $\phi$  is a formula in PL, then  $\neg\phi$  is a formula in PL.

# Well-formed formulae

The set of wff (aka grammatical sentences) in Predicate Logic is defined recursively as follows:

- If  $\phi$  and  $\psi$  are formulae in PL, then so are  $(\phi \vee \psi)$ ,  $(\phi \wedge \psi)$ ,  $(\phi \rightarrow \psi)$ ,  $(\phi \leftrightarrow \psi)$ .

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# Predicate Logic

- Recall that we can think of the world as being

$$U_{\langle w, t \rangle} = \{u : u \in U\}$$

- Enrich our vocabulary (notation system) with the following...

# Predicate Logic

The additional vocabulary of (first-order) predicate logic consists of the following:

- a set of constant symbols  $a, b, c$ , etc.
- a set of variable symbols  $x_1, x_2$ , etc.

# Constant Symbols

$a, b, c$

- The meaning of  $a$
- $[[a]] = \{x : x \text{ is denoted by } a\}$

# Variable Symbols

$x_1, x_2, x_3$

- A “placeholder” which gets meaning through an **assignment** function
- Some function checks through

$$u \in U_{\langle w, t \rangle}$$

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# Predicate Logic

The vocabulary of (first-order) predicate logic consists of the following:

- a set of predicate letters  $P, Q, R$ , etc., each having its own fixed *arity* (e.g. unary symbols, binary symbols, etc).

# Well-formed formulae

The set of wff (aka grammatical sentences) in Predicate Logic is defined recursively as follows:

- If  $P$  is an  $n$ -ary predicate letter and  $t_1, \dots, t_n$  are constant and/or variable symbols, then  $P(t_1, \dots, t_n)$  is a formula in PL.

# Predicates

- One place predicate:  $P(a)$
- Two place predicate:  $P(a, b)$
- Three place predicate:  $P(a, b, c)$

# Reading predicate logic symbols

$P(a)$

- the meaning of  $a$  is an element in the meaning of  $P$
- $[[a]] \in [[P]]$

# Reading predicate logic symbols

$P(a, b)$

- the meaning of ordered set  $\langle a, b \rangle$  is an element in the meaning of  $P$
- $[[\langle a, b \rangle]] \in [[P]]$

# Ternary Branching

Differences between PL syntax and Chomskian syntax



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# Predicate Logic

The vocabulary of (first-order) predicate logic consists of the following:

- the quantifiers  $\forall, \exists$  (“for-all”, and “exists”).

# Well-formed formulae

The set of wff (aka grammatical sentences) in Predicate Logic is defined recursively as follows:

- If  $\phi$  is a formula in PL and  $x$  is a variable symbol, then  $\forall x\phi$  and  $\exists x\phi$  are formulae in PL.

# Universal Quantifiers

“every person is friendly”

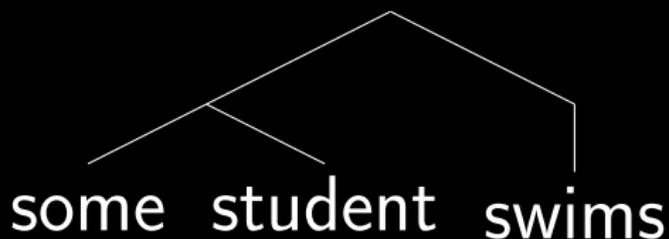
- $\forall x(P(x) \rightarrow F(x))$

# Existential Quantifier

“some student swims”

- $\exists x(P(x) \wedge S(x))$

# Syntactic arrangement differences



# Syntactic arrangement differences

