

# Numeral Semantics — Monday

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[[twelve]]

[[twelve]]

[[Twelve students came to the party]]

# Overview

**Monday:** Theories of numeral semantics

**Tuesday:** Continued

**Wednesday:** Continued

**Thursday:** (Im)precision

**Friday:** Beyond semantics

# Numerals as determiners

**Twelve** students came to the party.

# Numerals as determiners

**Twelve** students came to the party.

**Several** students came to the party.

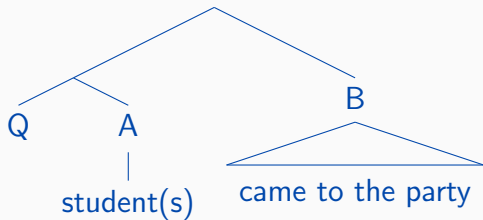
**Some** students came to the party.

**Most** students came to the party.

**No** students came to the party.

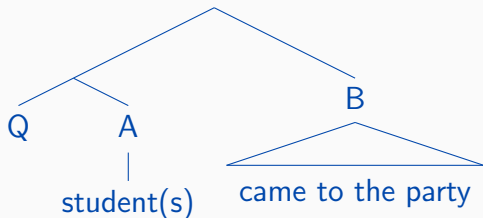
# Generalized Quantifier Theory

Q student(s) came to the party



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every(A)(B) iff  $A \subseteq B$

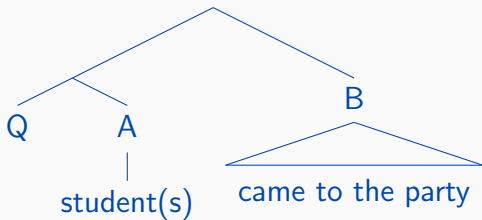
no(A)(B) iff  $A \cap B = \emptyset$

some(A)(B) iff  $A \cap B \neq \emptyset$



# Generalized Quantifier Theory

Q student(s) came to the party



**Big research question:**

Which of these are realised in NL? What properties do all realised quantifiers share?

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Barwise & Cooper, 1980; Keenan & Stavi 1984

# Constraints on quantifiers

QUANT:  $Q(A)(B) \Leftrightarrow Q(F(A))(F(B))$  for any bijection  $F$

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Upshot: only cardinalities ever matter, not the actual content of a set

every(A)(B) iff  $|A \cap B| = |A|$

no(A)(B) iff  $|A \cap B| = 0$

some(A)(B) iff  $|A \cap B| \neq 0$

The ultimate quantifier: twelve(A)(B) iff  $|A \cap B| = 12$

# Numerals are not quantifiers

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- (1) **Twelve** students came to the party.
- (2) **Twelve** people can fit in the lift.

## Numerals are not quantifiers

- (3) **Twelve** of my students built a boat together.
- (4) \***Every** student of mine built a boat together.
- (5) \***Most** of my students built a boat together.

# Numerals are not quantifiers

- (6) In this picture, **twelve** dots surround the triangle.
- (7) ?? In this picture, **every** dot surrounds the triangle.

## Numerals are not quantifiers

(8) This house has **twelve** windows.

(9) \*This house has **every** / **most** window(s).



# Numerals are not quantifiers

(10) The meeting lasted **twelve** hours.

(11) \*The meeting lasted **most** / **every** hour(s).

# Numerals are not quantifiers

(12) The girls in this class are **twelve** of our most promising students.

(13) \*The girls in this class are **all** / **every one** of our most promising students.

# Numerals are not quantifiers

(14) Every **two** houses come with one parking space.

# Numerals are not quantifiers

(15) Rod A is **three** times longer than rod B.

(16) **Two** is a Fibonacci number.

# Three strands of thought

1. the number view

$$\llbracket \text{twelve} \rrbracket = 12$$

2. the modifier view

$$\llbracket \text{twelve} \rrbracket = \lambda x. \#x = 12$$

3. the quantifier view (revisited)

$$\llbracket \text{twelve} \rrbracket = \text{the set of intervals that end in } 12$$

# The number view

`[[twelve]] = 12`      whatever that means

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(16) **Two** is a Fibonacci number.

$\llbracket \text{is a Fibonacci number} \rrbracket = \{0, 1, 2, 3, 5, 8, 13, 21, 34, \dots\}$

# The number view

[[twelve]] = 12      whatever that means

(15') Rod A is longer than rod B.

means: the length of rod A  $>$  the length of rod B

(15) Rod A is **three** times longer than rod B.

means: the length of rod A  $= 3 \times$  the length of rod B



# What could a number be?

Basic semantic ontology:

- Entities; type  $e$
- Truth-values; type  $t$

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- Entities; type  $e$
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We are going to add **degrees** to this picture: type  $d$

- Degrees are like entities, but ordered

John  $<$  Mary      2  $<$  3

- Numbers are a special case of degrees

## What could a degree be?

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John's height  $=$  Mary's height  $+ 2\text{cm}$

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this demonstrates a degree



# What could a degree be?

- We seem to be committed to a domain of abstract entities
- We don't have to be:
  - Cresswell 1977: **tall** involves an ability to decide that  $j < m$
  - We can see degrees as equivalence classes of individuals



# Would could a degree be?



- This is an ordinal scale
- No distances, no zero, no multiplication
- Height etc. would need to be added to the equivalence classes (Bale 2011)
- Back to square one

# The number view: challenges

How does this meaning connect with nouns, to give us sets with particular cardinalities?

- (1) Twelve students came to the party.
- (2) Twelve people can fit in the lift.
- (20) Every two houses come with one parking space.

# The number view: challenges

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## Preview of options:

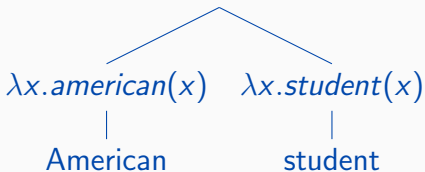
1. Keep this meaning of numerals, add something that connects it with nouns (lecture 2)
2. Assume a different meaning of numerals (in this position)

# The modifier view

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$\llbracket \text{twelve} \rrbracket = \lambda x. \#x = 12$  (the set of groups of cardinality 12)

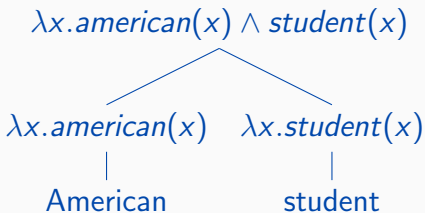
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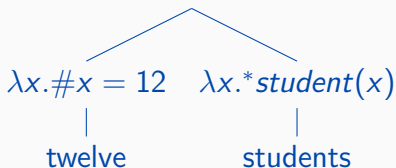
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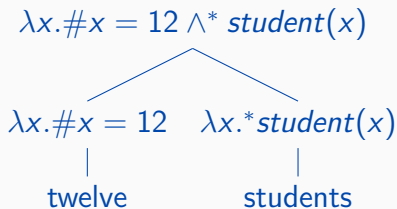




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The numeral expresses cardinality, not quantificational force

# The modifier view

In the absence of a determiner, it's parallel to a bare plural:

- (1) Twelve students came to the party
- (21) American students came to the party

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We will return to this.

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This is not NP ellipsis:

(16') \***Two** are a fibonacci number

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Maybe it's not a problem:

[[is a Fibonacci number]] =

$\{\lambda x. \#x = 1, \lambda x. \#x = 2, \lambda x. \#x = 3, \lambda x. \#x = 5, \dots\}$

# Type landscape

$e$

entity

$\langle e, t \rangle$

property

$\langle \langle e, t \rangle, t \rangle$

quantifier

$\langle \langle e, t \rangle, \langle \langle e, t \rangle, t \rangle \rangle$

quantifier

$d$

degree

$\langle d, t \rangle$

degree property

$\langle \langle d, t \rangle, t \rangle$

degree quantifier

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degree quantifier

See you tomorrow!