Introduction to Semantic Theory
Quantifying expressions I

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Connecting back to the previous lecture

Central result: to account for personal pronouns, we added two parameters to our system, the assignment function g and the context parameter c

- The assignment function g is a function that assigns to each index (= a natural number) an individual. 3rd sg pronouns access g for their interpretation.

  (1) Pronouns Rule (PR):
  If α is a pronoun, then for any assignment g and index i for which g assigns a value: $[\![\alpha_i]\!]^{w,g,c} = g(i)$

- The context parameter c encodes the immediate utterance context and provides information on the current speaker, the addressee, the utterance time, and the utterance location. 1st and 2nd sg pronouns access c.

Aim for today

The aim for today: to introduce quantifying expressions by the examples of nominal quantifiers.

- ⇒ Quantifying expressions can be found "everywhere" in language.
- ⇒ The extensional system that we have built up so far only allows us to deal with nominal quantifiers.
- ⇒ We will see: Nominal quantifying expressions look like other DPs, but cannot be the argument of verbs. They are used to make statements about amounts and quantities of individuals.

What are quantifying expressions?

Quantifying expressions are used to make quantificational statements.

More precisely, they are used when we want to say something about a certain quantity or amount of "things". Which kind of "things" are quantified over depends on the quantifying expression.

What is an example for a quantifying expression in English?

Where do we find quantifying expressions?

Quantifying expressions can be found in nearly all categories: they are frequent in the (pro)nominal, verbal, adjectival, and adverbial categories.

(2) a. *Everyone/someone is happy.*
b. *Peter must sing.*
c. *This is a unique/possible solution.*
d. *Peter is probably/always late.*

Which kinds of “things” do these expressions quantify over?

Some terminology: domain

The domain of a quantifier is the set of "things" that a quantifier quantifies over.

In our extensional system, we can only analyze quantifiers that have the domain of individuals *D* (→ lecture 4) as their quantificational domain – we have not introduced any other kinds of "things" that could be quantified over.

Example: The sentence

(3) *Someone is happy.*

can be analyzed in our extensional system. It can be used to make a quantificational statement about individuals.

What comes next: nominal quantifiers

Nominal quantifiers come in two variants: "atomic" quantifiers as in (4) and composed quantifiers as in (5).

(4)
a. *Everyone likes Mary.*
b. *Someone sneezes.*
c. *No one is unhappy.*

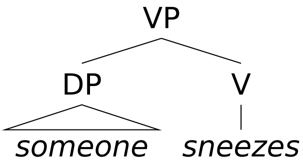
(5)
a. *Every boy likes Mary.*
b. *A boy sneezes.*
c. *No boy is unhappy.*

Plan for today: we will start out with atomic quantifiers and then move on to the composed quantifiers.

The semantic type of atomic nominal quantifiers

To determine the semantic type of quantifiers, we use the general semantic strategy that we have discussed: find a sentence that only contains a nominal quantifier as an unknown expression to derive the type that is needed.

(6) *Someone sneezes.*



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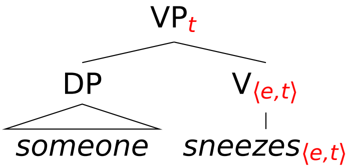

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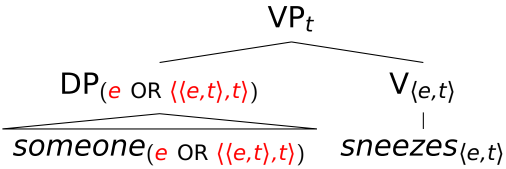


Why is $\langle e, t\rangle$ not an option?

Conceptual considerations – I

We have determined that *someone* could be

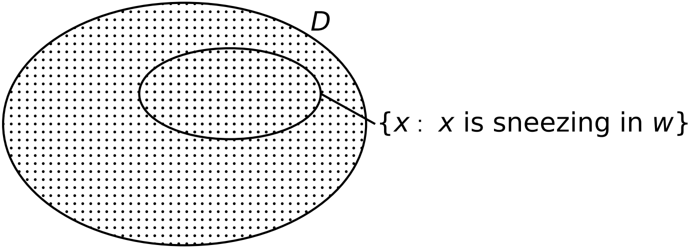
- of type e
- of type $\langle\langle e, t\rangle, t\rangle$

Which type is conceptually more plausible? What do we claim when we use '*someone*, for instance, as in (7)'?

(7) A to B: *Look! Someone is flirting with Mary again!*

Conceptual considerations – II

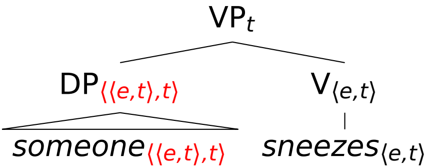
For instance, when we say ‘*someone sneezes*’, we do not state for a specific individual that (s)he sneezes. We claim that the set of sneezing individuals is not empty.



Or in set theoretic terms: $\{x : x \text{ is sneezing in } w\} \cap D \neq \emptyset$

Conceptual considerations – III

Given that we do not make a statement about a specific individual, type *e* becomes implausible.



What is the "semantic behavior" of a lexical element of type $\langle\langle e,t\rangle,t\rangle$? What does such an expression "do"?

Determining the extension of *someone* – I

The type of *someone* is $\langle\langle e,t\rangle,t\rangle$, which fits the quantificational nature of this expression: it takes an expression of type $\langle e,t\rangle$ (a set of individuals) as its input and outputs "true" if the set fulfils a certain requirement and "false" if the set does not fulfil it.

Based on the type, someone takes one argument – an expression of type $\langle e,t\rangle$

(8) $[\![someone]\!]^{w,g,c} = \lambda P_{\langle e,t\rangle}.?$

What does this function check for a given set to determine whether to output "true" or "false"?

Determining the extension of *someone* – II

Informally:

(9) $[\![someone]\!]^{w,g,c} =$
$\lambda P_{\langle e,t \rangle}$. the set corresponding to P in w is not empty

Since we cannot talk about sets (we are using function notation!), we need a different strategy.

(10) $[\![someone]\!]^{w,g,c} =$
$\lambda P_{\langle e,t \rangle}$.there is an individual x such that $P(x) = 1$

Determining the extension of *someone* – III

(11) $[\![someone]\!]^{w,g,c} =$
$\lambda P_{\langle e,t \rangle}$.there is an individual x such that $P(x) = 1$

This extension can be rewritten more formally (= with more symbols) as:

(12) $[\![someone]\!]^{w,g,c} = \lambda P_{\langle e,t \rangle}.\exists x : x \in D[P(x) = 1]$

The symbol '∃' stands for the English expression "there is (at least one)".

This captures the intuition we discussed above, but is this already precise enough?

The lexical restriction of *someone* – I

Consider the following dialogues:

(13) A: *Mary likes someone in this room.*
B: *I know. She likes Peter.*

(14) A: *Mary likes someone in this room.*
B: *I know. #She likes this book.*

Why is the first dialogue okay, but the second dialogue pragmatically odd?

The lexical restriction of *someone* – II

The restriction that *someone* only quantifies over persons/humans is lexically determined. This means that we should encode this restriction directly in the extension.

(15) $[\![someone]\!]^{w,g,c} =$
$$\lambda P_{\langle e,t \rangle}.\exists x : x \in D \;\&\; \text{human'}(x)(w) = 1 \; [P(x) = 1]$$

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The counterpart that quantifies over non-humans:

(16) $[\![something]\!]^{w,g,c} =$
$$\lambda P_{\langle e,t \rangle}.\exists x : x \in D \;\&\; \text{human'}(x)(w) = 0 \; [P(x) = 1]$$

BUT: This proposal is still not precise enough. Why?

Taking a look at *everyone* – I

The inadequacy of the current proposal is hard to see in the case of *someone*. The problem is more obvious when we look at *everyone*.

In analogy to *someone*, we could assign the following extension to *everyone*:

(17) $[\![everyone]\!]^{w,g,c} =$
$\lambda P_{\langle e,t \rangle}.\forall x : x \in D \;\&\; \text{human'}(x)(w) = 1 \; [P(x) = 1]$

The symbol '∀' stands for the English expression "for all".

Why is this extension problematic?

Taking a look at *everyone* – II

To determine the problem, consider the following dialogue:

(18) A: *The students in your class seem to be really smart.*
B: *Yes! Everyone will get an A.*

What does *everyone* quantify over in B's answer according to the given extension?

Taking a look at *everyone* – II

To determine the problem, consider the following dialogue:

(18) A: *The students in your class seem to be really smart.*
B: *Yes! Everyone will get an A.*

What does *everyone* quantify over in B's answer according to the given extension?

Everyone does not quantify over the entire set of people in the world – that is, the quantificational domain is not *D*. The domain is the set of students in B's class.
The quantificational domain for *everyone* (and *someone*) is contextually restricted to some subset of *D*.

Adding the contextually dependent restriction

To capture that *everyone* and *someone* quantify over some contextually given subset C of D:

(19) $[\![\textit{someone}]\!]^{w,g,c} =$
$$\lambda P_{\langle e,t\rangle}.\exists x : x \in C \; \& \; \text{human'}(x)(w) = 1 \; [P(x) = 1]$$

(20) $[\![\textit{everyone}]\!]^{w,g,c} =$
$$\lambda P_{\langle e,t\rangle}.\forall x : x \in C \; \& \; \text{human'}(x)(w) = 1 \; [P(x) = 1]$$

Which subset of D is meant can usually be determined from the discourse context. But: the set of individuals that are meant does not have to be explicitly mentioned.

(21) *Your birthday party will be awesome! Everyone will have so much fun!*

Illustration: ‘*someone sneezes*’

The following illustration shows one set of circumstances in which ‘*someone sneezes*’ is true.

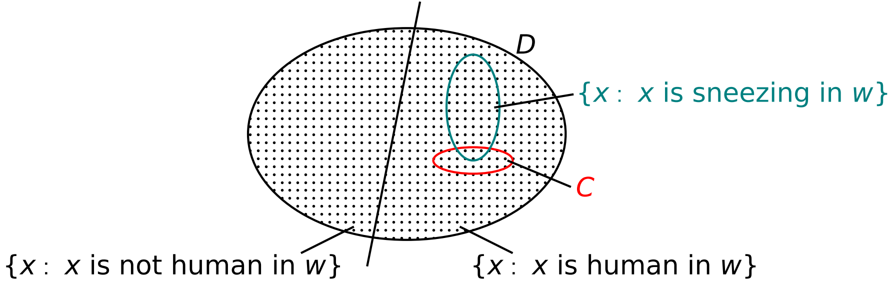
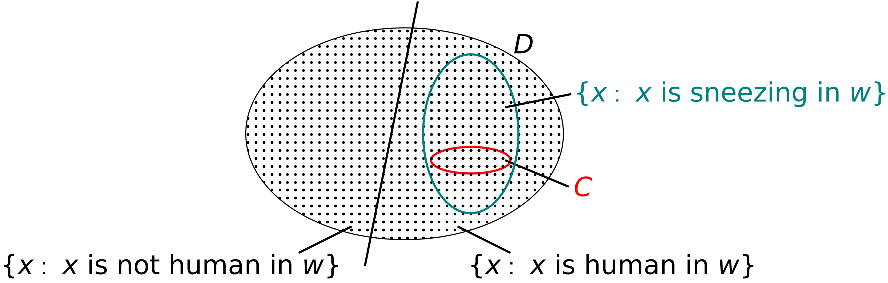


Illustration: ‘*everyone sneezes*’

The following illustration shows one set of circumstances in which ‘*everyone sneezes*’ is true.



Formal generalization – I

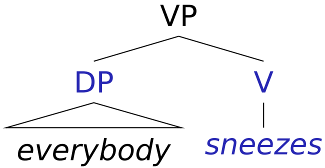
Different atomic quantifiers express different kinds of quantification. More specifically, they express different kinds of relations that need to hold between:

- the contextually restricted domain C
- the set of individuals specified by the lexical restriction
- the scope denoted by the argument of type $\langle e, t\rangle$

The extension of an atomic quantifier specifies how many individuals need to be in the intersection of all three of these sets.

Formal generalization – II

Semantically,“the scope of a quantifier” is the extension of the maximal structural node that the quantifier (= the DP) “has scope over”, i.e., the highest node that it c-commands in the LF.



The DP ‘*everybody*’ c-commands the entire tree below and including the V-node.

Interim summary

The final proposals for the extensions of the atomic quantifiers *someone*, *something*, *everyone*, and *everything* encode a contextual restriction and a lexical restriction.

(22) a. $[\![someone]\!]^{w,g,c} =$
$\lambda P_{\langle e,t\rangle}.\exists x : x \in C \;\&\; \text{human'}(x)(w) = 1 \; [P(x) = 1]$

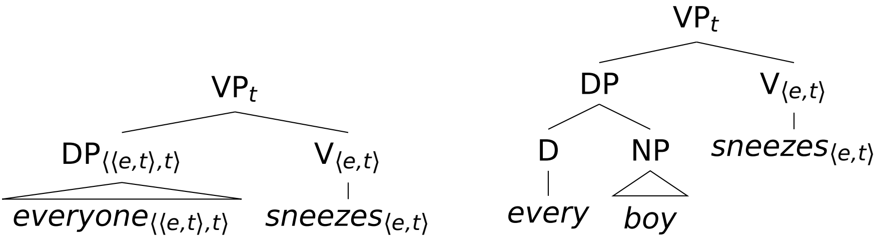
b. $[\![something]\!]^{w,g,c} =$
$\lambda P_{\langle e,t\rangle}.\exists x : x \in C \;\&\; \text{human'}(x)(w) = 0 \; [P(x) = 1]$

(23) a. $[\![everyone]\!]^{w,g,c} =$
$\lambda P_{\langle e,t\rangle}.\forall x : x \in C \;\&\; \text{human'}(x)(w) = 1 \; [P(x) = 1]$

b. $[\![everything]\!]^{w,g,c} =$
$\lambda P_{\langle e,t\rangle}.\forall x : x \in C \;\&\; \text{human'}(x)(w) = 0 \; [P(x) = 1]$

Comparison: atomic vs. composed quantifiers

Consider the following LFs:

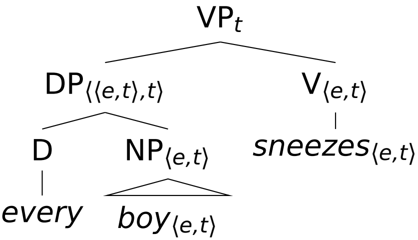


Would it be plausible to assign to the DP ‘*every boy*’ the same semantic type as ‘*everyone*’?

The type of *every* – II

Everyone quantifies over all contextually given people;
‘*every boy*’ quantifies over all contextually given boys.
Hence, it is plausible that ‘*every boy*’ also is of type $\langle\langle e,t\rangle,t\rangle$.

Which type does the quantificational determiner *every* have?



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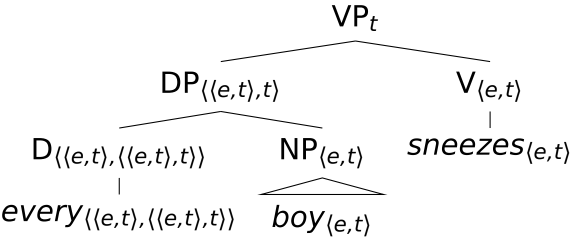
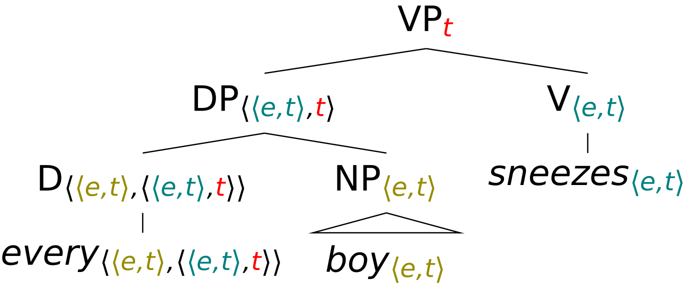


The type of *every* – II

To better see how the parts of this sentence fit together, consider the color coding:



The type of *every* – III

The quantificational determiner *every* takes two expressions of type $\langle e, t\rangle$ (sets of individuals in set notation) as its arguments and outputs a truth value (0 or 1) iff these two arguments stand in a certain, desired relation.

How can we determine which relation this is?

Backwards engineering: extension of *every* – I

We discussed the intuition that *everyone* and '*every boy*' seem to behave similarly – except for the set of entities that they quantify over.

(24) $[\![everyone]\!]^{w,g,c} =$
$\lambda P_{\langle e,t\rangle}.\forall x : x \in C \;\&\; \text{human'}(x)(w) = 1\; [P(x) = 1]$

What do we need to change to get a proposal for the extension of '*every boy*'?

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(25) $[\![every\ boy]\!]^{w,g,c} =$
$\lambda P_{\langle e,t\rangle}.\forall x : x \in C \;\&\; \text{boy'}(x)(w) = 1 \; [P(x) = 1]$

Backwards engineering: extension of *every* – II

(26) $[\![\textit{every boy}]\!]^{w,g,c} =$
$$\lambda P_{\langle e,t \rangle}.\forall x : x \in C \;\&\; \text{boy'}(x)(w) = 1 \; [P(x) = 1]$$

To get to the extension of *every*, we need to use the information that we want '*every boy*' to be the result of combining the function *every* with its argument *boy*.

What do we need to change to get a proposal for the extension of '*every*'?

Backwards engineering: extension of *every* – II

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What do we need to change to get a proposal for the extension of '*every*'?

(27) $[\![\textit{every}]\!]^{w,g,c} =$
$\lambda Q_{\langle e,t\rangle}.\lambda P_{\langle e,t\rangle}.\forall x : x \in C \;\&\; Q(x) = 1\; [P(x) = 1]$

Extending this proposal: *a / some*

As in the case of atomic quantifiers, it is attractive to assume that all quantificational determiners have the same type and their extensions the same general structure.

(28) $[\![\textit{every}]\!]^{w,g,c} =$
$$\lambda Q_{\langle e,t\rangle}.\lambda P_{\langle e,t\rangle}.\forall x : x \in C \;\&\; Q(x) = 1\; [P(x) = 1]$$

For *a* (in non-predicational uses) and *some*, the proposal for their extensions is based on *someone*.

(29) $[\![\textit{a / some}]\!]^{w,g,c} =$
$$\lambda Q_{\langle e,t\rangle}.\lambda P_{\langle e,t\rangle}.\exists x : x \in C \;\&\; Q(x) = 1\; [P(x) = 1]$$

That *a* and *some* have the same contribution is a strong simplification, though!

Illustration: ‘*every boy sneezes*’

The following illustration shows one set of circumstances in which ‘*every boy sneezes*’ is true.

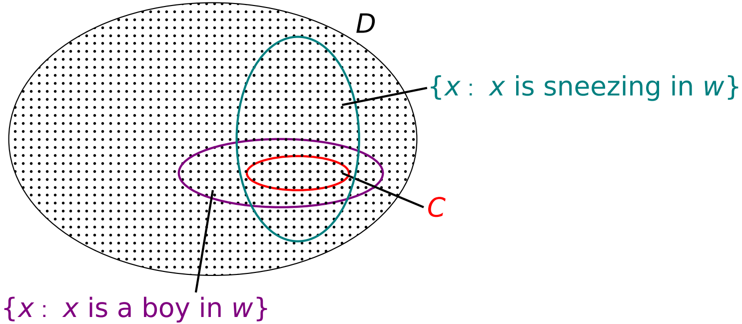
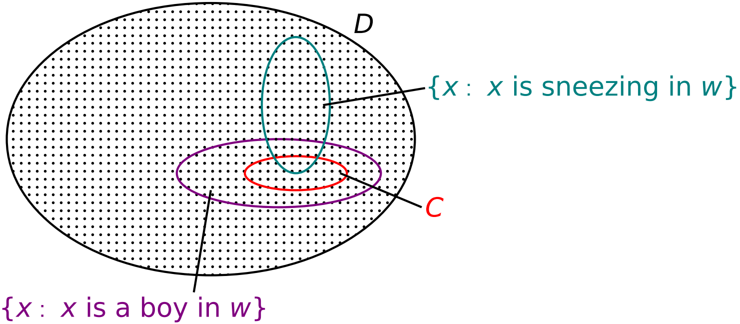


Illustration: ‘*some boy sneezes*’

The following illustration shows one set of circumstances in which ‘*some boy sneezes*’ is true.



Extending this proposal: *most*

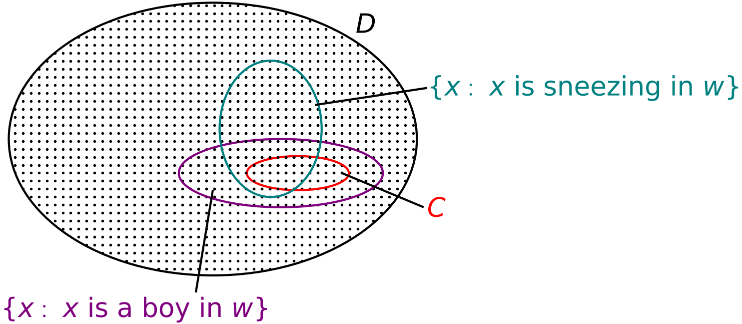
For most of the other quantificational determiners, there is no atomic variant – for instance, for *most*.

The kind of quantification that *most* expresses cannot be formalized with either ∃ or ∀. As a first proposal, we will simply write MOST:

(30) $[\![most]\!]^{w,g,c} =$
$\lambda Q_{\langle e,t\rangle}.\lambda P_{\langle e,t\rangle}.\textbf{MOST}x : x \in C \;\&\; Q(x) = 1\; [P(x) = 1]$

Illustration: ‘*most boys sneeze*’

The following illustration shows one set of circumstances in which ‘*most boys sneeze*’ is true – assuming that *most* means roughly the same as ‘*more than half*’.



Formal generalization

Different quantificational determiners express different kinds of quantification. More specifically, they express different kinds of relations that need to hold between:

- the contextually restricted domain C
- the restrictor denoted by the first argument of type $\langle e, t \rangle$
- the scope denoted by the second argument of type $\langle e, t \rangle$

The extension of a quantificational determiner specifies how many individuals need to be in the intersection of all three of these sets.

Summary

- Quantifying expressions can be found "everywhere" in language.
- The extensional system that we have built so far can only deal with quantifying expressions that quantify over individuals – nominal quantifiers.
- Nominal quantifiers can be atomic or composed from a quantificational determiner and an NP.
- The domain of atomic quantifiers is contextually and lexically restricted.
- The domain of composed quantifiers is contextually restricted – the counterpart of the lexical restriction for atomic quantifiers is given by the first argument of the quantificational determiner.