Quantification

2019.01.20

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Discourse referents (Karttunen 1969)

Automatic Text understanding

A **context** is a set of **discourse referents**. A discourse referent is a kind of peg on which we hang information, one peg for each entity we're talking about. A text may update a context with new dscourse referents or with information about old discourse referents. An indefinite NP tells us to introduce a **new** discourse referent. An definite NP tells us to update an **old** discourse referent.

Example

1. a. Bill has *a car*. b. *It* is black.
   c. *The car* is black.
   d. *Bill's car* is black.
2. Discourse referents are *file cards*, one to an entity:

a.

x
Bill(x)

y
car(y)

b.

x
Bill(x)

y
car(y)
black(y)

d.

x
Bill(x)

y
car(y)
own(x,y)
black(y)

Sentences

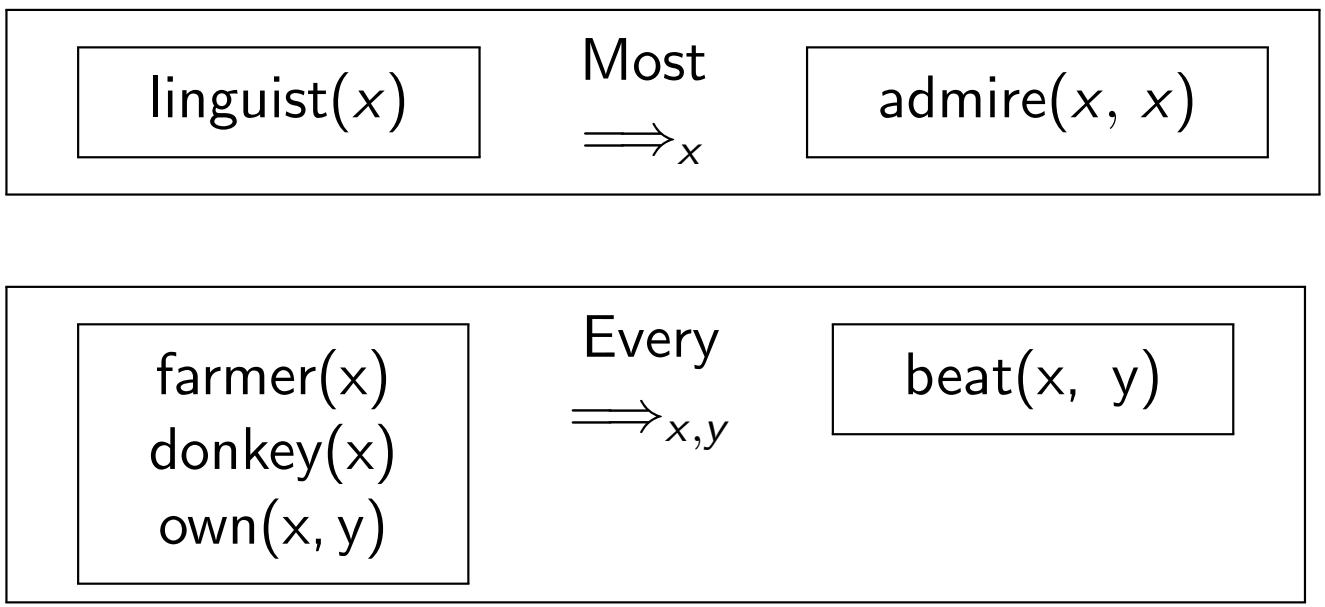
(1)
a. Every one smiled. $\Rightarrow \forall\, x$ [smile(x)]
b. Every linguist smiled/Every linguist admires himself.
c. Most linguists admire themselves.
d. Some linguist smiled. Some linguist did not (smile).
e. No linguist smiled.
f. Chomsky didn't greet every linguist.
g. Every linguist didn't greet Chomsky. (? = No linguist greeted Chomsky.)

(2)
a. A linguist eats chocolates.
b. Dogs must be carried. (Halliday, sign at the foot of an escalator)
c. If a farmer owns a donkey, he beats it.
d. When I go to France, I usually drink wine.

Quantification: temporary discourse referents

(3) a. [Most linguists]$_x$ admire [themselves]$_x$.
b. [Every farmer who owns [a donkey]$_y$]$_x$ beats [it]$_y$.
c. If [a farmer]$_x$ owns [a donkey]$_y$, [he]$_x$ beats [it]$_y$.

Karttunen (1969), Karttunen (1974)



Brief incomplete descriptive list

Quantification constructions

1. Determiners (*every, some, most, few, . . .*)
2. Conditionals (*if-then, when, Wh-ever, . . .*)
3. Adverbs of quantification (*always, usually, . . .*)
4. Generics, bare plurals (*A dog/Dogs has/have four legs . . .*)
5. Modals (*In order to enter, a child must be accompanied by an adult*)

Pragmatics and Quantification

Intereactions: quantificationally introduced contexts seem to have most of the same properties as discourse contexts, and interact with pragmatic requirements on context similarly

1. Every time a musician comes over, we play duets. (Barbara Partee)
2. Every time Trump makes a claim, his staff soon finds themselves scrambling to hedge or retract that claim.
3. Every linguist thinks he/she is a genius.
4. Presuppositions: *If France had a king, the king of France . . .*

Quantification: Restriction and Scope

Dynamic context

The restriction on a quantifier defines a dynamic context.

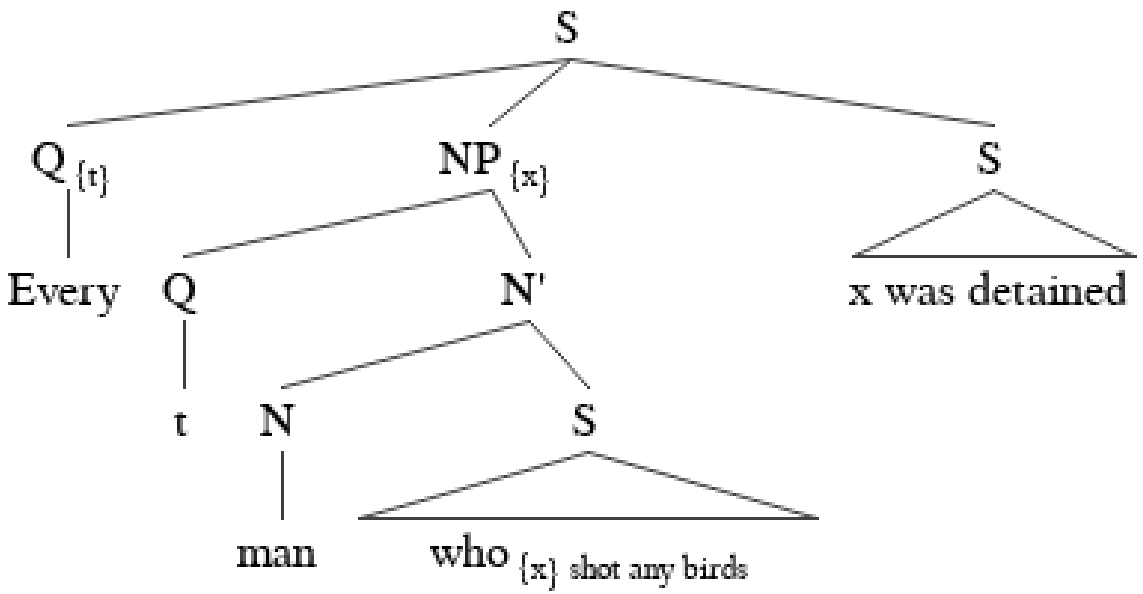
Op	Restriction	Scope
Every	**man who owns a donkey**	beats it.
If	**a man owns a donkey**,	he beats it.

(4) a. If **France had a king**, the king of France would have to love wine.

b. If **Mary went to France**, she would visit the king of France.

Tripartite quantification

(5) [NP Every man who shot any birds] was detained. (compare to *if . . . then*)



Tripartite Structure

Dynamic context

Why **temporary** discourse referents?

Taken as a whole, the sentence

(6) If France had a king, the king of France would have to love wine.

does **not presuppose** there is a unique king of France. Hence, outside the sentence:

(7) If France had a king, the king of France would have to love wine. # Otherwise, he abdicated.

Similarly,

(8) Every farmer who owned [a donkey]$_x$ beat it. # It$_x$ was unhappy.

Conclusions thus far

1. Language has constructions (**quantificational constructions**) which have the power to **temporarily** update the context.
2. During a temporary quantificational update (**inside the scope of the quantifier**), NPs may introduce discourse referents that are only temporarily available for pronouns to refer to.
3. Similarly, presuppositions may be "temporarily" satisfied in the scope of a quantifier.

Does logical scope determine the lifespan of a discourse referent?

1. Inside the scope of a quantifier, a variable takes values **temporarily**.
2. Every farmer who owned [a donkey]$_y$ beat it$_y$. # It$_y$ was unhappy.

$$\forall x[\text{farmer}(x) \,\&\, \text{own}(x, y) \rightarrow \text{beat}(x, y)] \,\&\, \text{unhappy}(y)$$

3. But logical scope does not determine the lifespan of an indefinite!

   (9) A farmer who owned [a donkey]$_x$ beat it. It$_x$ was unhappy.

Two languages for quantification

A quantifier like *every* is a **relation** between sets concisely expressible in the language of **set theory**.

	Every linguist danced.
Logic	$\forall x$ [linguist(x) $\rightarrow$ dance(x)]
Set Theory	$\{x \mid x \in [\![\text{linguist}]\!]\} \subseteq \{y \mid y \in [\![\text{dance}]\!]\}$
Set Theory	$[\![\text{linguist}]\!] \subseteq [\![\text{dance}]\!]$
	Every happy linguist danced.
Logic	$\forall x$ [(linguist(x) & happy(x)) $\rightarrow$ dance(x)]
Set Theory	$\{x \mid x \in [\![\text{linguist}]\!]$ and $x \in [\![\text{happy}]\!]\} \subseteq \{y \mid y \in [\![\text{dance}]\!]\}$
Set Theory	$[\![\text{linguist}]\!] \cap [\![\text{happy}]\!] \subseteq [\![\text{dance}]\!]$

What sets?

1. Every quantifier is a relation between two sets, the set described by the restrictor and the set described by the scope.
2. [[$_{\text{Op}}$ Every] [$_{\text{restrictor}}$ linguist]] [$_{\text{scope}}$ danced]
3. [[$_{\text{Op}}$ Most] [$_{\text{restrictor}}$ linguists attending the party]] [$_{\text{scope}}$ were unaware that Chomsky would attend.]

$[\![\text{linguists attending the party}]\!] =$

$$[\![\text{ linguist }]\!] \cap \{x | \text{ x attended the party}\}$$

Truth definitions in set theory language

Every(A)(B)	$A \subseteq B$
Some(A)(B)	$A \cap B \neq \emptyset$
No(A)(B)	$A \cap B = \emptyset$
Most(A)(B)	$\lvert A \cap B \rvert > \lvert A - B \rvert$

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