Quantifier scope
Chris Potts, Ling 230b: Advanced semantics and pragmatics, Spring 2012
April 10

1 Overview

• This handout uses the problem of quantifiers in non-subject positions as a catalyst for thinking more generally about how to model quantifier scope ambiguities.

• Where possible, I use or extend fragment 1 (April 10 handout).

2 The problem of non-subject quantifiers

In fragment 1, transitive verbs denote sets of pairs of entities, and thus we have no provision for structures like this:

(1)

2.1 Quantifying in

Montague (1973) allows multiple derivations for individual sentences; the rule-by-rule nature of the translation procedure then creates IL representations of the different scope possibilities.

(2) a woman loves every man \( [F_4] \)

\[
\begin{align*}
\forall y [ & \text{woman}'(y) \wedge \\
& \text{love}(\lambda x [\text{man}'(x) \rightarrow [\forall P](x)])](y)] \\
& \wedge x [\text{man}'(x) \rightarrow \\
& \text{love}(\lambda y [\text{woman}'(y) \rightarrow [\forall P](y)])](x)
\end{align*}
\]
2.2 Type shifting

Basically the converse of Montague's (1973) ∗ operator taking \( \langle \langle s, \langle \langle s, e \rangle, t \rangle \rangle, \langle \langle s, e \rangle, t \rangle \rangle \) expressions to \( \langle e, \langle e, t \rangle \rangle \) expressions:

\[
(3) \quad R : \langle e, \langle e, t \rangle \rangle \rightarrow \lambda Q \left( \lambda x \left( \langle e, \langle e, t \rangle \rangle \right) \right) : \langle \langle e, t \rangle, \langle e, t \rangle \rangle
\]

2.3 A new construction rule

We leave the meanings the same but stipulate that there is an additional mode of semantic composition (Barwise and Cooper 1981):

\[
(4) \quad \lambda x \left( \langle e, \langle e, t \rangle \rangle \right) : \langle e, t \rangle
\]

2.4 Quantifier raising

A phrase \( Q \) of type \( \langle \langle e, t \rangle, t \rangle \) can move to adjoin to a node \( N \) that c-commands it and has a denotation of type \( \langle e, t \rangle \), leaving behind a trace of type \( e \). We might impose other conditions, for example, that the node \( N \) involves lambda abstraction over the variable in the original position of \( Q \).

\[
(5) \quad R : \langle e, \langle e, t \rangle \rangle \quad Q : \langle \langle e, t \rangle, t \rangle
\]

2.5 Argument raising

Hendriks (1993) defines very general type-shifting operations that, among other things, map any two-place relation on entities into two different relations on generalized quantifiers. The rules basically build two local operations of QR directly into the meaning of the verb.

\[
(6) \quad R : \langle e, \langle e, t \rangle \rangle \overset{S \rightarrow Q}{\Rightarrow} \lambda P \left( \lambda Q \left( \langle \lambda x \left( \langle R x, y \rangle \right) \rangle \right) \right) : \langle \langle e, t \rangle, \langle \langle e, t \rangle, t \rangle \rangle
\]

\[
(7) \quad R : \langle e, \langle e, t \rangle \rangle \overset{O \rightarrow S}{\Rightarrow} \lambda P \left( \lambda Q \left( \langle \lambda x \left( \langle R x, y \rangle \right) \rangle \right) \right) : \langle \langle e, t \rangle, \langle \langle e, t \rangle, t \rangle \rangle
\]
3 Scope ambiguities

Examples like (8) are often used to motivate scope ambiguities. However, the wide-scope-object reading (8a) unilaterally entails the narrow-scope-object reading (8b). Thus, one might conclude that we need generate only the narrow-scope reading, allowing the wide-scope one to emerge via pragmatic enrichment.

(8) Every man loves a unicorn.

a. \[ \left( \text{every man} \right) \left( \lambda x \ (a \text{ unicorn}) \ (\lambda y \ ((\text{love} \ y) \ x)) \right) \]

b. \[ \left( \text{a unicorn} \right) \left( \lambda y \ (\text{every man}) \ (\lambda x \ ((\text{love} \ y) \ x)) \right) \]

For results concerning entailment relations and scope interactions, see van Benthem (1989), Zimmermann (1993), Westerståhl (1996), Ben-Avi and Winter (2004), Altman et al. (2005), and Peters and Westerståhl (2006:§10). (There is still important work to be done in this area.)

For present purposes, we can rely on the fact that non-monotonic quantifiers like exactly three unicorns ensure that the two scope orderings are independent assuming that the other quantifier is monotonic.

(9) A man loves exactly three unicorns.

a. \[ \left( \text{a man} \right) \left( \lambda x \ (\text{exactly_three unicorn}) \ (\lambda y \ ((\text{love} \ y) \ x)) \right) \]

b. \[ \left( \text{exactly_three unicorn} \right) \left( \lambda y \ (\text{a man}) \ (\lambda x \ ((\text{love} \ y) \ x)) \right) \]

c. \[ \| \text{man} \|_M = \{ a, b, c \} \]

d. \[ \| \text{unicorn} \|_M = \{ u_1, u_2, u_3, u_4 \} \]

e. A model for the surface reading (9a) but not the inverse reading (9b):
\[ \| \text{love} \|_M = \{ \langle a, u_1 \rangle, \langle a, u_2 \rangle, \langle a, u_3 \rangle, \langle b, u_4 \rangle \} \]

f. A model for the inverse reading (9b) but not the surface reading (9a):
\[ \| \text{love} \|_M = \{ \langle a, u_1 \rangle, \langle b, u_2 \rangle, \langle c, u_3 \rangle \} \]
4 QR as a syntactic operation

Hypothesis   QR involves the same movement operation that creates constituent questions, topicalizations, and other long-distance syntactic dependencies.

(10)   a. A man loves every unicorn. $\xrightarrow{QR}$ every unicorn ($\lambda x$ a man loves $t_x$)
   b. Which unicorn does a man love $t_x$?

The present section reviews this hypothesis briefly. For a detailed exploration of the syntactic theories of the 1970s, 1980s, and 1990s, as well as the semantic shortcomings of all of them, see Reinhart 1997:§1 (posted as an optional reading), as well as Ruys 1992, Winter 1997, and Szabolcsi 1997 and the references therein.

4.1 Parallels with syntactic islands

(11)   a. A man who loves every unicorn saw John. $\n\xrightarrow{QR}$ every unicorn ($\lambda x$ a man who loves $t_x$ saw John)
   b. *Which unicorn does a man who loves $t_x$ saw John?

(12)   a. A man will worry if John dates every woman. $\n\xrightarrow{QR}$ every unicorn ($\lambda x$ a man will worry if John dates $t_x$)
   b. *Which woman will a man worry if John dates $t_x$?

Other syntactic islands to check out

(13)   a. *Which woman did John suggest the possibility that Mary saw $t_x$? (complex NLP)
   b. *Which woman did John wish to see Mary and $t_x$? (coordination)
   c. *Which woman did John see Mary, who likes $t_x$? (appositive)

4.2 The parallel breaks down: universals

Universal quantifiers tend to be much more restricted than movement operations. I think the consensus is that they can scope out of infinitival clauses but not out of tensed ones, whereas Wh-movement is routine out of both environments:

(14)   a. Which woman did John want to wish to see $t_x$?
   b. A man wanted to wish to see every woman $\xrightarrow{QR}$ every woman ($\lambda x$ a man wanted to wish to see $t_x$)

(15)   a. Which woman did John believe that Mary saw $t_x$?
   b. A man believed that Mary saw every woman. $\n\n\xrightarrow{QR}$ every woman ($\lambda x$ a man believed that Mary saw $t_x$)
4.3 The parallel breaks down: existentials

Existentials are much, much less restricted than movement operations. I think the consensus is that unmodified indefinites can scope out of any environment, including most syntactic islands.

(16)  
\begin{itemize}
  \item a. Exactly three men will worry if John dates a unicorn.
  \item b. Exactly three men who saw a unicorn dated Mary.
  \item c. Exactly three men saw Mary and a unicorn.
\end{itemize}

Reinhart (1997) includes a thorough review of the various responses to this problem. Syntacticians sought to exempt indefinites from certain movement restrictions; Reinhart shows that this will not deliver the right semantics. There had earlier been attempts to treat wide-scope indefinites as quasi-referential expressions (Fodor and Sag 1982), but such approaches tend to struggle with instances where an indefinites takes exceptional scope but co-varies with an even higher quantifier (intermediate scope cases; Farkas 1981; Kratzer 1998; see also Schwarzschild 2002).

5 Conclusion: strategies for handling scope ambiguities

- Quantifying in and quantifier raising are extremely flexible at present. They can certainly generate every meaning we need and lots of others that we would prefer not to have. The task is to constrain them properly.

- Solutions based on type-shifting have the opposite problem: they can handle clausemate subject/object interactions, but they need to be generalized to handle multi-clause cases.

- Reinhart’s (1997) proposal is essentially that QR is right for non-existential quantifiers, but that existential ones are to be modeled as choice functions — extensionally,

\[ \|a_i\|_M = \text{the function } CH \text{ such that } CH(f) \text{ is the } i\text{th entity } d \text{ such that } f(d) = T \]

This idea proved extremely influential. Here’s a sample of earlier references and recent compendiums with extensive bibliographies: Ruys 1992; Winter 1997; Kratzer 1998; Matthewson 1999; von Fintel and Matthewson 2008; Chung and Ladusaw 2004; von Heusinger 2004; Schwarz 2011.
References


Farkas, Donka F. 1981. Quantifier scope and syntactic islands. In Roberta Hendrick; Carrie Masek; and Mary Frances Miller, eds., *Proceedings of the 17th Chicago Linguistic Society*, 59–66. Chicago, IL: CLS.


