Romero & Novel 2013: Variable Binding and Sets of Alternatives

Overview

- Combining a Predicate Abstraction (PA) rule with sets of alternatives leads to problems. In particular, we either end up with too many alternatives; or can't bind into an alternative generator (Shan 2004).
- Both problems can be circumvented if we use assignment-sensitive denotations *and* treat *wh*-phrases as definite descriptions (following Rullmann & Beck 1998).

Sketch of problems

(1) Denotation schema using assignments (and ignoring alternatives):
a. For all g, $[[\alpha]]^{M,g} = \pi$
b. $[[\alpha]]^{M} = \lambda g_a\, \pi_\tau$

(2) Denotation schema using sets of alternatives (ignoring g):
$[[\alpha_{ALT}]]^{M} = \{\pi, \pi_1, \pi_2\}$

(3) a. OPTION A: $[[\alpha_{ALT}]]^{M} = \lambda g.\{\pi, \pi_1, \pi_2\}$
b. OPTION B: $[[\alpha_{ALT}]]^{M} = \{\lambda g.\pi, \lambda g.\pi_1, \lambda g.\pi_2\}$

(4) a. Problem 1: OPTION A + PA rule → overgenerates alternatives

b. Problem 2: OPTION B + PA rule → desired set of alternatives; can't bind into a *wh*-phrase
(e.g. *which man$_i$ sold which of his$_i$ paintings?*)

Problem 1

(5) a. Who saw nobody?
b. LF: nobody λ_i [who saw t_i]
c. $[[t_i]]^{M,g} = \{g(i)\}$
d. $[[saw]]^{M,g} = \{\lambda x \lambda y.\ y \text{ saw } x\}$
e. $[[saw\ t_i]]^{M,g} = \{\lambda y.\ y \text{ saw } g(i)\}$
f. $[[who]]^{M,g} = \{\text{Alice, Barb, Carol}\}$
g. $[[who\ saw\ t_i]]^{M,g} = \{\text{Alice saw } g(i), \text{Barb saw } g(i), \text{Carol saw } g(i)\}$
h. Naïve PA rule: $[[\lambda i\ who\ saw\ t_i]]^{M,g} = \lambda x.\{\text{Alice saw } g^{x/i}(i), \text{ Barb saw } g^{x/i}(i), \text{ Carol saw } g^{x/i}(i)\}$
g. $[[nobody]]^{M,g} = \{\lambda Q_{e\to t}.\neg\exists x[Qx]\}$

- Applying the naïve rule yields a function from individuals to sets – type: $e \to (t \to t)$
- But $[[nobody]]^{M,g}$ is of type $(e \to t) \to t \to t$, which means that we can't apply $[[nobody]]^{M,g}$ to the result of PA.
- So we want the result of to PA be a set of functions (i.e. of type $(e \to t) \to t$) as opposed to a function into sets.
- But if we invoke a type shifting rule to get the right type, we end up with too many alternatives.

(6) Function into sets:

$$\left\{\begin{bmatrix} x_1 \to \text{Alice saw } x_1 \\ x_2 \to \text{Alice saw } x_2 \\ x_3 \to \text{Alice saw } x_3 \end{bmatrix} \begin{bmatrix} x_1 \to \text{Barb saw } x_1 \\ x_2 \to \text{Barb saw } x_2 \\ x_3 \to \text{Barb saw } x_3 \end{bmatrix} \begin{bmatrix} x_1 \to \text{Carol saw } x_1 \\ x_2 \to \text{Carol saw } x_2 \\ x_3 \to \text{Carol saw } x_3 \end{bmatrix}\right\}$$

(7) Sets of functions: $$\left\{\begin{bmatrix} x_1 \to \text{Alice saw } x_1 \\ x_2 \to \text{Barb saw } x_2 \\ x_3 \to \text{Carol saw } x_3 \end{bmatrix} \begin{bmatrix} x_1 \to \text{Barb saw } x_1 \\ x_2 \to \text{Carol saw } x_2 \\ x_3 \to \text{Alice saw } x_3 \end{bmatrix} [\ldots]\right\}$$

- The set in (6) consists of uniform properties only, *viz. to be seen Alice; to be seen by Barb; to be seen by Carol.*
- The set in (7), on the other hand, consists of both uniform and non-uniform properties – too many alternatives!
- Bad functional readings: Assume Alice is x_1*'s* mom, Barb is x_2*'s* mom, and Carol is x_3*'s* mom, then we wrongly predict the following QA-pair to be felicitous: Q: *Who saw nobody?* A: #His$_i$ mom saw nobody$_i$
- Bad pair-list readings: Suppose x_1 is Xavier, x_2 is Yves, and x_3 is Zack, then we also wrongly predict Q: *Who saw nobody?* A: *# Alice didn't see X, Barb didn't see Y, and Carol didn't see Z.*

Solution to Problem 1

- Instead of treating the assignment function as a parameter of ⟦·⟧, we treat the assignment as part of the denotation.

  E.g. $t_1 :: a \to e$ *saw* $:: a \to e \to e \to t$ Assignment-sensitive PA-rule (Poesio 1996)

  $$\begin{bmatrix} g_1 \to g_1(i) \\ g_2 \to g_2(i) \\ g_3 \to g_3(i) \end{bmatrix} \quad \begin{bmatrix} g_1 \to \lambda x \lambda y.\, y \text{ saw } x \\ g_2 \to \lambda x \lambda y.\, y \text{ saw } x \\ g_3 \to \lambda x \lambda y.\, y \text{ saw } x \end{bmatrix} \quad [[\lambda i \beta_{\,a\to\tau\to t}]]^{M} = \{\lambda g \lambda x. f(g^{x/i}) : f \in [[\beta]]^{M}\}$$

(8) a. Who saw nobody?   b. LF: nobody λ_i [who saw t_i]

c. $[[t_i]]^{M,g} = \{\lambda g. g(i)\}$

d. $[[\mathit{saw}]]^{M,g} = \{\lambda g \lambda x \lambda y.\, y \text{ saw } x\}$

e. $[[\mathit{saw}\ t_i]]^{M,g} = \{\lambda g \lambda y.\, y \text{ saw } g(i)\}$

f. $[[\mathit{who}]]^{M,g} = \{\lambda g.\text{Alice}, \lambda g.\text{Barb}, \lambda g.\text{Carol}\}$

g. $[[\mathit{who\ saw}\ t_i]]^{M,g} = \{\lambda g.\text{Alice saw } g(i), \lambda g.\text{Barbara saw } g(i), \lambda g.\text{Carol saw } g(i)\}$

h. $[[\lambda i\ \mathit{who\ saw}\ t_i]]^{M,g} = \{\lambda g \lambda x.\text{Alice saw } x, \lambda g \lambda x.\text{Barbara saw } x, \lambda g \lambda x.\text{Carol saw } x\}$

i. $[[\mathit{nobody}]]^{M,g} = \{\lambda g \lambda Q_{e\to t}.\neg \exists x[Qx]\}$

j. $[[\mathit{nobody}\ \lambda i\ \mathit{who\ saw}\ t_i]]^{M,g} = \{\lambda g.\neg \exists x \text{Alice saw } x, \lambda g.\neg \exists x.\text{Barbara saw } x, \lambda g.\neg \exists x \text{ Carol saw } x\}$

→ No unwanted functional or pair-list readings.

Problem 2

- So the assignment-sensitive PA-rule allows [[λ*i*...]] to be of type $(e \rightarrow t) \rightarrow t$, which is what we need for solving Problem 1.
- But there are cases where we actually want [[λ*i*...]] to be of type $e \rightarrow (t \rightarrow t)$.

(9) a. Which man [λi t_i sold which of his$_i$ paintings]

b. $\lambda x. \{x \text{ sold } y : y \text{ is a painting of } x\}$

Solution to Problem 2

- Following Beck & Rullmann 1998, treat *wh*-phrases as definite descriptions.

(10) a. $[[\textit{which man}]]^M = \{\lambda g.\ x \in \mathcal{D}_e \wedge \textit{man}(x)\} =_{e.g.} \{\lambda g.\text{Kandinsky}, \lambda g.\text{Magritte}\}$

b. $[[\textit{which man}]]^M = \{\lambda g.\ \iota x[\textit{man}(x) \wedge x = y]: y \in \mathcal{D}_e\}$

$=_{e.g.} \{\lambda g.\iota x[\textit{man}(x) \wedge x = \text{Kandinsky}], \lambda g.\ \iota x[\textit{man}(x) \wedge x = \text{Magritte}]\}$

c. $[[\text{which of his}_i \text{ paintings}]]^M = \{\lambda g.\ \iota v[\textit{painting-of}(v, g(i)) \wedge v = z]: z \in \mathcal{D}_e\}$ (set of partial functions)

(11) a. $[[\lambda i\ t_i \text{ sold which of his}_i \text{ paintings}]]^M = \{\lambda g.\lambda x.x \text{ sold } \iota v[\textit{painting-of}(v, x) \wedge v = \text{SM}],$

$\lambda g.\lambda x.x \text{ sold } \iota v[\textit{painting-of}(v, x) \wedge v = \text{BR}]\}$

b. $[[\textit{which man}\ \lambda i\ t_i \text{ sold which of his}_i \text{ paintings}]]^M$

$= \{\#\lambda g.\iota x[\textit{man}(x) \wedge x = \text{Kandinsky}] \text{ sold } \iota v[\textit{painting-of}(v, \iota x[\textit{man}(x) \wedge x = \text{Kandinsky}]) \wedge v = \text{SM}],$

$\lambda g.\iota x[\textit{man}(x) \wedge x = \text{Kandinsky}] \text{ sold } \iota v[\textit{painting-of}(v, \iota x[\textit{man}(x) \wedge x = \text{Kandinsky}]) \wedge v = \text{BR}],$

$\lambda g.\iota x[\textit{man}(x) \wedge x = \text{Magritte}] \text{ sold } \iota v[\textit{painting-of}(v, \iota x[\textit{man}(x) \wedge x = \text{Magritte}]) \wedge v = \text{SM}],$

$\#\ \lambda g.\iota x[\textit{man}(x) \wedge x = \text{Magritte}] \text{ sold } \iota v[\textit{painting-of}(v, \iota x[\textit{man}(x) \wedge x = \text{Magritte}]) \wedge v = \text{BR}]\}$

→ So for any painter *x*, a felicitous response to (9a) involves choosing among *x's* paintings.

References

Romero, Maribel & Marc Novel. 2013. Variable binding and sets of alternatives. In A. Falaus (ed.) *Alternatives in Semantics.* Palgrave.