Rigid and flexible quantification in Plural Predicate Logic

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Research questions

- Why do indefinite/cardinal NPs behave uniformly as if quantized under *all*, *for*-adverbials, etc.?
- How does *every* restore covariation in these scopal environments?

Take-home messages

- Indefinite/cardinal NPs involve **rigid** quantification while bare NPs involve **flexible** quantification
- Rigidity leads to quantization-like behavior and lack of covariation
- *Every* involves distributivity that breaks up a quantificational context
- We model this behavior in **Plural Predicate Logic**, a novel generalization of PrL that works with sets of assignment functions

Data: bare vs quantificational NPs

Bare nouns are compatible with *for*:

(1) John ate **apples** for 1hr.

Numerals and other NPs cause deviance:

(2) #John ate **some/three apples** for 1hr.

(3) #He found **a flea** on his dog for a year

Similarly for spatial adverbials and indefinite quantity adverbials:

(4) **Trees/#some trees** grow for miles.

(5) He read **poetry/#something** a lot.

Habitual interpretations preferred with bare NPs:

(6) Li wrote **copy/an article** for NYTimes.

Every restores the ability to covary (a problem for standard wide scope story):

(7) He found **a flea** on his dog **every day** for a year.

Rigidity in Plural Predicate Logic (PPL)

- Inspired by Dynamic Plural Logic (DPlL, Brasoveanu 2008, 2010; Henderson 2014) and Team Logic (Väänänen 2007, Dotlačil 2011), we propose **Plural Predicate Logic (PPL)** to formalize rigid vs. non-rigid quantification.
- In PPL, formulas are evaluated w.r.t. **sets of assignments**, or quantificational contexts ($G = \{g_1, \dots g_n\}$). PPL is **static**: only 1 set of assignments per formula.

(8) a. $g[x]h$:= for any variable v if $v \neq x$, then $h(v) = g(v)$

b. $G[x]H := \forall g \in G\ \exists h \in H$ s.t. $g[x]h$ and $\forall h \in H\ \exists g \in G$ s.t. $g[x]h$

c. $G[x!]H := G[x]H$ and $h(x) = h'(x)$ for any $h, h' \in H$.

- Flexible existential quantifiers: bare NPs

(9) $[\![\exists^{flex} x\ [\varphi](\psi)]\!]^G = [\![\varphi \wedge \psi]\!]^H$ for some H s.t. $G[x]H$

- Rigid existential quantifiers: indefinite/cardinal NPs

(10) $[\![\exists^{rigid} x\ [\varphi](\psi)]\!]^G = [\![\varphi \wedge \psi]\!]^H$ for some H s.t. $G[x!]H$

A case study: *for*-adverbials

Fragment

for an hour(φ)	$\exists^{rigid}$ t [**hours**(t)=1] ($\exists^{flex}$ t' [t' < t $\wedge$ t' $=_\oplus$ t] (φ)), where $[\![x =_\oplus y]\!]^G$ iff $\oplus\{g(x) : g \in G\} = \oplus\{g(y) : g \in G\}$ ($\oplus$ is mereological sum, < mereological proper parthood)
[$_{DP}$ $\varnothing^x$ apples] (φ)	$\exists^{flex}$ x [*__apple__(x)] (φ)
[$_{DP}$ two^x apples] (φ)	$\exists^{rigid}$ x [*__apple__(x) $\wedge$ |x|=2] (φ)

(11) John ate apples for an hour.

$\exists^{rigid}$ *t* [**hours**(*t*)=1] ($\exists^{flex}$ t' [t' < t $\wedge$ t' $=_\oplus$ t] ($\exists^{flex}$ *x* [*__apple__(*x*)] ($\exists^{rigid}$ *y* [*y* = **j**] (***eat** (*x*, *y*, *t'*)))))

H	t	t'	x
h1	8am-9am	8-8:20	🍎$_1$
h2	8am-9am	8:20-8:40	🍎$_2$ ⊕ 🍎$_3$
h3	8am-9am	8:40-9	🍎$_4$ ⊕ 🍎$_5$

(12) *John ate two apples for an hour.

$\exists^{rigid}$ *t* [**hours**(*t*)=1] ($\exists^{flex}$ t' [t' < t $\wedge$ t' $=_\oplus$ t] ($\exists^{rigid}$ *x* [*__apple__(*x*) $\wedge$ \|*x*\|=2] ($\exists^{rigid}$ *x* [*x* = **j**] (***eat** (*x*, *y*, *t'*)))))

H	t	t'	x
h1	8am-9am	8-8:20	🍎$_1$ ⊕ 🍎$_2$
h2	8am-9am	8:20-8:40	🍎$_1$ ⊕ 🍎$_2$
h3	8am-9am	8:40-9	🍎$_1$ ⊕ 🍎$_2$

Adding distributivity

- As in DPlL, we analyze *every N* as launching a separate quantificational context for each *N*.

(13) [every^x N] V ⇝ **M***x* [N(*x*)] (**D**(V(*x*)))

- Maximalization operator **M**

(14) $[\![$**M**x $[\varphi]\ (\psi)]\!]^G$ iff $[\![\varphi \wedge \psi]\!]^H$ for H s.t. G[x]H and there is no H' s.t. G[x]H' where $[\![\varphi]\!]^{H'}$ and H'(x) ⊊ H(x)

- Distributive operator **D**

(15) $[\![$**D**$(\varphi)]\!]^G$ iff $[\![\varphi]\!]^{G_{x=a}}$ for each a s.t. ∃g ∈ G. g(x) = a

where $G_{x=a}$:= { g ∈ G : g(x) = a }

- Example:

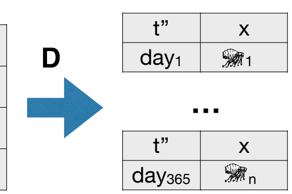
(16) John found a flea on his dog every day for a year.

$\exists^{rigid}$ *t* [**years**(*t*)=1] ($\exists^{flex}$ t' [t' < t $\wedge$ t' $=_\oplus$ t]

(**M** *t''* [**days**(*t''*)=1 $\wedge$ t''∩t ≠ ∅] (**D** *t''* ($\exists^{rigid}$ *y* [*y* = **j**] (

$\exists^{rigid}$ *x* [**flea**(*x*) $\wedge$ **on-j's-dog**(x)] (***find**(*x, y, t''*)))))))

H	t	t''
h$_1$	2016	day$_1$ ⊕ … ⊕ day$_{365}$
h$_2$	2016	day$_1$ ⊕ … ⊕ day$_{365}$
h$_3$	2016	day$_1$ ⊕ … ⊕ day$_{365}$



Compare Zucchi & White (2001), who stipulate that *every day* binds either the individual variable of *a flea* or a reference time variable introduced by *a flea*.

Outlook: application to *all*

Bare vs quantificational NPs pattern similarly with *all:*

(17) All the guests are (**#ten / #several**) **French**.

- All can be seen as an "unfurler" that spreads its host's plural entity throughout a quantificational context.

References

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