Generalized Quantifiers in Categorial Grammar

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□ 1. Quantifier Scope (QS) in Natural Language

"Quantifiers in natural logic can take scope wider than where they occur overtly." (Generative Grammar Approach) [Reinhart]

"Quantifiers can remain *in situ* yet take semantic scope around an arbitrary amount of surranding material." (Type Logic Approach) [Carpenter]

1. (Existensial Presuppositions)

   John *wants* to marry *a canadian princess*.

2. (Distributivity)

   Every boy read *two books*;

3. (Negation)

   John *didn't* marry *a canadian princess*.

4. (Predicate Bridge)

   Nobody think *anybody* left.

□ 2. QS in Generative Grammar (I)

The Uniformity of QS Assignment. (May 1977)

a. Quantifier Phrases (QPs) are raised by Quantifier Raising (QR) from surface positions into appropriate positions at Logical Form (LF).

b. QR applies *uniformly* to all QPs. Neither QR nor any particular QP is landing-site selective.

The Standard Theory of QS. (Reinhart 1995 ?)

a. Quantifier scope is determined by *c-command* relations holding at the level of LF;

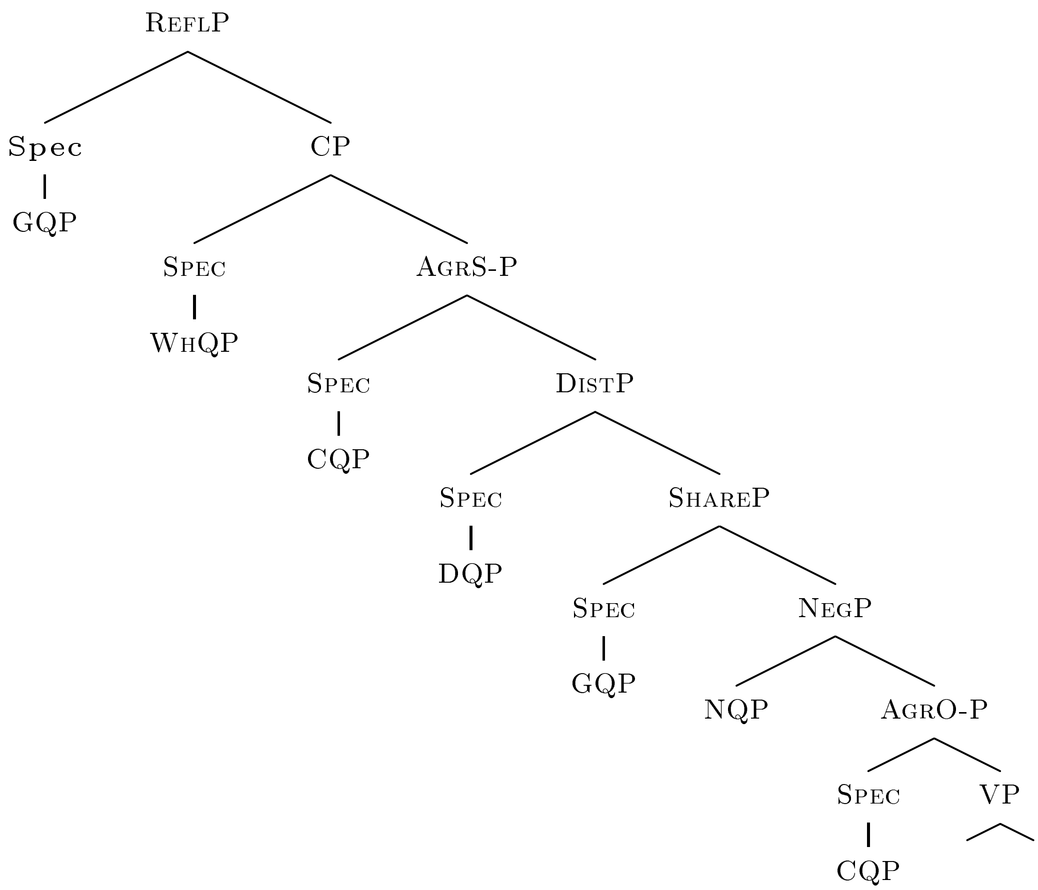
b. QPs are assigned scope by undergoing *movement* to their scope positions in the derivation of the LF representations.

□ 3. QS in Generative Grammar (II).

Checking Theory of Scope Assignment. (Beghelli and Stowell 1997)

a. QPs show *different* scope possibilities: Certain QPs may take scope in their Case positions (i.e. remain in situ at LF) vs. others must move to distinct LF scope position reserved for them.

b. Scope is the by product of *agreement* processes: Memembership in any of the QP-types is indicated by a number of syntactic properties encoded in the determiner position, e.g. negative quantifers ("nobody") bear a feature [+Neg].



□ 4. QS in Categorial Grammar (CG) (I).

CG is a *monostratal* Grammar. We need an *in situ* binding operation to account for the scope possibilities of GQs.

In [Moortgat 91] a GQ is assigned the type $q(np, s, s)$: It acts locally like a noun phrase but takes scope semantically at a higher sentential level.

The scoping constructor q is intended to provide the *full set* of combinatorially possible scope relations in a multiple quantifier context — it could be seen as the deductive version of May's (1977) Scope Uniformity thesis.

In [Bernardi-Moot 00] it is given a categorial account of the *different* possibilities of QPs with respect to negation, following Beghelli and Stowell Theory.

In [Areces-Bernardi-Moortgat ?] the logic system used in [Bernardi-Moot 00] has been extended with new operators which allow to properly treat *polarity items* phenomena as well.

□ 5. Scope Ambiguity [Moortgat 91] (I).

[a] $\neg GQ_{obj}$

$$
\dfrac{\dfrac{\dfrac{np \vdash np \qquad \dfrac{np \vdash np \qquad \boxed{s \vdash s}}{np \bullet np\backslash s \vdash s}[\backslash L]}{np \bullet ((np\backslash s)/np \bullet np) \vdash s}[/L] \qquad \boxed{s \vdash s}}{np \bullet ((np\backslash s)/np \bullet \boxed{q(np,s,s)}) \vdash s}[qL]}{(np\backslash s)/np \bullet q(np,s,s) \vdash np\backslash s}[\backslash R] \qquad np\backslash s \vdash np\backslash s}{\underbrace{np}_{\text{John}} \bullet (\underbrace{((np\backslash s)/(np\backslash s)}_{\text{didn't}} \bullet (\underbrace{(np\backslash s)/np}_{\text{marry}} \bullet \underbrace{q(np,s,s)}_{\text{quant}})) \vdash s}[/L]
$$

[b] $GQ_{obj}\neg$

$$
\dfrac{\dfrac{np \vdash np \qquad \dfrac{np\backslash s \vdash np\backslash s \qquad \dfrac{np \vdash np \qquad \boxed{s \vdash s}}{np \bullet np\backslash s \vdash s}[\backslash R]}{np \bullet (np\backslash s)/(np\backslash s) \bullet np\backslash s \vdash s}[/L]}{np \bullet ((np\backslash s)/(np\backslash s) \bullet ((np\backslash s)/np \bullet np)) \vdash s}[/L] \qquad \boxed{s \vdash s}}{\underbrace{np}_{\text{John}} \bullet (\underbrace{(np\backslash s)/(np\backslash s)}_{\text{didn't}} \bullet (\underbrace{(np\backslash s)/np}_{\text{marry}} \bullet \underbrace{\boxed{q(np,s,s)}}_{\text{quant}})) \vdash s}[qL]
$$

□ 6. Scope Ambiguity [Moortgat 91] (II).

$$
\neg GQ_{sub} \qquad
\dfrac{np\backslash s \vdash np\backslash s \qquad
\dfrac{\dfrac{\dfrac{\dfrac{np \vdash np \qquad \boxed{s \vdash s}}{np \bullet np\backslash s \vdash s}\;[\backslash L] \qquad s \vdash s}{q(np,s,s) \bullet np\backslash s \vdash s}\;[qL]}{q(np,s,s) \vdash s/(np\backslash s)}\;[/R] \qquad s \vdash s}{q(np,s,s) \bullet ((s/(np\backslash s))\backslash s \vdash s}\;[\backslash L]}
{\underbrace{q(np,s,s)}_{\text{quant.}} \bullet (\underbrace{((s/(np\backslash s))\backslash s)/(np\backslash s)}_{didn't} \bullet \underbrace{np\backslash s}_{\text{study}}) \vdash s}\;[\backslash L]
$$

$$
GQ_{sub}\neg \qquad
\dfrac{\dfrac{np\backslash s \vdash np\backslash s \qquad \dfrac{\begin{matrix}\vdots \\ np \vdash s/(np\backslash s)\end{matrix} \qquad s \vdash s}{np \bullet (s/(np\backslash s)\backslash s \vdash s}\;[\backslash L]}{np \bullet (((s/(np\backslash s))\backslash s)/np\backslash s \bullet np\backslash s) \vdash s}\;[\backslash L] \qquad \boxed{s \vdash s}}
{\underbrace{q(np,s,s)}_{\text{quant.}} \bullet (\underbrace{((s/(np\backslash s))\backslash s)/(np\backslash s)}_{didn't} \bullet \underbrace{np\backslash s}_{\text{study}}) \vdash s}\;[qL]
$$

□ 7. Data.

1. John didn't marry *a canadian princess*
   a.) There exists a canadian princess who John didn't married. $\exists\neg$.
   b.) It is not the case that John married a canadian princess. $\neg\exists$.
2. John didn't marry *any canadian princess*
   b.) It is not the case that John married a canadian princess. $\neg\exists$.
3. John didn't marry *some canadian princess*
   a.) There exist some canadian princess who John didn't married. $\exists\neg$.
4. *Every student* didn't study.
   a.) For all student it is the case that they didn't study. $\forall\neg$.
   b.) It is not the case that all students studied. $\neg\forall$.
5. *A student* didn't study.
   a.) There is a student who didn't study. $\exists\neg$.
6. **Anybody* left.
7. *Somebody* left.

□ 8. Subcategorization.[Bernardi-Moot 00] [Areces-Bernardi-Moortgat ?]

$$[\mathrm{RES}] \quad \Diamond\Box^{\downarrow}s \quad \vdash \quad s \quad \vdash \quad \Box^{\downarrow}\Diamond s$$

$$[\mathrm{GC}] \quad s \quad \vdash \quad ({}^{0}s)^{0}$$

$$[\mathrm{GC}] \quad s \quad \vdash \quad {}^{0}(s^{0})$$

didn't : $((\Diamond\Box^{\downarrow}s/np)\backslash\Diamond\Box^{\downarrow}s)\backslash s/(np\backslash({}^{0}s)^{0})$

anybody : $q(np, ({}^{0}s)^{0}, ({}^{0}s)^{0})$

somebody : $q(np, \Box^{\downarrow}\Diamond s, \Box^{\downarrow}\Diamond s)$

everybody : $q(np, \Box^{\downarrow}\Diamond s, \Diamond\Box^{\downarrow}s)$

Sentence : $\Box^{\downarrow}\Diamond s$

$$\dfrac{\dfrac{np \vdash np \qquad \boxed{s \vdash s_2}}{np \bullet np\backslash s \vdash s_2}[\backslash\mathrm{L}] \qquad \boxed{s_1 \vdash \Box^{\downarrow}\Diamond s}}{\underbrace{q(np, s_2, s_1)}_{\text{quant.}} \bullet \underbrace{np\backslash s}_{\text{left}} \vdash \Box^{\downarrow}\Diamond s}[\mathrm{q}]$$

□ 9. Polarity Items (I)

$$
\dfrac{
\dfrac{
\dfrac{
\dfrac{np \vdash np \qquad \dfrac{np \vdash np \quad \boxed{s \vdash s_1}}{np \bullet np\backslash s \vdash s_1}\,(\backslash L)}{np \bullet ((np\backslash s)/np \bullet np) \vdash s_1}\,(/L)
\qquad \boxed{s_2 \vdash ({}^0 s)^0}
}{np \bullet ((np\backslash s)/np \bullet \boxed{q(np, s_1, s_2)}) \vdash ({}^0 s)^0}\,(qL)
}{(np\backslash s)/np \bullet q(np, s_1, s_2) \vdash np\backslash({}^0 s)^0}\,(\backslash R)
\qquad
\dfrac{np \vdash s/(np\backslash s) \quad s \vdash \Box^{\downarrow}\Diamond s}{np \bullet (s/(np\backslash s))\backslash s \vdash \Box^{\downarrow}\Diamond s}\,(\backslash L)
}{\underbrace{np}_{\text{subject}} \bullet (\underbrace{((s/(np\backslash s))\backslash s)/(np\backslash({}^0 s)^0)}_{\text{negation}} \bullet (\underbrace{(np\backslash s)/np}_{\text{trans. verb}} \bullet \underbrace{q(np, s_1, s_2)}_{\text{gen. quantifier}})) \vdash \Box^{\downarrow}\Diamond s}\,(/L)
$$

Wide Scope Negation (¬GQ).

$\square$ 10. Polarity Items (II)

$$
\cfrac{np \vdash np \qquad \cfrac{\cfrac{s \vdash ({}^0 s)^0 \quad np \vdash np}{np\backslash s \vdash np\backslash({}^0 s)^0}\,(\backslash R-L) \qquad \cfrac{np \vdash s/(np\backslash s) \quad \boxed{s \vdash s_1}}{np \bullet (s/(np\backslash s))\backslash s \vdash s_1}\,(\backslash L)}{np \bullet (((s/(np\backslash s))\backslash s)/(np\backslash({}^0 s)^0) \bullet np\backslash s) \vdash s_1}\,(/L)}{\cfrac{np \bullet (((s/(np\backslash s))\backslash s)/(np\backslash({}^0 s)^0) \bullet ((np\backslash s)/np \bullet np)) \vdash s_1 \qquad \boxed{s_2 \vdash \square^{\downarrow}\Diamond s}}{\underbrace{np}_{\text{subject}} \bullet (\underbrace{((s/(np\backslash s))\backslash s)/(np\backslash({}^0 s)^0)}_{\text{negation}} \bullet (\underbrace{(np\backslash s)/np}_{\text{trans. verb}} \bullet \underbrace{\boxed{q(np, s_1, s_2)}}_{\text{gen. quantifier}})) \vdash \square^{\downarrow}\Diamond s}\,(qL)}\,(/L)
$$

Narrow Scope Negation (GQ¬).

□ 11. Scope Ambiguity (II).

GQ_{sub}

$$\dfrac{\dfrac{\dfrac{np \vdash np \quad s \vdash ({}^0 s)^0}{np \bullet np\backslash s \vdash ({}^0 s)^0}\,[\backslash L]}{np\backslash s \vdash np\backslash({}^0 s)^0}\,[\backslash R] \qquad \dfrac{\dfrac{\dfrac{\dfrac{\dfrac{np \vdash np \quad \boxed{\Diamond\Box^{\downarrow}s \vdash s_1}}{np \bullet np\backslash\Diamond\Box^{\downarrow}s \vdash s_1}\,[\backslash L] \quad s_2 \vdash \Diamond\Box^{\downarrow}s}{q(np, s_1, s_2) \bullet np\backslash\Diamond\Box^{\downarrow}s \vdash \Diamond\Box^{\downarrow}s}\,[qL]}{q(np, s_1, s_2) \vdash \Diamond\Box^{\downarrow}s/(np\backslash\Diamond\Box^{\downarrow}s)}\,[/R] \quad s \vdash \Box^{\downarrow}\Diamond s}{q(np, s_1, s_2) \bullet ((\Diamond\Box^{\downarrow}s/(np\backslash\Diamond\Box^{\downarrow}s))\backslash s \vdash \Box^{\downarrow}\Diamond s}\,[\backslash L]}{\underbrace{q(np, s_1, s_2)}_{\text{quant.}} \bullet (\underbrace{((\Diamond\Box^{\downarrow}s/(np\backslash\Diamond\Box^{\downarrow}s))\backslash s)/(np\backslash({}^0 s)^0)}_{didn't} \bullet \underbrace{np\backslash s}_{\text{study}}) \vdash \Box^{\downarrow}\Diamond s}\,[\backslash L]$$

$Q_{sub}\neg$

$$\dfrac{\dfrac{\begin{matrix}\vdots\\ np\backslash s \vdash np\backslash({}^0 s)^0\end{matrix} \qquad \dfrac{\begin{matrix}\vdots\\ np \vdash \Diamond\Box^{\downarrow}s/(np\backslash\Diamond\Box^{\downarrow}s)\end{matrix} \quad s \vdash s_1}{np \bullet (\Diamond\Box^{\downarrow}s/(np\backslash\Diamond\Box^{\downarrow}s))\backslash s \vdash s_1}\,[\backslash L]}{np \bullet (((\Diamond\Box^{\downarrow}s/(np\backslash\Diamond\Box^{\downarrow}s))\backslash s)/np\backslash({}^0 s)^0 \bullet np\backslash s) \vdash \Box^{\downarrow}\Diamond s}\,[\backslash L] \qquad \boxed{s_2 \vdash \Box^{\downarrow}\Diamond s}}{\underbrace{q(np, s_1, s_2)}_{\text{quant.}} \bullet (\underbrace{((\Diamond\Box^{\downarrow}s/(np\backslash\Diamond\Box^{\downarrow}s))\backslash s)/(np\backslash({}^0 s)^0)}_{didn't} \bullet \underbrace{np\backslash s}_{\text{study}}) \vdash \Box^{\downarrow}\Diamond s}\,[qL]$$

$\Box$ 11. Conclusion. QS in Categorial Grammar.

[a.] "Movement":

$$\dfrac{\dfrac{\dfrac{A \vdash A \qquad \boxed{\Delta[A] \vdash B}}{\Delta[A \bullet_{se} A\backslash_{se} A] \vdash B}\,[\backslash_{se}\mathrm{L}]}{\Delta[A\backslash_{se} A] \vdash A\backslash_{se} B}\,[\mathrm{SE}^n] \qquad \boxed{\Gamma[C] \vdash D}}{\dfrac{\dfrac{\Gamma[(C/_{nw}(A\backslash_{se} B)) \bullet_{nw} \Delta[(A\backslash_{se} A)]] \vdash D}{\Gamma[\Delta[(C/_{nw}(A\backslash_{se} B)) \bullet_{nw} (A\backslash_{se} A)]] \vdash D}\,[\mathrm{NW}^n]}{\boxed{\Gamma[\Delta[q(A, B, C)]] \vdash D}}\,[\mathrm{def}]}\,[/_{nw}\mathrm{L}]$$

[b.] "Feature Agreement":

$$\Diamond\Box^{\downarrow} s \quad \Rightarrow \quad s \quad \Rightarrow \quad \Box^{\downarrow}\Diamond s$$

$$s \quad \vdash \quad {}^{0}(s^{0})$$

$$s \quad \vdash \quad ({}^{0}s)^{0}$$

$$\dfrac{\dfrac{s \vdash s}{\Diamond s \vdash \Diamond s}\,(\Diamond R)}{s \vdash \Box^{\downarrow}\Diamond s}\,(\Box^{\downarrow} R) \qquad \dfrac{\text{FAILS}}{s \vdash \Diamond\Box^{\downarrow} s} \qquad \dfrac{\text{FAILS}}{({}^{0}s)^{0} \vdash \Box^{\downarrow}\Diamond s}$$