Semantik
9. Quantifikation und Grammatik 1

Fabian Heck
(basierend auf Folien von Gereon Müller)
Institut für Linguistik
home.uni-leipzig.de/heck

Quantifiers in Object Position

The system developed so far can handle quantifiers in subject position, as in (1), but not quantifiers in object position, as in (2).

(1) Subject quantifiers:
Every woman saw John

(2) Object quantifiers:
John saw every woman

The problem with object quantifiers:
(i) $[\![$**every woman**$]\!] \in D_{<<e,t>,t>}$
$\Leftarrow$ ($[\![$**every**$]\!] \in D_{<<e,t>,<<e,t>,t>>}$, $[\![$**woman**$]\!] \in D_{<e,t>}$).
(ii) $[\![$**saw**$]\!] \in D_{<e,<e,t>>}$.
(iii) The denotations of **saw** and of **every woman** cannot be combined via any existing semantic composition principle (in particular, not via FA or via PM).

Type Shifting vs. Quantfier Raising at Logical Form (LF)

Two possible solutions:

- The Flexible Type approach (Type Shifting):
  Quantifying determiners like **every** exhibit systematic type ambiguity: If they show up as subjects, they have denotations in $D_{<<e,t>,<<e,t>,t>>}$ and take first NP denotations in $D_{<e,t>}$, and then VP denotations in $D_{<e,t>}$ as arguments. If they show up as objects, they have denotations in $D_{<<e,t>,<<e,<e,t>>,<e,t>>>}$, i.e., they then take first NP denotations in $D_{<e,t>}$, and then transitive V denotations in $D_{<e,<e,t>>}$ as arguments, and deliver a VP type denotation in $D_{<e,t>}$ that finally applies to the subject.
- The LF Movement approach:
  Quantifying determiners like **every** have denotations in $D_{<<e,t>,<<e,t>,t>>}$ throughout. The type mismatch is repaired by movement at LF, and LF representations (rather than S-structure representations) are the input to semantic interpretation: Quantifier Raising (QR). On this view, QR is forced by type-theoretic considerations (i.e., it is a last resort operation – otherwise, interpretability could not be ensured), and not (necessarily, purely) so as to represent scope ambiguity (as is often maintained).

Type Shifting

(3) Type ambiguity with quantifying determiners:

a. $[\![\textbf{every}_1]\!] = \lambda f \in D_{<e,t>}$. [$\lambda g \in D_{<e,t>}$. $\forall x \in D_e$: f(x) = 1 $\rightarrow$ g(x) = 1]

b. $[\![\textbf{every}_2]\!] \in D_{<<e,t>,<<e,<e,t>>,<e,t>>>} =$ $\lambda f \in D_{<e,t>}$. [$\lambda Q \in D_{<e,<e,t>>}$. [$\lambda y \in D_e$. $\forall x \in D_e$: f(x) = 1 $\rightarrow$ Q(x)(y) = 1]]

Type Shifting: Illustration

(4) a. $[\![\textbf{John saw every}_2\ \textbf{woman}]\!] = 1$ iff (by FA, TN)

b. $[\![\textbf{saw every}_2\ \textbf{woman}]\!](\text{John}) = 1$ iff (by FA)

c. $[\![\textbf{every}_2\ \textbf{woman}]\!]([\![\textbf{saw}]\!])(\text{John}) = 1$ iff (by FA)

d. $[\![\textbf{every}_2]\!]([\![\textbf{woman}]\!])([\![\textbf{saw}]\!])(\text{John}) = 1$ iff (by TN)

e. $\lambda f \in D_{<e,t>}.\ [\ \lambda Q \in D_{<e,<e,t>>}.\ [\ \lambda y \in D_e\ .\ \forall x \in D_e\text{: } f(x) = 1 \rightarrow Q(x)(y) = 1\ ]](\lambda z \in D_e\ .\ z \text{ is a woman})([\![\textbf{saw}]\!])(\text{John}) = 1$ iff (by λ-conversion)

f. $\lambda Q \in D_{<e,<e,t>>}.\ [\ \lambda y \in D_e\ .\ \forall x \in D_e\text{: } [\ \lambda z \in D_e\ .\ z \text{ is a woman}\ ](x) = 1 \rightarrow Q(x)(y) = 1\ ]([\![\textbf{saw}]\!])(\text{John}) = 1$ iff (by λ-conversion)

g. $\lambda Q \in D_{<e,<e,t>>}.\ [\ \lambda y \in D_e\ .\ \forall x \in D_e\text{: } x \text{ is a woman} \rightarrow Q(x)(y) = 1\ ]([\![\textbf{saw}]\!])(\text{John}) = 1$ iff (by TN)

h. $\lambda Q \in D_{<e,<e,t>>}.\ [\ \lambda y \in D_e\ .\ \forall x \in D_e\text{: } x \text{ is a woman} \rightarrow Q(x)(y) = 1\ ]([\ \lambda k \in D_e\ .\ [\ \lambda l \in D_e\ .\ l \text{ saw } k\ ]])(\text{John}) = 1$ iff (by λ-conversion)

i. $[\ \lambda y \in D_e\ .\ \forall x \in D_e\text{: } x \text{ is a woman} \rightarrow [\ \lambda k \in D_e\ .\ [\ \lambda l \in D_e\ .\ l \text{ saw } k\ ]](x)(y) = 1\ ](\text{John}) = 1$ iff (by λ-conversion, twice)

j. $[\ \lambda y \in D_e\ .\ \forall x \in D_e\text{: } x \text{ is a woman} \rightarrow y \text{ saw } x\ ](\text{John}) = 1$ iff (by λ-conversion))

k. $\forall x \in D_e\text{: } x \text{ is a woman} \rightarrow \text{John saw } x$

Type Shifting: A First Problem

Thus, the Flexible Type approach works well for this type of example. However, it has a number of disadvantages. First, for indirect object quantifiers as in (5), a third denotation must be assumed:

(5) **every** in indirect object position:
Ann introduced everybody to Maria

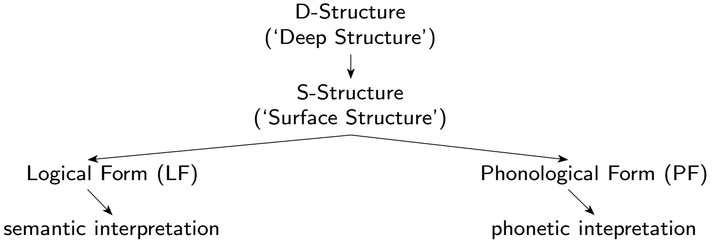
Type Shifting: Three More Problems

Further problems that will be discussed next week:

- Second, this approach must again be revised if scope ambiguity is to be taken into account (in particular, wide scope of the object over the subject is a problem).
- Third, there are problems with so-called antecedent-contained deletion.
- Fourth, binding of pronouns by quantifiers is a problem. For these reasons, we will adopt the second a priori possible solution.

Quantifier Raising at LF

(6) Model of grammar:



(7) S-structure representation (not interpreted):
John saw every woman

(8) LF representation after QR (input to interpretation):
$[_{S}\ [_{DP}\ [_{D}\ \textbf{every}\ ]\ [_{NP}\ \textbf{woman}\ ]]\ [_{S}\ \textbf{1}\ [_{S}\ \textbf{John}\ [_{VP}\ \textbf{saw}\ \mathbf{t}_1\ ]]]]$

The only thing that is a bit unusual here is the fact that the movement index of the QR-ed item **every woman** is adjoined to S, rather than part of the moved phrase itself. This is necessary because the index will trigger the application of PA, and must therefore form a constituent with the rest of the clause that excludes the QR-ed item.

(Note: typo on page 185: "**1**" $\rightarrow$ "**t**".)

Predicate Abstraction Again

(9) Predicate Abstraction (PA; 3. revision, final):
If α is a branching node whose daughters are β and γ, where β is an index i $\in \mathbb{N}$, then for any variable assignment a:
$[\![\alpha]\!]^{a} = \lambda x \in D_e \,.\, [\![\gamma]\!]^{a^{x/i}}$.

Note:
This formulation of PA is actually an improvement over preceding versions, since it does not make reference to specific wh-operators or relativizers like **such** anymore. (Assumption: These items are LF-deleted or LF-invisible.) The only thing that was necessary for the application of PA was the index.

System

(10) Terminale Knoten (TN):
Wenn α ein terminaler Knoten (aber kein Variablenausdruck) ist, ist $[\![\alpha]\!]$ im Lexikon spezifiziert.

(11) Regel für Variablenausdrücke (RV; Regel für Spuren und Pronomina):
Wenn α ein Pronomen oder eine Spur ist, a eine Variablenbelegung, und i $\in$ dom(a), dann gilt: $[\![\alpha_i]\!]^a$ = a(i).

(12) Nicht verzweigende Knoten (NN):
Wenn α ein nicht verzweigender Knoten ist und β sein Tochterknoten ist, dann gilt für jede beliebige Belegung a: $[\![\alpha]\!]^{\mathrm{a}} = [\![\beta]\!]^{\mathrm{a}}$.

(13) Funktionale Applikation (FA):
Wenn α ein verzweigender Knoten ist und $\{\beta,\gamma\}$ die Menge von αs Töchtern ist, dann gilt für jede beliebige Belegung a: Wenn $[\![\beta]\!]^{\mathrm{a}}$ eine Funktion ist, deren Argumentbereich $[\![\gamma]\!]^{\mathrm{a}}$ enthält, dann gilt: $[\![\alpha]\!]^{\mathrm{a}} = [\![\beta]\!]^{\mathrm{a}}([\![\gamma]\!]^{\mathrm{a}})$.

(14) Prädikatmodifikation (PM):
Wenn α ein verzweigender Knoten ist, $\{\beta,\gamma\}$ die Menge von αs Töchtern ist, und $[\![\beta]\!]$ und $[\![\gamma]\!]$ beide in $D_{<e,t>}$ sind, dann gilt für jede beliebige Belegung a:
$[\![\alpha]\!]^a = \lambda \, x \in D_e \, . \, [\![\beta]\!]^a(x) = [\![\gamma]\!]^a(x) = 1$.

(15) Prädikatabstraktion (PA):
Wen α ein verzweigender Knoten ist, dessen Töchter ein β und γ sind, wobei β ein Index i $\in$ |N ist, dann gilt für jede Variablenbelegung a:
$[\![\alpha]\!]^a = \lambda x \in D_e \, . \, [\![\gamma]\!]^{a^{x/i}}$.

Quantifier Raising: Illustration

(18)

a. $[\![$**every woman 1 John saw t$_1$**$]\!] = 1$ iff (by FA)

b. $[\![$**every woman**$]\!]([\![$**1 John saw t$_1$**$]\!]) = 1$ iff (by FA & TN)

c. $[\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e$: x is a woman $\rightarrow g(x) = 1\ ]([\![$**1 John saw t$_1$**$]\!])$ $= 1$ iff (by KLB & PA)

d. $[\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e$: x is a woman $\rightarrow g(x) = 1\ ]([\ \lambda y \in D_e\ .$ $[\![$**John saw t$_1$**$]\!]^{\{\}^{y/1}}]) = 1$ iff (by assignment modification)

e. $[\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e$: x is a woman $\rightarrow g(x) = 1\ ]([\ \lambda y \in D_e\ .$ $[\![$**John saw t$_1$**$]\!]^{[\ 1 \rightarrow y\ ]}]) = 1$ iff (by FA, twice, BD, & TN)

f. $[\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e$: x is a woman $\rightarrow g(x) = 1\ ]([\ \lambda y \in D_e\ .\ [\ \lambda k$ $\in D_e\ .\ [\ \lambda l \in D_e\ .$ l saw k $]]([\![\mathbf{t_1}]\!]^{[\ 1 \rightarrow y\ ]})$(John)]) $= 1$ iff (by RV)

g. $[\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e$: x is a woman $\rightarrow g(x) = 1\ ]([\ \lambda y \in D_e\ .\ [\ \lambda k$ $\in D_e\ .\ [\ \lambda l \in D_e\ .$ l saw k]](y)(John)]) $= 1$ iff (by λ-conversion, twice)

h. $[\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e$: x is a woman $\rightarrow g(x) = 1\ ]([\ \lambda y \in D_e$. John saw y]) $= 1$ iff (by λ-conversion)

i. $[\ \forall x \in D_e$: x is a woman $\rightarrow [\ \lambda y \in D_e$. John saw y $](x) = 1\ ]$ $= 1$ iff (by λ-conversion)

j. $\forall x \in D_e$: x is a woman $\rightarrow$ John saw x

Scope Ambiguity

(19) An ambiguous sentence with two LF representations:
Somebody$_1$ offended everybody$_2$

a. LF$_1$: **everybody 2 somebody$_1$ offended t$_2$**
("For everybody, there is somebody who offended her/him.")

b. LF$_2$: **somebody 1 everybody 2 t$_1$ offended t$_2$**
("There is somebody who offended everbody.")

Disambiguating context: 5 people, such that

1. 1 offended 2,
2. 2 offended 3,
3. 3 offended 4,
4. 4 offended 5,
5. 5 offended 1, and
6. nobody offended anybody else.

Conclusion:
In this scenario,

- $[\![$**Somebody$_1$ offended everybody$_2$**$]\!] = 1$ under LF$_1$.
- $[\![$**Somebody$_1$ offended everybody$_2$**$]\!] = 0$ under LF$_2$.

Reading No.1: Wide Scope for Universal Quantifier

(20) LF_1: $[\![$**everybody 2 somebody**$_1$ **offended t**$_2]\!] = 1$ iff

a. $[\ \lambda f \in D_{<e,t>}\ .\ \forall x \in D_e\text{: } f(x) = 1\ ](\lambda z \in D_e\ .\ [\![$**somebody**$_1$ **offended t**$_2]\!]^{[\ 2 \to z\ ]}) = 1$ iff

b. $[\ \lambda f \in D_{<e,t>}\ .\ \forall x \in D_e\text{: } f(x) = 1\ ](\lambda z \in D_e\ .\ [\ \lambda g \in D_{<e,t>}\ .\ \exists y \in D_e\text{: } g(y) = 1\ ]([\![$**offended t**$_2]\!]^{[\ 2 \to z\ ]})) = 1$ iff

c. $[\ \lambda f \in D_{<e,t>}\ .\ \forall x \in D_e\text{: } f(x) = 1\ ](\lambda z \in D_e\ .\ \exists y \in D_e\text{: y offended z}\ ) = 1$ iff

d. $[\ \forall x \in D_e\text{: } [\ \lambda z \in D_e\ .\ \exists y \in D_e\text{: y offended z}\ ]\ (x) = 1\ ] = 1$ iff

e. $\forall x \in D_e\text{: } \exists y \in D_e\text{: y offended x}$

Reading No.2: Wide Scope for Existential Quantifier

(21) LF_2: **somebody 1 everybody 2 $\mathbf{t_1}$ offended $\mathbf{t_2}$** $= 1$ iff

a. $[\ \lambda f \in D_{<e,t>}\ .\ \exists y \in D_e\text{: } f(y) = 1\ ]\ (\lambda z \in D_e\ .\ [\![\textbf{everybody 2 } \mathbf{t_1} \textbf{ offended } \mathbf{t_2}]\!]^{[\ 1 \to z\ ]}) = 1$ iff

b. $[\ \lambda f \in D_{<e,t>}\ .\ \exists y \in D_e\text{: } f(y) = 1\ ]\ (\lambda z \in D_e\ .\ [\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e\text{: } g(x) = 1\ ]\ ([\![\textbf{2 } \mathbf{t_1} \textbf{ offended } \mathbf{t_2}]\!]^{[\ 1 \to z\ ]})) = 1$ iff

c. $[\ \lambda f \in D_{<e,t>}\ .\ \exists y \in D_e\text{: } f(y) = 1\ ]\ (\lambda z \in D_e\ .\ [\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e\text{: } g(x) = 1\ ]\ (\lambda u \in D_e\ .\ [\![\mathbf{t_1} \textbf{ offended } \mathbf{t_2}]\!]^{\left[\begin{smallmatrix} 1 \to z \\ 2 \to u \end{smallmatrix}\right]})) = 1$ iff

d. $[\ \lambda f \in D_{<e,t>}\ .\ \exists y \in D_e\text{: } f(y) = 1\ ]\ (\lambda z \in D_e\ .\ [\ \lambda g \in D_{<e,t>}\ .\ \forall x \in D_e\text{: } g(x) = 1\ ]\ (\lambda u \in D_e\ .\ z \text{ offended } u)) = 1$ iff

e. $[\ \exists y \in D_e\text{: } [\ \lambda z \in D_e\ .\ \forall x \in D_e\text{: } z \text{ offended } x\ ]\ (y) = 1\ ] = 1$ iff

f. $\exists y \in D_e\text{: } \forall x \in D_e\text{: } y \text{ offended } x$ iff

Note:
In this example, we have ignored the restrictions of the quantifiying determiners (since they are trivial). But things work in essentially the same way if there are non-trivial restrictions.

System Again

(22) Terminale Knoten (TN):
Wenn α ein terminaler Knoten (aber kein Variablenausdruck) ist, ist $[\![\alpha]\!]$ im Lexikon spezifiziert.

(23) Regel für Variablenausdrücke (RV; Regel für Spuren und Pronomina):
Wenn α ein Pronomen oder eine Spur ist, a eine Variablenbelegung, und i $\in$ dom(a), dann gilt: $[\![\alpha_i]\!]^a = \text{a(i)}$.

(24) Nicht verzweigende Knoten (NN):
Wenn α ein nicht verzweigender Knoten ist und β sein Tochterknoten ist, dann gilt für jede beliebige Belegung a: $[\![\alpha]\!]^{\mathrm{a}} = [\![\beta]\!]^{\mathrm{a}}$.

(25) Funktionale Applikation (FA):
Wenn α ein verzweigender Knoten ist und $\{\beta,\gamma\}$ die Menge von αs Töchtern ist, dann gilt für jede beliebige Belegung a: Wenn $[\![\beta]\!]^{\mathrm{a}}$ eine Funktion ist, deren Argumentbereich $[\![\gamma]\!]^{\mathrm{a}}$ enthält, dann gilt: $[\![\alpha]\!]^{\mathrm{a}} = [\![\beta]\!]^{\mathrm{a}}([\![\gamma]\!]^{\mathrm{a}})$.

(26) Prädikatmodifikation (PM):
Wenn α ein verzweigender Knoten ist, $\{\beta,\gamma\}$ die Menge von αs Töchtern ist, und $[\![\beta]\!]$ und $[\![\gamma]\!]$ beide in $D_{<e,t>}$ sind, dann gilt für jede beliebige Belegung a: $[\![\alpha]\!]^a = \lambda\, x \in D_e\ .\ [\![\beta]\!]^a(x) = [\![\gamma]\!]^a(x) = 1$.

(27) Prädikatabstraktion (PA):
Wen α ein verzweigender Knoten ist, dessen Töchter ein β und γ sind, wobei β ein Index i $\in$ |N ist, dann gilt für jede Variablenbelegung a:
$[\![\alpha]\!]^a = \lambda x \in D_e\ .\ [\![\gamma]\!]^{a^{x/i}}$.

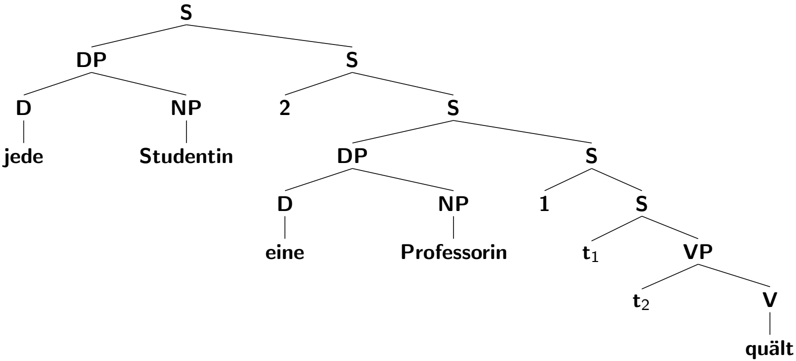
Scope Ambiguity: Another Example

(30) dass irgend- **eine Professorin$_1$** wohl schon **jede Studentin$_2$ quält**

a. Für jede Studentin gibt es eine Professorin, die sie quält.
b. Es gibt eine Professorin, die jede Studentin quält.

Assumption:
All quantified DPs (= generalized quantifiers) undergo QR, even if this is not strictly speaking necessary for type-driven interpretation.

(31) Inverse scope: LF representation of (31-a) after QR:



Derivation of Inverse Scope Reading

(32) ⟦**jede Studentin [2 [eine Professorin [1 [t_1 [t_2 quält]]]]]**⟧ = 1 gdw.

a. ⟦**jede Studentin**⟧ (⟦**[2 [eine Professorin [1 [t_1 [t_2 quält]]]]**⟧) = 1 gdw.

b. [⟦**jede** ⟧(⟦**Studentin**⟧)] (⟦**[2 [eine Professorin [1 [t_1 [t_2 quält]]]]**⟧) = 1 gdw.

c. $[\lambda f \in D_{<e,t>} . [\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: } f(x) = 1 \rightarrow g(x) = 1]]$ (⟦**Studentin**⟧)] (⟦**[2 [eine Professorin [1 [t_1 [t_2 quält]]]]]**⟧) = 1 gdw.

d. $[\lambda f \in D_{<e,t>} . [\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: } f(x) = 1 \rightarrow g(x) = 1]]$ ($\lambda z \in D_e$. z ist Studentin)] (⟦**[2 [eine Professorin [1 [t_1 [t_2 quält]]]]]**⟧) = 1 gdw.

e. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: } [\lambda z \in D_e$. z ist Studentin$](x) = 1 \rightarrow g(x) = 1]$ (⟦**[2 [eine Professorin [1 [t_1 [t_2 quält]]]]]**⟧) = 1 gdw.

f. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\rightarrow g(x) = 1]$ (⟦**[2 [eine Professorin [1 [t_1 [t_2 quält]]]]]**⟧) = 1 gdw.

g. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\rightarrow g(x) = 1]$ (⟦**[2 [eine Professorin [1 [t_1 [t_2 quält]]]]]**⟧$^{\{\ \}}$) = 1 gdw.

h. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\rightarrow g(x) = 1]$ ($\lambda z \in D_e$. ⟦**[eine Professorin [1 [t_1 [t_2 quält]]]]**⟧$^{\{\ \}^{z/2}}$) = 1 gdw.

i. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\rightarrow g(x) = 1]$ ($\lambda z \in D_e$. ⟦**[eine Professorin [1 [t_1 [t_2 quält]]]]**⟧$^{[\ 2 \rightarrow z\ ]}$) = 1 gdw.

j. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\rightarrow g(x) = 1]$ ($\lambda z \in D_e$. ⟦**eine Professorin**⟧$^{[\ 2 \rightarrow z\ ]}$ (⟦**[1 [t_1 [t_2 quält]]]**⟧$^{[\ 2 \rightarrow z\ ]}$) = 1 gdw.

k. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\rightarrow g(x) = 1]$ ($\lambda z \in D_e$. ⟦**eine Professorin**⟧ (⟦**[1 [t_1 [t_2 quält]]]**⟧$^{[\ 2 \rightarrow z\ ]}$) = 1 gdw.

Part 2

(33) a. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ [\![\textbf{eine}]\!]$ $([\![\textbf{Professorin}]\!])]\ ([\![\textbf{[1 [t}_1\textbf{ [t}_2\textbf{ quält]]]}]\!]^{\left[\ 2 \rightarrow z\ \right]}) = 1$ gdw.

b. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ \lambda f \in D_{<e,t>} . [\ \lambda h$ $\in D_{<e,t>} . \exists y \in D_e\text{: } f(y) = 1\ \&\ h(y) = 1]]\ ([\![\textbf{Professorin}]\!])]\ ([\![\textbf{[1 [t}_1\textbf{ [t}_2\textbf{ quält}$ $\textbf{]]]}]\!]^{\left[\ 2 \rightarrow z\ \right]}) = 1$ gdw.

c. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ \lambda f \in D_{<e,t>} . [\ \lambda h$ $\in D_{<e,t>} . \exists y \in D_e\text{: } f(y) = 1\ \&\ h(y) = 1]]\ (\lambda u \in D_e\ .\ \text{u ist Professorin})\ ([\![\textbf{[1 [t}_1\textbf{ [t}_2$ $\textbf{quält]]]}]\!]^{\left[\ 2 \rightarrow z\ \right]}) = 1$ gdw.

d. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ \lambda h \in D_{<e,t>} . \exists y \in$ $D_e\text{: } [\lambda u \in D_e\ .\ \text{u ist Professorin}](y) = 1\ \&\ h(y) = 1]\ ([\![\textbf{[1 [t}_1\textbf{ [t}_2\textbf{ quält}$ $\textbf{]]]}]\!]^{\left[\ 2 \rightarrow z\ \right]})) = 1$ gdw.

e. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ \lambda h \in D_{<e,t>} . \exists y \in$ $D_e\text{: y ist Professorin}\ \&\ h(y) = 1]\ ([\![\textbf{[1 [t}_1\textbf{ [t}_2\textbf{ quält]]]}]\!]^{\left[\ 2 \rightarrow z\ \right]})) = 1$ gdw.

f. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ \lambda h \in D_{<e,t>} . \exists y \in$ $D_e\text{: y ist Professorin}\ \&\ h(y) = 1]\ (\lambda r \in D_e\ .\ [\![\textbf{[t}_1\textbf{ [t}_2\textbf{ quält]]}]\!]^{\left[\ 2 \rightarrow z\ \right]^{r/1}})) = 1$ gdw.

g. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ \lambda h \in D_{<e,t>} . \exists y \in$ $D_e\text{: y ist Professorin}\ \&\ h(y) = 1]\ (\lambda r \in D_e\ .\ [\![\textbf{[t}_1\textbf{ [t}_2\textbf{ quält]]}]\!]^{\left[\begin{smallmatrix} 2 \rightarrow z \\ 1 \rightarrow r \end{smallmatrix}\right]})) = 1$ gdw.

h. $[\lambda g \in D_{<e,t>} . \forall x \in D_e\text{: x ist Studentin} \rightarrow g(x) = 1]\ (\lambda z \in D_e . [\ \lambda h \in D_{<e,t>} . \exists y \in$ $D_e\text{: y ist Professorin}\ \&\ h(y) = 1]\ (\lambda r \in D_e\ .\ [\![\textbf{[t}_2\textbf{ quält}$ $\textbf{]}]\!]^{\left[\begin{smallmatrix} 2 \rightarrow z \\ 1 \rightarrow r \end{smallmatrix}\right]}([\![\textbf{t}_1]\!]^{\left[\begin{smallmatrix} 2 \rightarrow z \\ 1 \rightarrow r \end{smallmatrix}\right]}))) = 1$ gdw.

Part 3

(34) a. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . [\lambda h \in D_{<e,t>} . \exists y \in D_e$: y ist Professorin & $h(y) = 1]$ $(\lambda r \in D_e . [\![[\, t_2 \textbf{ quält }]]\!]^{\begin{bmatrix} 2 \to z \\ 1 \to r \end{bmatrix}}(r))) = 1$ gdw.

b. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . [\lambda h \in D_{<e,t>} . \exists y \in D_e$: y ist Professorin & $h(y) = 1]$ $(\lambda r \in D_e . [[\![\textbf{quält}]\!]^{\begin{bmatrix} 2 \to z \\ 1 \to r \end{bmatrix}}([\![t_2]\!]^{\begin{bmatrix} 2 \to z \\ 1 \to r \end{bmatrix}})](r)))$ $= 1$ gdw.

c. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . [\lambda h \in D_{<e,t>} . \exists y \in D_e$: y ist Professorin & $h(y) = 1]$ $(\lambda r \in D_e . [[\![\textbf{quält}]\!]^{\begin{bmatrix} 2 \to z \\ 1 \to r \end{bmatrix}}(z)](r))) = 1$ gdw.

d. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . [\lambda h \in D_{<e,t>} . \exists y \in D_e$: y ist Professorin & $h(y) = 1]$ $(\lambda r \in D_e . [[\lambda u \in D_e . [\lambda v \in D_e$. v quält u$]]^{\begin{bmatrix} 2 \to z \\ 1 \to r \end{bmatrix}}(z)](r))) = 1$ gdw.

e. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . [\lambda h \in D_{<e,t>} . \exists y \in D_e$: y ist Professorin & $h(y) = 1]$ $(\lambda r \in D_e . [[\lambda u \in D_e . [\lambda v \in D_e$. v quält u$]](z)](r)))$ $= 1$ gdw.

f. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . [\lambda h \in D_{<e,t>} . \exists y \in D_e$: y ist Professorin & $h(y) = 1]$ $(\lambda r \in D_e . [\lambda v \in D_e$. v quält z$](r))) = 1$ gdw.

g. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . [\lambda h \in D_{<e,t>} . \exists y \in D_e$: y ist Professorin & $h(y) = 1]$ $(\lambda r \in D_e$. r quält z$)) = 1$ gdw.

h. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . \exists y \in D_e$: y ist Professorin & $[[\lambda r \in D_e$. r quält z$](y) = 1]) = 1$ gdw.

i. $[\lambda g \in D_{<e,t>} . \forall x \in D_e$: x ist Studentin $\to g(x) = 1]$ $(\lambda z \in D_e . \exists y \in D_e$: y ist Professorin & y quält z$) = 1$ gdw.

j. $[\forall x \in D_e$: x ist Studentin $\to [\lambda z \in D_e . \exists y \in D_e$: y ist Prof. & y quält z$](x) = 1] = 1$ gdw.

k. $\forall x \in D_e$: x ist Studentin $\to \exists y \in D_e$: y ist Professorin & y quält x

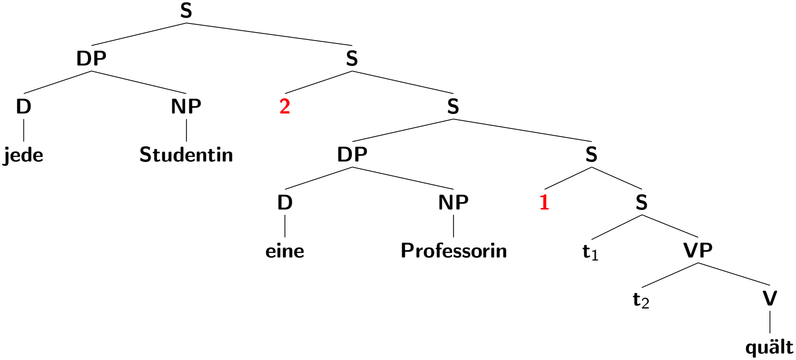
Derivation of Surface Scope Reading

Note:
The derivation of the surface scope reading works in exactly the same way, except for exchanging the two generalized quantifiers.

Indices and Constituency

Observation:
It is normally assumed in syntax that indices belong to the moved item, and not to the sister node of the moved item.

(35) Indices and constituency:

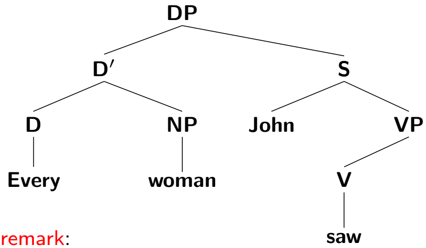


Conclusion:
This is unproblematic.

Predicting the Head of a Phrase in the Syntax

Adger's (2003) slogan:
The item that selects is the item that projects.
Question: Wouldn't one then expect the structure of a clause containing a quantifying determiner to look roughly as in (36)?
Answer: This prediction would be wrong; c-selection and s-selection must be distinguished.

(36) A wrong structure – clauses are not DPs:



Historical remark:
In the model of Generative Semantics that was widely pursued in the late 60's and early 70's as an alternative to the predecessor of the current Chomskyan model based on Interpretive Semantics, something like (36) was regularly postulated as the underlying, base-generated deep structure that served as the locus of semantic interpretation; on the way towards surface structure, the D′ constituent was assumed to be lowered into its surface position (cf. Lakoff (1971)).

Adger, David (2003): *Core Syntax*. Oxford University Press, Oxford, New York.

Lakoff, George (1971): On Generative Semantics. In: D. Steinberg & L. Jakobovits, eds., *Semantics*. Cambridge University Press, Cambridge, pp. 232–296.