Indefinites and Sluicing
A Type-Logical Approach

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Workshop *Cross-modular approaches to ellipsis*

Outline of talk

- Anaphora in Type Logical Grammar
- Extrapolation to indefinites
- Linguistic consequences:
  - Indefinites and scope
  - Sluicing

Anaphora in TLG

Jacobson's proposal

- Semantics: pronouns denote identity functions
- Syntax: third slash: "$A|B$" is category of anaphoric expression
- Pronouns: category $np|np$

Adaptation to TLG

- Natural Deduction rules for anaphora slash

$$[M : A]_i \quad \cdots \quad \frac{N : B|A}{[NM : B]_i}\, |E, i$$

$$\frac{\begin{array}{ccc} \vdots & \dfrac{M : A|B}{Mx : A}\, i & \vdots \\ \vdots & \vdots & \vdots \end{array}}{\dfrac{np : C}{\lambda x N : C|B}\, |I, i}$$

- Only constraint on anaphora resolution: The antecedent must precede the pronoun

Binding

(1) John said he walked

$$\dfrac{\dfrac{John}{[\mathrm{J'} : np]_i}\,lex \qquad \dfrac{\dfrac{said}{\mathrm{SAY'} : np\backslash s/s}\,lex \qquad \dfrac{\dfrac{\dfrac{he}{[\lambda x.x : np|np]_i}\,lex}{\mathrm{J'} : np}\,|E \qquad \dfrac{walked}{\mathrm{WALK'} : np\backslash s}\,lex}{\mathrm{WALK'}\ \mathrm{J'} : s}\,\backslash E}{\mathrm{SAY'}(\mathrm{WALK'}\ \mathrm{J'}) : np\backslash s}\,/E}{\mathrm{SAY'}(\mathrm{WALK'}\ \mathrm{J'})\mathrm{J'} : s}\,\backslash E$$

Percolation

$$\dfrac{he}{\lambda x.x : np|np}\ lex$$

$$\dfrac{\lambda x.x : np|np}{y : np}\ 1$$

$$\dfrac{walked}{\textsf{WALK'} : np\backslash s}\ lex$$

$$\dfrac{y : np \qquad \textsf{WALK'} : np\backslash s}{\textsf{WALK'}y : s}\ \backslash E$$

$$\dfrac{said}{\textsf{SAY'} : np\backslash s/s}\ lex$$

$$\dfrac{\textsf{SAY'} : np\backslash s/s \qquad \textsf{WALK'}y : s}{\textsf{SAY'}(\textsf{WALK'}y) : np\backslash s}\ /E$$

$$\dfrac{John}{\textsf{J'} : np}\ lex$$

$$\dfrac{\textsf{J'} : np \qquad \textsf{SAY'}(\textsf{WALK'}y) : np\backslash s}{\textsf{SAY'}(\textsf{WALK'}y)\textsf{J'} : s}\ \backslash E$$

$$\dfrac{\textsf{SAY'}(\textsf{WALK'}y)\textsf{J'} : s}{\lambda y.\textsf{SAY'}(\textsf{WALK'}y)\textsf{J'} : s|np}\ |I, 1$$

VP Ellipsis

(2) John revised his paper, and Harry did (too).

- stranded auxiliary *did* is treated as proverb ($\lambda P.P : (np\backslash s)|(np\backslash s)$)
- the lexical entry for non-elliptical *did* is $\lambda P.P : (np\backslash s)/(np\backslash s)$
- strict/sloppy ambiguity: pronoun is either identified with the actual subject or with a hypothetical premise that is discharged later

$$
\dfrac{
 \dfrac{
  \dfrac{\textit{John}}{\begin{array}{c}[\mathsf{J'}]_i\\ np\end{array}}\,lex
  \qquad
  \dfrac{\dfrac{\textit{revised his paper}}{\begin{array}{c}[\lambda x.\mathsf{R'}(\mathsf{P'}x)]_i\\ (np\backslash s)|np\end{array}}}{\begin{array}{c}[\mathsf{R'}(\mathsf{P'J'})]_j\\ np\backslash s\end{array}}\,|E
 }{\begin{array}{c}\mathsf{R'}(\mathsf{P'J'})\mathsf{J'}\\ s\end{array}}\,\backslash E
 \qquad
 \dfrac{
  \dfrac{\textit{and}}{\begin{array}{c}\mathsf{AND'}\\ s\backslash s/s\end{array}}\,lex
  \qquad
  \dfrac{
   \dfrac{\textit{Harry}}{\begin{array}{c}\mathsf{H'}\\ np\end{array}}\,lex
   \qquad
   \dfrac{\dfrac{\textit{did}}{\begin{array}{c}[\lambda P.P]_j\\ (np\backslash s)|(np\backslash s)\end{array}}\,lex}{\begin{array}{c}\mathsf{R'}(\mathsf{P'J'})\\ np\backslash s\end{array}}\,|E
  }{\begin{array}{c}\mathsf{R'}(\mathsf{P'\ J'})\mathsf{H'}\\ s\end{array}}\,\backslash E
 }{\begin{array}{c}\mathsf{AND'}(\mathsf{R'}(\mathsf{P'\ J'})\mathsf{H'})\\ s\backslash s\end{array}}\,/E
}{\begin{array}{c}\mathsf{AND'}(\mathsf{R'}(\mathsf{P'\ J'})\mathsf{H'})(\mathsf{R'}(\mathsf{P'\ J'})\mathsf{J'})\\ s\end{array}}\,\backslash E
$$

$$
\dfrac{
\dfrac{
\dfrac{}{\begin{matrix}\mathsf{J}'\\ np\end{matrix}}\textit{John}\ lex
\quad
\dfrac{
\dfrac{
\dfrac{}{\begin{matrix}[x]_i\\ np\end{matrix}}1
\quad
\dfrac{\begin{matrix}\underline{\textit{revised his paper}}\\ [\lambda x.\mathsf{R}'(\mathsf{P}'x)]_i\\ (np\backslash s)|np\end{matrix}}{\begin{matrix}\mathsf{R}'(\mathsf{P}'x)\\ np\backslash s\end{matrix}}|E
}{\begin{matrix}\mathsf{R}'(\mathsf{P}'x)x\\ s\end{matrix}}\backslash E
}{\begin{matrix}[\lambda x.\mathsf{R}'(\mathsf{P}'x)x]_j\\ np\backslash s\end{matrix}}\backslash I,1
}{\begin{matrix}\mathsf{R}'(\mathsf{P}'\mathsf{J}')\mathsf{J}'\\ s\end{matrix}}\backslash E
\quad
\dfrac{
\dfrac{}{\begin{matrix}\mathsf{AND}'\\ s\backslash s/s\end{matrix}}\textit{and}\ lex
\quad
\dfrac{
\dfrac{}{\begin{matrix}\mathsf{H}'\\ np\end{matrix}}\textit{Harry}\ lex
\quad
\dfrac{
\dfrac{}{\begin{matrix}[\lambda P.P]_j\\ (np\backslash s)|(np\backslash s)\end{matrix}}\textit{did}\ lex
}{\begin{matrix}\lambda x.\mathsf{R}'(\mathsf{P}'x)x\\ np\backslash s\end{matrix}}|E
}{\begin{matrix}\mathsf{R}'(\mathsf{P}'\ \mathsf{H}')\mathsf{H}'\\ s\end{matrix}}\backslash E
}{\begin{matrix}\mathsf{AND}'(\mathsf{R}'(\mathsf{P}'\ \mathsf{H}')\mathsf{H}')\\ s\backslash s\end{matrix}}/E
}{\begin{matrix}\mathsf{AND}'(\mathsf{R}'(\mathsf{P}'\ \mathsf{H}')\mathsf{H}')(\mathsf{R}'(\mathsf{P}'\ \mathsf{J}')\mathsf{J}')\\ s\end{matrix}}\backslash E
$$

Interaction with Quantification

- Background: Moortgat's *in situ* binder $q(np, s, s)$
- to scope a quantifier, 1. insert an hypothetical np into its position, 2. derive the local clause, 3. discharge the assumption, and 4. apply the quantifier to the resulting predicate
- Hypothetical np can serve as antecedent of a pronoun

(3) a. Everybody loves his mother

b.

$$\dfrac{\dfrac{\dfrac{\dfrac{everybody}{\begin{array}{c}q(np,s,s)\\ \text{EVERY'}\end{array}}\,lex}{\begin{array}{c}[np]_i\\ x\end{array}}\,1 \qquad \dfrac{\dfrac{loves}{\begin{array}{c}np\backslash s/np\\ \text{LOVE'}\end{array}}\,lex \qquad \dfrac{\dfrac{his\ mother}{\begin{array}{c}[np|np]_i\\ \text{MOTHER'}\end{array}}}{\begin{array}{c}np\\ \text{MOTHER'}x\end{array}}\,|E}{\begin{array}{c}np\backslash s\\ \text{LOVE'}(\text{MOTHER'}x)\end{array}}\,/E}{\begin{array}{c}s\\ \text{LOVE'}(\text{MOTHER'}x)x\end{array}}\,\backslash E}{\begin{array}{c}s\\ \text{EVERY'}(\lambda x.\text{LOVE'}(\text{MOTHER'}x)x)\end{array}}\,qE,1$$

- Derivation of a bound reading for *His mother loves everybody* fails since the hypothetical np does not precede the pronoun $\Rightarrow$ accounts for Crossover phenomena
- bound readings only possible as long as quantifier isn't scoped $\Rightarrow$ bound pronouns are in the scope of the binder

Embedded Antecedents

(4) a. Everybody's mother loves him

b.

$$\dfrac{\textit{everybody}}{\dfrac{q(np,s,s)}{\mathrm{EVERY}'}}\ lex$$

$$\dfrac{\dfrac{q(np,s,s)}{\mathrm{EVERY}'}}{\dfrac{[np]_i}{y}}\ 1 \qquad \dfrac{'s}{\dfrac{np\backslash np/n}{\mathrm{OF}'}}\ lex \qquad \dfrac{\textit{him}}{\dfrac{[np|np]_i}{\lambda x.x}}\ lex$$

$$\dfrac{\dfrac{[np]_i}{y} \quad \dfrac{np\backslash np/n}{\mathrm{OF}'}}{\dfrac{np/n}{\mathrm{OF}'y}}\ \backslash E \qquad \dfrac{\textit{mother}}{\dfrac{n}{\mathrm{MOTHER}'}}\ lex \qquad \dfrac{\textit{loves}}{\dfrac{np\backslash s/np}{\mathrm{LOVES}'}}\ lex \qquad \dfrac{\dfrac{[np|np]_i}{\lambda x.x}}{\dfrac{np}{y}}\ |E$$

$$\dfrac{\dfrac{np/n}{\mathrm{OF}'y} \quad \dfrac{n}{\mathrm{MOTHER}'}}{\dfrac{np}{\mathrm{OF}'y\mathrm{MOTHER}'}}\ /E \qquad \dfrac{\dfrac{np\backslash s/np}{\mathrm{LOVES}'} \quad \dfrac{np}{y}}{\dfrac{np\backslash s}{\mathrm{LOVE}'y}}\ /E$$

$$\dfrac{\dfrac{np}{\mathrm{OF}'y\mathrm{MOTHER}'} \quad \dfrac{np\backslash s}{\mathrm{LOVE}'y}}{\dfrac{s}{\mathrm{LOVE}'y(\mathrm{OF}'y\mathrm{MOTHER}')}}\ \backslash E$$

$$\dfrac{\dfrac{s}{\mathrm{LOVE}'y(\mathrm{OF}'y\mathrm{MOTHER}')}}{\dfrac{s}{\mathrm{EVERY}'(\lambda y.\mathrm{LOVE}'y(\mathrm{OF}'y\mathrm{MOTHER}'))}}\ qE,1$$

Covering indefinites

Basic idea

(5) a. It moved.
b. Something moved.

- Proposal: (a) and (b) have
  - the same denotation: $\lambda x.\textsc{move}'x$
  - different syntactic categories

Type Logical implementation

- yet another substructural implication, “$\leadsto$”
- Intuition: $A \leadsto B$: category of B-sign containing an indefinite A
- category of indefinite NPs: $np \leadsto np$
- *it* and *something* both denote the identity function on individuals

- indefinites function compose with their semantic environment
- Natural deduction rule:

$$
\dfrac{\dfrac{\begin{array}{ccc} \vdots & \dfrac{M : A \leadsto B}{Mx : B}\,i & \vdots \\ \vdots & \vdots & \vdots \end{array}}{N : C}}{\lambda x N : A \leadsto C}\ \leadsto, i
$$

(6) a. John saw something.

b.

$$
\dfrac{\dfrac{John}{\begin{array}{c}\text{JOHN'}\\ np\end{array}}lex \quad \dfrac{\dfrac{saw}{\begin{array}{c}\text{SEE'}\\ (np\backslash s)/np\end{array}}lex \quad \dfrac{\dfrac{something}{\begin{array}{c}\lambda xx\\ np \leadsto np\end{array}}lex}{\begin{array}{c}y\\ np\end{array}}i}{\begin{array}{c}\text{SEE'}y\\ np\backslash s\end{array}}/E}{\dfrac{\begin{array}{c}\text{SEE'}y\text{JOHN'}\\ s\end{array}}{\begin{array}{c}\lambda y.\text{SEE'}y\text{JOHN'}\\ np \leadsto s\end{array}}\leadsto, i}\backslash E
$$

Descriptive content

- Idea: descriptive content expresses domain restriction
- $\|$a$\|$ = function that maps a property to the identity function over its extension
- $\|$a cup$\|$ = identity function on the set of cups
- $\|$a cup moved$\|$ = partial function f from individuals to truth values:
  - $f(x) = 1$ iff x is a cup that moved
  - $f(x) = 0$ iff x is a cup that did not move
  - $f(x)$ is undefined iff x is not a cup

Variable free existential closure

- Existential closure of a partial function: “big union” over its domain
- built in into the truth definition and the semantics of propositional operators (as in DRT)
- Relativization to syntactic categories to confine existential closure to indefinites

- Truth is relativized to sequence of referents and syntactic category

Definition 1 (Truth)

$$\vec{e} \models \alpha : s \quad \text{iff} \quad \alpha = 1$$

$$c\vec{e} \models \alpha : S|np \quad \text{iff} \quad \vec{e} \models (\alpha c) : S$$

$$\vec{e} \models \alpha : np \rightsquigarrow S \quad \text{iff} \quad \vec{e} \models \Big(\bigcup_{\alpha c \text{ is defined}} (\alpha c)\Big) : S$$

(7) A cup moved.

$$\vec{e} \models \|\lambda x_{\textsf{CUP'}x}.\textsf{MOVE'}x\|_g : np \rightsquigarrow s \iff$$
$$\vec{e} \models \bigcup_{a \in \|\textsf{CUP'}\|_g} \|\textsf{MOVE'}\|_g(a) : s \iff$$
$$\bigcup_{a \in \|\textsf{CUP'}\|_g} \|\textsf{MOVE'}\|_g(a) = 1 \iff$$
$$\exists a.a \in \|\textsf{CUP'}\|_g \cap \|\textsf{MOVE'}\|_g$$

Negation

- Negation is polymorphic
- indefinites in its scope are (optionally) existentially closed
- anaphora slots are passed through unchanged

Definition 2 (Negation)

$$\begin{aligned}
\sim \alpha : s &= 1 - \alpha \\
\sim \alpha : S|A &= \lambda c. \sim (\alpha c) \\
\sim \alpha : A \rightsquigarrow S &= \sim (\bigcup_{c \in Dom(\alpha)} \alpha c)
\end{aligned}$$

Linguistic consequences

Indefinites and scope

(8) John didn't see a cup move.

- First option: existential closure by negation:

$$\neg\lambda x_{\text{CUP'}x}.\text{SEE'}(\text{MOVE'}x)\text{JOHN'}$$
$$\equiv$$
$$\neg\exists x(\text{CUP'}x \wedge \text{SEE'}(\text{MOVE'}x)\text{JOHN'})$$

- Second option: existential closure at matrix level:

$$\lambda x_{\text{CUP'}x}.\neg\text{SEE'}(\text{MOVE'}x)\text{JOHN'}$$
$$\equiv$$
$$\exists x(\text{CUP'}x \wedge \neg\text{SEE'}(\text{MOVE'}x)\text{JOHN'})$$

Properties of the analysis

No island effects

- An indefinite can take scope over each clause it is contained in
- Indefinites scopally interact with operators like negation, but:
  - No movement involved $\leadsto$ not constrained by constraints on movement
  - scoping mechanism is independent from quantifier scoping $\leadsto$ not constrained by constraints on quantifier scope

No split between existential force and descriptive content

- descriptive part is interpreted as domain restriction of partial function
- is inherited by superconstituents in semantic composition:

$$Dom(f) \subseteq Dom(f \circ g)$$

- Existential closure entails non-emptiness of domain
- Thus existential and descriptive scope are always identical

Avoids

- "Donald Duck Problem" of naive long-distance existential closure analysis:

(9) a. Max will be offended if we invite a certain philosopher.

b. $\simeq \exists x(\textsf{PHILO'}x \wedge (\textsf{INVITE'}x\textsf{WE'} \rightarrow \textsf{OFFENDED'M'}))$

c. $\neq \exists x(\textsf{PHILO'}x \wedge \textsf{INVITE'}x\textsf{WE'} \rightarrow \textsf{OFFENDED'M'})$

Sluicing

(10) a. A cup moved, and Bill wonders which cup.
b. A cup moved, and Bill wonders which cup moved.

- Syntax:
  - Sluicing involves a bare *wh*-phrase
  - needs a declarative clause containing an indefinite as antecedent
- Semantics:
  - “missing” material is identical to antecedent except that indefinite is replaced by *wh*-trace

- Proposal: *which cup* has two types (but only one meaning):

(11) a. $q/(s \uparrow np) : \lambda P.?x\textsf{CUP'}x \wedge Px$
b. $q|(np \rightsquigarrow s) : \lambda P.?x\textsf{CUP'}x \wedge Px$

- Antecedent clause has exactly the denotation that is needed to complete the elliptical question

$$
\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\textit{John}}{np}\,\textit{lex} \quad \dfrac{\dfrac{\textit{invited}}{(np\backslash s)/np}\,\textit{lex} \quad \dfrac{\dfrac{\dfrac{\textit{some}}{(np \leadsto np)/n}\,\textit{lex} \quad \dfrac{\textit{philosopher}}{n}\,\textit{lex}}{np \leadsto np}\,/E}{np}\,i}{np\backslash s}\,/E}{s}\,\backslash E}{[np \leadsto s]_j}\,\leadsto, i}{s}\,k \quad \dfrac{\dfrac{\textit{but}}{(s\backslash s)/s}\,\textit{lex} \quad \dfrac{\dfrac{\textit{it\_is\_unclear}}{s/q} \quad \dfrac{\dfrac{\dfrac{\textit{which}}{(q|(np \leadsto s))/n}\,\textit{lex} \quad \dfrac{\textit{philosopher}}{n}\,\textit{lex}}{q|(np \leadsto s)}\,/e}{q}\,|E, j}{s}\,/E}{s\backslash s}\,/E}{s}\,\backslash E}{np \leadsto s}\,\leadsto k
$$

Predictions

Antecedent must contain an indefinite

(12) *The cup moved, and Bill wonders which cup.

- First conjunct has category s
- *which cup* requires antecedent of category $np \rightsquigarrow s$
- $|$-elimination not applicable

Sluicing is island insensitive

- No transformational connection to non-elliptical counterpart
- No restrictions on scope of indefinites $\Rightarrow$ no restrictions on embedding depth of antecedent indefinites in Sluicing

(13) a. The administration has issued a statement that it is willing to meet with one of the student groups, but I'm not sure which one

b. *The administration has issued a statement that it is willing to meet with one of the student groups, but I'm not sure which one the administration has issued a statement that it is willing to meet with

from Chung, Ladusaw and McCloskey 1995

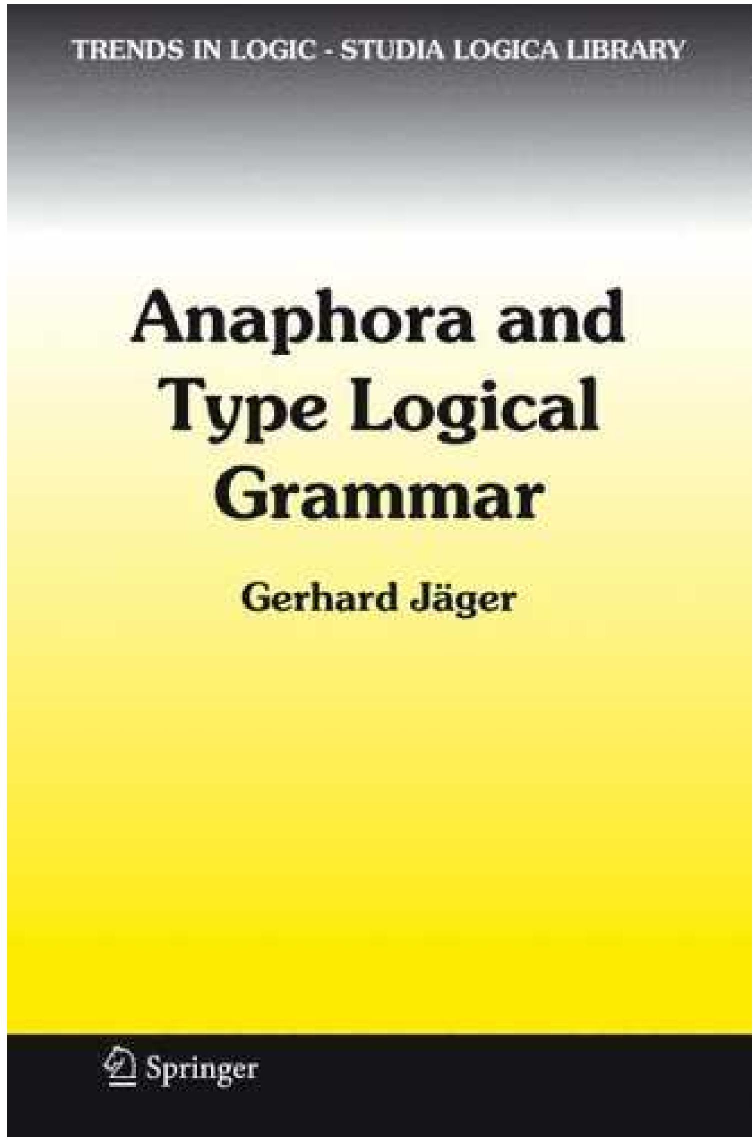
Morphological sensitivity

(14) Er will jemandem schmeicheln, aber sie wissen nicht {wem / *wen}
HE WANTS SOMEONE$_{\text{DAT}}$ FLATTER BUT THEY KNOW NOT $\{$WHO$_{\text{DAT}}$ / *WHO$_{\text{ACC}}\}$
'He wants to flatter someone, but they don't know whom'

- morphological information coded in syntactic category
- indefinite NP in dative has category $np(dat) \rightsquigarrow np(dat)$
- clause containing dative indefinite: $np(dat) \rightsquigarrow s$
- Sluicing remnant in dative: $q|(np(dat) \rightsquigarrow s)$

Conclusion

- Indefinites and pronouns are interpreted as (partial) identity functions
- Pronoun binding via syntactic deduction
- existential impact of indefinites is buried in truth definition/semantics of negation etc.
- descriptive content of indefinites is interpreted as domain restriction
- empirical coverage: specificity and sluicing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