Gerhard Jäger

Resource Sharing in Type Logical Grammar

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Outline of talk

- Jacobson's treatment of pronominal anaphora in CCG
- ullet $\mathbf{L}_{|}$: Lambek calculus + anaphora
- Linguistic application:
- Pronominal anaphora
- VP-ellipsis
- Cataphora
- Interaction of anaphora and hypothetical reasoning

Jacobson's proposal

- Semantics: pronouns denote identity functions
- \bullet Syntax: next to forward and backward looking categories, there are categories that look for an antecedent (A|B)
- Crucial inferences:

$$X, A, Y \Rightarrow B$$

$$X, A|C, Y \Rightarrow B|C$$
 $A \setminus A$

$$A \setminus B/C, C|A \Rightarrow A \setminus B$$

The logic $\mathbf{L}_{|}$

- Anaphors use a resource without consuming it
- Thus apparently some version of Contraction is called for.
- Makes search space infinite
- Finite reading property is lost.
- Semantic intuition:

 $a \models B | A \text{ iff } a \text{ behaves like a } B \text{ provided the context supplies an antecedent of type } A.$

Rule of use

$$Y\Rightarrow\alpha:B \qquad X,x:B,Z,y:A,W\Rightarrow\beta:C$$

$$X,Y,Z,z:A|B,W\Rightarrow\beta[x\leftarrow\alpha][y\leftarrow(z\alpha)]:C$$

• In presence of Cut equivalent to

 $x:A,y:B|A\Rightarrow \langle x,(yx)\rangle:A\bullet B$

plus

 $x:A,z:C,y:B|A\Rightarrow\langle x,z,(yx)\rangle:A\bullet C\bullet B$

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Theorem 1 Cut is admissible in $L_{|}$.

 Proof idea: Simultaneous induction over complexity of Cuts and number of distinct atoms in a proof.

Theorem 2 $\mathbf{L}_{|}$ is decidable and has the finite reading property.

 $\bullet\,$ Proof idea: Find a complexity measure that makes every sequent rule increase complexity

Definition 1

- 1. c(p) = 1
- 2. $c(A \setminus B) = c(A \bullet B) = c(A/B)$ = c(A) + c(B) + 1
- 3. c(A|B) = c(A) + 2c(B) + 5

Rule of proof

 $x: B, y: p, X \Rightarrow \langle x, y, \alpha \rangle : B \bullet p \bullet A \qquad x: B, X \Rightarrow \langle x, \alpha \rangle : B \bullet A$

 $X \Rightarrow \lambda x.\alpha : A|B$

ullet Side condition: the atom p does not occur anywhere else

Curry-Howard labeling is a genuine restriction

Natural Deduction format

$$x:B$$
 $y:p$: \vdots : \vdots $x:B$ $y:p$: \vdots : \vdots $x:B$ $y:A$ $y:A$

$$\frac{x:B \cdots y:A|B}{x:B \cdots (yx):A}|E$$

$$\begin{array}{cccc} & f:A|B\\ \hline & & i\\ \vdots & & \vdots\\ \vdots & & \vdots\\ & & \alpha:C\\ \hline & & \lambda x.\alpha:C|B \end{array} |I,i$$

$$[x:B]_i \quad \cdots \quad \dfrac{[y:A|B]_i}{(yx):A}|E$$

- Only constraint on anaphora resolution:
- The Antecedent must precede the pronoun (contrast to Jacobson and Hepple)

Simple cases

(1) a. John said he walked

<u></u> Б					
	$[j]:N]_i$	John			
$say'(walk'\ j')j':S$	say'(wa	$say': N\setminus S/S$	said		
	$say'(walk'\ j'): N\setminus S$	walk' j' : S	j':N	$[\lambda x.x:N N]_i$	he
	t	j' : <i>S</i>	$walk': N\setminus S \setminus E$	walked	

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VP Ellipsis

- (2) John revised his paper, and Harry did (too).
- ullet stranded auxiliary *did* is treated as proverb $(\lambda P.P:(N\setminus S)|(N\setminus S))$
- \bullet strict/sloppy ambiguity: pronoun is either identified with the actual subject or with a hypothetical premise that is discharged later

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Interaction with Quantification

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revised his paper

ullet Background: Moortgat's in situ binder q(N,S,S)

 $(N \setminus S)|(N \setminus S)|E$

-lex

- ullet to scope a quantifier, 1. insert an hypothetical N into its position, 2. derive the local clause, 3. discharge the assumption, and 4. apply the quantifier to the resulting predicate
- ullet Hypothetical N can serve as antecedent of a pronoun

and'(r'(p' h')h')(r'(p' j')j')

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(5) a. Everybody loves his mother

 $\frac{q(N,S,S)}{[N]_i} \frac{lex}{love} \frac{\frac{[N|N]_i}{mother'}}{\frac{N}{[N]_i}}$ $\sup_{S} s$ every $(\lambda x. \mathsf{love'}(\mathsf{mother'} x)x)$ S love'(mother'x)x $N \setminus S$ love'(mother'x) $\setminus E$ $\frac{\text{mother'}x}{}/E$ --qE, 1his mother

- Derivation of a bound reading for His mother loves everybody fails since the hypothetical N 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

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Embedded Antecedents

(6) a. Everybody's mother loves him

 $\overline{q(N,S,S)}$ lex everybodyN = 0 of ymother every'(λy .love'y(of'ymother')) $\frac{S}{\text{love'}y(\text{of'}y\text{mother'})}$ $\frac{mother}{CN}$ lex $\frac{loves}{N \setminus S/N}$ lex $\frac{1}{N \setminus S}$ $\frac{1}{N \setminus S}$ $\frac{N \setminus S}{\mathsf{love'}y} \setminus E$ $[N|N]_i$

Backward Anaphora

- Only constraint on anaphora: Antecedent/binder must precede anaphor
- What about cataphora?
- Four cases are to be considered
- 1. Interaction of anaphora and hypothetical reasoning
- 2. Accidental coreference
- 3. Backward binding
- 4. Psych verbs

(7) a. Which of his_i friends did everybody_i see

Interaction of anaphora and hypothetical reasoning # 1

Accidental coreference

- Antecedent of a pronoun may be supplied by context

Nothing prevents coreference with a name occurring after the pronoun

- Displays anaphoric de-accenting
- (8) He_i won the race and $\text{we} \left\{ \begin{array}{c} \text{WELCOMED John}_i \\ \text{*welcomed JOHN}_i \end{array} \right\}$

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Backward binding

- Evidence for non-accidental coreference would come from bound cataphoric pronouns
- excluded by Weak Crossover, as in
- (9) His mother gave every student a book
- Furthermore no sloppy readings with cataphora
- (10) a. John, gave his, mother a book and $Bill_j$ gave his, mother flowers
- b. Mary gave his; mother a picture of John;.
- c. *Mary gave his, mother a picture of John, and Sue gave his, mother a photo of Bill_j

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Apparent counterexample (from Williams 1997):

(11) Anyone who has written it, can turn [his term paper], in to me now

- Accidental coreference is impossible
- No sloppy reading, however:
- (12) Anybody who has written it can turn his term paper in to me and submit his thesis to the committee.
- Furthermore, the "antecedent" requires anaphoric de-accenting
- (13) ?Anyone who has written it can turn in HIS TERM PAPER to me now
- $^{\mbox{\tiny LS}}$ Proposal: it is a paycheck pronoun here (category: (N|N)|(N|N)), denoting the identity function over Skolem functions

Psych verbs

- (14) a. That he might someday meet the queen inspires every British soldier.
- That he had won encouraged John and electrified Bill
- Bound and sloppy readings possible
- Has to be taken care of in the lexicon
- Proposal: Curry and Fey's combinator S

 $x:(S\setminus S)/N\Rightarrow \lambda yz.xz(yz):(S|N)\setminus (S/N)$

is available as lexical rule (restricted to psych verbs)

Interaction of anaphora and hypothetical reasoning # 2

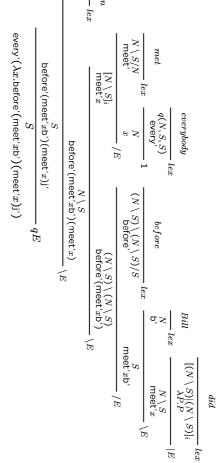
Quantification

- Sag's ambiguity
- (15) a. John met everybody before Bill did
- b. John met everybody before Bill met everybody
- John met everybody before Bill met him
- First reading: everybody receives VP scope before ellipsis resolution takes place

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second reading: ellipsis resolution before scoping



Focus

Sag-style interplay of A'-movement with VPE:

Wh-movement

- (16)a. who Mary met before Sue did.
- b. who Mary met before Sue met him
- $\lambda Qx.(\mathsf{before'}(\mathsf{meet'}x\;\mathsf{s'})(\mathsf{meet'}x\;\mathsf{m'}) \wedge Qx)$

 $RC/(S/\triangle N)$ whoMary-lex $N \setminus S/N$ $S/ \triangle N$ -/E $(N \setminus S) \setminus (N \setminus S)/S$ $(N \setminus S) \setminus (N \setminus S)$ -lex $[(N \setminus S)|(N \setminus S)]_i$

- If we assume that focus interpretation involves hypothetical reasoning as well, Kratzer's Tanglewood example falls out immediately
- (17) a. I only went to TANGLEWOOD because you did

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- b. I only went to TANGLEWOOD because you went to TANGLEWOOD
- c. I only went to TANGLEWOOD because you went there
- (17a) can only mean (17c), not (17b)
- Under a movement analysis of focus, this could be handled by "vehicle change"
- problems arise if pronominalization is not possible, as in
- (18) a. I'm even [prepared to walk TEN miles if you want me to]
- b. I'm even prepared to walk TEN miles if you want me to walk as many miles.

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- Gawron and Peters:
- (19) Every student revised his paper before the teacher did
- \bullet critical reading: Every student revised his paper before the teacher revised the students paper
- Delay quantifier scoping until the end:
- $\boldsymbol{-}$ plug a hypothetical N into the matrix subject position
- give the ellipsis a strict construal
- scope the quantifier