Formale Semantik
06. Quantifikation und Modelltheorie

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stets aktuelle Fassungen: `https://github.com/rsling/VL-Deutsche-Syntax`

Inhalt

From PC to F1

Back to semantics: F1

- before we turn to quantification in F1/F2 English:
- names refer to individuals
- itr. verbs refer to sets of individuals
- tr. verbs refer to sets of ordered pairs of individuals
- sentences refer to truth values

Reference of pronouns

- ***This** drives a Golf.*
- *this* = a pronominal NP
- denotes an individual
- but not rigidly
- fixed only within a specific context (SOA)

Pronouns and variables

- quantified expression: $(\forall x)Px$
- *for all assignments of 'this', 'this' has property P*
- Q evaluation in PC is algorithmic
- variables interpreted like definite pronominal NPs (within a fixed context)

Categories and lexicon

- $a \rightarrow$ const, var
- conn $\rightarrow \wedge, \vee, \rightarrow, \leftrightarrow$
- neg $\rightarrow \neg$
- Q $\rightarrow \exists, \forall$

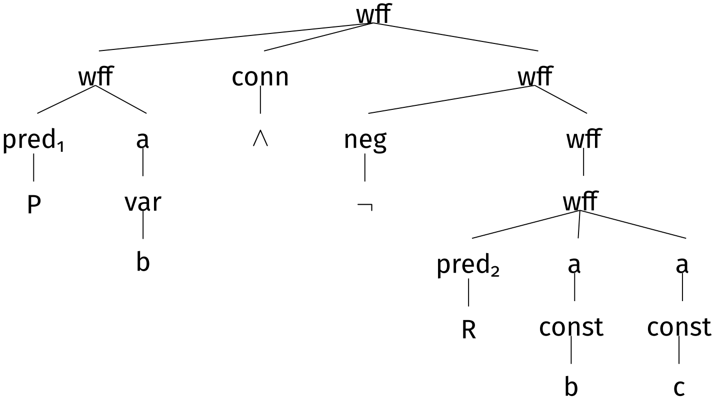
Categories and lexicon

- $\text{pred}_1 \rightarrow$ P, Q
- $\text{pred}_2 \rightarrow$ R
- $\text{pred}_3 \rightarrow$ S
- const $\rightarrow$ b, c
- var $\rightarrow x_1, x_2, ..., x_n$

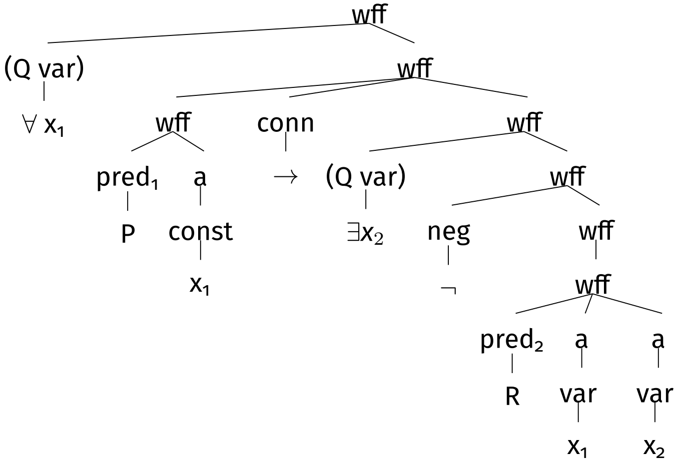
Phrase structure

- wff $\rightarrow$ pred_n a_1 a_2 ...a_n
- wff $\rightarrow$ neg wff
- wff $\rightarrow$ wff con wff
- wff $\rightarrow$ (Q var) wff

A wff without Q



A wff with Q's


wff
(Q var)
wff
$\forall$ x_1
wff
conn
wff
$pred_1$
a
$\rightarrow$
(Q var)
wff
P
const
$\exists x_2$
neg
wff
x_1
$\neg$
wff
$pred_2$
a
a
R
var
var
x_1
x_2

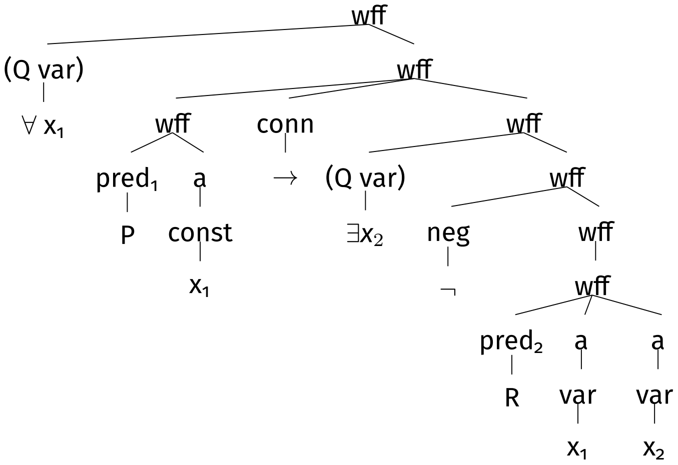
Definition of c-command

- Node A c-commands (constituent-commands) node B iff
  - A does not dominate B and
  - and the first branching node dominating A also dominates B.
- The definition in CM allows a node to dominate itself.

Configurational binding

- in configurational tree-structures:
- A variables is bound by the closest c-commanding coindexed quantifier.
- scope = binding domain

A wff with Q’s


wff
(Q var)
∀ x1
wff
wff
pred1
P
a
const
x1
conn
→
wff
(Q var)
∃x2
wff
neg
¬
wff
wff
pred2
R
a
var
x1
a
var
x2

Model theory

Refinement of PC semantics

- remember T-sentences: **S of L is true in v iff p**.
- $\mathcal{M}$ is a model of the accessible universe of discourse
  - $\mathcal{M} = \langle U_n, V_n \rangle$
  - U_n = the set of accessible individuals (domain)
  - V_n = a valuation function which assigns
    - individuals to names
    - sets of n-tuples of indivuiduals to $pred_n$
- **g** is function from variables to individuals in $\mathcal{M}$
- we evaluate: $[\![\alpha]\!]^{\mathcal{M}_n, g_n}$
- *the extension of α relative to $\mathcal{M}_n$ and g_n*

Fixed and context-bound denotation

- $\mathrm{V_n}$ valuates statically
- Q's require flexible valuation of pronominal matrices
- g_n is like $\mathrm{V_n}$ for constants, only flexible
- it can iterate through $\mathrm{U_n}$
- initial assignment can be anything:

$$g_1 = \begin{bmatrix} x_1 \rightarrow \textit{Herr Webelhuth} \\ x_2 \rightarrow \textit{Frau Eckardt} \\ x_3 \rightarrow \textit{Turm} - \textit{Mensa} \end{bmatrix}$$

Iterating through U_n

- for each Q loop, one modification
- read $g_n\,[d/x_m]$ as
  '...relative to g_n where x_m is reassigned to d'
- $[\![x_1]\!]^{\mathcal{M}_1,g_1[Eckardt/x_1]} = \textit{Frau Eckardt}$
- $[\![x_2]\!]^{\mathcal{M}_1,g_1[[Eckardt/x_1]Mensa/x_2]} = \textit{Mensa}$

Interpreting with g_n

- $[\![(\forall x_1)Px_1]\!]^{\mathcal{M}_1,g_1}$
- start with initial assignment: $[\![x_1]\!]^{\mathcal{M}_1,g_1} = \textit{Webelhuth}$
  check: $[\![Px_1]\!]^{\mathcal{M}_1,g_1}$
- modify: $[\![x_1]\!]^{\mathcal{M}_1,g_1[\textit{Eckardt}/x_1]} = \textit{Eckardt}$
  check: $[\![Px_1]\!]^{\mathcal{M}_1,g_1}$
- modify: $[\![x_1]\!]^{\mathcal{M}_1,g_1[\textit{Mensa}/x_1]} = \textit{Mensa}$
  check: $[\![Px_1]\!]^{\mathcal{M}_1,g_1}$
- iff the answer was never 0, then $[\![(\forall x_1)Px_1]\!]^{\mathcal{M}_1,g_1} = 1$

Multiple Q's: subloops

- $[\![(\forall x_1)(\exists x_2)Px_1x_2]\!]^{\mathcal{M}_1,g_1}$
- $[\![x_1]\!]^{\mathcal{M}_1,g_1} = \mathit{Webelhuth}$
  - $[\![x_2]\!]^{\mathcal{M}_1,g_1} = \mathit{Eckardt}$
  - $[\![x_2]\!]^{\mathcal{M}_1,g_1[\mathit{Webelhuth}/x_2]} = \mathit{Webelhuth}$
  - $[\![x_2]\!]^{\mathcal{M}_1,g_1[\mathit{Mensa}/x_2]} = \mathit{Mensa}$
- $[\![x_1]\!]^{\mathcal{M}_1,g_1[\mathit{Eckardt}/x_1]} = \mathit{Eckardt}$
  - $[\![x_2]\!]^{\mathcal{M}_1,g_1[\mathit{Eckardt}/x_1]} = \mathit{Eckardt}$
  - $[\![x_2]\!]^{\mathcal{M}_1,g_1[[\mathit{Eckardt}/x_1]\mathit{Webelhuth}/x2]} = \mathit{Webelhuth}$
  - $[\![x_2]\!]^{\mathcal{M}_1,g_1[[\mathit{Eckardt}/x_1]\mathit{Mensa}/x2]} = \mathit{Mensa}$
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  - $[\![x_2]\!]^{\mathcal{M}_1,g_1[[\mathit{Mensa}/x_1]\mathit{Mensa}/x_2]} = \mathit{Mensa}$

Problems with natural language

Natural weirdness

- quantifying expressions in NL beyond $\forall$ and $\exists$
- some seem to work differently:
- *All patients adore Dr. Rick Dagless M.D.*
  $(\forall x_1)Px_1 \rightarrow Ax_1d$ (ok)
- but: *Most patients adore Dr. Rick Dagless M.D.*
  $(MOST\ x_1)Px_1 \rightarrow Ax_1d$ (wrong interpretation)
- domain should be the set of patients, not individuals
- For NL: Assume that the checking domain for Q is the set denoted by CN.

Scope ambiguities

- c-command condition on binding/scope fails in NL
- no PNF's in NL
- Q and common noun (CN) usually in-situ (e.g., argument position)
- ambiguities independent of Q position
  - *Everybody loves somebody.* (*ELS*)
  - $(\forall x_1)(\exists x_2)Lx_1x_2$
  - $(\exists x_2)(\forall x_1)Lx_1x_2$
- Q ambiguity cannot be structural (e.g., $\exists$ will never c-command $\forall$)

Cases of overt movement and traces

- wh movement:
- *What$_i$ will Agent Cooper solve t$_i$?*
-
- passive movement:
- *(Laura Palmer)$_i$ was killed t$_i$.*
-
- raising verbs:
- *(Laura Palmer)$_i$ seems t$_i$ to be dead.*
-

Levels of representation

- construction of an independent representational level LF
- could use movement mechanism as used at surface level
- All quantifiers adjoin to the left periphery of S at LF.
- LF is constructed by syntactic rules!

Ambiguities at LF

- $[_{S''}$ *everybody*$_i$ $[_{S'}$ *somebody*$_j$ $[_S$ t_i *loves* t_j $]]]$
-
- $[_{S''}$ *somebody*$_j$ $[_{S'}$ *everybody*$_i$ $[_S$ t_i *loves* t_j $]]]$
-

Quantification in English: F2

The Q raising rule

$$[_S\ X\ NP\ Y\ ] \ \Rightarrow\ [_{S'}\ NP_i\ [_S\ X\ t_i\ Y\ ]]$$

- specify a PS as input and output
- QR rule also introduces coindexing of traces

Syntax

- copies all definitions from F1
- adds appropriate definitions of quantifying determiners etc.
  - $Det \rightarrow every, some$
  - $NP \rightarrow DetN_{common-count}$
- adds the QR rule
- assume introduction of reasonable syntactic types/rules without specifying
- assume admissible (reasonable, possible) models $\mathcal{M}$

Semantics for QR output: *every*

$$[\![\,[\,[\textit{every}\ \beta]_i\ S]\!]^{\mathcal{M},g} = 1 \textit{ iff for all } u \in U: \\ \textit{if } u \in [\![\beta]\!]^{\mathcal{M},g} \textit{ then } [\![S]\!]^{\mathcal{M},g[u/t_i]}$$

A sentence containing the trace t_i with an adjoined NP_i (which consists of *every* plus the common noun β) extend to 1 iff for each individual u in the universe U which is in the set referred to by the common noun β, S denotes 1 with u assigned to the pronominal trace t_i. g is modified iteratively to check that.

$$[\![\,[\,[a\ \beta]_i\ S]\!]^{\mathcal{M},g} = 1 \textit{ iff for some } u \in U:$$
$$u \in [\![\beta]\!]^{\mathcal{M},g} \textit{ and } [\![S]\!]^{\mathcal{M},g[u/t_i]}$$

(similar)

Literatur I

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