Unterspezifikation in der Semantik
Lexical Resource Semantics (LRS)

Laura Kallmeyer
Heinrich-Heine-Universität Düsseldorf

Wintersemester 2011/2012

Overview

1. The Framework
2. Core Principles
3. Quantifier Scope
4. Comparing LRS and LTAG

[Richter and Sailer, 2004]

Slides from a Tutorial on LTAG and LRS by Laura Kallmeyer and Frank Richter

The Framework (1)

- HPSG: Grammar = $\langle$Signature, Set of Principles$\rangle$
- Model theoretic: Linguistic expressions as sets of structures
- Consequences for LRS in HPSG:
  - LRS principles *describe* predicate logical expression
  - Underspecification on the description level

The Framework (2)

Lexical Resource Semantics:

- Feature-based grammar (signature and principles) of predicate logic. Type *me* (meaningful expression) encodes typed predicate logical expressions. In the following, we use however the standard predicate logic formulas instead of the corresponding feature structure description.
- Feature geometry for LRS with separaton of local content and an LF (logical form) attribute on signs with *lrs* value:

$$sign\left[\begin{array}{l} \text{SYNSEM LOC CONTENT} \begin{bmatrix} \text{VAR} & me \\ \text{MAIN} & me \end{bmatrix} \\ \text{LF} \quad lrs \begin{bmatrix} \text{EXTERNAL CONTENT} & me \\ \text{INTERNAL CONTENT} & me \\ \text{PARTS} & list \end{bmatrix} \end{array}\right]$$

The Framework (3)

Lexical entry for *John*:

$$\begin{bmatrix} \textsc{phon} & \text{John} \\ \textsc{synsem loc} & \begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head} & \text{noun} \end{bmatrix} \\ \textsc{content} & \begin{bmatrix} \textsc{var} & \boxed{1} john' \\ \textsc{main} & \boxed{1} john' \end{bmatrix} \end{bmatrix} \\ \textsc{lf} & \begin{bmatrix} \textsc{excont} & me \\ \textsc{incont} & \boxed{1} john' \\ \textsc{parts} & \langle \boxed{1} john' \rangle \end{bmatrix} \end{bmatrix}$$

The Framework (4)

Lexical entry for *laughs*:

$$\begin{bmatrix} \textsc{phon} & \text{laughs} \\ \textsc{synsem loc} & \begin{bmatrix} \textsc{cat} & \begin{bmatrix} \textsc{head} & \text{verb} \\ \textsc{subcat} & \langle \text{NP}_{\boxed{1}} \rangle \end{bmatrix} \\ \textsc{content} & \begin{bmatrix} \textsc{main} & \boxed{2a} laugh' \end{bmatrix} \end{bmatrix} \\ \textsc{lf} & \begin{bmatrix} \textsc{excont} & me \\ \textsc{incont} & \boxed{2} laugh'\Big(\boxed{1}\Big) \\ \textsc{parts} & \langle\ \boxed{2} laugh'\Big(\boxed{1}\Big), \boxed{2a} laugh'\ \rangle \end{bmatrix} \end{bmatrix}$$

The Framework (5)

- Principles that take care of the syntax-semantics interface:
  - EXCONT PRINCIPLE, INCONT PRINCIPLE
  - LRS PROJECTION PRINCIPLE
  - SEMANTICS PRINCIPLE
- Syntax: Can be HPSG.

Core Principles (1)

The INCONT PRINCIPLE (IContP):
In each *lrs*, the INCONT value is an element of the PARTS list and a component of the EXCONT value.

The EXCONT PRINCIPLE (EContP):

Clause (a):
In every phrase, the EXCONT value of the non-head daughter is an element of the non-head daughter's PARTS list.

Clause (b):
In every utterance, every subexpression of the EXCONT value of the utterance is an element of its PARTS list, and every element of the utterance's PARTS list is a subexpression of the EXCONT value.

Core Principles (2)

LRS Projection Principle: In each *headed-phrase*,

the EXCONT value of the head and the mother are identical,

the INCONT value of the head and the mother are identical,

the PARTS value contains all and only the elements of the PARTS values of the daughters.

Core Principles (3)

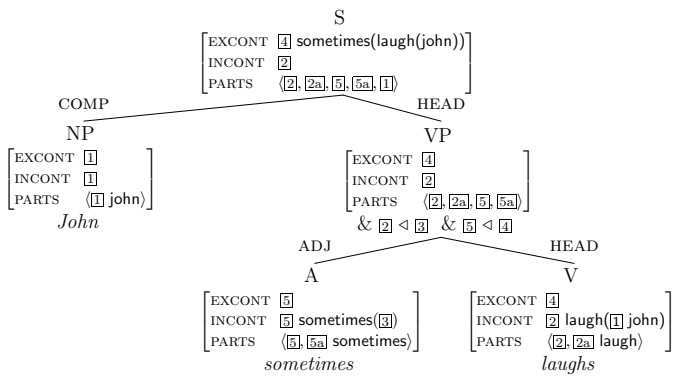
Lexical entry for *sometimes*:

$$\left[\begin{array}{ll}\text{PHON} & \text{sometimes} \\ \text{SYNSEM LOC} & \left[\begin{array}{ll}\text{CAT} & \left[\text{HEAD} \left[\text{MOD V LOC CONT MAIN } \boxed{2a}\right]\right] \\ \text{CONTENT} & \left[\text{MAIN } \boxed{5a}\mathit{sometimes}'\right]\end{array}\right] \\ \text{LF} & \left[\begin{array}{ll}\text{EXCONT} & \mathit{me} \\ \text{INCONT} & \boxed{5}\mathit{sometimes}'\left(\boxed{3}\right) \\ \text{PARTS} & \langle\, \boxed{5},\, \boxed{5a}\,\rangle\end{array}\right]\end{array}\right]$$

$\& \boxed{2a} \lhd \boxed{3}$

$\lhd$ signifies "being a subterm of".

Core Principles (4)



Core Principles (5)

Semantics Principle: In each *headed-phrase*,

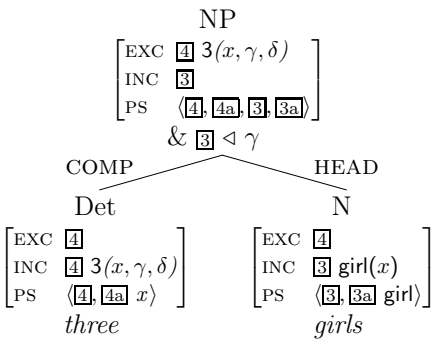
1. if the non-head is a quantifier then its INCONT value is of the form $Q(x, \rho, \nu)$, the INCONT value of the head is a component of ρ, and the INCONT value of the non-head daughter is identical with the EXCONT value of the head daughter;

2. if the non-head is a quantified NP with an EXCONT value of the form $Q(x, \rho, \nu)$, then the INCONT value of the head is a component of ν.

Consequently, 1. the noun of a quantified NP contributes to its restriction while 2. the verb the NP combines with contributes to its nuclear scope.

Core Principles (6)

$\exists(x, \ldots \mathsf{girl}'(x) \ldots, \ldots)$



Quantifier Scope (1)

Quantificational NPs: can in principle scope freely; their scope is not directly linked to their surface position.

(1) Exactly one student admires every professor
$\exists > \forall, \forall > \exists$

(2) Two policemen spy on someone from every city
$\forall > \exists > 2$ (among others)

(3) John seems to have visited everybody
$seem > \forall, \forall > seem$

(4) Three girls are likely to come
$three > likely, likely > three$

Quantifier Scope (2)

Two things must be guaranteed:

1. the proposition to which a quantifier attaches must be in its nuclear scope
2. a quantifier cannot scope higher than the next finite clause

Idea: scope window delimited by some maximal scope and some minimal scope for a quantifier.

Quantifier Scope (3)

LRS analysis: features EXCONT and INCONT are responsable for maximal and minimal scope of a quantifier:

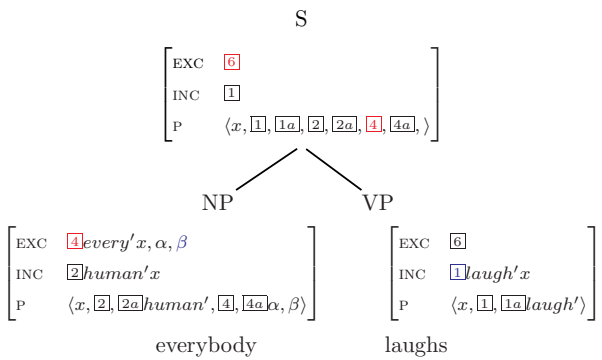
EXCONT PRINCIPLE:
a) The EXCONT of the non-head daughter is an element of the PARTS list of the non-head daughter.
b) In an utterance, everything on the PARTS list is a component of the EXCONT.

⇒ maximal scope of a quantifier: EXCONT of the next embedding utterance.

SEMANTICS PRINCIPLE:
If the non-head of a headed phrase is a quantified NP, then the INCONT of the head is a component of its nuclear scope.

⇒ minimal scope of a quantifier: INCONT of the verb it combines with.

Quantifier Scope (4)



Constraints: $\boxed{2} \lhd \alpha$ (from lexical entry of *everybody*), $\boxed{1} \lhd \beta$, $\boxed{4} \lhd \boxed{6}$

Quantifier Scope (5)

A simple example with scope ambiguity:

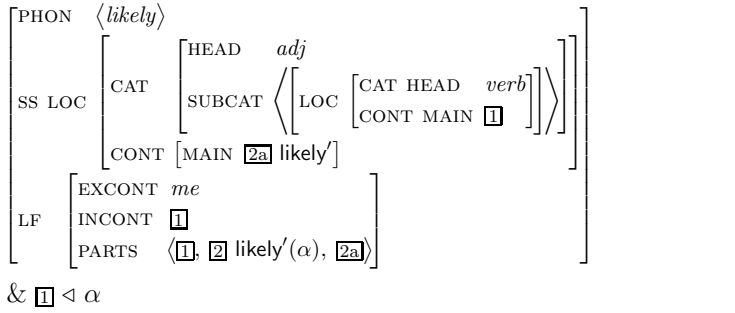
(5) Three girls are likely to come.

(6) Two readings:

a. $3(x, \mathsf{girl}'(x), \mathsf{likely}'(\mathsf{come}'(x)))$

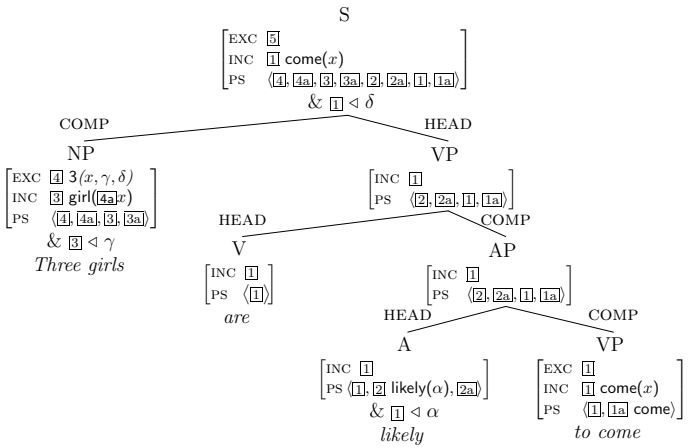
b. $\mathsf{likely}'(3(x, \mathsf{girl}'(x), \mathsf{come}'(x)))$

Quantifier Scope (6)

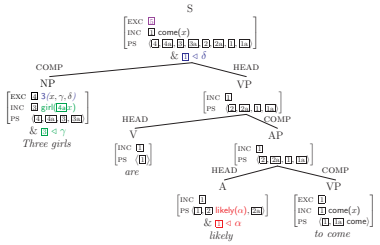


$\& \boxed{1} \lhd \alpha$

Quantifier Scope (7)



Quantifier Scope (8)



The grammar specifies two possible values for $\boxed{5}$:

1. $\boxed{5} = 3(x, \mathsf{girl}'(x), \mathsf{likely}'(\mathsf{come}'(x)))$
2. $\boxed{5} = \mathsf{likely}'(3(x, \mathsf{girl}'(x), \mathsf{come}'(x)))$

Quantifier Scope (9)

The approach models the freedom of quantifiers wrt scope

- using features for a quantifier scope window, and
- using underspecified representations involving 'component-of'-constraints

The use of feature structures and feature value identifications in combination with underspecification allows to avoid movements (in the syntax or in LF) as assumed in traditional generative semantics.

Quantifier Scope (10)

Three things may happen to the upper boundary of the scoping possibilities of an NP when that NP is the argument of some predicate P embedded under some higher predicate Q:

1. Q blocks NP-scope,
   (7) Mary thinks John likes everybody
   thinks > everybody, *everybody > thinks
2. Q lets the NP-scope pass imposing no limitations,
   (8) Mary tries to be nice to everybody
   tries > everybody, *everybody > tries
3. Q lets NP-scope pass imposing some limitations.
   (9) Two policemen spy on someone from every city
   $\forall > \exists > 2$ (among others), *$\forall > 2 > \exists$

Quantifier Scope (11)

LRS specifies scope islands in general grammar principles, like any other restrictions in HPSG.

Universal Boundary Principle
Universal quantifiers may not outscope finite clauses.

Quantified Complex NP Constraint
In a complex quantified NP, embedded quantifiers may only outscope the quantifier of the NP if they take immediate scope over it.

Comparison LRS and LTAG (1)

Similarities between LTAG and LRS:

- predicate logics for semantics
- scope constraints $\geq$ in LTAG and component-of constraints $\lhd$ in LRS for scope ambiguities
- scope window to delimit quantifier scope: MAXS and MINS in LTAG, EXCONT and INCONT in LRS
- feature logic for specifying and computing semantic representations

Comparison LRS and LTAG (2)

Differences between LRS and LTAG:

- Extended domain of locality in LTAG
- General principles in LRS vs. lexicalization in LTAG
- Interleaved specification of syntax and semantics in LRS vs. modular architecture in LTAG
- LRS: (partial) descriptions of fully specified models vs LTAG: underspecified representations in the style of Bos with subsequent disambiguation (pluggings)

References

[Richter and Sailer, 2004] Richter, F. and Sailer, M. (2004). Basic concepts of lexical resource semantics. In Beckmann, A. and Preining, N., editors, *ESSLLI 2003 – Course Material I, (*= Collegium Logicum*, 5)*, pages 87–143. Kurt Gödel Society, Wien.