Unterspezifikation in der Semantik
MRS and typed feature structures

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Overview

1. HPSG
2. MRS in typed feature structures
3. Using MRS in HPSG

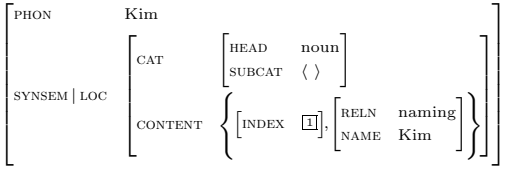
[Copestake et al., 2005]

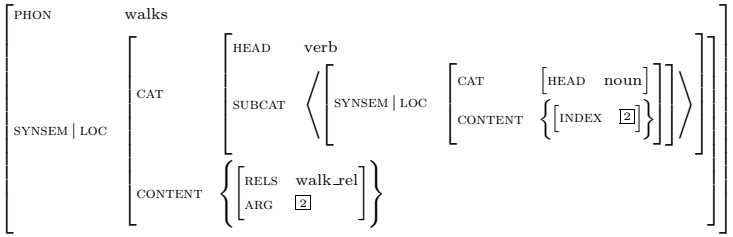
HPSG (1)

Miminal Recursion Semantics could, in principle, be integrated into any grammar formalism. So far, it is used in Head-Driven Phrase Structure Grammar (HPSG), [Pollard and Sag, 1994].

- HPSG is a constraint-based grammar formalism that uses typed feature structures.
- An HPSG grammar consists of
  1. a signature for typed feature structures that defines types and a type hierarchy, including a specification of attributes for each types and of the value types of attributes;
  2. a set of lexical constraints that specify the feature and values that are determined by lexical items;
  3. a set of principles that are more general constraints.

HPSG (2)



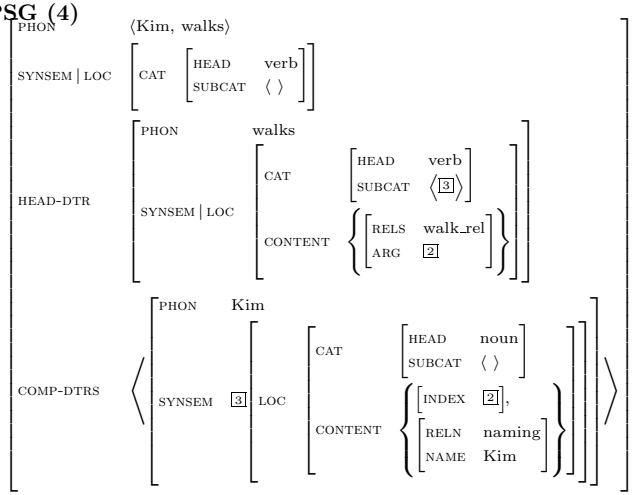


HPSG (3)

Principles:

- **Immediate Dominance Principle**: A headed *phrase* with SYNSEM|LOC|CAT|SUBCAT = ⟨ ⟩ has a DTRS list containing a phrasal HEAD-DTR and a list COMP-DTRS of phrasal complements.
- **Head Feature Principle**: The HEAD value of a *phrase* is identical to the HEAD value of its HEAD-DTR.
- **Subcategorization Principle**: In a headed *phrase*, the SUBCAT of the HEAD-DTR is the concatenation of the phrase's SUBCAT list and the SYNSEM values of the COMP-DTRS.

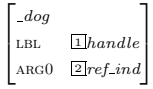
HPSG (4)

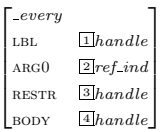


MRS in typed feature structures (1)

Encoding of EPs:

- The EP relation is encoded in the type of the fs.
- A feature LBL gives the labeling handle.
- There is one feature for each argument. These features can be ARG0, ARG1, ..., RESTR, BODY.
- There are types *handle* and *ref_ind* for handles and argument variables respectively. The values of LBL, RESTR and BODY are of type *handle*, those of ARG0, ARG1, ... of type *ref_ind*.





MRS in typed feature structures (2)

Encoding MRSs: A feature structure of type *mrs* has

- a feature HOOK (type *hook*) with features GTOP (global top) and LTOP (local top), both with values of type *handle*, and with an additional feature INDEX or type *ref_ind*;
- a feature RELS whose value is a list of EPs;
- a feature HCONS whose value is a list of features structures of type *qeq*.
- A fs of type *qeq* encodes a qeq constraint. It has features HARG and LARG encoding its hole and label argument. Both are of type *handle*.

Idea: the HOOK feature provides those things that need to be accessable when composing MRSs.

MRS in typed feature structures (3)

$$\begin{bmatrix} mrs \\ \text{HOOK} & \begin{bmatrix} hook \\ \text{GTOP} & \boxed{1} \\ \text{LTOP} & \boxed{7} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \_every \\ \text{LBL} & \boxed{2} \\ \text{ARG0} & \boxed{3} \\ \text{RESTR} & \boxed{4} \\ \text{BODY} & \boxed{10} \end{bmatrix}, \begin{bmatrix} \_dog \\ \text{LBL} & \boxed{6} \\ \text{ARG0} & \boxed{3} \end{bmatrix}, \begin{bmatrix} \_prbly \\ \text{LBL} & \boxed{7} \\ \text{ARG0} & \boxed{8} \end{bmatrix}, \begin{bmatrix} \_sleep \\ \text{LBL} & \boxed{9} \\ \text{ARG0} & \boxed{3} \end{bmatrix} \right\rangle \\ \text{HCONS} & \left\langle \begin{bmatrix} qeq \\ \text{HARG} & \boxed{1} \\ \text{LARG} & \boxed{7} \end{bmatrix}, \begin{bmatrix} qeq \\ \text{HARG} & \boxed{4} \\ \text{LARG} & \boxed{6} \end{bmatrix}, \begin{bmatrix} qeq \\ \text{HARG} & \boxed{8} \\ \text{LARG} & \boxed{9} \end{bmatrix} \right\rangle \end{bmatrix}$$

(some types are omitted for reasons of space)

MRS in typed feature structures (4)

Lexical entries for *dog* and *every*:

$$\begin{bmatrix} mrs \\ \text{HOOK} & \begin{bmatrix} hook \\ \text{GTOP} & \boxed{1} \\ \text{LTOP} & \boxed{2} \\ \text{INDEX} & \boxed{3} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \_dog \\ \text{LBL} & \boxed{2} \\ \text{ARG0} & \boxed{3} \end{bmatrix} \right\rangle \\ \text{HCONS} & \langle\,\rangle \end{bmatrix} \qquad \begin{bmatrix} mrs \\ \text{HOOK} & \begin{bmatrix} hook \\ \text{GTOP} & \boxed{21} \\ \text{LTOP} & \boxed{22} \\ \text{INDEX} & \boxed{23} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \_every \\ \text{LBL} & \boxed{24} \\ \text{ARG0} & \boxed{23} \\ \text{RESTR} & \boxed{25} \\ \text{BODY} & \boxed{26} \end{bmatrix} \right\rangle \\ \text{HCONS} & \left\langle \begin{bmatrix} qeq \\ \text{HARG} & \boxed{25} \\ \text{LARG} & \boxed{27} \end{bmatrix} \right\rangle \end{bmatrix}$$

Composition: We must make sure $\boxed{27}$ and $\boxed{2}$ get identified as well as $\boxed{3}$ and $\boxed{23}$.

MRS in typed feature structures (5)

Lexical entries for *probably* and *sleep*:

$$\begin{bmatrix} mrs \\ \text{HOOK} & \begin{bmatrix} hook \\ \text{GTOP} & \boxed{11} \\ \text{LTOP} & \boxed{12} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \_prbly \\ \text{LBL} & \boxed{12} \\ \text{ARG0} & \boxed{13} \end{bmatrix} \right\rangle \\ \text{HCONS} & \left\langle \begin{bmatrix} qeq \\ \text{HARG} & \boxed{13} \\ \text{LARG} & \boxed{14} \end{bmatrix} \right\rangle \end{bmatrix} \qquad \begin{bmatrix} mrs \\ \text{HOOK} & \begin{bmatrix} hook \\ \text{GTOP} & \boxed{31} \\ \text{LTOP} & \boxed{32} \\ \text{INDEX} & \boxed{33} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \_sleep \\ \text{LBL} & \boxed{32} \\ \text{ARG0} & \boxed{33} \end{bmatrix} \right\rangle \\ \text{HCONS} & \langle\,\rangle \end{bmatrix}$$

Composition: We must make sure $\boxed{14}$ and $\boxed{32}$ get identifide.

Using MRS in HPSG (1)

Integrating MRS into HPSG:

- The value of the CONT (CONTENT) attribute, embedded under SYNSEM|LOCAL is of type *mrs*.
- Depending on the specific semantics, we distinguish sub-types *intersective-phrase* and *scopal-phrase* of *phrase*.
- Furthermore, we assume, slightly simplifying, that every syntactic node has two daughters and that the first is the semantic head which is HOOK-identical with the mother.

Using MRS in HPSG (2)

The following principles are adopted for semantics:

The HOOK of the mother is the HOOK of the semantic head daughter, GTOPs are equated and RELS and HCONS are accumulated.

$$\begin{bmatrix} \textit{phrase} & \\ \text{CONT} & \begin{bmatrix} \text{HOOK} & \boxed{1}\begin{bmatrix}\text{GTOP} & \boxed{0}\end{bmatrix} \\ \text{RELS} & \boxed{2}+\boxed{3} \\ \text{HCONS} & \boxed{4}+\boxed{5} \end{bmatrix} \\ \text{DTR1} \mid \text{CONT} & \begin{bmatrix} \text{HOOK} & \boxed{1} \\ \text{RELS} & \boxed{2} \\ \text{HCONS} & \boxed{4} \end{bmatrix} \\ \text{DTR2} \mid \text{CONT} & \begin{bmatrix} \text{HOOK} & \begin{bmatrix}\text{GTOP} & \boxed{0}\end{bmatrix} \\ \text{RELS} & \boxed{3} \\ \text{HCONS} & \boxed{5} \end{bmatrix} \end{bmatrix}$$

Using MRS in HPSG (3)

In an intersective phrase, LTOPs are equated which amounts to putting things in a bag and thereby interpreting them conjunctively:

$$\begin{bmatrix} \textit{intersective-phrase} & \\ \text{DTR1} \mid \text{CONT} \mid \text{HOOK} \mid \text{LTOP} & \boxed{1} \\ \text{DTR2} \mid \text{CONT} \mid \text{HOOK} \mid \text{LTOP} & \boxed{1} \end{bmatrix}$$

Using MRS in HPSG (4)

In a scopal phrase, the LTOP of the non-head daughter is qeq embedded under the scopal argument.

$$\begin{bmatrix} \textit{scopal-phrase} & \\ \text{DTR1} \mid \text{CONT} & \begin{bmatrix} \text{HOOK} & \boxed{1}\begin{bmatrix}\text{LTOP} & \boxed{0}\end{bmatrix} \\ \text{RELS} & \left\langle \ldots, \begin{bmatrix}\textit{scopal-reln} \\ \text{LTOP} & \boxed{0} \\ \text{ARG1} & \boxed{1}\end{bmatrix}, \ldots \right\rangle \\ \text{HCONS} & \left\langle \ldots, \begin{bmatrix}\textit{qeq} \\ \text{HARG} & \boxed{2} \\ \text{LARG} & \boxed{3}\end{bmatrix}, \ldots \right\rangle \end{bmatrix} \\ \text{DTR2} \mid \text{CONT} & \begin{bmatrix} \text{HOOK} & \begin{bmatrix}\text{LTOP} & \boxed{3}\end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Quantifiers are not scopal phrases, only scopal adverbs such as *probably*, *alledgedly*, sentence-embedding verbs such as *think*, *want*, etc.

Using MRS in HPSG (5)

In other words, scopal phrases are "handle-taking" since they embed the LTOP of their argument.

Consequently, the scope order of these phrases is fixed by the order of their composition. This correctly predicts the following scope orders:

(1) Bill thinks that Mary probably wins the race
thinks $>$ *probably*, *probably* $\not>$ *thinks*

(2) John seems to want to win the race
seems $>$ *want*, *want* $\not>$ *seems*

Using MRS in HPSG (6)

Furthermore, in between all these operators, there are qeq relations and therefore quantifiers can float in. This correctly predicts

(3) every boy seems to win the race
seems $>$ *every*, *every* $\not>$ *seems*

(4) a unicorn appears to be approaching
a $>$ *appears*, *appears* $\not>$ *a*

References

[Copestake et al., 2005] Copestake, A., Flickinger, D., Pollard, C., and Sag, I. A. (2005). Minimal recursion semantics: An introduction. *Research on Language and Computation*, 3:281–332.

[Pollard and Sag, 1994] Pollard, C. and Sag, I. A. (1994). *Head-Driven Phrase Structure Grammar*. Studies in Contemporary Linguistics. The University of Chicago Press, Chicago, London.