

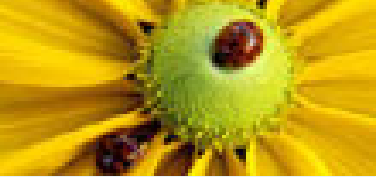
Linking by Types in the Hierarchical Lexicon (Davis 2001, ch. 4-7)

Seminar: Morphosyntax-Semantics Interface in Lexicalist Theories - Valia Kordoni

Joël Wagner

Universität des Saarlandes

wagner@coli.uni-sb.de



Overview

● Overview

HPSG: A brief description

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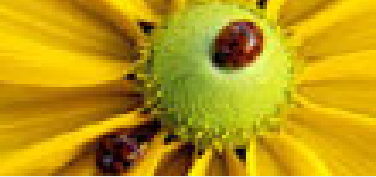
Linking Constraints 2

Prepositional Complements

Passive Verbs

Conclusions

- Brief description of HPSG.
- Linking Constraints in a strongly grounded lexical hierarchy.
- Interaction of Semantics and Subcategorization.
- Prepositional Complements.
- Passive verbs and "By" Phrases.
- Conclusions.



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- Unification
- Semantics of predicators
- Linking

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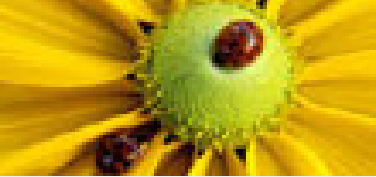
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AVMs

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● **AVMs**

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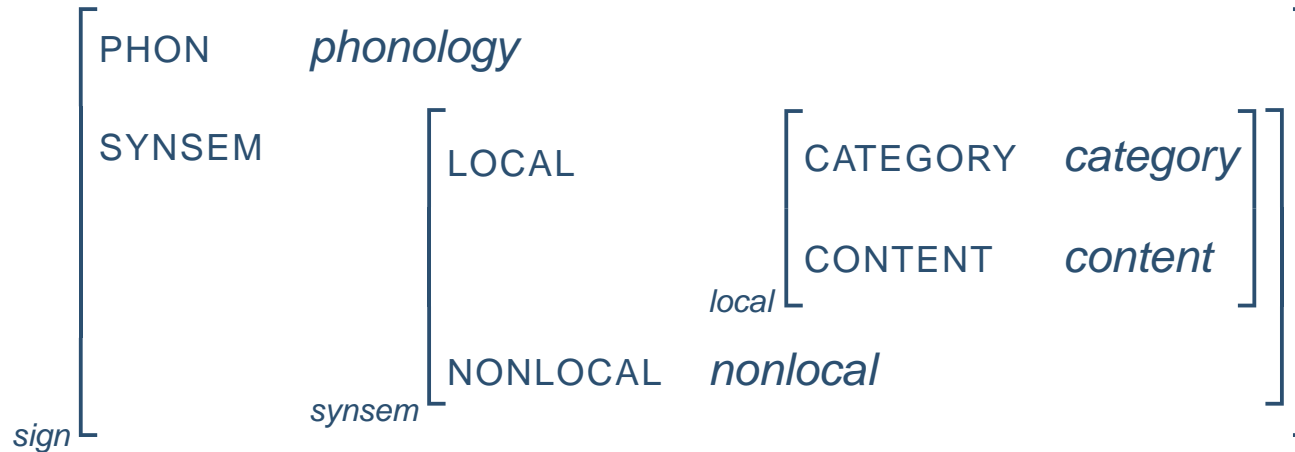
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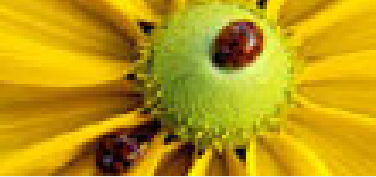
Conclusions

■ The sign



■ The class of verbs that have semantics of the type *act-rel*:





Unification

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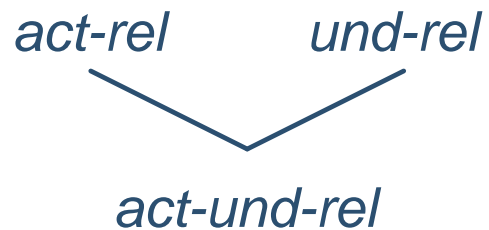
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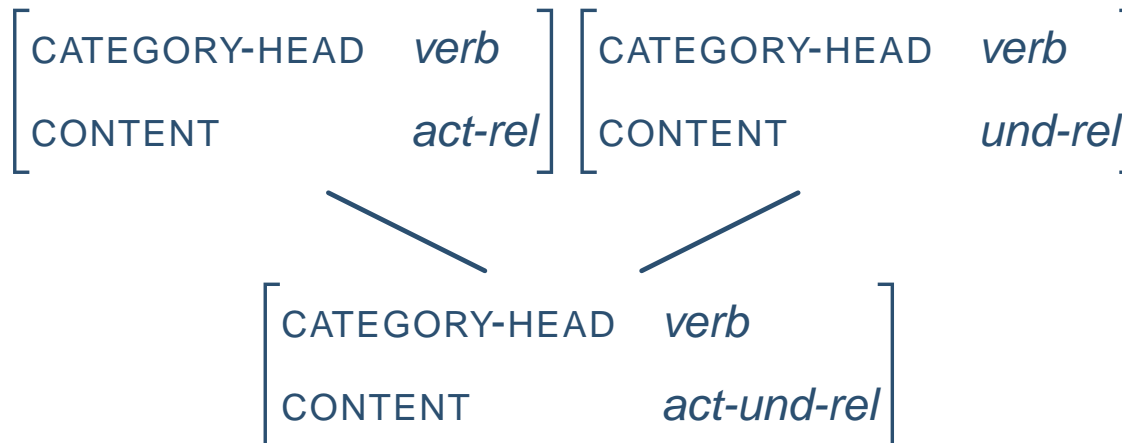
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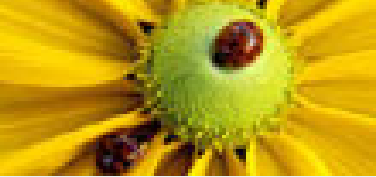
Conclusions

- Unification: the operation of combining two or more descriptions of an object into a single coherent description.
- part of the hierarchy of lexical semantic relations:



- successful unification:





Semantics of predicates

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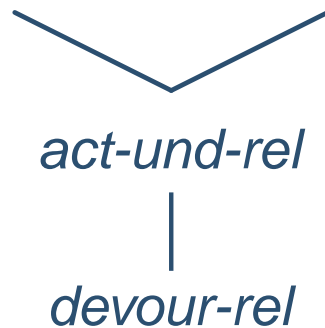
- Predicators: verbs and predicative prepositions, which have a semantics involving a situation type in which one or more entities participate.

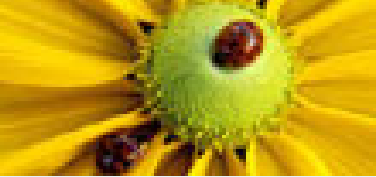
- Example: "devour"

<i>devour-rel</i>	ACT
	UND

- The semantics of predicates are treated as types arranged in a multiple inheritance hierarchy.

- The *devour-rel* is a subtype of the *act-und-rel*.





Linking

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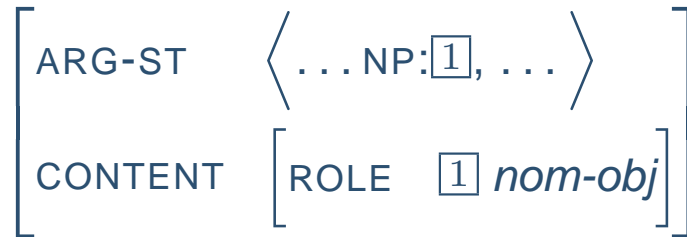
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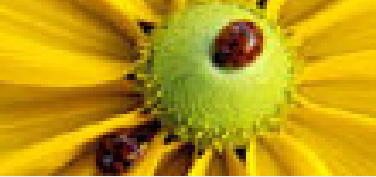
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- Structure sharing: two attributes are token-identical.
- Linking between semantic roles and syntactic arguments.



- ARG-ST list (simplified): the canonical surface order of constituents in English. Usually SUBJ ⊕ COMPS.
- Colon: The following tag designates the content value.
- The boxes represent structure sharing.
- ROLE is a variable that stands for any proto-role attribute.
- some HPSG sort partitions:
 - ◆ content: psoa, nom-obj (nominal-object), quant
 - ◆ nom-obj: nonpronoun (npro), pronoun (pron)



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- Alternative *und-It*
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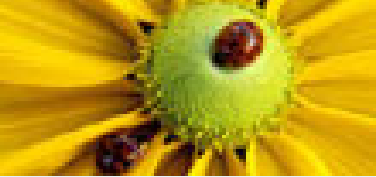
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Semantic Grounding



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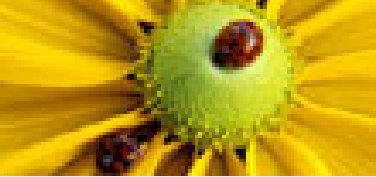
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- If one verb's semantics is a more specific instance of another's, then the linking of arguments in the semantically more specific verb reflects a possible linking pattern for the semantically more general verb.
- "devour" is semantically more specific than "eat".
"devour" allows only transitive subcategorization.
→ "eat" allows transitive subcategorization.
- "gorge" is semantically more specific than "eat".
"gorge" allows only intransitive subcategorization.
→ "eat" allows intransitive subcategorization.
- "eat" allows transitive and intransitive subcategorization.
- but:
 - ◆ the principle holds only for direct objects:
"gorge on" \nrightarrow "*eat on".
 - ◆ "ingest" is less specific than "eat", but obligatory transitive.



Linking Types

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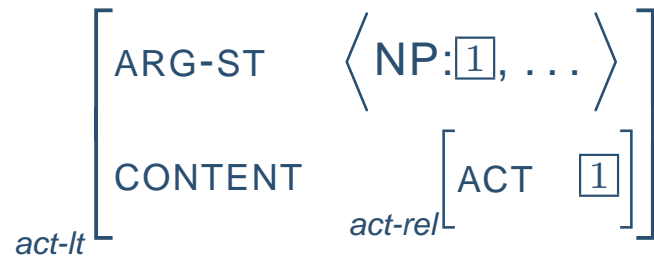
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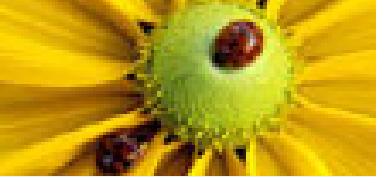
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- Example: intransitive verbs like "laugh", "walk":



- The type *act-lt* specifies a linking constraint, which all words of this type will have to obey.
- Each linking constraint is a partial specification of the semantic type and subcategorization of a lexical entry.
- The combination of them determines the lexical entry's subcategorization.
- The linking types are subtypes of *predicator*.



Semantic Grounding Principle

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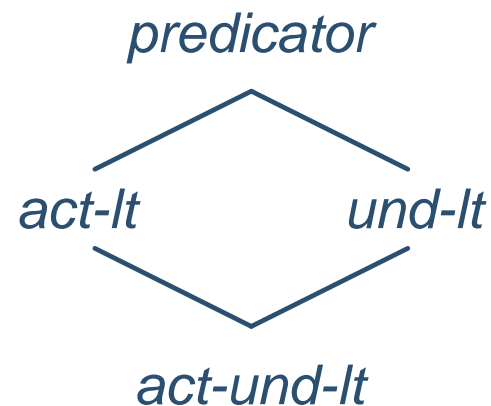
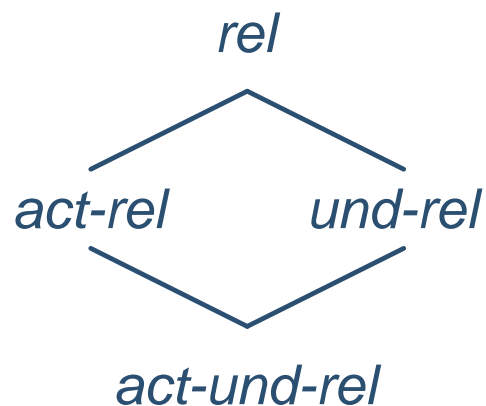
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- Let $s1$ and $s2$ be two semantic relations (i.e., subtypes of rel) such that $s2$ is a proper subtype of $s1$. Then every linking type $lt2$ with CONTENT of type $s2$ is a subtype of every linking type $lt1$ with CONTENT of type $s1$.
- hierarchies of lexical semantic relations and of linking types:





act-It and und-It

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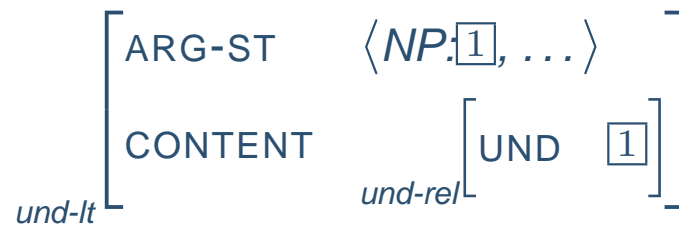
Conclusions

■ act-It:

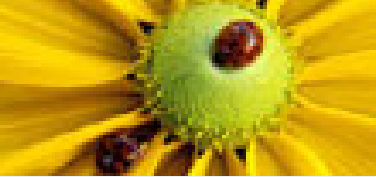


Example: Peter laughs.

■ und-It (first version):



Example: The snow melts.



act-und-It

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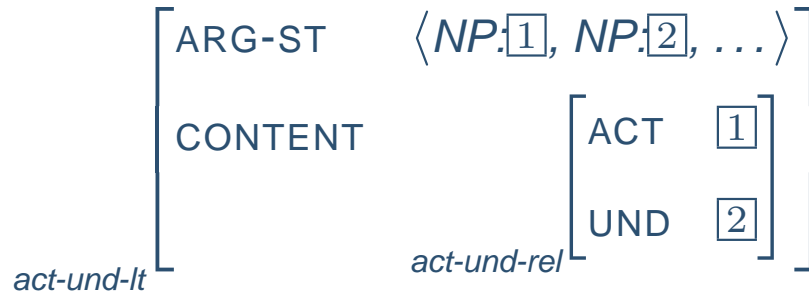
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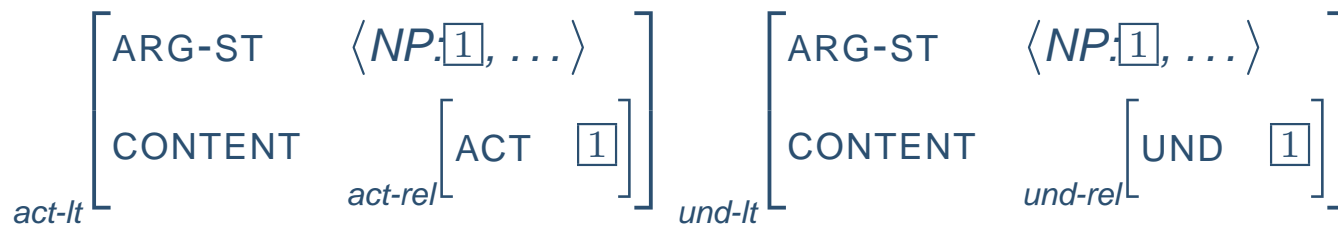
Conclusions

- An *act-und-It* should look like this:

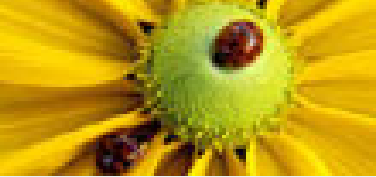


Example: Peter hits a wall.

- But this gets inherited from *act-It* and *und-It*:



- There's a conflict with the first NP getting linked to both ACT and UND.



Alternative *und-lt*

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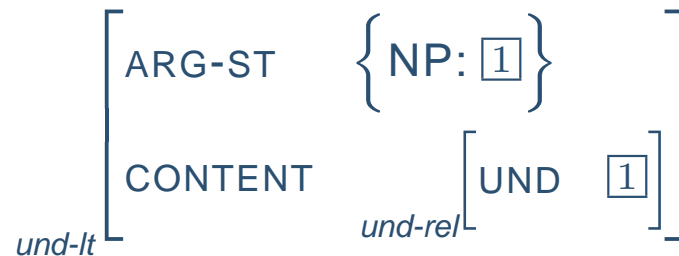
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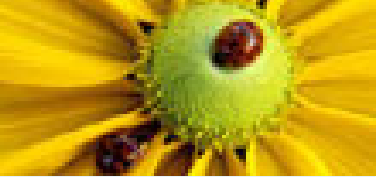
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■ Alternative *und-lt*:



- The curly brackets indicate a vagueness to the NP's position.
- If no other semantic roles are linked to elements on the ARG-ST list, then the undergoer will be the first element in the ARG-ST list.
- In the case of actor-undergoer verbs, that position is taken; the type *act-und-rel* specifies that the undergoer is linked to the second element.

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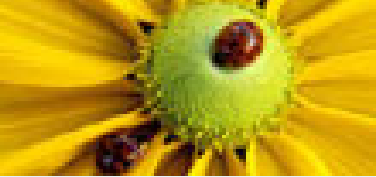
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- The grounding principle requires us to specify a certain set of types in the lexical hierarchy as linking types.
- It also requires lexical entries to inherit from all of the applicable types.
- The grounding principle ensures the inheritance of information from linking types with a more general CONTENT value to those with more specific CONTENT values.
- However such inheritance is only required of linking types.
- A lexical entry might inherit from a very general linking type, but not from more specific ones that its semantics is compatible with, unless that lexical entry itself were declared to be a linking type.
- So a lexical entry could stipulate any kind of odd linking for those semantic roles whose linking is left unspecified by the general linking type.

Problems



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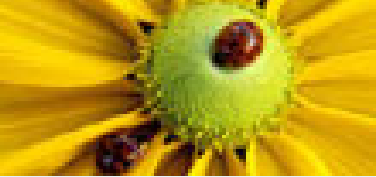
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Conclusions

- Which types in the lexical hierarchy count as linking types?
 - ◆ Only predicator, *act-It*, *und-It* and *act-und-It*.
 - Weak model because it doesn't require every lexical item to inherit from all the linking types whose semantics are compatible.
 - Nothing forbids the existence of lexical items with arbitrary linking patterns, and the grounding principle has no force.
 - ◆ Every type, including the lexical entries themselves, becomes a linking type.
 - The semantic content of a predicator would precisely determine which of its semantic roles are realized syntactically and how they are realized.
 - Semantic generalizations about classes of predicators would be lost in the linking type hierarchy.
 - Example: *load/spray* alternations.
- This model ties subcategorization too closely to semantics.



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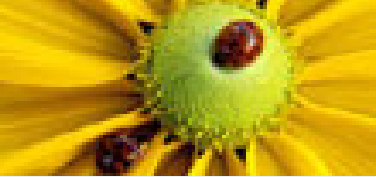
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Lex. Sem. & Syn. Valence

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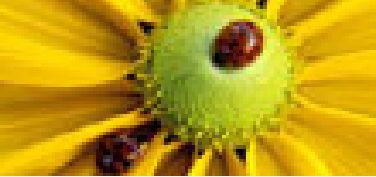
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- Interaction of lexical semantics and syntactic valence:
Using independent specifications of a predicator's semantics and its syntactic valence to determine its linking pattern.
- Two related principles substitute for the grounding principle:
 - ◆ One concerns the mapping between relations and predicators.
 - ◆ The other concerns the mapping between valence and predicators.



Principle 1

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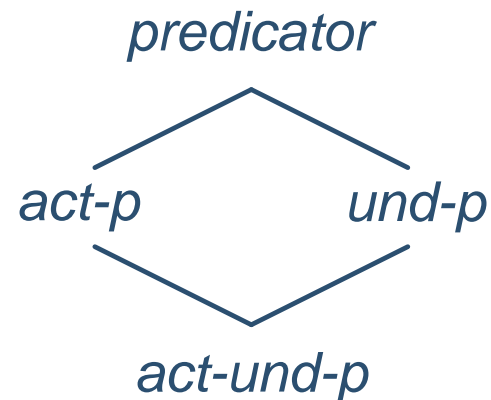
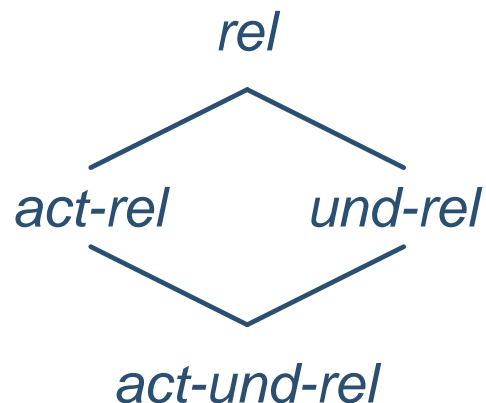
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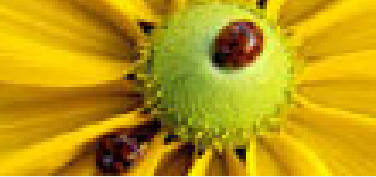
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Conclusions

- If s is a type in the semantic relations hierarchy and there exists a type in the lexical hierarchy with CONTENT of type s , then there exists a type $s-p$ in the lexical hierarchy with CONTENT of type s such that every type in the lexical hierarchy with CONTENT a subtype of s is a subtype of $s-p$.
- Type hierarchies: Semantic relations & Relation predictors:





Valence types

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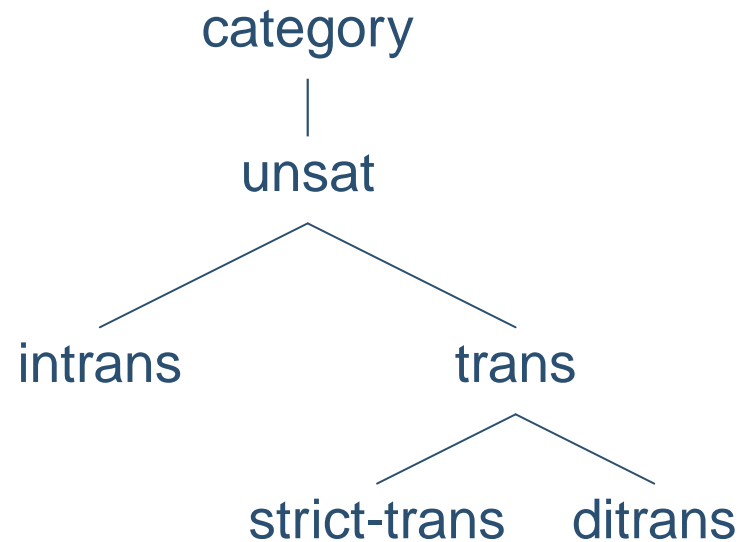
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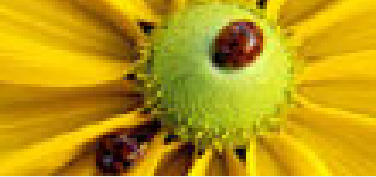
■ Hierarchy of valence types:



unsat [ARG-ST {XP}]

trans [COMPS {NP}]

ditrans [COMPS {NP, NP}]



Principle 2

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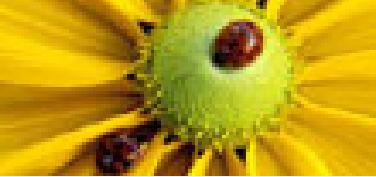
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- If v is a type of valence (a subtype of *category*) and there exists a type in the lexical hierarchy with CATEGORY of type v , then there exists a type $v-p$ in the lexical hierarchy with CATEGORY of type v such that every type in the lexical hierarchy with CATEGORY a subtype of v is a subtype of $v-p$.



Valence predictor types

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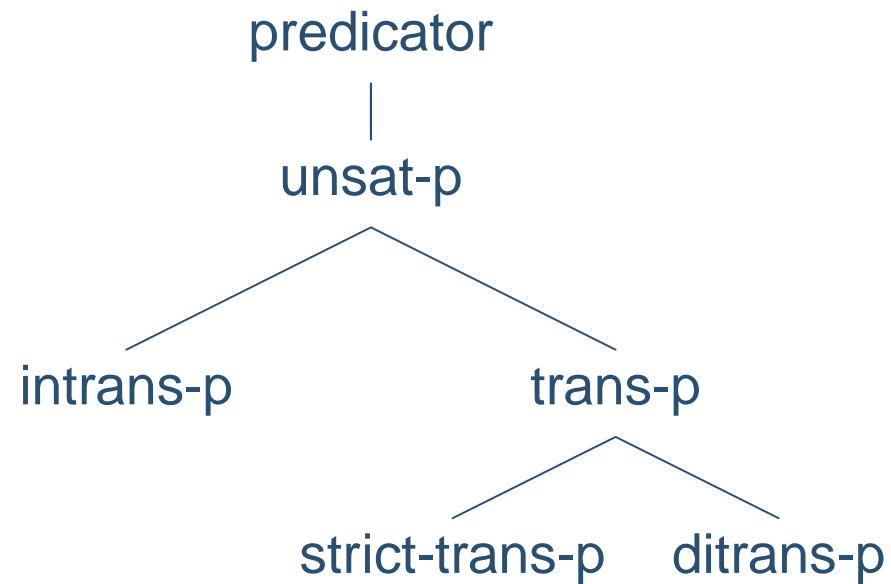
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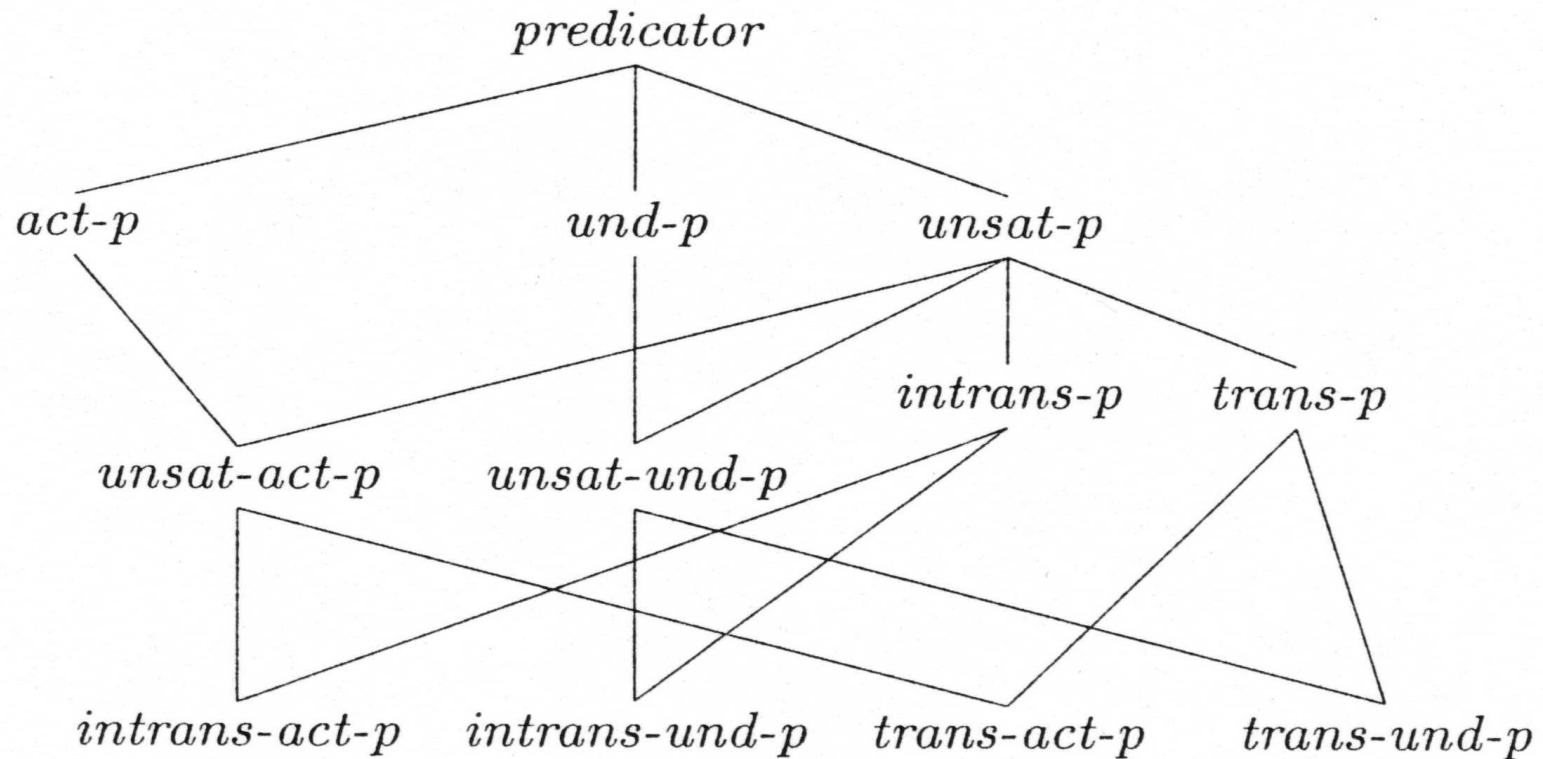
Conclusions

■ Hierarchy of valence predictor types:



Subtypes hierarchy

- Subtypes of relation and valence predictors at the top of the lexical hierarchy, as a result from the two principles:



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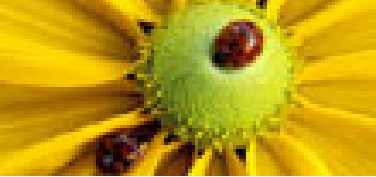
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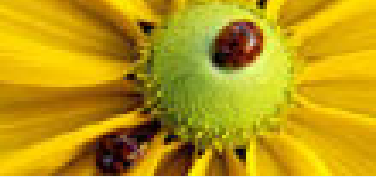
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- Linking types are those types that inherit from a relation predictor and from a valence predictor.
- They specify constraints on word classes.
- Example: The linking type *unsat-act-p* is the greatest lower bound of *act-p* and *unsat-p*. It is equivalent to the act-It in the previous section.
- The linking type *unsat-act-p* inherits
 - ◆ a type specification for CONTENT from *act-p*.
 - ◆ a type specification for valence features from *unsat-p*.





Other linking constraints

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- Unconstrained semantic roles may be linked to any element of the ARG-ST list or not at all.
- There's redundancy in specifying the linked semantic roles for each individual predicator.
- It is useful to have types in the lexical hierarchy that specifically link each proto-role to some (arbitrary) element of the ARG-ST list.
- "UND is linked to some element of the ARG-ST list.":



- It is a subtype of *unsat-und-p*.
- It applies to both the transitive "eat" and the transitive and intransitive "shatter", but not to the intransitive "eat", which is a subtype only of *unsat-und-p*.

Actor Priority



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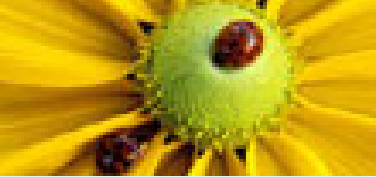
- Conclusions

- Free variation among ditransitive verbs does not seem to occur in English: "* Marge gave a donut Homer."

- Elements of the ARG-ST list linked to an ACT attribute precede elements that are not.

- $$\left[\begin{array}{l} \text{ARG-ST} \quad \langle XP, \dots \boxed{3} XP: \boxed{1} \dots \rangle \\ \text{CONTENT} \quad [\Pi [A [ACT \boxed{1}]]] \end{array} \right] \rightarrow \left[\begin{array}{l} \text{ARG-ST} \quad \langle \dots XP: \boxed{2}, \boxed{3}, \dots \rangle \\ \text{CONTENT} \quad [\Pi [ACT \boxed{2}]] \end{array} \right]$$

- Π is a variable over paths of proto-role attributes.
- A is a variable over proto-role attributes.
- For any ACT attribute at some arbitrary depth in a lexical semantic structure linked to an element of the ARG-ST list, the immediately preceding element of ARG-ST is linked to an actor one level less embedded in that semantic structure.
- The "second-highest" actor immediately follows the top level actor.



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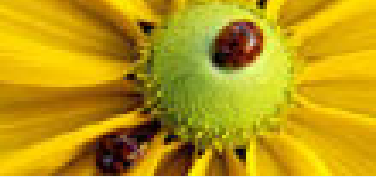
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- Subcategorization is essentially determined by semantics.
- The first model captures a lot of regularities, but doesn't allow for semantic classes of verbs that vary slightly in their subcategorization.
- The second model improved by permitting subcategorization information to be stated independently of a predicator's semantics.
- A small set of linking constraints suffice to constrain the mapping between semantics and subcategorization.
- It leaves open the possibility to specify additional constraints for small sets of predicators.



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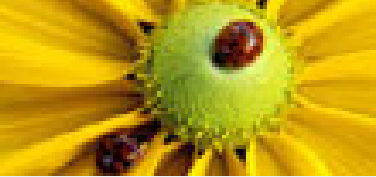
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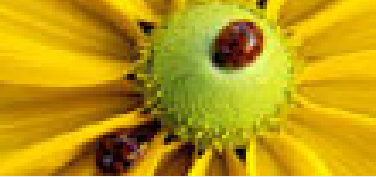
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- Examples of PP complements:
 - ◆ Bart tampered with Lisa's bicycle.
 - ◆ Homer thinks of/thinks about beer.
 - ◆ Burns depends on/counts on/relies on Smithers.
- Some PP's are required for grammaticality.
- The ARG-ST list of these verbs requires a particular PP (headed by "on", "with", "about", ...).
- Many prepositions that head PP complements are semantically contentful.
- The semantic content of such PP's is structure-shared with (a part of) the content of the predicators that they are complements of.
- Both subcategorization and semantic compatibility therefore determine which PP's may occur with a given verb.



Content-sharing

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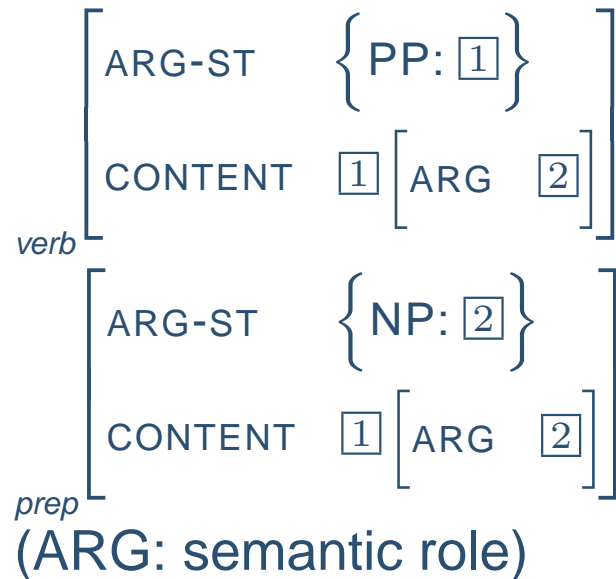
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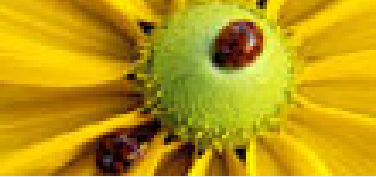
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- Content-sharing: A predicator subcategorizes for PP complements, whose semantic content unifies with that of the predicator.
- The CONTENT of a verb and the CONTENT of its PP complement is the same object, to which the PP may contribute additional information.
- Content-sharing between verb and preposition:



Type-compatibility



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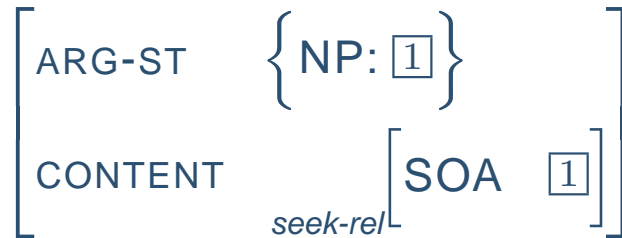
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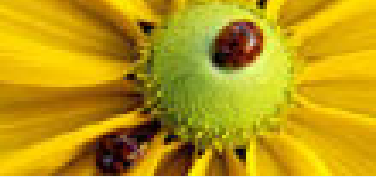
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- Example: "for"



- Type-compatibility accounts for a large part of the distribution of type PP complements.
- The "for" above is compatible with verbs with semantics that do not entail (but permit) the presence of a "sought" entity, given the proper context.
- "Claude ate 20 hotdogs for the prize money."
- But it's incompatible with the semantics of "fear" or "grow":
"Claude feared for his life."



Linking

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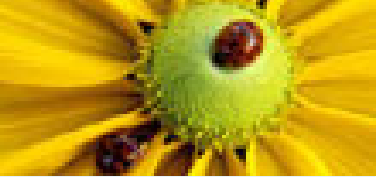
Conclusions

- PP complements are best regarded as having no subjects, because prepositions, as predicators, should be subject to the same linking constraints as verbs.
- PP complements share semantic roles, but not syntactic arguments, with the predicators that subcategorize for them.
- lexical entry for "for" as in "*Kim for the train"

SUBJ	⟨ ⟩				
COMPS	⟨ NP: [2] ⟩				
ARG-ST	⟨ NP: [1], NP: [2] ⟩				
CONTENT	<table style="border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding-right: 10px;">ACT</td> <td style="padding-left: 10px;">[1]</td> </tr> <tr> <td style="border-right: 1px solid black; padding-right: 10px;">SOA</td> <td style="padding-left: 10px;">[2]</td> </tr> </table>	ACT	[1]	SOA	[2]
ACT	[1]				
SOA	[2]				

seek-rel

- "Atypical": ARG-ST isn't SUBJ ⊕ COMPS, but linking constraints get preserved and * because the SUBJ list being empty, the head-subject schema is inapplicable.



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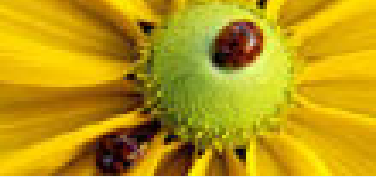
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Noncanonical valence align.

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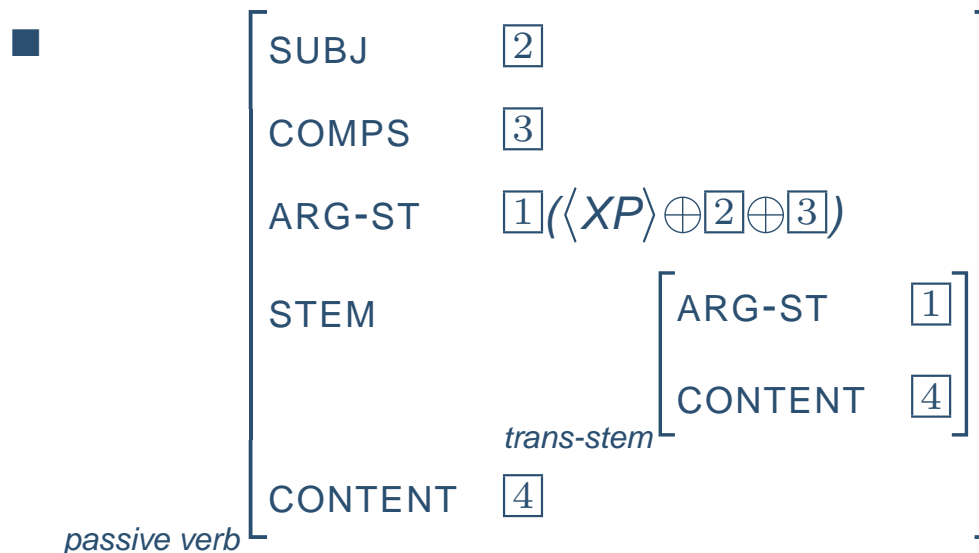
● Noncanonical valence align.

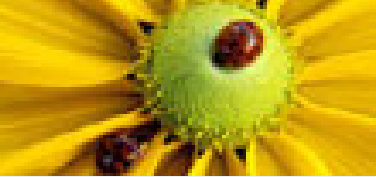
● Example

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Conclusions

- The semantics of active and passive usage of verbs are assumed to be identical, so the CONTENT values of the stem and the passive verb are token identical.
- The ARG-ST list of the the passive verb is token identical to that of the stem, so linking constraints are not violated.
- The first element of the ARG-ST list (logical subject) appears neither on SUBJ or COMPS: noncanonical valence.





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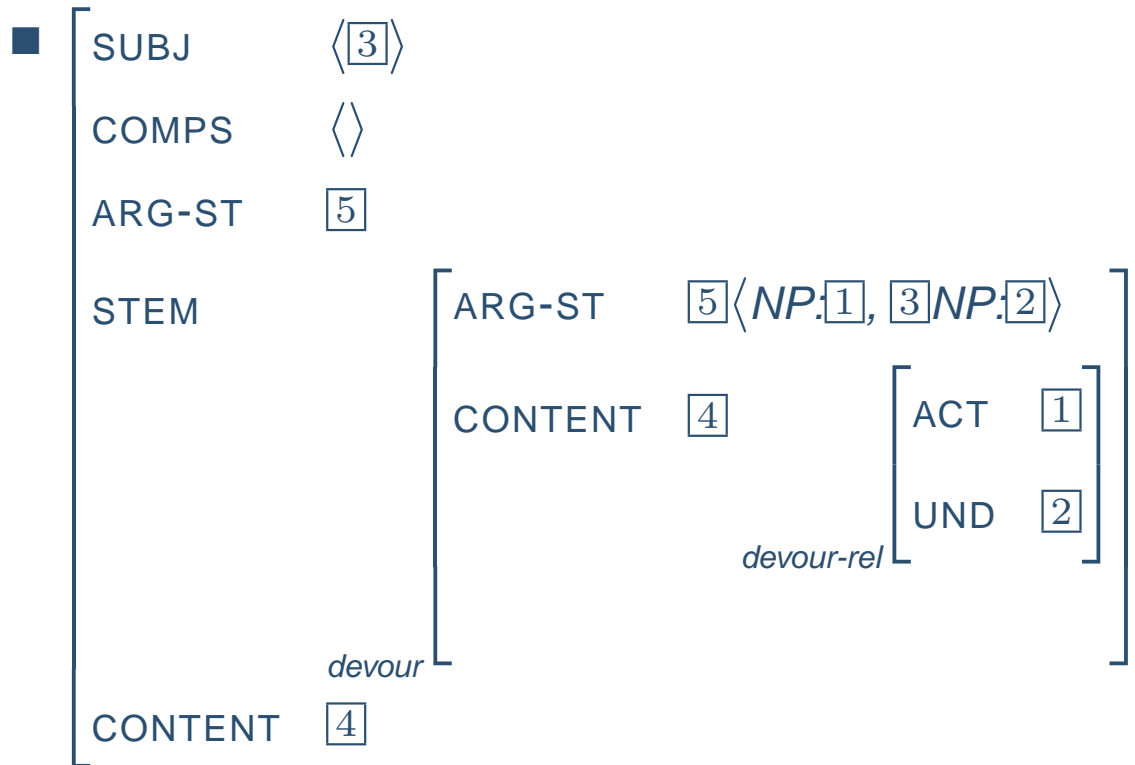
● Noncanonical valence align.

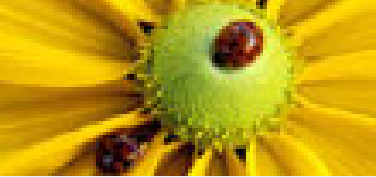
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■ "was devoured"





passive "by" phrases

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- passive "by" lexical rule:

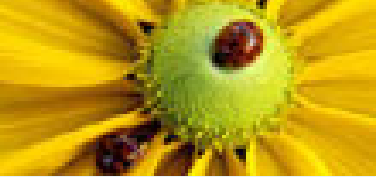
$$\left[\begin{array}{l} \text{ARG-ST} \quad [2] \\ \text{STEM} \quad \left[\text{ARG-ST} \quad \langle \text{XP}:[1], \dots \rangle \right] \end{array} \right] \rightarrow \left[\text{ARG-ST} \quad [2] \oplus \langle \text{PP}[\textit{by}]: [1] \rangle \right]$$

- example: "was devoured by John."

$$\left[\begin{array}{l} \text{SUBJ} \quad \langle [3] \rangle \\ \text{COMPS} \quad \langle \rangle \\ \text{ARG-ST} \quad [5] \oplus \langle \text{PP}[\textit{by}]: [1] \rangle \\ \text{STEM} \quad \left[\begin{array}{l} \text{ARG-ST} \quad [5] \langle \text{NP}:[1], [3] \text{NP}:[2] \rangle \\ \text{CONTENT} \quad [4] \quad \left[\begin{array}{l} \text{ACT} \quad [1] \\ \text{UND} \quad [2] \end{array} \right] \end{array} \right] \\ \text{CONTENT} \quad [4] \end{array} \right] \end{array} \right]$$

devour-rel

devour



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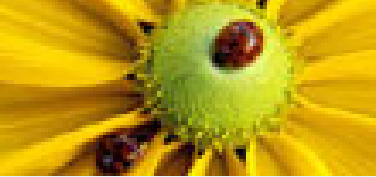
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- The model describes the mapping between semantic roles and syntactic arguments within HPSG.
- The model is constraint-based, semantically grounded, and constructed using monotonic multiple inheritance of typed feature structures.
- Regularities in mapping between semantic roles and syntactic arguments provide evidence for a level of lexical semantic representation.
- Two linking specific principles are enough to establish the homomorphisms between the lexical hierarchy and the hierarchies of semantic relations and valence types.
- The linking constraints are not numerous, and function no differently from other constraints in the grammar.



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● **References**

- Davis, Anthony R. 2001. *Linking by Types in the Hierarchical Lexicon*. CSLI Publications.
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