Introduction to Head-Driven Phrase Structure Grammar II

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Last week's recapitulation

Based on [Sag and Wasow, 1999]

- Lexical entries:
  - Lexical items are of different types.
  - They encode the syntactic and semantic template of the word's usage.
  - The lexicon is organized in a type hierarchy with default inheritance, which can be overridden (non-monotonic).

- Lexical rules:
  - Lexical rules turn lexemes (dictionary entries) into words (as observed in the sentence).
  - Lexical rules derive word forms, e.g. plural nouns, past tense verbs, different subcat patterns of the same verb.

Last week's recap

- Grammar rules and Principles:
  - Lexical SDs can be combined into larger SDs in the ways permitted by the grammar rules, filtering in features as required by 4 principles:
    - the Semantic Compositionality Principle
    - the Head Feature Principle
    - the Valence Principle
    - the Semantic Inheritance Principle
  - Grammar rules are generally phrase-independent, but they have linear ordering of the constraints.
  - The principles ensure that the parse tree is constructed correctly and that all the well-formedness conditions are satisfied.
    - E.g. the Head-Feature Principle enforces that, in any headed phrase, the HEAD value of the head daughter must be unified with the HEAD value of the mother.

Overview

- The Passive Construction (chap. 10)
- Infinitival Complements (chap. 12)
- Long-Distance Dependencies (chap. 15)

The Passive Construction

- Examples
  - a. He gave her a book.
  - b. She was given a book (by him).
  - c. *She was give a book.
  - d. *She were given a book.
  - e. *She was given.
  - f. *Her was given a book.
  - g. *She was given a book by he.
- Many ways a formalism can deal with this (e.g. adding entries for the passive forms of verbs)
- using a **lexical rule** to express the active/passive relationship between two verb forms better captures a linguistic generalization and is more

realistic psycologically (given new transitive verbs, native speakers can immediately use them in passive sentences).

- We need a lexical rule that given the sentence in a licenses the one in b, but none of the other sentences above, and thus that:
  - turns the first NP complement into the subject;
  - allows the subject either to turn into a PP[by] or to be omitted;
  - leaves the subcategorization (valence) features otherwise unchanged;
  - leaves the semantics unchanged; and
  - makes the appropriate morphological change in the from of the verb.

Passive Lexical Rule

$$\left\langle \boxed{1}, \begin{bmatrix} \text{tv-lxm} & \\ \text{ARG-ST} & \langle \text{NP}_i \rangle \oplus \boxed{a} \end{bmatrix} \right\rangle \Longrightarrow \left\langle \text{F}_{PSP}\boxed{1}, \begin{bmatrix} \text{word} & \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{FORM} & \text{pass} \end{bmatrix} \end{bmatrix} \\ \text{ARG-ST} & \boxed{a} \oplus \left\langle \left(\text{PP} \begin{bmatrix} \text{FORM} & \text{by} \\ \text{P-OBJ} & \text{NP}_i \end{bmatrix} \right) \right\rangle \end{bmatrix} \right\rangle$$

- This rule rearranges the elements of the ARG-ST list, and because of the Argument Realization Principle, the values of the valence features are also affected.
- Specifically, it eliminates the first element of the input's ARG-ST list, moves up the other elements in the list, and introduces an optional PP(coindexed with the subject of the active form) at the end of the new list (same semantic role).
- Since the object of the active form, the first element in the list $\boxed{a}$, is identical with the subject of the passive form, it follows that the subject of the passive and the object of the active are also coindexed, and thus have the same semantic role.

What was the Argument Realization Principle again?

Lexical Satisfaction

A word structure:

$$F \rightarrow w$$

satisfies a lexical entry

$$\langle w, d \rangle$$

just in case:
1. F is of type word and F satisfies d,
2. **Argument Realization Principle**
F satisfies the following FSD:

$$\begin{bmatrix} SYN & \begin{bmatrix} SPR & \boxed{a} \\ COMPS & \boxed{b} \end{bmatrix} \\ ARG-ST & \boxed{a} \oplus \boxed{b} \end{bmatrix}$$

and
3. **Case Constraint**
Any NP in a noninitial position of F's ARG-ST list is

$$\begin{bmatrix} CASE & acc \end{bmatrix}$$

So it's immediately obvious that the Passive Lexical Rule stated above allows us to derive b from a with the right semantics:

- a. He gave her a book.
- b. She was given a book (by him).

and rules out c and e:

- c. *She was give a book.
- e. *She was given.

but how does it prevent us from deriving the rest of the ungrammatical sentences?

- d. *She were given a book.
- f. *Her was given a book.
- g. *She was given a book by he.

The verb *Be* in Passive Sentences

- Some passive participles can also occur without any form of *be* (e.g. The cat got bitten (by the dog). Anyone handed a note will be watched closely.)
- So, even though some form of *be* is typical in passive sentences, it would not be appropriate to build it into the rule introducing the passive form of verbs.
- Need to provide an analysis of the relevant lexical entry for *be* that links its occurrence to the presence of a passive participle.
- It needs to agree with the subject (SPR) of *was* (*She were given a book.); however, for semantic reasons and as stated by the passive lexical rule, *she* is also the subject of *given*. Thus, we need to treat *she* as the subject of both *was* and *given*.
- The data about the case marking on the subjects of passive verbs also points to the conlusion that the finite forms of *be* (e.g. *was*) are the only forms of *be* that allow a nominative case subject (and so do all other finite verbs).

Lexical entry for the passive *be*

$$\left\langle \text{be}, \begin{bmatrix} \textit{be}-\textit{lxm} & \\ \text{ARG-ST} & \left\langle \boxed{1}\ , \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{FORM} & \text{pass} \end{bmatrix} \\ \text{SPR} & \langle \boxed{1} \rangle \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & \boxed{3} \end{bmatrix} \end{bmatrix} \right\rangle \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & \boxed{3} \\ \text{RESTR} & \langle \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

- *be* takes a VP argument headed by a passive participle
- the subject of the sentence serves as subject for both this form of *be* and for its passive argument
- adds nothing to the meaning except the information that the complement's INDEX value is the same as that of *be* (and thus of the mother VP)

So far, the passive lexical rule + the lexical entry for the passive *be* have accounted for:

- a. He gave her a book.
- b. She was given a book (by him).
- c. *She was give a book.
- d. *She were given a book.
- e. *She was given.
- f. *Her was given a book.

What about g?

- g. *She was given a book by he

No further constraints, rules or principles need to be introduced to rule this sentence out, there is already a constraint which takes care of that.

Dative Alternation

From a, we got b:

- a. He gave her a book.
- b. She was given a book (by him).

And from h, we want to get i:

- h. He gave a book to her.
- i. A book was given to her (by him).

but probably not j:

- j. ?*A book was given her (by him).

So we need to have a lexical rule to obtain h from a (or viceversa), that contains the following:

$$\begin{bmatrix} \text{tv-lxm} & \\ \text{ARG-ST} & \left\langle \text{NP}_i,\ \text{NP}_j[\text{her}],\ \text{NP}_k[\text{a book}] \right\rangle \end{bmatrix} \Longleftrightarrow \begin{bmatrix} \text{tv-lxm} & \\ \text{ARG-ST} & \left\langle \text{NP}_i,\ \text{NP}_k[\text{a book}],\ \text{PP}[\text{to NP}_j[\text{her}]] \right\rangle \end{bmatrix}$$

And then, by applying the Passive Lexical Rule, we obtain the desired result, with $abook$ as the subject of the passive sentence:

He gave a book to her $\Longrightarrow$ A book was given to her (by him)

Infinitival Complements

- Subject raising verbs (e.g. Pat continues to avoid conflict)
- Subject control verbs (e.g. Pat tries to avoid conflict)
- Object raising verbs (e.g. I expected Leslie to be aggressive)
- Object control verbs (e.g. I persuaded Leslie to be aggressive)
- Despite the superficial parallelism, they have quite different semantics and syntactic properties.
- *To* doesn't contribute to the semantics of these sentences in any substantial way (e.g. Pat helped Chris (to) solve the problem).

Lexical entry for the complementizer *to* + constraints inherited from the type *comp − lxm*

$$\left\langle \text{to}, \begin{bmatrix} \textit{comp}-\textit{lxm} & \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{comp} & \\ \text{FORM} & \boxed{3}\text{inf}\end{bmatrix} \\ \text{SPR} & \langle [\,] \rangle \end{bmatrix} \\ \text{ARG-ST} & \left\langle \boxed{1}, \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{FORM} & \boxed{3}\text{inf} \end{bmatrix} \\ \text{SPR} & \langle \boxed{1} \rangle \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{prop} \\ \text{INDEX} & \boxed{2} \end{bmatrix} \end{bmatrix} \right\rangle \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \text{prop} \\ \text{INDEX} & \boxed{2} \\ \text{RESTR} & \langle\,\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

Subject raising (SR) verbs (*continue*)

$$subject - raising - verb - lxm(srv - lxm) : \left[\text{ARG-ST} \left\langle \boxed{1} , \begin{bmatrix} phrase & \\ \text{SPR} & \langle \boxed{1} \rangle \end{bmatrix} \right\rangle \right]$$

- Subject Raising verbs express properties (relations of one argument) of propositions
- SR verbs allow subject NPs without referential indices (e.g. Sandy continues to eat oysters. There continued to be riots in Freedonia.)
- They are usually *transparent* to the co-occurrence restrictions between the subject and the verb in its complement.
- They must have the same subject as its complement
- The co-occurrence restrictions involving the nonreferential NPs will be transmitted from the verbs heading the infinitival VPs through *to* up to the subject of the SR verb.

- If we passivize the complement's verb, the meaning of the sentence does not change:
  - k. The FBI continues to visit Lee.
  - l. Lee continues to be visited by the FBI.

Lexical entry for *continue*

$$\left\langle \text{continue}, \begin{bmatrix} \textit{srv} - \textit{lxm} & \\ \text{ARG-ST} & \left\langle \left[\boxed{1}\right], \text{CP}\begin{bmatrix}\text{FORM} & \text{inf}\\ \text{SYN} & \left[\text{SPR} \quad \left\langle\left[\boxed{1}\right]\right\rangle\right] \\ \text{SEM} & \left[\text{INDEX} \quad \boxed{2}\right]\end{bmatrix}\right\rangle \\ \text{SEM} & \begin{bmatrix}\text{INDEX} & \text{s} \\ \text{RESTR} & \left\langle\begin{bmatrix}\text{RELN} & \text{continue}\\ \text{SIT} & \text{s}\\ \text{ARG} & \boxed{2}\end{bmatrix}\right\rangle\end{bmatrix}\end{bmatrix}\right\rangle$$

- the Complementizer Phrase (CP) is the semantic argument of *continue*,
- the subject of *continue* is the subject of the CP complement,
- the subject of *continue* plays no role in the continue relation (nonreferential), and
- as a result, sentences k and l both receive a semantic analysis equivalent to the one sketched in (11) on page 276 [Sag and Wasow, 99].

Note that unification analysis is necessary for raising verbs, because they accept a nonreferential subject just in case that subject satisfies the co-occurrence restrictions imposed by the CP complement.

Subject control (SC) verbs *try*

$$subject-control-verb-lxm(scv-lxm): \begin{bmatrix} \text{ARG-ST} & \left\langle \text{NP}_i , \begin{bmatrix} \textit{phrase} & \\ \text{FORM} & \text{inf} \\ \text{SPR} & \langle \text{NP}_i \rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

- Subject Control verbs express a relation between an individual and a situation (referred to via its situational index)

- SC verbs never take nonreferential subjects; the subject position of a SC verb always correspond to a semantic argument slot, namely to the individual involved in the relation.

- If we passivize the complement's verb, this can induce a change of meaning

- In the case of m and n, they are clearly not synonymous (unlike k and l):
  - m. The FBI tried to find Lee.
  - n. Lee tried to be found by the FBI.

Lexical entry for *try*

$$\left\langle \text{try}, \begin{bmatrix} \textit{scv} - \textit{lxm} & \\ \text{ARG-ST} & \left\langle \text{NP}_i \,,\, \text{CP}\begin{bmatrix}\text{SPR} & \langle \text{NP}_i \rangle \\ \text{SEM} & \begin{bmatrix}\text{INDEX} & \boxed{2}\end{bmatrix}\end{bmatrix}\right\rangle \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & \text{s} \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \text{try} \\ \text{SIT} & \text{s} \\ \text{TRIER} & \text{i} \\ \text{ARG} & \boxed{2} \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

- the subject of *try* is assigned to the TRIER role, and hence a nonreferential NP can never be its subject,
- the infinitival complements can never be of a kind that requires an nonreferential subject (because they must have an index identified with the trier); and
- m and n have different meanings, because in one case the FBI is the trier and in the other, Lee is.
- Note that the first argument of *try* and the subject of the CP are not unified; rather, their indices must be identical.

Object raising verbs *expect*

$$object-raising-verb-lxm(orv-lxm):$$

$$\left[\text{ARG-ST} \quad \left\langle \text{NP}\ ,\ \boxed{1}\ ,\ \begin{bmatrix} phrase & \\ \text{SPR} & \left\langle \boxed{1} \right\rangle \end{bmatrix} \right\rangle \right]$$

Object control verbs *persuade*

$$object-control-verb-lxm(ocv-lxm):$$

$$\left[\text{ARG-ST} \quad \left\langle \text{NP},\ \text{NP}_i\ ,\ \begin{bmatrix} phrase & \\ \text{SPR} & \left\langle \text{NP}_i \right\rangle \end{bmatrix} \right\rangle \right]$$

Long-Distance Dependencies

The Problem

- We want to be able to build clauses with elements missing within them. But somehow we have to keep track of the fact that something is missing.

Examples

- **Wh-questions:** What did they hand - to the baby?
- **Relative clauses:** The toy which they handed - to the baby is old.
- **Embedded questions:** I wonder who they handed the toy to -.
- **Topicalization:** This toy, I think he wants -.
- **Tough Movement:** These problems are tough to even try to solve -.
- **More-More:** The more people I try to talk to -, the more lonely I get -.

By looking at examples on pp. 337 and 338, we note that:

- we need to keep track of just what is missing,
- sentences missing a phrase of type X (no matter how deeply embedded the X-type gap may be) have to combine with a filler of type X, and
- fillers are allowed only when there is a gap for them to fill.

HPSG Approach to Long-Distance Dependencies (LDD)

To deal with LDD we will require several changes to the theory:

- a new feature (**GAP**)
- a reformulation of the **Argument Realization Principle**
- a new principle (**GAP Principle**)
- a new phrase structure rule (**Head-Filler Rule**)
- a new lexical rule (**Subject extraction Lexical Rule**)

The Feature GAP

- There are sentences with more than one phrase missing (e.g. Problems this involved, my friends on the East Coast are difficult to talk to - about -).

- We might need to keep track of many missing elements (e.g. Polish allows multiple gaps more freely than English)

- This suggests that the value of GAP is a list of FS, like the values of COMPS and STR, and ARG-ST. For example: [GAP ⟨NP, NP⟩], [GAP ⟨NP⟩], [GAP ⟨NP, PP⟩], etc.

- When nothing is missing, we want the relevant phrase to be [GAP ⟨⟩], which indicates that something is present in the argument structure but absent from the valence features.

- We could accomplish this by means of a lexical rule, but a more general solution is to modify the Argument Realization Principle.

- We need to introduce a kind of substraction operation on lists ($\ominus$). If A and B are lists, then A $\ominus$ B is a list that results from removing the elements of B from A.
  - we want A $\ominus$ B to be defined only when the elements of B all occur in A and in the same order,
  - when A $\ominus$ B is defined it need not be unique. For example, if A $=$ $\langle$NP, PP, NP$\rangle$ and B $=$ $\langle$NP$\rangle$, then there are two possible values for A $\ominus$ B, namely $\langle$NP, PP$\rangle$ and $\langle$PP, NP$\rangle$.

Reformulation of the Argument Realization Principle to include GAP

Lexical Satisfaction

A word structure:

$$F \rightarrow w$$

satisfies a lexical entry

$$\langle w, d \rangle$$

just in case:
1. F is of type word and F satisfies d,
2. **Argument Realization Principle**
F satisfies the following FSD:

$$\begin{bmatrix} SYN & \begin{bmatrix} SPR & \boxed{1} \\ COMPS & \boxed{2} \ominus \boxed{3} \\ GAP & \boxed{3} \end{bmatrix} \\ ARG-ST & \boxed{1} \oplus \boxed{2} \end{bmatrix}$$

and
3. **Case Constraint**
Any NP in a noninitial position of F's ARG-ST list is

$$\begin{bmatrix} CASE & acc \end{bmatrix}$$

- The GAP featur tells us which of a word's arguments is missing

- The ARP, as reformulated above, permits us to instanciate gaps freely (other than with elements from the SPR list).

- Now we need some way of passing the information in the GAP value up from words so that phrases that they head will register the fact that something is missing. To do this, we adopt a general principle.

The GAP Principle

A well-formed phrase structure licensed by a headed rule other than the Head-Filler rule must saitsfy the following SD:

$$[GAP \quad \boxed{1} \oplus \cdots \oplus \boxed{n}]$$

/ | \

$$[GAP \quad \boxed{1}] \qquad \ldots \qquad [GAP \quad \boxed{n}]$$

Head-Filler rule

$$\begin{bmatrix} phrase & \\ GAP & \langle\rangle \end{bmatrix} \rightarrow \boxed{1}\begin{bmatrix} phrase & \\ GAP & \langle\rangle \end{bmatrix} \quad H\begin{bmatrix} phrase & \\ FORM & fin \\ SPR & \langle\rangle \\ GAP & \langle\boxed{1}\rangle \end{bmatrix}$$

- This way we account for the disappearance of the NP from the GAP value at the topmost node (example (19) on page 346).

- The GAP Principle (like the Valence Pricniple) allows the gap information to be propagated upward throuhg tree structures. But because the Head-Filler Rule is not subject to the GAP Principle, it terminates the upward propagationof a nonempty GAP specification.

- Consequently, the analysis presented introduces a filler iff there is a gap for it to fill.

- We need one more modification to our grammar to ensure that all gaps ultimately get filled. We do this by revising the initial symbol to include a specification that it must have an empty GAP list:

$$\begin{bmatrix} phrase & \\ SYN & \begin{bmatrix} HEAD & \begin{bmatrix} verb \\ FORM & fin \end{bmatrix} \\ SPR & \langle\rangle \\ COMPS & \langle\rangle \\ GAP & \langle\rangle \end{bmatrix} \end{bmatrix}$$

Subject Extraction Lexical Rule

$$\left\langle \boxed{0}, \begin{bmatrix} word \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} verb \\ \text{FORM} & \text{fin} \end{bmatrix} \\ \text{SPR} & \langle [\,] \rangle \end{bmatrix} \end{bmatrix} \right\rangle \Longrightarrow \left\langle \boxed{0}, \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{SPR} & \langle\,\rangle \\ \text{GAP} & \left\langle \left[\boxed{1}\right] \right\rangle \end{bmatrix} \\ \text{ARG-ST} & \left\langle \boxed{1}, \ldots \right\rangle \end{bmatrix} \right\rangle$$

- Subject extraction is subject to special constraint in many languages, so it is not unreasonable to treat it in terms of a special rule (instead of in the ARP)

- This rule maps any lexical entry for a finite form into a lexical entry with an empty SPR list and a GAP list containing an element identified as the first argument, i.e. the subject of the verb.

Comparing with the LFG's Functional Uncertainty approach

Summary

We have presented the Sag and Wasow's HPSG approach to

- Passives
  - added new lexical rule (**Passive Lexical Rule**)
- Infinitival Complements
  - posed lexical distinction between raising and control verbs in the hierarchy of lexemes ($srv - lxm$, $scv - lxm$, $orv - lxm$ and $ocv - lxm$), thus we made no modification to the theory or added any rules.
- Long-Distance Dependencies
  - added a new feature (**GAP**)
  - a reformulation of the **Argument Realization Principle**
  - a new principle (**GAP Principle**)
  - a new phrase structure rule (**Head-Filler Rule**)
  - a new lexical rule (**Subject extraction Lexical Rule**)

Summary of Grammar Rules

- **Head-Complement Rule**

$$\begin{bmatrix} phrase \\ COMPS & \langle\rangle \end{bmatrix} \rightarrow H \begin{bmatrix} word \\ COMPS & \langle \boxed{1}, \ldots, \boxed{n} \rangle \end{bmatrix} \boxed{1}, \ldots, \boxed{n}$$

- **Head-Specifier Rule**

$$\begin{bmatrix} phrase \\ SPR & \langle\rangle \end{bmatrix} \rightarrow \boxed{1} \quad H \begin{bmatrix} phrase \\ SPR & \langle \boxed{1} \rangle \end{bmatrix}$$

- **Head-PreModifier Rule**

$$[phrase] \rightarrow \begin{bmatrix} phrase \\ MOD & \langle \boxed{1} \rangle \end{bmatrix} H \boxed{1} [phrase]$$

- **Head-PostModifier Rule**

$$[phrase] \rightarrow H \boxed{1} [phrase] \quad \begin{bmatrix} phrase \\ MOD & \langle \boxed{1} \rangle \end{bmatrix}$$

Summary of Grammar Rules cont.

- **Coordination Rule**

$$\begin{bmatrix} SYN & \boxed{0} \\ IND & s_0 \end{bmatrix} \rightarrow \begin{bmatrix} SYN & \boxed{0} \\ IND & s_0 \end{bmatrix} \ldots$$

$$\begin{bmatrix} SYN & \boxed{0} \\ IND & s_{n-1} \end{bmatrix} \begin{bmatrix} HEAD & conj \\ IND & s_0 \\ RESTR & \langle [\ ARGS \quad \langle s_1 \ldots s_n \rangle\ ] \rangle \end{bmatrix} \begin{bmatrix} SYN & \boxed{0} \\ IND & s_n \end{bmatrix}$$

- **Imperative Rule**

$$\begin{bmatrix} phrase & \\ HEAD & \begin{bmatrix} verb & \\ FORM & fin \end{bmatrix} \\ SPR & \langle\rangle \\ COMPS & \langle\rangle \\ SEM & \begin{bmatrix} MODE & dir \\ INDEX & s \end{bmatrix} \end{bmatrix} \rightarrow \begin{bmatrix} phrase & \\ HEAD & \begin{bmatrix} verb & \\ FORM & inf \end{bmatrix} \\ SPR & \langle NP[\ PER \quad 2nd\ ] \rangle \\ SEM & [\ INDEX \quad s\ ] \end{bmatrix}$$

- **Head-Filler rule**

$$\begin{bmatrix} phrase & \\ GAP & \langle\rangle \end{bmatrix} \rightarrow \boxed{1} \begin{bmatrix} phrase & \\ GAP & \langle\rangle \end{bmatrix} \quad H \begin{bmatrix} phrase & \\ FORM & fin \\ SPR & \langle\rangle \\ GAP & \langle \boxed{1} \rangle \end{bmatrix}$$