Chapter 14:

Long Distance Dependencies
Examples of LDDs

• **wh-questions:**
  
  What did you find?
  Tell me who you talked to.

• **topicalization:**
  
  The manual, I can’t find.
  Chris, you should talk to.

• **relative clauses:**
  
  the item that I found
  the guy who(m) I talked to

• **easy-adjectives:**
  
  My house is easy to find.
  Pat is hard to talk to.

• **Common properties:**
  
  • There is a ‘gap’: nothing following *find* and *to*, even though both normally require objects.
  
  • Something that fills the role of the element missing from the gap occurs at the beginning of the clause.
  
  • We use topicalization and *easy*-adjectives to illustrate
Very Rough Sketch of HPSG Approach to Long-Distance Dependencies

- A feature GAP (usually called SLASH) records information about a missing constituent.
- The GAP value is passed up the tree by a new principle.
- A new grammar rule expands S as a filler, followed by another S whose GAP value matches the filler.
- Caveat: Making the details of this general idea work is non-trivial.
The Feature GAP

- Like valence features and ARG-ST, GAP’s value is a list of feature structures (often empty).
- Subject gaps are introduced by a lexical rule we’ll talk about later.
- Non-subject gaps are introduced by revising the Argument Realization Principle.
The Revised ARP

- \( \ominus \) is a kind of list subtraction, but:
  - it’s not always defined, and
  - when defined, its value is not always unique

- The ARP now says the non-SPR arguments are distributed between COMPS and GAP.
A Word with a Non-Empty GAP Value

\[
\langle \text{hand}, \begin{array}{l}
\text{word}\\
\text{SYN}
\end{array}
\rangle
\]

\[
\begin{array}{l}
\text{HEAD} \\
\text{VAL} \\
\text{GAP}
\end{array}
\begin{array}{l}
[\text{FORM}\ fin] \\
[\text{SPR}\ 1] \\
[\text{COMPS}\ 3\ PP[to]]
\end{array}
\]

\[
\begin{array}{l}
\text{ARG-ST} \\
\text{NP}
\end{array}
\begin{array}{l}
[\text{CASE}\ nom] \\
[\text{AGR}\ non-3sing]
\end{array}
\]

\[
[1, 2, 3]
\]
How We Want GAP to Propagate

How we want GAP to propagate is shown in the tree diagram. The structure represents the phrase structure of a sentence, with nodes for each constituent and labels for each category. The diagram illustrates the movement of a gap across the sentence, starting from the subject NP (Kim) to the complement VP (knows). The gaps are represented as [GAP ⟨ ⟩] to indicate the presence of a missing element.

The sentence structure is as follows:

S

[ GAP ⟨ ⟩ ]

NP

[ GAP ⟨ ⟩ ]

Kim

NP

[ GAP ⟨ ⟩ ]

we

V

[ GAP ⟨ ⟩ ]

know

NP

[ GAP ⟨ ⟩ ]

Dana

V(P)

[ GAP ⟨ ⟩ ]

hates

[ GAP ⟨ NP ⟩ ]

S

[ GAP ⟨ NP ⟩ ]

VP

[ GAP ⟨ NP ⟩ ]

we

Kim

NP

[ GAP ⟨ ⟩ ]

V

[ GAP ⟨ ⟩ ]

know

NP

[ GAP ⟨ ⟩ ]

Dana

V(P)

[ GAP ⟨ NP ⟩ ]

hates

[ GAP ⟨ NP ⟩ ]
What We Want the GAP Propagation Mechanism to Do

• Pass any GAP values from daughters up to their mothers,
• except when the filler is found.
• For topicalization, we could write the exception into the grammar rule, but
• For *easy*-adjectives, the NP that corresponds to the gap is the subject, which is introduced by the Head-Specifier Rule.
• Since specifiers are not generally gap fillers, we can’t write the gap-filling into the HSR.
Our Solution to this Problem

- For *easy*-adjectives, we treat the adjective formally as the filler, marking its SPR value as coindexed with its GAP value.
- We use a feature STOP-GAP (usually called TO-BIND) to trigger the emptying of the GAP list.
  - STOP-GAP stops gap propagation
  - *easy*-adjectives mark STOP-GAP lexically
  - a new grammar rule, the Head-Filler Rule mentions STOP-GAP
The GAP Principle

A local subtree $\Phi$ satisfies the GAP Principle with respect to a headed rule $\rho$ if and only if $\Phi$ satisfies:

$$\exists \Phi \left[ \text{GAP} \left( A_1 \oplus \ldots \oplus A_n \right) \ominus A_0 \right]$$

...
How does STOP-GAP work?

- STOP-GAP is empty almost everywhere
- When a gap is filled, STOP-GAP is nonempty, and its value is the same as the gap being filled.
- This blocks propagation of that GAP value, so gaps are only filled once.
- The nonempty STOP-GAP values come from two sources:
  - a stipulation in the Head-Filler Rule
  - lexical entries for *easy*-adjectives
- No principle propagates STOP-GAP
The Head-Filler Rule

\[ [\text{phrase}] \rightarrow H[\text{GAP} \langle \rangle] \]

- This only covers gap filling in finite Ss
- The filler has to be identical to the GAP value
- The STOP-GAP value is also identical
- The GAP Principle ensures that the mother’s GAP value is the empty list
Dana hates
Gap Filling with *easy*-Adjectives

Because STOP-GAP and GAP have the same value, that value will be subtracted from the mother’s GAP value.

The first argument is coindexed with the GAP value, accounting for the interpretation of the subject as the filler.
A Tree for *easy to talk to***

\[
\begin{align*}
A & \quad \text{VAL} \quad \text{SPR} \langle 2NP_i \rangle \\
& \quad \text{GAP} \quad \langle \rangle
\end{align*}
\]

\[
\begin{align*}
\text{VAL} & \quad \text{SPR} \langle 2 \rangle \\
\text{COMPS} & \quad \langle 3 \rangle \\
\text{GAP} & \quad \langle \rangle \\
\text{STOP-GAP} & \quad \langle 1 \rangle
\end{align*}
\]

\[
\begin{align*}
\text{VAL} & \quad \text{SPR} \langle NP \rangle \\
\text{GAP} & \quad \langle 1NP_i \rangle
\end{align*}
\]

easy to talk to ___
GAP & STOP-GAP Housekeeping

• The initial symbol must say [GAP < >], to block \*Pat found and \*Chris talked to as stand-alone sentences.

• Lexical entries with nonempty STOP-GAP values (like easy) are rare, so STOP-GAP is default empty in the lexicon.

• HeadSpecifier and Head-Modifier rules need to say [STOP-GAP < >]

• Lexical rules preserve STOP-GAP values.
Sentences with Multiple Gaps

• Famous examples:
  
  *Sonatas, this violin is easy to play___ on___.

• Our analysis gets this:
  
  • The subject of easy is coindexed with the first element of the GAP list.
  
  • The Head-Filler rule only allows one GAP remaining.

  • This approach has the flexibility to deal with languages that allow multiple gaps more generally.
Subject Gaps

- The ARP revision only allowed missing complements.
- But gaps occur in subject position, too:
  
  *This problem, everyone thought ___ was too easy.*

- We handle these via a lexical rule that, in effect, moves the contents of the SPR list into the GAP list
The Subject Extraction Lexical Rule

\[
\begin{bmatrix}
\text{pi-rule} \\
\text{INPUT} \left\langle \, X , \\
\text{ARG-ST} \, [A] \\
\text{SYN} \\
\text{VAL} \end{bmatrix} \\
\text{OUTPUT} \left\langle \, Y , \\
\text{ARG-ST} \, [A \, \langle 1 , \ldots \rangle] \\
\text{SYN} \\
\text{VAL} \end{bmatrix}
\]

Note: This says nothing about the phonology, because the default for \textit{pi-rules} is to leave the phonology unchanged.
A Lexical Sequence This Licenses

Note that the ARP is satisfied
A Tree with a Subject Gap

```plaintext
S
  [GAP ⟨ ⟩]
  NP
  [GAP ⟨ ⟩]
  Kim
  NP
  [GAP ⟨ ⟩]
  we
  V
  [GAP ⟨ ⟩]
  know
  S
  [GAP ⟨ NP ⟩]
  NP
  [GAP ⟨ NP ⟩]
  likes Dana
```

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The Coordinate Structure Constraint

In a coordinate structure,

• no conjunct can be a gap (conjunct constraint), and

• no gap can be contained in a conjunct if its filler is outside of that conjunct (element constraint)

• .....unless each conjunct has a gap that is paired with the same filler (across-the-board exception)
HPSG Treatment of the Coordinate Structure Constraint

• Based on ideas of Gerald Gazdar, first developed within GPSG

• In our analysis, the conjunct constraint is an immediate consequence: individual conjuncts are not on the ARG-ST list of any word, so they can’t be put on the GAP list

• The element constraint and ATB exception suggest that GAP is one of those features (along with VAL and FORM) that must agree across conjuncts.

• Note: There is no ATB exception to the conjunct constraint.

  *This problem, you can compare only___ and____.
Our Coordination Rule, so far

Recall that we have tinkered with what must agree across conjuncts at various times.

Now we’ll add GAP to the things that conjuncts must share.
Our Final Coordination Rule

- We’ve just added GAP to all the conjuncts and the mother.
- This makes the conjuncts all have the same gap (if any)
the principal suspended and Sandy defended him

a portrait of and two photos of
Conclusions

• Filler-Gap dependencies have been analyzed through a new feature GAP.

• The distribution of GAP is controlled by the GAP Principle and its interaction with lexical and constructional constraints.

• This analysis derives as a theorem Ross’s Coordinate Structure Constraint, its Across-the-Board exceptions, and the exceptions to those exceptions.

• This approach has been extended to the analysis of many other filler-gap constructions in English and other languages.