Lexical-Functional Grammar

Coordination and Long-Distance Dependencies

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Outline

Set description for adjuncts

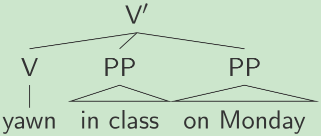
Definition (Open set description)

$g \in f$ holds iff f is a set and g is a member of f.

Example

$$
\begin{array}{llll}
\mathrm{V}' \rightarrow & \mathrm{V} & (\mathrm{NP}) & \mathrm{PP}^* \\
 & \uparrow=\downarrow & (\uparrow \textsc{obj}) =\downarrow & \downarrow\in (\uparrow \textsc{adj})
\end{array}
$$

(1) yawn <u>in class</u> <u>on Monday</u>

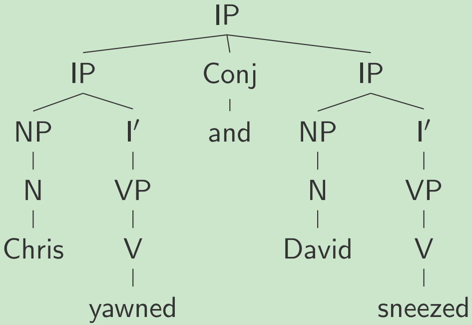


$$
\left[\begin{array}{ll}
\textsc{pred} & \text{'yawn}\langle\textsc{subj}\rangle\text{'} \\
\textsc{adj} & \left\{\begin{array}{l}
\left[\begin{array}{ll}
\textsc{pred} & \text{'in}\langle\textsc{obj}\rangle\text{'} \\
\textsc{obj} & \left[\begin{array}{ll}\textsc{pred} & \text{'class'}\end{array}\right]
\end{array}\right] \\
\left[\begin{array}{ll}
\textsc{pred} & \text{'on}\langle\textsc{obj}\rangle\text{'} \\
\textsc{obj} & \left[\begin{array}{ll}\textsc{pred} & \text{'monday'}\end{array}\right]
\end{array}\right]
\end{array}\right\}
\end{array}\right]
$$

Constituent coordination

(2) Chris yawned and David sneezed.

Example



Basic idea

Proposal

A coordinate structure is represented as a set whose members are the individual conjuncts.

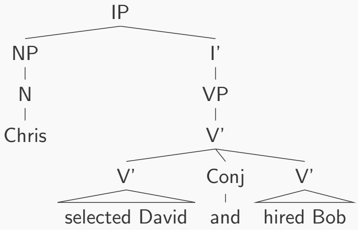
Example

$$\left\{ \begin{array}{l} \begin{bmatrix} \textsc{pred} & \text{'yawn}\langle \textsc{subj} \rangle\text{'} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{'chris'} \end{bmatrix} \end{bmatrix} \\ \begin{bmatrix} \textsc{pred} & \text{'sneeze}\langle \textsc{subj} \rangle\text{'} \\ \textsc{subj} & \begin{bmatrix} \textsc{pred} & \text{'david'} \end{bmatrix} \end{bmatrix} \end{array} \right\}$$

$$\begin{array}{lllll} \text{IP} & \rightarrow & \text{IP}^{+} & \text{Conj} & \text{IP} \\ & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

Predicate coordination

(3) Chris selected David and hired Bob.



$$\left[\left\{\begin{array}{l} \left[\begin{array}{ll} \text{PRED} & \text{'select}\left\langle\text{SUBJ,OBJ}\right\rangle\text{'} \\ \text{OBJ} & \boxed{1}\left[\begin{array}{ll}\text{PRED} & \text{'david'}\end{array}\right] \\ \text{SUBJ} & \boxed{2}\left[\begin{array}{ll}\text{PRED} & \text{'chris'}\end{array}\right] \end{array}\right] \\ \left[\begin{array}{ll} \text{PRED} & \text{'hire}\left\langle\text{SUBJ,OBJ}\right\rangle\text{'} \\ \text{OBJ} & \left[\begin{array}{ll}\text{PRED} & \text{'bob'}\end{array}\right] \\ \text{SUBJ} & \boxed{2} \end{array}\right] \end{array}\right\}\right]$$

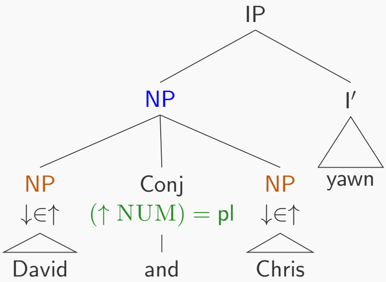
$$\begin{array}{lllll} \text{V} & \rightarrow & \text{V}^{+} & \text{Conj} & \text{V} \\ & & \downarrow\in\uparrow & & \downarrow\in\uparrow \end{array}$$

Sets with properties

Proposal

Coordinate structures as hybrid objects, **sets** with both **elements** and **properties**.

(4) David and Chris yawn.



$$\left[\begin{array}{ll}
\text{PRED} & \text{'yawn}\langle \text{SUBJ} \rangle\text{'} \\
\text{SUBJ} & \left[\begin{array}{ll}
\text{NUM} & \text{pl} \\
\multicolumn{2}{l}{\left\{\begin{array}{l}
\left[\begin{array}{ll} \text{PRED} & \text{'david'} \\ \text{PERS} & 3 \\ \text{NUM} & \text{sg} \end{array}\right] \\
\left[\begin{array}{ll} \text{PRED} & \text{'chris'} \\ \text{PERS} & 3 \\ \text{NUM} & \text{sg} \end{array}\right]
\end{array}\right\}}
\end{array}\right]
\end{array}\right]$$

Distributive and nondistributive features

The property may or may not **distribute** to the members of the set.

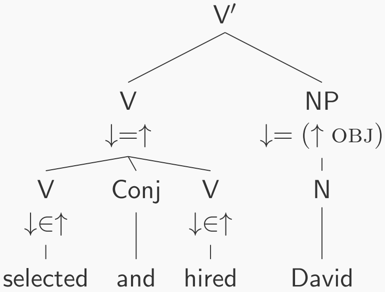
Nondistributive features

If a feature is nondistributive, it and its value become a property of the set as a whole, rather than the individual conjuncts.
E.g. PERS, NUM, GEND

Distributive features

A distributive feature is an attribute of each member of the set, not of the set as a whole.

Distributive features



$$f\left\{\begin{bmatrix}\text{PRED} & \text{'select}\langle\text{SUBJ,OBJ}\rangle\text{'}\end{bmatrix}\;\begin{bmatrix}\text{PRED} & \text{'hire}\langle\text{SUBJ,OBJ}\rangle\text{'}\end{bmatrix}\right\}$$

$$g\begin{bmatrix}\text{PRED} & \text{'david'}\end{bmatrix}$$

$$(f\ \text{OBJ}) = g$$

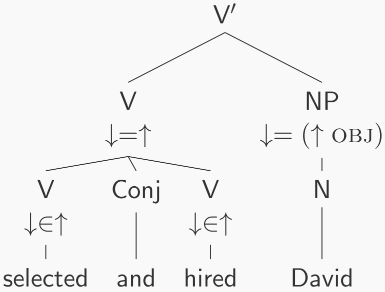
Definition (Distributive feature)

If a is a *distributive* feature and s is a set of f-structures, then $(s\ a) = v$ holds iff $(f\ a) = v$ for all f-structures $f \in s$.

Governable GFs are distributive

Two verbs can only be coordinated if they share the same syntactic argument structure.

Distributive features



$$\left\{ \begin{bmatrix} \text{PRED} & \text{'select}\langle \text{SUBJ,OBJ} \rangle\text{'} \\ \text{OBJ} & \boxed{1}\begin{bmatrix} \text{PRED} & \text{'david'} \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{PRED} & \text{'hire}\langle \text{SUBJ,OBJ} \rangle\text{'} \\ \text{OBJ} & \boxed{1} \end{bmatrix} \right\}$$

Definition (Distributive feature)

If a is a *distributive* feature and s is a set of f-structures, then $(s\ a) = v$ holds iff $(f\ a) = v$ for all f-structures $f \in s$.

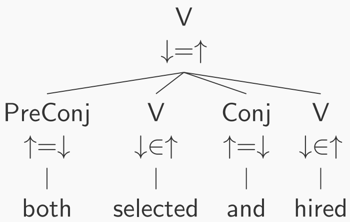
Governable GFs are distributive

Two verbs can only be coordinated if they share the same syntactic argument structure.

Nondistributive features

Definition (Nondistributive feature)

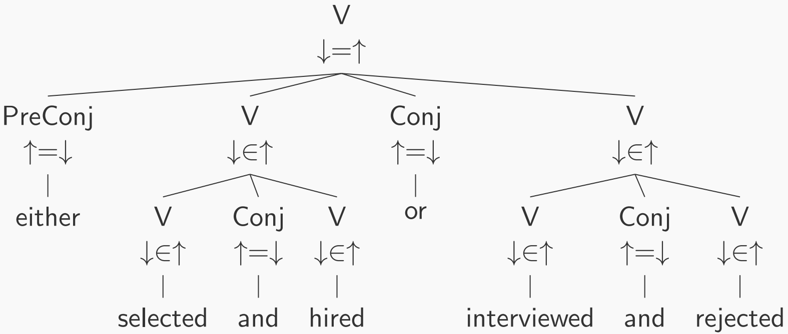
If a is a *nondistributive* feature, then $(f\ a) = v$ holds iff the pair $\langle a, v\rangle \in f$.



$$\begin{bmatrix} \textsc{preconj} & \text{BOTH} \\ \textsc{conj} & \text{AND} \\ \multicolumn{2}{l}{\left\{ \begin{matrix} \begin{bmatrix} \textsc{pred} & \text{'select}\left\langle\textsc{subj,obj}\right\rangle\text{'} \\ \textsc{obj} & \boxed{1}\begin{bmatrix}\textsc{pred} & \text{'david'}\end{bmatrix} \end{bmatrix} \\ \begin{bmatrix} \textsc{pred} & \text{'hire}\left\langle\textsc{subj,obj}\right\rangle\text{'} \\ \textsc{obj} & \boxed{1} \end{bmatrix} \end{matrix} \right\}} \end{bmatrix}$$

both	PreConj	$(\uparrow \textsc{preconj})=\text{BOTH}$
		$(\uparrow \textsc{preconj})=\text{BOTH}$
and	Conj	$(\uparrow \textsc{conj})=\text{AND}$

A complex example



A complex example (cont)

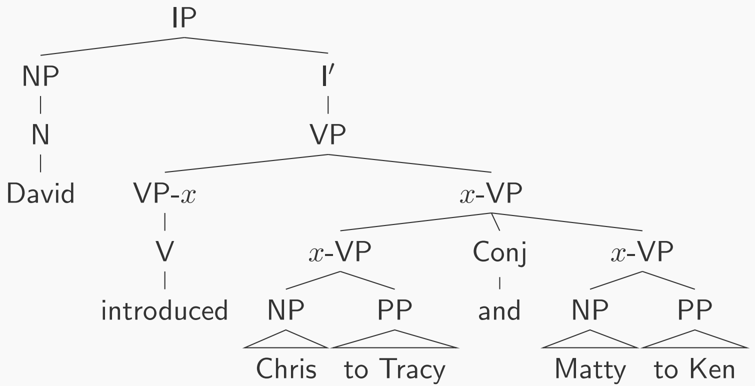
$$
\left[\begin{array}{ll}
\textsc{preconj} & \text{EITHER} \\
\textsc{conj} & \text{OR} \\
\multicolumn{2}{l}{\left\{\begin{array}{l}
\left[\begin{array}{ll}
\textsc{conj} & \text{AND} \\
\multicolumn{2}{l}{\left\{\begin{array}{l}
\left[\begin{array}{ll}\textsc{pred} & \text{'select}\langle \textsc{subj},\textsc{obj} \rangle\text{'}\end{array}\right] \\
\left[\begin{array}{ll}\textsc{pred} & \text{'hire}\langle \textsc{subj},\textsc{obj} \rangle\text{'}\end{array}\right]
\end{array}\right\}}
\end{array}\right] \\
\left[\begin{array}{ll}
\textsc{conj} & \text{AND} \\
\multicolumn{2}{l}{\left\{\begin{array}{l}
\left[\begin{array}{ll}\textsc{pred} & \text{'interview}\langle \textsc{subj},\textsc{obj} \rangle\text{'}\end{array}\right] \\
\left[\begin{array}{ll}\textsc{pred} & \text{'reject}\langle \textsc{subj},\textsc{obj} \rangle\text{'}\end{array}\right]
\end{array}\right\}}
\end{array}\right]
\end{array}\right\}}
\end{array}\right]
$$

Nonconstituent coordination

(5) David introduced [[Chris] [to Tracy]] and [[Matty] [to Ken]].

Proposal

VP $\rightarrow$ V NP PP $\Rightarrow$ VP $\rightarrow$ VP-x x-VP

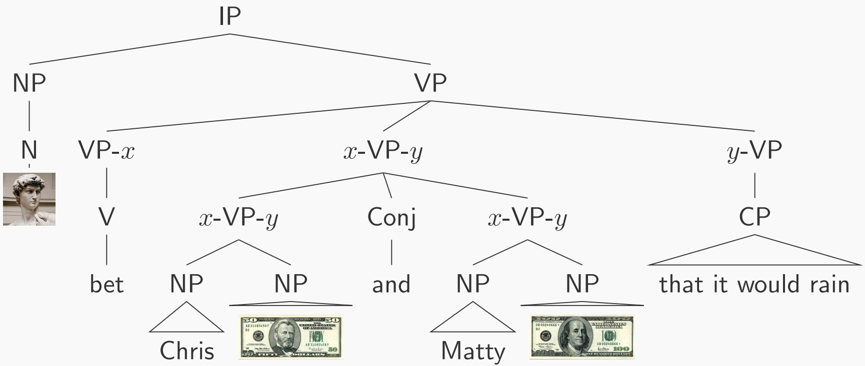


Nonconstituent coordination

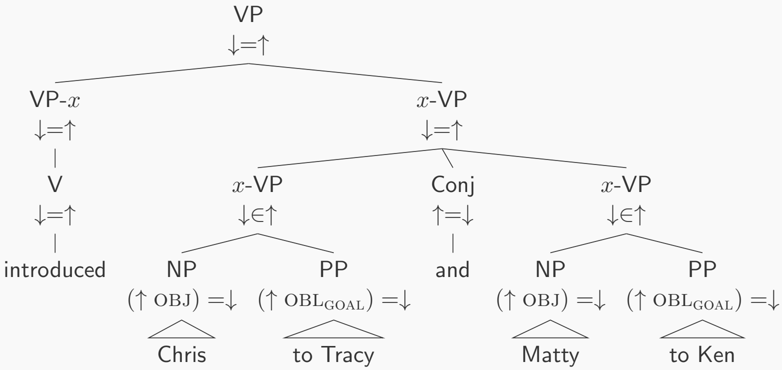
(6) David bet Chris fifty dollars and Matty one hundred dollars that it would rain.

Proposal

VP $\rightarrow$ V NP NP CP $\Rightarrow$ VP $\rightarrow$ VP-x x-VP-y y-VP



Nonconstituent coordination



Outline

Coordination

Long-Distance Dependencies

Local dependencies

Locality

A head generally realizes its arguments locally within its head domain. There are limitations on what can occur together as elements of a single clause.

(7) a. I laugh.
    b. I saw him.
    c. I give her the book.
    d. I said that she left.

(8) a. *They handed to the baby.
    b. *They handed the toy.
    c. *You have talked to.
    d. *The children discover.

Long-distance dependencies

Wh-question

(9) a. What did they hand to the baby?
b. To whom did they hand the toy?
c. Who(m) should you have talked to?
d. What will the children discover?

Relative clause

(10) a. The toy which they hand to the baby
b. The baby to whom they hand the toy
c. The people who(m) you have talked to
d. The presents that the children discover

Long-distance dependencies

Topicalization

(11) a. That toy, they hand to the baby.

b. To the baby, they hand the toy.

c. That kind of person, you have talked to (many times).

d. Presents that come from grandma, the children (always) discover.

Certain adjectives like *easy* and *hard*

(12) a. That toy would be easy to hand to the baby.

b. You are easy to talk to.

c. The presents from grandma were hard for the children to discover.

Filler-gap (1)

Observations

In each of the above examples, there is a dependency between a phrase or *filler* at the beginning of a clause and a *gap* somewhere within the clause.

- Elements whose presence is usually required in a clause are allowed to be absent if there is an appropriate filler.
- If there is a filler, then there must be an appropriate gap.

Example

(13) a. *What did Kim hand the toys to the baby?
b. *The dolls that Kim handed the toys to the baby.
c. *The dolls, Kim handed the toys to the baby.
d. *The dolls are easy to hand the toys to the baby.

Filler-gap (2)

(14) a. What did you say they handed _ to the baby?

b. Who(m) did he claim that they handed the toy to _?

c. Who(m) do you think you have talked to _?

d. What will he predict that the children discover _?

(15) a. The toy which we believe they handed _ to the baby

b. The baby that I think they handed the toy to _

c. The person who(m) everyone thinks you have talked to _

d. The presents that it annoys me that the children discover _

Filler-gap (3)

Link

- A syntactic link is needed
- And this link has to be established for an unbounded length

Example

(16) a. Kim_i, Sandy trusts t_i.

b. $[\text{On Kim}]_i$, Sandy depends t_i.

(17) a. *$[\text{On Kim}]_i$, Sandy trusts t_i.

b. *Kim_i, Sandy depends t_i.

Filler-gap (4)

- A syntactic link is needed
- And this link has to be established for an unbounded length

Example

(18) a. Kim$_i$, Bob knows Sandy trusts t_i.
b. [On Kim]$_i$, Bob knows Sandy depends t_i.

(19) a. *[On Kim]$_i$, Bob knows Sandy trusts t_i.
b. *Kim$_i$, Bob knows Sandy depends t_i.

(20) a. Kim$_i$, Ada believes Bob knows Sandy trusts t_i.
b. [On Kim]$_i$, Ada believes Bob knows Sandy depends t_i.

(21) a. *[On Kim]$_i$, Ada believes Bob knows Sandy trusts t_i.
b. *Kim$_i$, Ada believes Bob knows Sandy depends t_i.

TOPIC & FOCUS

Information structure

- How information is formally packaged within a sentence.
  - E.g. prominence and newness of information.
- Which part of a sentence is more informative?
- A range of linguistic means can encode IS, e.g.
  - Intonation and prosody in speech
  - Syntactic structures
  - Word order

Grammaticized discourse function

TOPIC	Old or known information that is prominent.
FOCUS	New and prominent information.

(22) a. Chris, we like.

b. Who did we think that David saw.

Extended coherence condition

Extended coherence condition

FOCUS and TOPIC must be linked to the semantic predicate argument structure of the sentence in which they occur, either by *functionally* or by *anaphorically binding an argument*.

Chris, we like

$$\begin{bmatrix} \text{PRED} & \text{'like}\langle \text{SUBJ,OBJ} \rangle\text{'} \\ \text{TOPIC} & \boxed{1} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{PERS} & \text{1st} \\ \text{NUM} & \text{pl} \end{bmatrix} \\ \text{OBJ} & \boxed{1} \begin{bmatrix} \text{PRED} & \text{'chris'} \\ \text{PERS} & \text{3rd} \\ \text{NUM} & \text{sg} \end{bmatrix} \end{bmatrix}$$

Extended coherence condition (cont)

Extended coherence condition

FOCUS and TOPIC must be linked to the semantic predicate argument structure of the sentence in which they occur.

Chris, we think that David saw

$$
\left[\begin{array}{ll}
\text{PRED} & \text{'think}\left\langle \text{SUBJ,COMP} \right\rangle\text{'} \\
\text{TOPIC} & \boxed{1}\left[\begin{array}{ll} \text{PRED} & \text{'chris'} \end{array}\right] \\
\text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{'pro'} \\ \text{PERS} & \text{1st} \\ \text{NUM} & \text{pl} \end{array}\right] \\
\text{COMP} & \left[\begin{array}{ll} \text{PRED} & \text{'see}\left\langle \text{SUBJ,OBJ} \right\rangle\text{'} \\ \text{SUBJ} & \text{'david'} \\ \text{OBJ} & \boxed{1} \end{array}\right]
\end{array}\right]
$$

Functional uncertainty (1)

- TOPIC must be linked to a grammatical function in the sentence, but which function does the TOPIC plays?
- In many cases more than one function may be candidate.

Functional uncertainty

There is more than one grammatical function that may appear as a TOPIC.

Example

(23) a. OBJ: Chris, I like.

b. OBL_θ: To Chris, I gave a book.

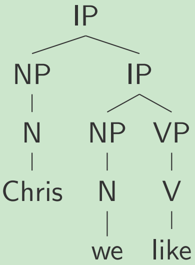
c. COMP: That Chris was a movie star, I never would have guessed.

Functional uncertainty (2)

Functional abbreviation

- TopicCat $\equiv$ NP|PP|VP|AP|CP
- TopicPath $\equiv$ $\textsc{obj}|\textsc{obl}_\theta|\textsc{comp}$

$$
\begin{array}{lcc}
\text{IP} \rightarrow & \text{TopicCat} & \text{IP} \\
 & (\uparrow \textsc{topic}){=}\downarrow & \uparrow{=}\downarrow \\
 & (\uparrow \textsc{topic}){=}(\uparrow \text{TopicPath}) &
\end{array}
$$



Functional uncertainty (3)

Definition

$(f\ \alpha) = v$ holds iff f is an f-structure, α is a set of strings, and for some s in the set of strings α, $(f\ s) = v$.

Example

- TopicCat $\equiv$ NP|PP|VP|AP|CP
- TopicPath $\equiv$ $\text{OBJ}|\text{OBJ}_\theta|\text{OBL}_\theta|\text{COMP}$

$$\begin{array}{lcc} \text{IP} \rightarrow & \text{TopicCat} & \text{IP} \\ & (\uparrow \text{TOPIC}){=}\downarrow & \uparrow{=}\downarrow \\ & (\uparrow \text{TOPIC}){=}(\uparrow \text{TopicPath}) & \end{array}$$

Functional uncertainty (4)

Longer paths are possible

(24) a. Chris, we think that David saw. (TopicPath = $\textsc{comp obj}$)

b. Chris, we think that David wants to like. (TopicPath = $\textsc{comp xcomp obj}$)

Solution

We extend TopicPath:

- TopicPath $\equiv$ GF*GF
- GF $\equiv \textsc{subj}|\textsc{obj}|\textsc{obj}_\theta|\textsc{obl}_\theta|\textsc{comp}|\textsc{xcomp}|\textsc{adj}|\textsc{xadj}$

and add more constraints.

Why use a regular expression?

Infinite vs. finite

Inside-out functional uncertainty (1)

From *outside-in* to *inside-out*

- Outside-in functional uncertainty is used to define constraints on more deeply embedded structures
  - $(\uparrow\ \textsc{pred}) = \text{`rock'}$
  - $(\uparrow\ \textsc{case}) = \text{LOC}$
- Inside-out functional uncertainty is used to define constraints on enclosing structures.
  - $((\textsc{obl}_{\textsc{loc}}\ \uparrow)\ \textsc{case}) = \text{ERG}$
  - $(\textsc{subj}\ \textsc{obl}_{\textsc{loc}}\ \uparrow)$

Definition (Inside-out expression)

- $(a\ g) = f$ holds iff f is an f-structure, a is a symbol, and the pair $\langle a, g\rangle \in f$.
- $(s\ a\ f) \equiv (s(af))$

Inside-out functional uncertainty (2)

Example

Assume that $\uparrow$ is instantiated to the f-structure named g, then $(\text{OBL}_{\text{LOC}}\ \uparrow)$ is labeled f: $f = (\text{OBL}_{\text{LOC}}\ g)$

$$\begin{bmatrix} \text{SUBJ} & f\begin{bmatrix} \text{CASE} & \text{ERG} \\ \text{OBL}_{\text{LOC}} & g\begin{bmatrix} \text{PRED} & \text{'rock'} \\ \text{CASE} & \text{LOC} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Definition (Inside-out functional uncertainty)

$(\alpha\ f) = g$ iff g is an f-structure, α is a set of strings, and for some $s \in \alpha$, $(s\ f) = g$.

Off-path constraints

(25) Chris, we think/*whispered that David saw

$$\left[\begin{array}{ll} \text{PRED} & \text{'whisper}\left\langle \text{SUBJ,OBJ} \right\rangle\text{'} \\ \text{TOPIC} & \boxed{1}\left[\begin{array}{ll} \text{PRED} & \text{'chris'} \end{array}\right] \\ \text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{'pro'} \end{array}\right] \\ \text{COMP} & \left[\begin{array}{ll} \text{PRED} & \text{'see}\left\langle \text{SUBJ,OBJ} \right\rangle\text{'} \\ \text{LDD} & - \\ \text{SUBJ} & \text{'david'} \\ \text{OBJ} & \boxed{1} \end{array}\right] \end{array}\right]$$

Off-path constraints

There are cases in which a LDD is constrained in terms of other properties of the f-structures on the path.

Off-path constraints

Proposal

The sentential complement COMP of a nonbridge verb bears a feature LDD with value "−", which bridge verbs lack.

Verbs allowing extraction are often called *bridge verbs*, while those disallowing extraction are called *nonbridge verbs*.

Constraint

A COMP in the extraction path must not contain the pair $\langle \text{LDD}, - \rangle$.

$$(\uparrow \text{TOPIC}) = (\uparrow \underset{(\rightarrow \text{LDD}) \neq -}{\text{COMP}^*} \text{OBJ})$$

"$\rightarrow$" stands for the value of the attribute COMP.

Reading

- *Lexical Functional Grammar*
  - 6.2, 6.3
  - 13.1-13.4, 13.6
  - 14.1
- * R. Kaplan. *The formal architecture of lexical-functional grammar*

Final project

Why project?

In my opinion, the best way to fully understand this approach, to be able to write and read HPSG grammars, is to build an HPSG grammar from scratch, inventing and revising the details as one goes along, in accordance with the constraints imposed by the formal model.

Elementary Principles of HPSG

Final project

Project

Analyzing representative Mandarin Chinese sentences.

- ca. 30 sentences per person.
- Report
- Presentation

Annotation tool: LinguaView

`https://github.com/shuoyangd/LinguaView`

OMG

`http://www.icst.pku.edu.cn/lcwm/omg`