Grammar Formalisms:
Lexical Functional Grammar (LFG)

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Overview
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Principle ideas of LFG (1)
Lexical Functional Grammar (Kaplan & Bresnan, 1982):
• One level of constituent structure, c-structure, non-transformational.
  C-structures are represented with trees.
• A separate level of functional structure, f-structure, representing grammatical functions and predicate-argument relations.
  F-structures are represented with feature structures.
• Other levels such as argument structure (encoding thematic roles), semantic structure, morphological structure.
• Syntactic phenomena (including long-distance dependencies) are treated locally.

Principle ideas of LFG (2)
C-structure  F-structure

\[
\begin{array}{c}
 NP \\
 Det \\
\hline
 N \\
 V \\
 NP \\
 Det \\
\hline
 Subj \\
 Def + \\
 Num sg \\
 Tense past \\
 Pred 'eat (subj, obj)' \\
 Obj \\
 Pred apple \\
 Def + \\
 Num sg \\
\end{array}
\]
**Principle ideas of LFG (3)**

Evidence for a functional representational level comes from non-configurational languages.

Example: Warlpiri.

1. The two small children are chasing that dog.

   \[\text{wita-jarra-rlu ka-pala wajuli-pi-nyi yalumpu kurdu-jarr a-rlu maliki}\]

   small-pres chase-NPAST that ABS child- dog ABS dual-erg 3dsSUBJ

   dual-erg

   PRED SUBJ OBJ

   chase \(\langle\text{agent patient}\rangle\)

**F-structures (1)**

F-structures are attribute-value structures notated with the usual avm-notation.

Linguistic terminology:
- Attributes whose values are f-structures are called *grammatical functions*.
- Attributes whose values are symbols are called *features*.
- Attributes whose values are semantic forms are called *semantic features*.

**F-structures (2)**

Description of f-structures:

\[
\begin{align*}
(f_1 \text{SUBJ}) &= f_2 \\
(f_2 \text{PRED}) &= \text{`man'} \\
(f_2 \text{DEF}) &= + \\
(f_2 \text{NUM}) &= \text{SG} \\
(f_1 \text{TENSE}) &= \text{PAST} \\
(f_1 \text{PRED}) &= \text{`eat \langle subj, obj \rangle'} \\
(f_1 \text{OBJ}) &= f_5 \\
(f_5 \text{PRED}) &= \text{`apple'} \\
(f_5 \text{DEF}) &= + \\
(f_5 \text{NUM}) &= \text{SG}
\end{align*}
\]

**F-structures (3)**

More examples

- \((f_1 \text{SUBJ NUM}) = \text{SG}\)

  \[
  f_1 \begin{bmatrix} \text{SUBJ} & \text{NUM} & \text{SG} \end{bmatrix}
  \]

- \((f_1 \text{SUBJ}) = (f_1 \text{XCOMP SUBJ})\)

  \[
  f_1 \begin{bmatrix} \text{SUBJ} \end{bmatrix} \\
  f_1 \begin{bmatrix} \text{XCOMP} & \text{SUBJ} \end{bmatrix}
  \]
Linking C-structures and F-structures (1)

Each node in the c-structure is linked to exactly one f-structure.

```
NP  
|    |
|_Det_|
|    |
|_the_
|    |
|_man_|
V    
|    |
|    |
|ate  |
|    |
|    |
NP    
|    |
|    |
|_Det_|
|    |
|_the_
|    |
|_apple |
```

- **SUBJ** f₁
  - PRED 'man'
  - DEF +
  - NUM sg

- **TENSE** f₂
  - past

- **PRED** f₃
  - 'eat (subj, obj)'

- **OBJ** f₄
  - PRED 'apple'
  - DEF +
  - NUM sg

---

Linking C-structures and F-structures (2)

C-structures are described with standard phrase structure rules.

- **S** → NP VP, NP → Det N, ...

The phrase structure rules are equipped with information about how the mother f-structure and the daughter f-structures are related.

For a given node, the symbols ↑ and ↓ refer to the f-structures of the mother node and of the node itself.

```
S → NP VP
  (↑ SUBJ) = ↓ ↑ = ↓

NP → Det N
    ↑ = ↓ ↑ = ↓

VP → V NP
    ↑ = ↓ (↑ OBJ) = ↓
```
Control and raising (1)

Control:

(2) John believes to understand f-structures.
(3) John promised Bill to eat the apples.
(4) John persuaded Bill to eat the apples.

An argument of the matrix verb is identical to the non-overt subject of the complement clause.

There is no empty category PRO: the control relation is represented only in the f-structure.

Control and raising (2)

(5) John believes to understand f-structures.

Control and raising (3)

(6) John persuaded Bill to eat the apples.

Control and raising (4)

Raising:

(7) John seems to eat the apples
(8) John believes Bill to like Mary

An athematic argument of the main verb is identical with the non-overt subject of the embedded verb.

Athematic arguments are listed in the pred value (to satisfy coherence) but occur outside the brackets (…).
**Control and raising (5)**

(9) John seems to eat the apples

\[
\begin{array}{l}
\text{SUBJ} [\text{PRED} 'John'] \\
\text{TENSE} \text{past} \\
\text{PRED} 'seem' \langle \text{xcomp subj} \rangle \\
\text{XCOMP} \langle \text{SUBJ} \rangle \\
\text{OBJ} \langle \text{PREP} 'eat' \langle \text{subj, obj} \rangle \rangle \\
\end{array}
\]

\[
V \rightarrow \text{seems} \\
(\uparrow \text{PRED}) = 'seem' \langle \text{xcomp subj} \rangle \\
(\uparrow \text{SUBJ}) = (\uparrow \text{xcomp subj})
\]

**Long-distance dependencies (1)**

(10) Which book does Mary think John prefers?

F-structure for a wh-question without a long-distance dependency:

(12) Which book does John prefer?

\[
\begin{array}{l}
\text{SUBJ} [\text{PRED} 'John'] \\
\text{TENSE} \text{pres} \\
\text{PRED} 'believe' \langle \text{subj, xcomp} \rangle \\
\text{OBJ} \langle \text{PREP} 'like' \langle \text{subj, obj} \rangle \rangle \\
\end{array}
\]

Inside-out equation:

\[
\text{which}: \\
((\text{FOCUS} \uparrow) \text{TYPE}) = Q
\]

**Control and raising (6)**

(10) John believes Bill to like Mary

\[
\begin{array}{l}
\text{SUBJ} [\text{PRED} 'John'] \\
\text{TENSE} \text{pres} \\
\text{PRED} 'believe' \langle \text{subj, xcomp} \rangle \text{obj} \\
\text{OBJ} [\text{PREP} 'Bill'] \\
\text{XCOMP} \langle \text{SUBJ} \rangle \\
\text{OBJ} \langle \text{PREP} 'like' \langle \text{subj, obj} \rangle \rangle \\
\end{array}
\]

\[
V \rightarrow \text{believes} \\
(\uparrow \text{PRED}) = 'believe' \langle \text{subj, xcomp} \rangle \text{obj} \\
(\uparrow \text{OBJ}) = (\uparrow \text{xcomp subj})
\]

**Long-distance dependencies (2)**

So far, which book is linked to the focus f-structure. Because of completeness, an object f-structure is needed as well.

Therefore, an empty category is introduced and equipped with an inside-out equation ((OBJ \uparrow)FOCUS) = \uparrow.
Long-distance dependencies (3)

![Diagram](image)

(13) Which book does Mary think John prefers?

\[
\begin{array}{c}
\text{TYPE} = q \\
\text{FOCUS} = \begin{cases} \\
\text{PRON} = \text{wh} \\
\text{NUM} = \text{sg} \\
\text{SUBJ} = \text{PRED} = \text{Mary} \\
\text{TENSE} = \text{pres} \\
\text{PRED} = \langle \text{think (subj, comp)} \rangle \\
\text{COMP} = \begin{cases} \\
\text{SUBJ} = \text{RED} = \langle \text{John} \rangle \\
\text{OBJ} = \text{RED} = \langle \text{prefer (subj, obj)} \rangle \\
\end{cases}
\end{cases}
\end{array}
\]

empty category: \((\text{COMP OBJ }) \Rightarrow \text{FOC} = \uparrow\)

Summary

- LFG distinguishes between two levels of representation: a constituent structure (a tree) and a functional structure (an attribute value structure).
- This distinction allows to capture languages where single elements in the f-structure are linked to discontinuous parts in the c-structure.
- C-structure is described with phrase structure rules. The single nodes in the c-structure are equipped with equations defining properties of their own and their mother’s f-structure.
- The description language for the f-structures is very powerful, including in particular functional uncertainty, a device that allows to describe paths of arbitrary length in the f-structure.