LFG

Syntactic Theory
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Outline

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Lexical Functional Grammar, Recap

- Main ideas:
  - A formal system to model human speech (fits in the tradition of generative grammar)
  - Psychological plausibility: the formalism should be able to represent a native speaker's syntactic knowledge appropriately
  - Strong typological basis: analyses should capture cross-linguistic similarities
- A Lexical Functional Grammar represents expressions in (minimally) two levels of representation:
  - **constituent structure** (c-structure), where languages are very different
  - **functional structure** (f-structure), where languages are very similar

F-structures, recap I

- F-structures represent the grammatical relations of expressions, e.g. SUBJ, OBJ, OBL, (X)COMP, (X)ADJ
- Motivation:
  - No advantage in representing such information as phrase-structure information
  - Languages are similar on this level: allows to explain cross-linguistic properties of phenomena
- Formally, an f-structure is a set of attribute-value pairs
  - attributes are symbols
  - values are symbols, semantic forms or f-structures
  - an attribute-value pair is a function, leading to a specific value for an attribute within the f-structure

F-structures, recap II

- LFG posits a universal inventory of grammatical functions (where we distinguish governable functions and modifiers (among other properties))
  - governable functions are grammatical functions that are subcategorized by a predicate
- F-structures must be:
  - complete:
    - All governable functions subcategorized for by the predicate must be present in the f-structure
  - coherent:
    - All governable functions present in the f-structure must be subcategorized for by a predicate
  - consistent:
    - Each attribute must lead to at most one value (which may be a set)

Organization of the coming lectures

- An overview of the architecture of LFG
  - F-structures: formal definition and basic properties
  - C-structures: basic properties
  - Mapping between c- and f-structures
  - Example analysis
- Phenomena and constraints in LFG
  - How to integrate and use constraints in LFG analyses
  - Some basic phenomena and their analyses in LFG

An example of an F-structure

- Example: the f-structure of *I saw the girl*:

$$\begin{bmatrix} \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'pro'} \\ \text{PERS} & 1 \\ \text{NUM} & \text{SG} \end{bmatrix} \\ \text{TENSE} & \text{PAST} \\ \text{PRED} & \text{'see}\langle(\uparrow\text{SUBJ}),(\uparrow\text{OBJ})\rangle\text{'} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'girl'} \\ \text{DEF} & + \\ \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix}$$

Outline

Constituent structure

- The constituent structure represents the organization of overt phrasal syntax
- It provides the basis for phonological interpretation
- Languages are very different on the c-structure level

Constituency I

- Why constituency?
  - Example *the dachshund is barking*

  → Observations by Noam Chomsky:
    - The same sequence of categories may appear in more than one environment e.g. *David petted the dachshund*
    - Such sequences can be replaced by the same sequence with additional modifiers *the black dachshund is barking*, *David petted the black dachshund*

    → constituents capture the intuitions that certain sequences form phrasal units (e.g. *the dachshund*), and others do not (e.g. *petted the*)

    → constituents simplify linguistic description: distribution can be defined for a phrase, and need not be defined for each individual sequence of words
- What is a constituent?

How to identify constituents? I

There are several tests to identify constituents:

- Distribution: can the sequence occur in a variety of other sentence positions?
- Questions: is the sequence an answer to *who*, *what*, *how*, *where*?
- Scrambling: can the sequence be topicalized? Appear in the first position of a verb-second language?
- Non-separability: are there elements that may not be inserted in the sequence?

Constituency in LFG I

In LFG constituency depends on the surface properties of expressions (Dalrymple 2001):

- Intonation:
  - In Russian a falling intonation on the right edge of a constituent indicates the element is in focus (+F)(King 1995)

    (1) kolxoz zakončil [uborku urožaja$_{+F}$].
    kolxoz finished harvest crop
    'The *kolxoz* finished [the crop harvest]-FOCUS

  - In French, stress is placed on the final syllable of a phrase:

    (2) [le **chat**]/[le [chat **noir**]]
    the cat/the cat black

    (3) je [vois [le chat **noir**] [avec [le **téléscope**]]]
    I see the cat black with the telescope

Constituency in LFG II

- Clitic placement: in English the placement of the genitive *'s* is best described as at the right edge of a constituent (Zwicky 1990)

  (4) [my friend from Chicago]'s crazy ideas

- Verb-second: in verb-second languages, the conjugated verb must be preceded by exactly one constituent

  (5) [Den Mann mit dem Fernglas] habe ich gesehen
  the man with the telescope have I seen

  (6) [Mit dem Fernglas] habe ich den Mann gesehen
  with the telescope have I the man seen
  'I saw the man with the telescope'

Constituency in LFG III

- Question formation: only single displaced constituents can appear in clause initial position in English wh-questions (Zwicky (1990))

  (7) Which people from California did you introduce to Tracy?

  (8) Which people from California [to Tracy] did you introduce?

  (9) To how many of your friends did you introduce people from California?

  (10) People from California [to how many of your friends] did you introduce?

Constituency in LFG IV

- Adverb placement: certain adverbs cannot be inserted in a VP. E.g. In Icelandic, an adverb has restricted distribution when a modal is present:

(11) a. Hann mun sjaldan stinga smjörinu í vasann.
he will seldom put butter.DEF in pocket.DEF

b. * Hann mun stinga sjaldan smjörinu í vasann.
he will put seldom butter.DEF in pocket.DEF

Constituency in LFG V

c. * Hann mun stinga smjörinu sjaldan í
he will put butter.DEF seldom in
vasann.
pocket.DEF

d. Hann mun stinga smjörinu í vasann
he will put butter.DEF in pocket.DEF
sjaldan.
seldom

(12) a. Hann stingur sjaldan smjörinu í vasann.
he puts seldom butter.DEF in pocket.DEF

b. Hann stingur smjörinu sjaldan í vasann.
he puts butter.DEF seldom in pocket.DEF

c. Hann stingur smjörinu í vasann sjaldan.
he puts butter.DEF in pocket.DEF seldom

Constituency in LFG VI

- Explanation: distribution of adverbs depends on the presence or absence of a VP. In Icelandic VPs are formed when there is an auxiliary present

(13)

Hann	mun	[stinga	smjörinu	í	vasann]$_{VP}$
he	will	put	butter.DEF	in	pocket.DEF

Properties of c-structures

- C-structures are conventional phrase structure trees: they are defined in terms of syntactic categories, terminal nodes, dominance and precedence
- They are determined by a context free grammar that describes all possible surface strings of the language
- LFG does not reserve constituent structure positions for affixes: all leaves are indivual words

Lexical Categories I

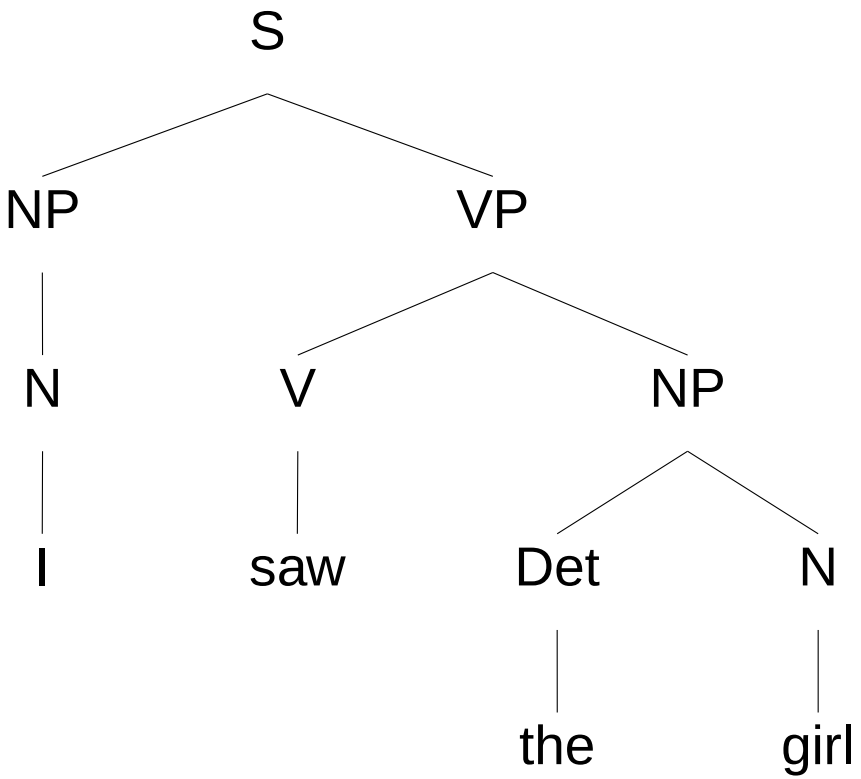
LFG assumes the following major lexical categories (Dalrymple (2001); p.52):

- N(oun), P(reposition), V(erb), A(djective), Adv(erb)
- These categories are heads of phrases with a corresponding category:
  - NP: *the boy*
  - PP: *on the boat*
  - VP: *sail the boat*
  - AP: *very fearful of the storm*
  - AdvP: *quite fearfully*
- Individual languages may have additional minor lexical categories. Minor categories do not project full phrase structures
  - David called Chris [up]$_{Part}$.

Lexical Categories II

- There are also “functional categories” such as I(nflectional)P as head of a finite clause, C(omplementizer)P typically head of a subordinate clause (filled by a verbal element or a complementizer (*that*) and D(eterminer)P
- It is not universally fixed which categories are used in a particular language

Example of a c-structure

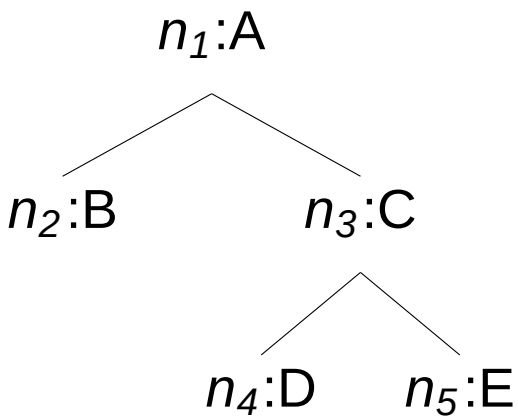


Properties of a tree (Kaplan 1995)

- A tree consists of:
  - N: a set of nodes
  - M: $N \rightarrow N$
    a mother function M that takes nodes into nodes
  - $< \subseteq N \times N$
    a partial ordering $<$
  - λ: $N \rightarrow L$
    Nodes are related by a labeling function λ that takes nodes into some finite labeling set L
- LFG admits only nontangled trees:
  - For any nodes n_1 and n_2, if $M(n_1) < M(n_2)$, then $n_1 < n_2$

Description of a tree

- Tree:



- Description of the tree:

$$\begin{array}{lll} M(n_2) = n_1 & \lambda(n_1) = A & \lambda(n_2) = B \\ M(n_3) = n_1 & \lambda(n_3) = C & n_2 < n_3 \\ M(n_4) = n_3 & \lambda(n_4) = D & M(n_5) = n_3 \\ \lambda(n_5) = E & n_4 < n_5 & \end{array}$$

Constituent Structure Rules

- A PS-tree in LFG is admitted by a set of Phrase Structure Rules
- A difference between LFG PS-tree and 'typical' linguistic PS-rules is that in LFG the right-hand side of a rule consists of a regular expression, i.e. we find optionality, kleene stars, disjunction

Immediate Dominance and Linear Precedence

- Immediate dominance (ID) and linear precedence (LP) can be defined separately in LFG
- An ID rule, only expressing immediate dominance is written with commas separating the daughters:

  $VP \rightarrow V, NP$

  corresponds to the following two rules:

  $VP \rightarrow V\ NP$

  $VP \rightarrow NP\ V$
- Linear precedence can be specified with an additional constraint:

  $VP \rightarrow V, NP \qquad V < NP$
- A more complex example:

  $VP \rightarrow V, NP, PP \qquad V < NP, V < PP$

  corresponds to

  $VP \rightarrow \{V\ NP\ PP \mid V\ PP\ NP\}$

Some additional operators on PS-rules

- The 'ignore' operator:
  - XP $\rightarrow$ X1 X2 X3 / Cat
    This rule means: XP goes to X1 X2 X3 ignoring occurrences of 'Cat'. An alternative notation:
  - XP $\rightarrow$ Cat* X1 Cat* X2 Cat* X3 Cat*
- The shuffle operator:
  - XP $\rightarrow$ [X1 X2 X3], [Y1 Y2 Y3]
    This rule states that the linear precedence constraints between Xs must be respected, as well as those between Ys, but the order is free across these sequences. The following sequences are all allowed:
  - X1 X2 Y1 Y2 X3 Y3
  - X1 Y1 X2 X3 Y2 Y3
  - X1 Y1 Y2 X2 Y3 X3

Metacategories

- Metacategories allow to group phrases together that are of different category and can occur in the same position.
- E.g.

  $S \rightarrow XP\ Aux$
  $XP \equiv \{NP \mid PP \mid VP\}$

- This equivalence states that “XP” may be replaced by “NP”, “PP” or “VP”.
- The equivalent set of rules is:

  $S \rightarrow NP\ Aux$
  $S \rightarrow PP\ Aux$
  $S \rightarrow VP\ Aux$

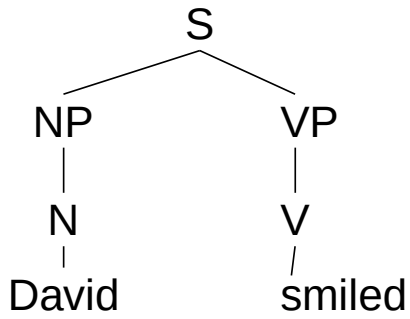
Outline

structural correspondences

- C-structures and f-structures represent different properties of an utterance
- How can these structures be associated properly to a particular sentence?
- Words and their ordering carry information about the linguistic dependencies in the sentence
- This is represented by the c-structure (licensed by a CFG)
- LFG proposes simple mechanisms that maps between elements from one structure and those of another: correspondence functions
- A function ϕ allows to map c-structures to f-structures
  ϕ: N $\rightarrow$ F

Mapping from c- to f-structure: The head convention

- Consider the following example:



$$\begin{bmatrix} \text{PRED} & \text{'smile<(}\uparrow \text{ SUBJ)>'} \\ \text{TENSE} & \text{PAST} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'David'} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \end{bmatrix} \end{bmatrix}$$

- The **head convention** states that a phrase inherits its functional properties and requirements from its head: a constituent structure phrase and its head map to the same f-structure
- S, VP and V thus map to the same f-structure

Mapping from c- to f-structure: The head convention

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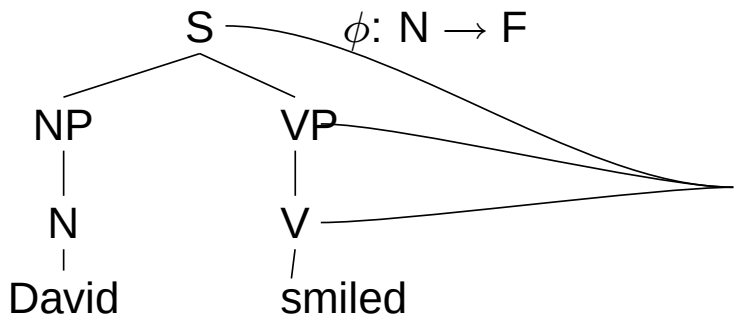

$$\begin{bmatrix} \text{PRED} & \text{'smile<(↑ SUBJ)>'} \\ \text{TENSE} & \text{PAST} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'David'} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \end{bmatrix} \end{bmatrix}$$

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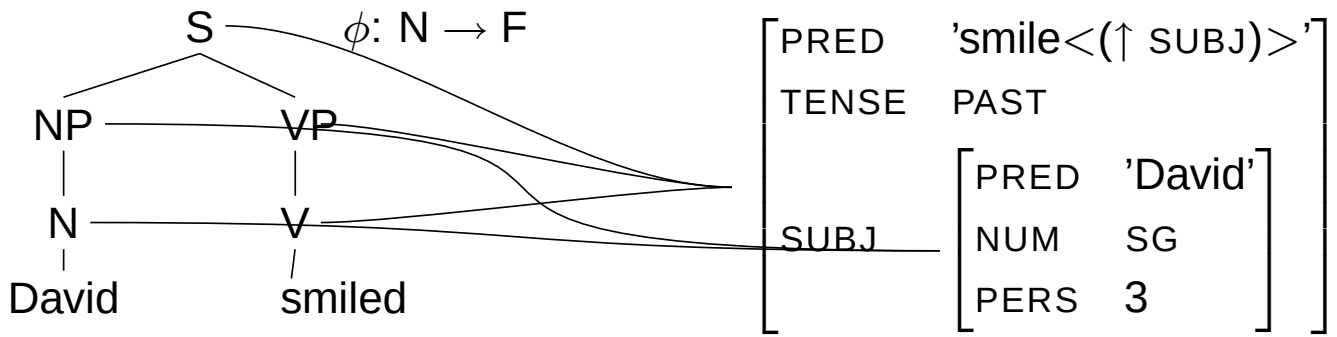

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Annotating PS-rules: heads

- Consider the following rule to expand VP to V

  $$\text{VP} \rightarrow \text{V}$$

- We express the fact that VP and V have the same f-structure by annotating the V-node:

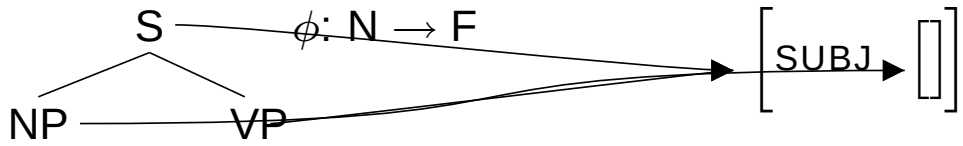
  $$\begin{array}{ll}\text{VP} \rightarrow & \text{V} \\ & \phi(\text{M}(n)) = \phi(n)\end{array}$$

- This equation indicates that the f-structure of the mothernode of V ($\phi(\text{M}(n))$) is equal to the node of V ($\phi(n)$)
  - An alternative notation:

    $$\begin{array}{ll}\text{VP} \rightarrow & \text{V} \\ & \uparrow = \downarrow\end{array}$$

Annotating PS-rules: grammatical functions

- Consider the following example:



- Here the NP bears the SUBJ function
- The following phrase structure rule carries the additional information to derive the correct f-structure:

$$\begin{array}{lll} S \rightarrow & NP & VP \\ & (\phi(M(n))\ \text{SUBJ}) = \phi(n) & \phi(M(n)) = \phi(n) \end{array}$$

- An alternative notation:

$$\begin{array}{lll} S \rightarrow & NP & VP \\ & (\uparrow \text{SUBJ}) = \downarrow & \uparrow = \downarrow \end{array}$$

Lexical Entries

In lexical entries, information about the item's f-structure is represented in the same way as in c-structures:

smiled V (↑ PRED) = 'smile<(↑ SUBJ)>'
(↑ TENSE) = PAST

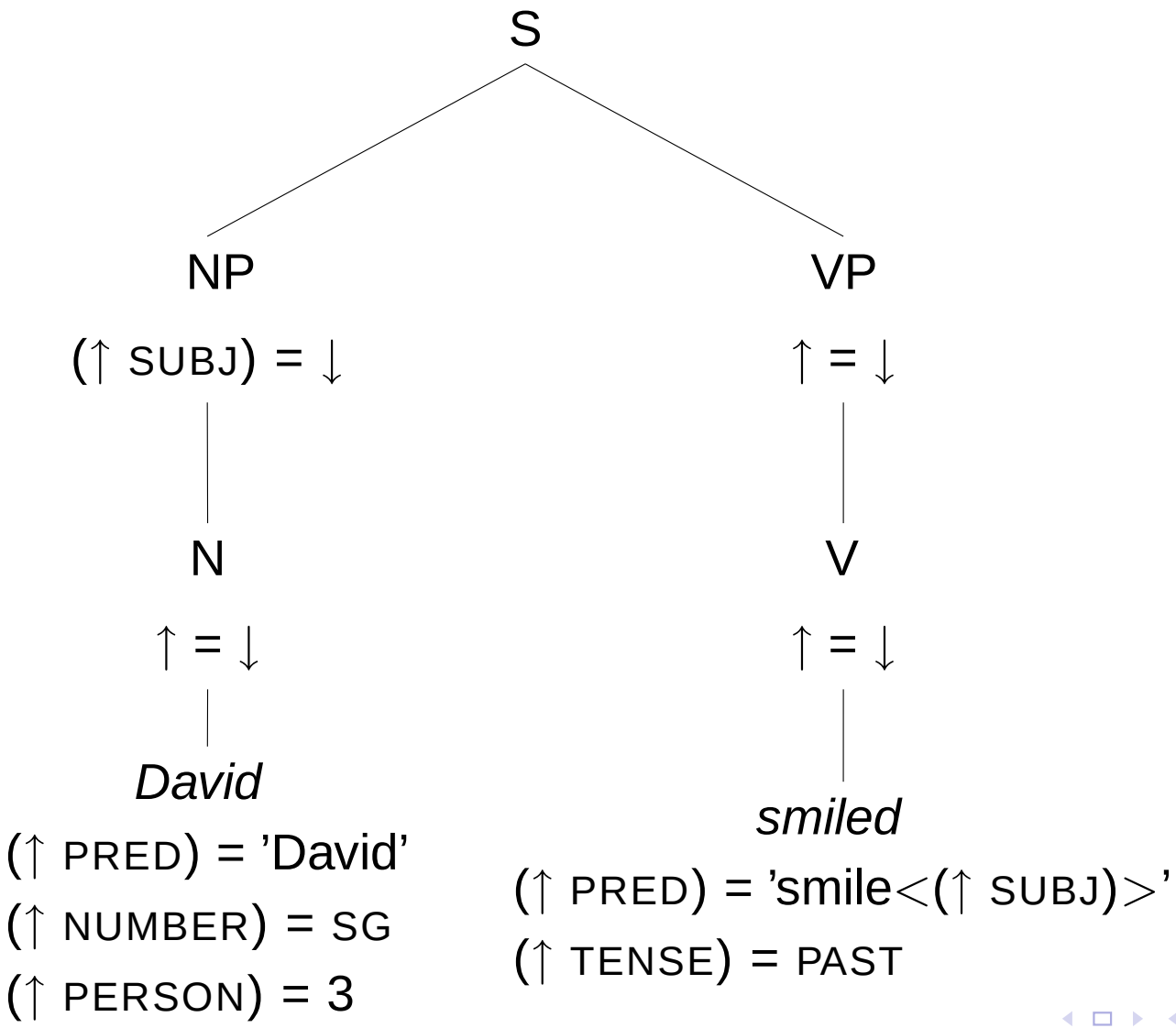
- The equivalent phrase structure rule:

V → *smiled*
(↑ PRED) = 'smile<(↑ SUBJ)>'
(↑ TENSE) = PAST

An example analysis: *David smiled*

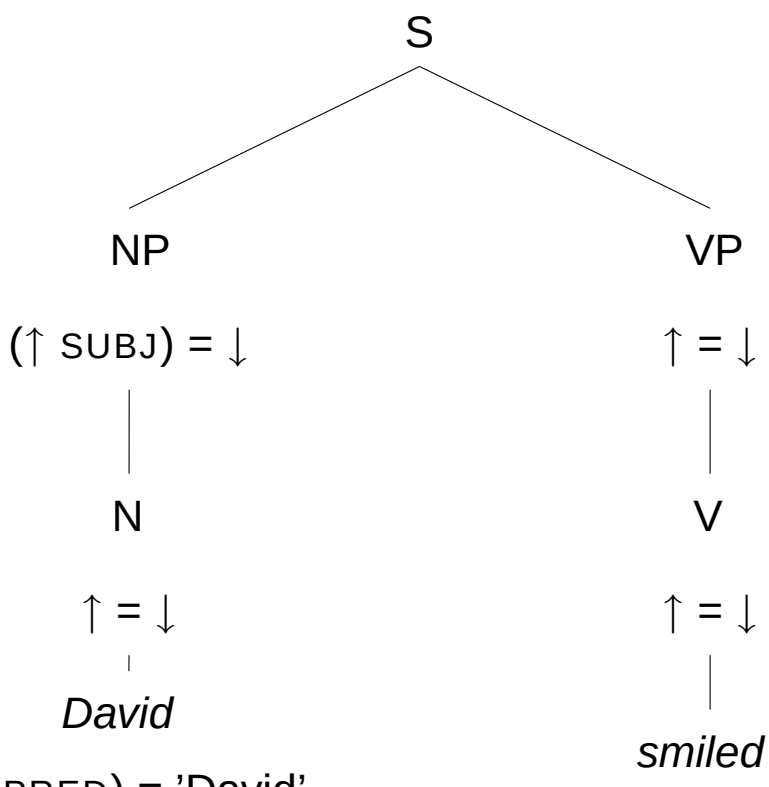
- We assume the following annotated PS-rules:
  - S → NP VP
    (↑ SUBJ) = ↓ ↑ = ↓
    VP → V
    ↑ = ↓
    NP → N
    ↑ = ↓
- and the following lexical entries
  - *smiled* V (↑ PRED) = 'smile<(↑ SUBJ)>'
    (↑ TENSE) = PAST
    David N (↑ PRED) 'David'
    (↑ NUMBER) = SG
    (↑ PERSON) = 3

Analysis of *David smiled*



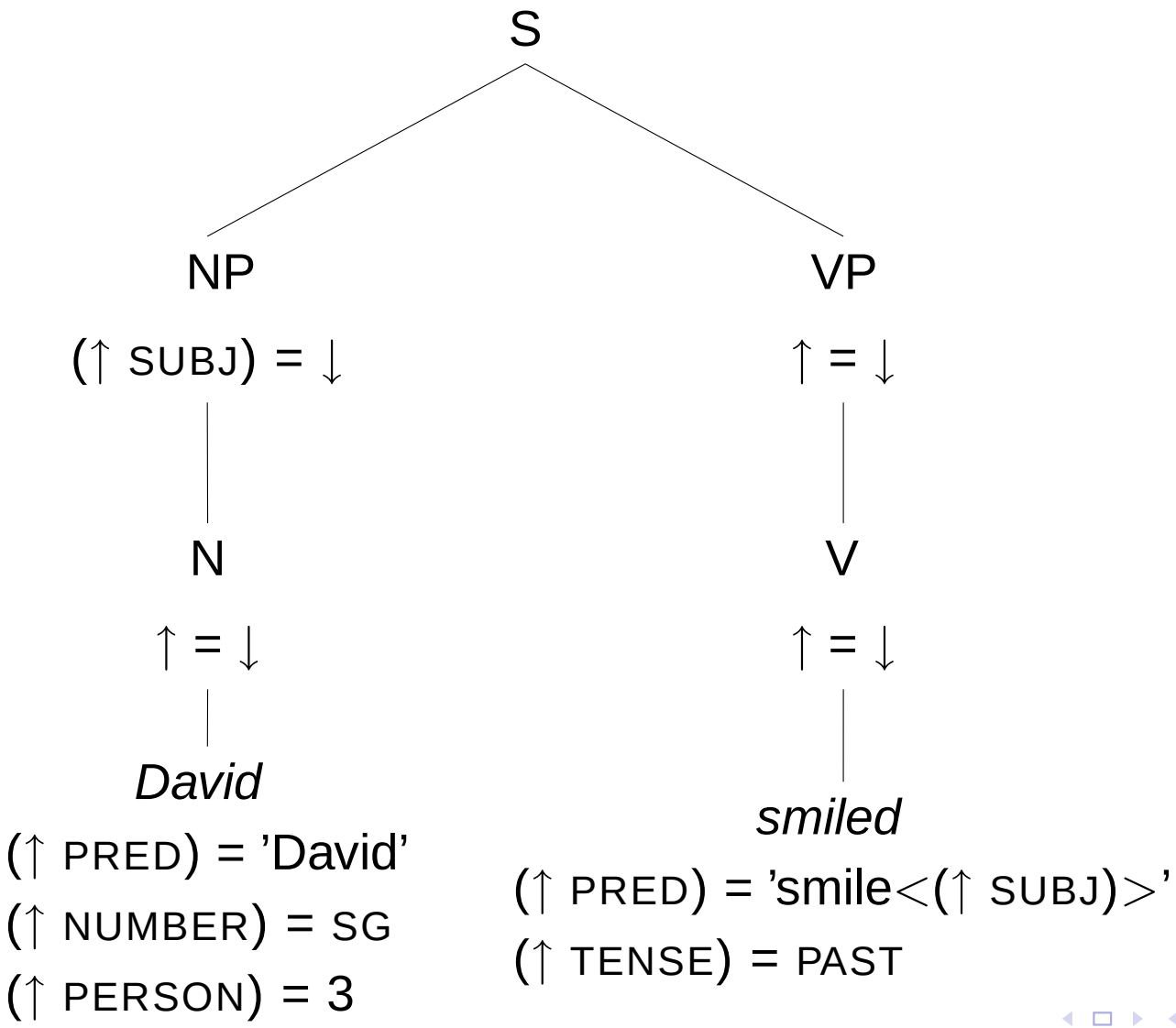
Instantiating the f-description of the sentence

- In order to get the functional description of the sentence, we associate each node with an f-structure:



f_s corresponds to node S
f_{np} corresponds to node NP
f_n corresponds to node N
f_{vp} corresponds to node VP
f_v corresponds to node V

References of ↑ and ↓



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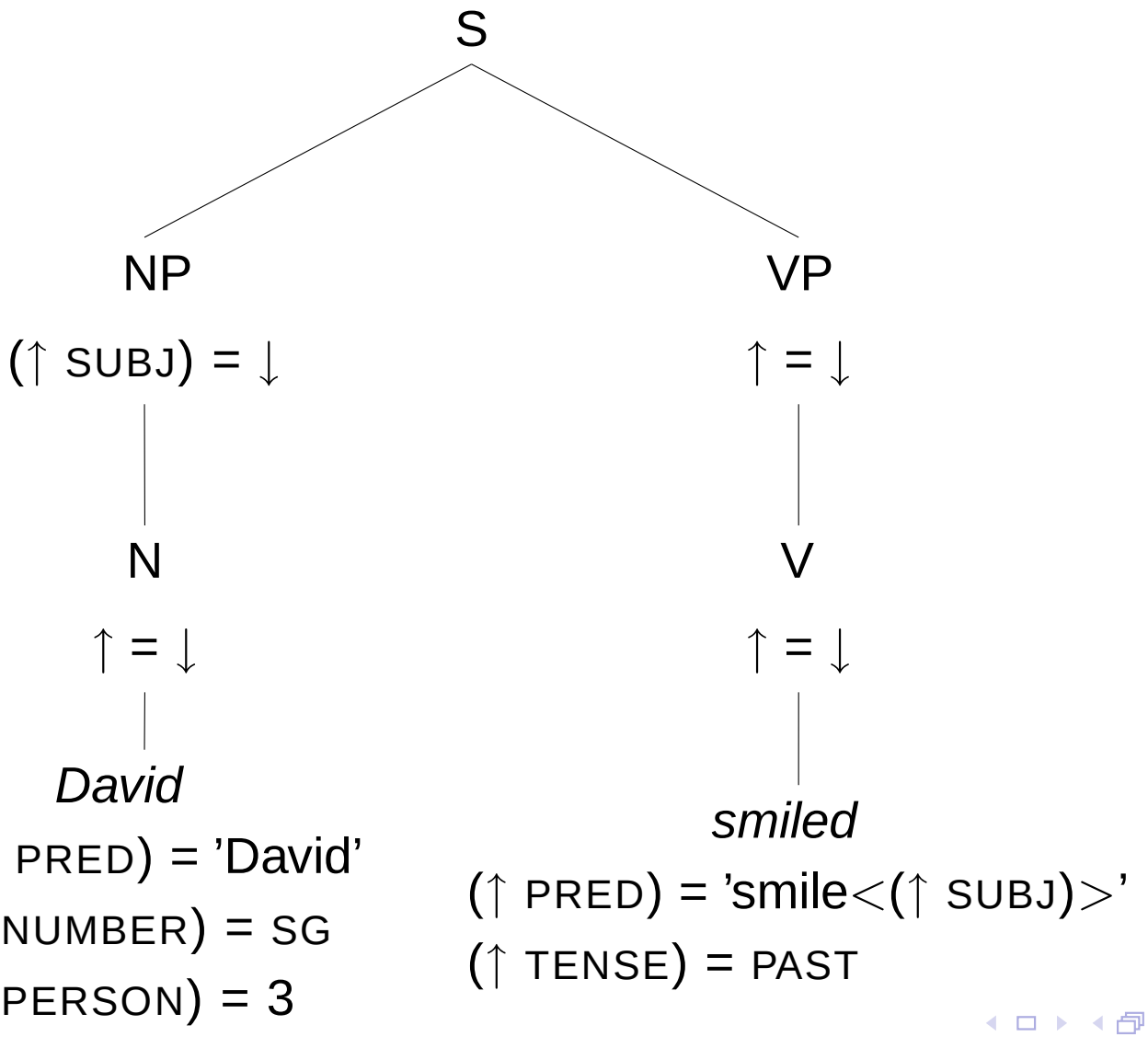

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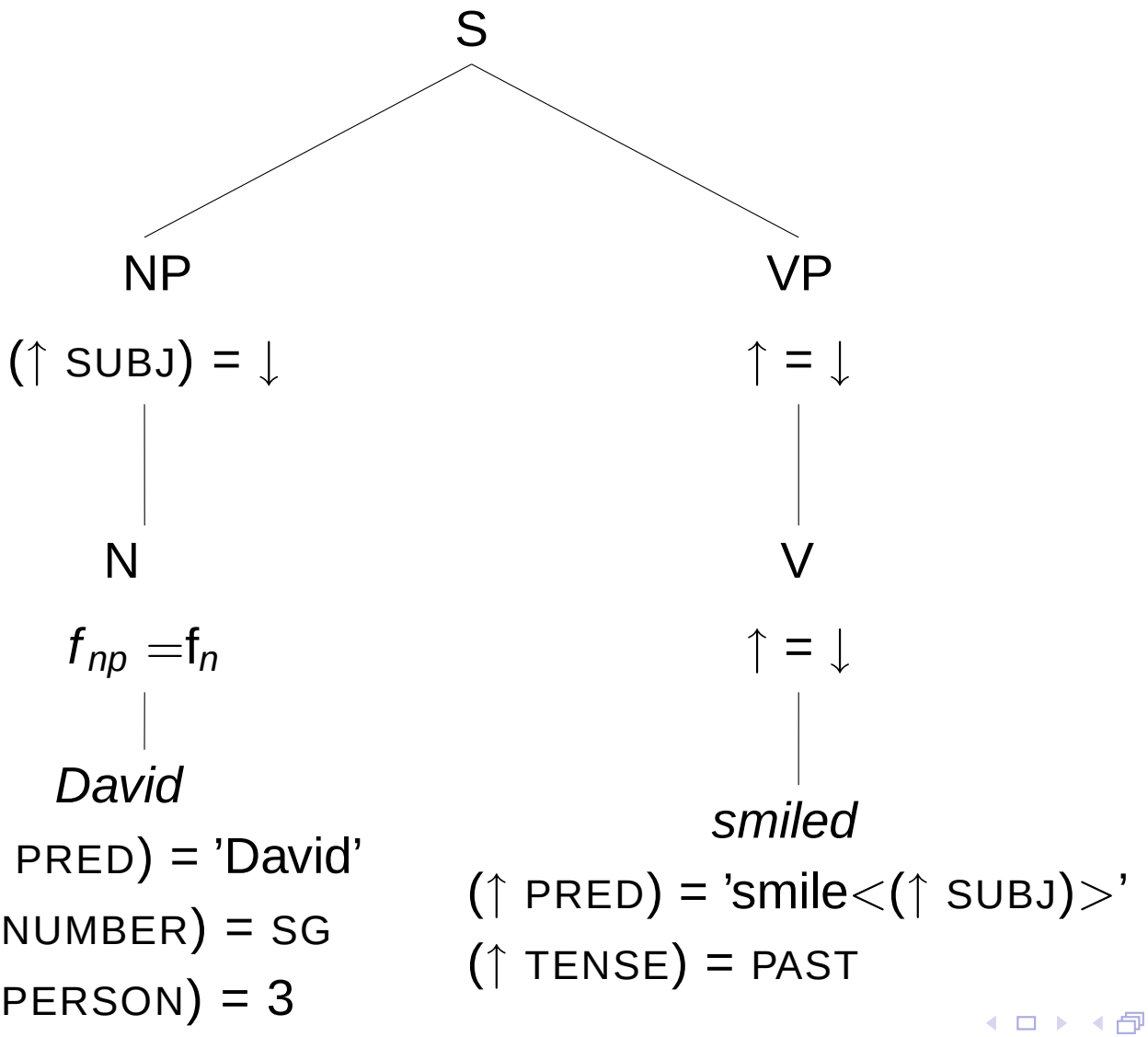

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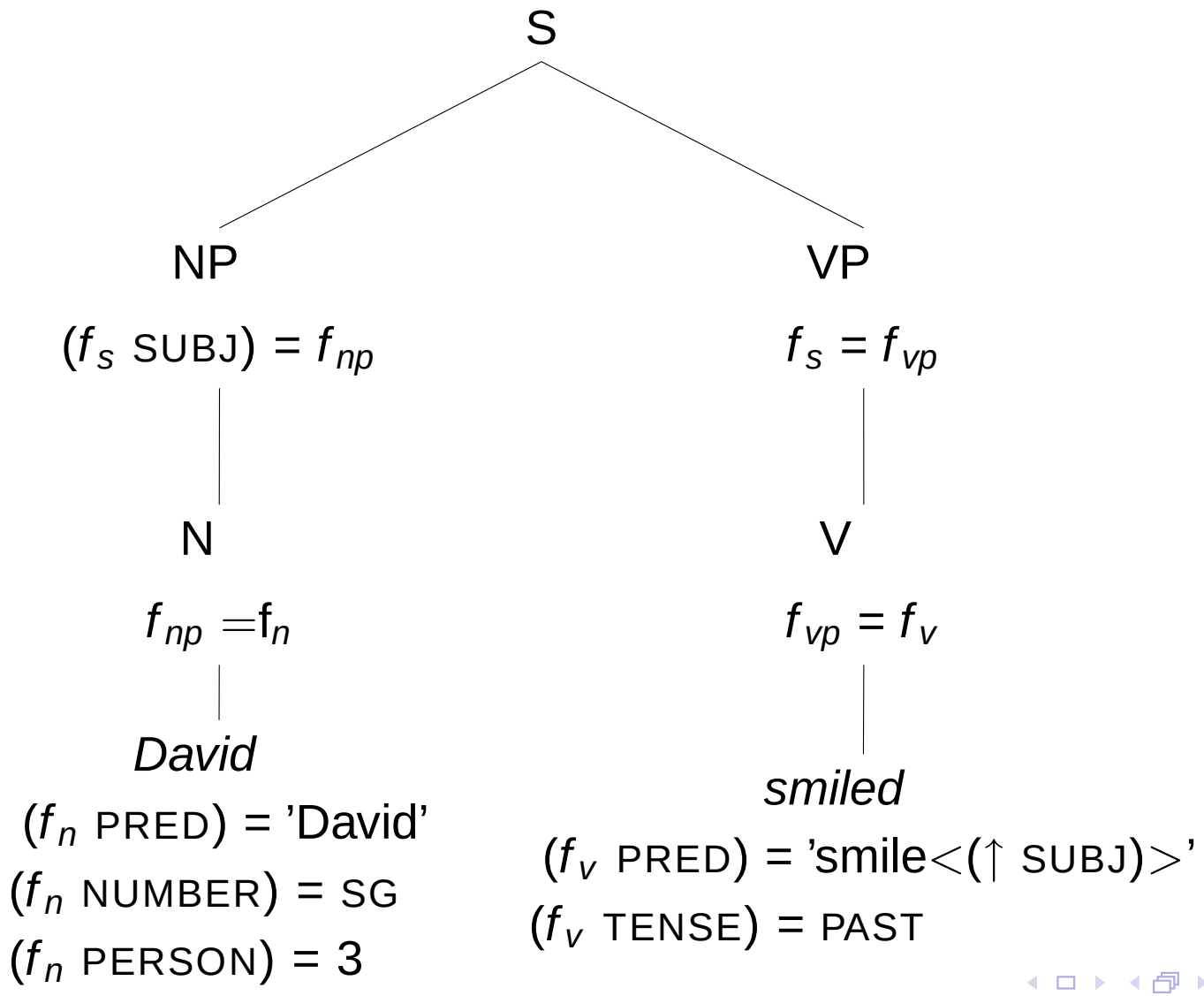

The functional description

- The tree on the previous slide provides the following functional description:

$(f_s\ \text{SUBJ}) = f_{np}$
$f_{np} = f_n$
$(f_n\ \text{PRED}) = \text{'David'}$
$(f_n\ \text{NUMBER}) = \text{SG}$
$(f_n\ \text{PERSON}) = 3$
$f_s = f_{vp}$
$f_{vp} = f_v$
$(f_v\ \text{PRED}) = \text{'smile}\langle(\uparrow\text{SUBJ})\rangle\text{'}$
$(f_v\ \text{TENSE}) = \text{PAST}$

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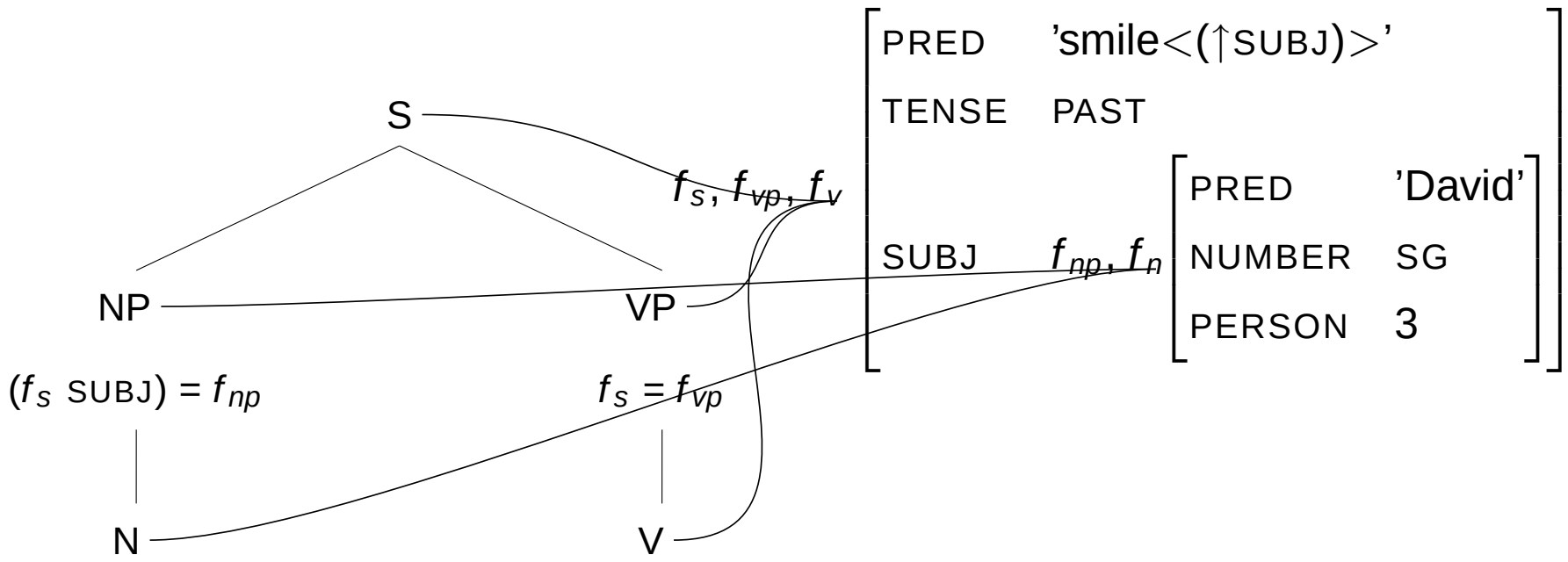
$(f_v\ \text{TENSE}) = \text{PAST}$

$$f_s, f_{vp}, f_v \begin{bmatrix} \text{PRED} & \text{'smile}\langle(\uparrow\text{SUBJ})\rangle\text{'} \\ \text{TENSE} & \text{PAST} \\ \text{SUBJ} & f_{np}, f_n \begin{bmatrix} \text{PRED} & \text{'David'} \\ \text{NUMBER} & \text{SG} \\ \text{PERSON} & 3 \end{bmatrix} \end{bmatrix}$$

David smiled: f- and annotated c-structure



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