Problems with Complement Extraction Lexical Rules

Stefan Müller[*][†]

DFKI GmbH
Stulsatzenhausweg 3
66123 Saarbrücken

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[*]e-mail: `Stefan.Mueller@dfki.de`; comments welcome.

[†]Thanks to Andreas Kathol for comments on an earlier version of this paper. The paper was written during my time at the Chair for Computational Linguistics at Humboldt University Berlin.
It is available via WWW: http://www.dfki.de/~stefan/Pub/celr.html

Contents

1 Introduction

While implementing the Babel-System[1] (Müller, 1996) I found that it is impossible to use complement extraction lexical rules (CELRs) if the extracted complements have structural case. Apart from that it is difficult to describe German agreement if one uses CELRs. I will mention the problems known to me so far and will suggest some solutions. At least as far as the solutions provided for case assignment are concerned, I don not consider the proposals given to be final because of the loss of some linguistic generalizations.

In section 8 I show how one could implement the functionality of lexical rules for extractions using a special kind of trace. The examples I provide are examples for

[1] http://www.compling.hu-berlin.de/˜stefan/Babel/

a nonlocal phenomenon: extraposition. This section might be of particular interest for implementors who do not want to use an ARG-S list for binding theory. This seems reasonable for systems in which lexical rules are not computed off line. In those systems lexical rules do not have any computational advantage over traces and one might therefore prefer to use the same representation for both nonlocal dependencies, i.e., for topicalization and extraposition.

This paper does not want to imply that lexical rules should not be used at all to introduce nonlocal information. There are some cases in which they can be used perfectly well. One example is the topicalization of separable prefixes in German (cf. (Müller, 1998)). I use lexical rules even for the introduction of nonlocal extraposition information. But as I mentioned above, this makes the use of an ARG-S list necessary.

2 Versions of CELRs

2.1 Pollard and Sag (1994)

The following complement extraction lexical rule is given by Pollard and Sag (1994) and used by many other authors (Hinrichs and Nakazawa (1994), Hukari and Levine (1994)).[2]

$$\begin{bmatrix} COMPS & \left\langle \ldots, \boxed{3}[LOC\ \boxed{1}], \ldots \right\rangle \\ ARG-S & \left\langle \ldots, \boxed{3}, \ldots \right\rangle \\ INHER|SLASH & \boxed{2} \end{bmatrix} \rightarrow \begin{bmatrix} COMPS & \left\langle \ldots, \ldots \right\rangle \\ ARG-S & \left\langle \ldots, \boxed{4}[LOC\ \boxed{1}, INHER|SLASH\ \left\{\boxed{1}\right\}], \ldots \right\rangle \\ INHER|SLASH & \boxed{2} \cup \left\{\boxed{1}\right\} \end{bmatrix} \quad (1)$$

> The intended interpretation of the lexical rule is that all occurrences of $\boxed{3}$ in the input (except the one on the COMPS list, which is eliminated in the output) are to be replaced in the output by a specification $\boxed{4}$, which is exactly like $\boxed{3}$ except that it bears the additional specification [SLASH|INHER $\{\boxed{1}\}$].(Pollard and Sag, 1994, p. 378, footnote 36)

2.2 Sag and Godard (1994)

$$\begin{bmatrix} COMPS & \left\langle \ldots, [LOC\ \boxed{1}, NLOC|SLASH\ \left\{\boxed{1}\right\}], \ldots \right\rangle \\ INHER|SLASH & \boxed{2} \end{bmatrix} \rightarrow \begin{bmatrix} COMPS & \left\langle \ldots, \ldots \right\rangle \\ INHER|SLASH & \boxed{2} \cup \left\{\boxed{1}\right\} \end{bmatrix} \quad (2)$$

[2]In Pollard and Sag (1994) the ARG-S list is called SUBCAT list. In order to avoid confusion I will use the following features throughout the paper: SUBJ is a list of at most one *synsem* object. SUBJ contains the subject of a verb, if there is one. COMPS contains all other complements of the verb and ARG-S is the concatenation of SUBJ and COMPS. SUBCAT is the old-fashioned subcat list containing both subject, if there is one, and the other complements.

2.3 Nerbonne (1994)

$$
\left[SYNSEM|LOC|CAT \left[\begin{array}{ll} HEAD & \left[{}_{verb} \right] \\ SUBCAT & \boxed{1} \left\langle \ldots, \boxed{2} [LOC\ \boxed{3}], \ldots \right\rangle \end{array} \right] \right] \rightarrow
$$

$$
\left[SYNSEM \left[\begin{array}{ll} LOC|CAT & \left[\begin{array}{ll} HEAD & \left[FIN\ + \right] \\ SUBCAT & \boxed{1} - \boxed{2} \end{array} \right] \\ NONLOC|SLASH & \left\{ \boxed{3} \sqcap' unspec-lex \right\} \end{array} \right] \right] \tag{3}
$$

2.4 Criticism

Just one of these three rules is almost correct. It is the one by Sag and Godard (1994). But even this one is too general if a grammar contains lexical entries with variables in the COMPS list (for instance German auxiliaries which do attract the arguments of their verbal complements).

What is wrong about those rules? There are two points to notice: First there is the possibility to block extraction lexically. If one specifies complements as NONLOC|INHER|SLASH {} no trace would unify during the application of the subcat or valence principle. The rules of Nerbonne and Pollard and Sag however do not specify the structure sharing of LOCAL and NONLOC|INHER|SLASH value on the input side. Therefore lexical entries will be generated which should not exist.

As an example take German separable prefixes. There are some of them which can be topicalized and some which cannot.

(4) a. Karl fährt häufig Bus.

b. Bus fährt Karl häufig.

c. Karl färbt die Jacke um.

d. *Um färbt Karl die Jacke.

One possibility to block the topicalization of *um* in (4d) is to specify its NONLOC|-INHER|SLASH value as {}. Clearly the lexical rules proposed by Nerbonne and Pollard and Sag would ignore this information and therefore (4d) would be analyzed as correct.

Second, there might be lexical entries in which the NONLOC|INHER|SLASH value of a complement is different from the LOC value of the complement. One example for such an entry is given by Pollard, Kasper, and Levine (1994) (see also section 7). The same problem arises for CELRs which do not specify the NONLOC value in the input sign.

Because the NONLOC|INHER|REL value is not specified, the rules shown above could extract the first complement of the empty relativizer proposed in (Pollard and Sag, 1994, p. 216).

This is not possible if the lexical rule is fully equivalent to the trace solution. The correct version of the CELR should therefore be the rule in (5).

$$\left[\begin{array}{ll} SYNSEM & \left[\begin{array}{ll} LOC & \left[\begin{array}{ll} CAT|COMPS & \boxed{1} \oplus \left\langle \boxed{2} \right\rangle \oplus \boxed{3} \end{array}\right] \\ NONLOC & \left[\begin{array}{ll} INHER|SLASH & \boxed{4} \end{array}\right] \end{array}\right] \end{array}\right]_{\textit{lexical-sign}} \rightarrow$$

$$\left[\begin{array}{ll} SYNSEM & \left[\begin{array}{ll} LOC & \left[\begin{array}{ll} CAT|COMPS & \boxed{1} \oplus \boxed{3} \end{array}\right] \\ NONLOC & \left[\begin{array}{ll} INHER|SLASH & \boxed{4} \cup \left\{ \boxed{5} \right\} \end{array}\right] \end{array}\right] \end{array}\right]_{\textit{lexical-sign}} \tag{5}$$

Where $\boxed{2}$ corresponds to the structure in (6).

$$\left[\begin{array}{ll} LOC & \boxed{5} \\ NONLOC & \left[\begin{array}{ll} INHER & \left[\begin{array}{ll} QUE & \{\} \\ REL & \{\} \\ SLASH & \left\{ \boxed{5} \right\} \end{array}\right] \end{array}\right] \end{array}\right]_{\textit{synsem}} \tag{6}$$

3 German V2

In all German HPSG-Analyses I am aware of,[3] verb-second (V2) sentences are analysed by means of unbounded dependencies. That is, the basis of a V2 sentence is a verb-initial sentence one constituent of which is topicalized. This constituent can originate form an arbitrarily deep level of embedding. Subjects, objects and more oblique complements can be topicalized.

The consequence of this is that in finite clauses there is no distinction made between the subject and the other complements. In most HPSG analysis for German a subject insertion lexical rule (SILR) is used to generate finite forms having their subject, i.e., the value of the SUBJ list, on the COMPS list. The CELR can then apply to such lexical entries. In versions of German grammars where there is no subject insertion lexical rule, there has to be a separate subject extraction lexical rule which allows for topicalization of subjects.

4 German Subject-Verb Agreement—Impersonal Constructions

In German sentences without a subject are possible. Verbs like *grauen*, *schwindeln* as in *Mir schwindelt* can appear without a subject. The arguments of these verbs can be raised by raising verbs like *scheinen*:

[3] In GPSG analyses this is assumed as well (cf. (Uszkoreit, 1987)).

(7) a. Ihm scheint vor der Prüfung gegraut zu haben.

b. Ihm scheint zu schwindeln.

In this case the form of *scheinen* has to be 3rdSg. However *scheinen* agrees with the subject of the embedded verb, if there is a subject:

(8) a. Ich scheine mich geirrt zu haben.

b. Er scheint wegzulaufen.

c. Sie scheinen wegzulaufen.

The Problem with this is to state lexical entries for auxiliaries without having to write extra entries for each construction. There are three solutions for this which I am aware of, one of **?**),[4] the one of Kiss (1993) and the one of myself. I want to show that CELRs are problematic for both accounts of German subject-verb agreement.

4.1 Kathol (1994)

Kathol uses the type *fin-v-pattern* (see figure 1) in his specifications of finite verbs. After the instantiation of the auxiliary complements, the appropriate subtype forces the agreement. This crucially depends on whether there is a subject in the SUBJ list or not.

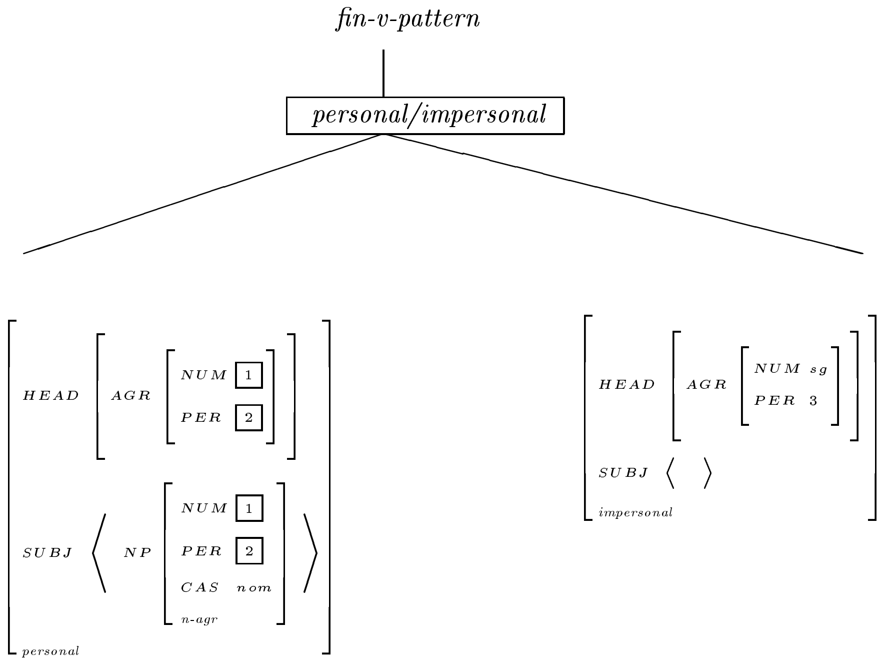


Figure 1: Kathol's types for agreement

[4]The problem with Kathol's solution is that he assumes an underspecified lexical entry for auxiliaries which would produce two entries in the sort-resolved lexicon. However this is not the topic of the paper.

4.2 Müller (1994)

Principle 1 (Agreement principle for German) *If there is a nominative NP in a finite sentence and it is in the first position on the subcat list, then it has to agree with the verb. Otherwise the verb of a finite sentence has to be in third singular form.*

$$
\begin{bmatrix}
SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFORM\ fin \\ \textit{verb} \end{bmatrix} \\ SUBCAT\ \langle\rangle & \end{bmatrix} \end{bmatrix} \\
DTRS & \begin{bmatrix} H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle\ NP[nom], \ldots \right\rangle \\ \textit{head-complement-structure} \end{bmatrix} \\
\textit{phrasal-sign} &
\end{bmatrix} \Rightarrow
$$

$$
\begin{bmatrix}
SYNSEM & \begin{bmatrix} LOC|CAT|HEAD|AGR & \begin{bmatrix} PER\ \boxed{1} \\ NUM\ \boxed{2} \end{bmatrix} \end{bmatrix} \\
DTRS & \begin{bmatrix} H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle\ NP[nom]_{[PER\ \boxed{1}, NUM\ \boxed{2}]}, \ldots \right\rangle \\ \textit{head-complement-structure} \end{bmatrix}
\end{bmatrix} \wedge \tag{9}
$$

$$
\begin{bmatrix}
SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFORM\ fin \\ \textit{verb} \end{bmatrix} \\ SUBCAT\ \langle\rangle & \end{bmatrix} \end{bmatrix} \\
DTRS & \begin{bmatrix} H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle\ \neg NP[nom], \ldots \right\rangle \\ \textit{head-complement-structure} \end{bmatrix} \\
\textit{phrasal-sign} &
\end{bmatrix} \Rightarrow
$$

$$
\begin{bmatrix}
SYNSEM|LOC|CAT|HEAD & \begin{bmatrix} AGR & \begin{bmatrix} PER\ 3 \\ NUM\ sg \end{bmatrix} \\ \textit{verb} & \end{bmatrix}
\end{bmatrix}
$$

4.3 Kiss (1993)

Kiss combines the subject-verb-agreement with nominative assignment in the subject insertion lexical rule. I will first show the agreement part:

$$
\begin{bmatrix}
CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFROM\ inf \\ SUBJ\ \ \boxed{1} \end{bmatrix} \\ SUBCAT\ \boxed{2} & \end{bmatrix}
\end{bmatrix} \rightarrow
\begin{bmatrix}
CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFROM\ fin \\ INFL\ \ svk(\boxed{1}) \end{bmatrix} \\ SUBCAT\ \boxed{1} \oplus \boxed{2} & \end{bmatrix}
\end{bmatrix} \tag{10}
$$

svk is expressing the following constraint:

$$svk(\boxed{1}) = \begin{bmatrix} \textit{NUM} & \boxed{3} \\ \textit{PERS} & \boxed{4} \end{bmatrix} if\ \boxed{1} = \left\langle\ NP : \begin{bmatrix} \textit{NUM} & \boxed{3} \\ \textit{PERS} & \boxed{4} \end{bmatrix} \right\rangle$$
$$and\ \begin{bmatrix} \textit{NUM} & sg \\ \textit{PERS} & 3rd \end{bmatrix} otherwise. \qquad (11)$$

The value of INFL corresponds to the AGR features of the other accounts.

For verbs like *scheinen* (*seem*) that may embed verbs with or without subject the constraint cannot be applied before the syntactic analysis takes place because the value of SUBJ is not instantiated. If the rule is applied before the syntactic analysis, it generates two entries for *scheint*. To prevent this late evaluation techniques have to be used to postpone the evaluation of the constraint until the SUBJ value becomes instantiated.

4.4 The Problem

Kathol's account and my account make the assumption that there is either a subject to agree with or the verb has to be 3rdSg. If the subject is extracted in order to be topicalized, the implication above wrongly enforces the verb to be specified as 3rdSg regardless of the features on the subject. The same happens to the auxiliaries of Kathol because they 'believe' the attracted verb to be subjectless.

Kiss's account produces two lexical entries for each auxiliary. Using late evaluation techniques, one could suspend the computation of the *svk*-value until the subject of the auxiliary becomes instantiated.

4.4.1 The ARG-S list

The ARG-S-List has been introduced in order to have a complete representation of the underlying argument structure. This means that for participles, all arguments—even those which do not surface—are elements of the ARG-S list. Therefore the subject—if there is one—will come first on the ARG-S list.

(12) a. Karl schenkt Maria die Bücher.

b. Die Bücher werden Maria geschenkt.

One possible solution would be to state two auxiliary entries which have access to their complement's ARG-S list and agree appropriately:

$$werden: \left[\begin{array}{ll} HEAD & \left[\begin{array}{l} AUX\ + \\ _{verb} \end{array}\right] \\ DA & \langle\rangle \\ SUBCAT & \boxed{2} \oplus \left\langle \left[\begin{array}{ll} LOC|CAT & \left[\begin{array}{ll} HEAD & \left[\begin{array}{l} VFORM\ ppp \\ _{verb} \end{array}\right] \\ LEX & + \\ DA & \boxed{1} \left\langle \left[\ \right]_{synsem} \right\rangle \\ SUBCAT & \boxed{2} \\ ARG-S & \boxed{1} \oplus \boxed{3} \end{array}\right] \\ _{synsem} & \end{array}\right] \right\rangle \\ _{cat} & \end{array}\right] \tag{13}$$

The value of the DA feature is a list of *synsem*-objects with at most one element. Roughly speaking this element is the subject if there is one. Otherwise the value is the empty list. If $\boxed{3}$ starts with an NP with structural case and the VFORM of *werden* is *fin* then the form of *werden* has to agree with it. If $\boxed{3}$ is an empty list as in (14) then the form of *werden* would have to be 3rdSg.

(14) Morgen wird getanzt.

And finally if $\boxed{3}$ is not an empty list and does not start with an NP with structural case like in (15) the form of *werden* again has to be 3rdSg.

(15) Mir wird geholfen.

4.5 Conclusion

If we use the ARG-S list to implement agreement, we would end up with a number of lexical entries for auxiliaries and lose any generalization expressed for instance by principle 1 above.

5 Case in German

In many theories about German there is a distinction between structural and lexical case (see Heinz and Matiasek (1994) for an introduction and detailed examples for structural and lexical case). Again the case assignment interacts with the complement saturation.

There are three[5] accounts I am aware of which assign case by a principle ((Heinz and Matiasek, 1994), (Abb, 1994) and (Lebeth, 1994)) and two in which case is assigned by the governing verb ((Kiss, 1993), (Pollard, 1994)).

The account of Abb (1994) differs from that of Heinz and Matiasek (1994) in so far as Abb assumes a binary branching structure for head complement structures. I will show the problems which arise if one uses CELRs only for the account of Heinz and Matiasek.

[5] I (Müller, 1998) am using a version of the account of Heinz and Matiasek which is adapted for a grammar with a SUBJ feature.

5.1 The Case Principle of Heinz and Matiasek (1994)

The account for German passive which seems to me to be most promising is the one of Heinz and Matiasek (1994). They make a distinction between structural and lexical case. Nominative case is structural whereas there are both structural and lexical accusative forms. Heinz and Matiasek use a complex type hierarchy for subtypes of the type *case* (cf. Figure 2). Heinz and Matiasek (1994, p. 34) state the

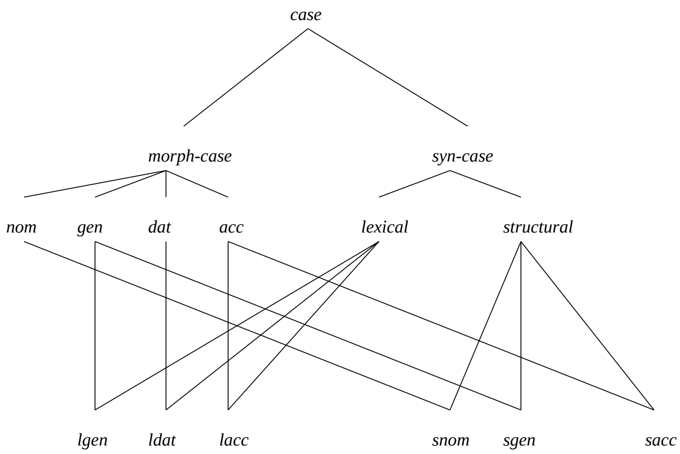


Figure 2: Subtypes of *case*

following case principle:[6]

Principle 2 (German Case Principle)
In a head-complement-structure of the category

S[fin]	*the external argument has a CASE value of snom*
S ∨ VP	*the internal argument has a CASE value of sacc*
NP	*the internal argument has a CASE value of sgen*

[6] I am using my abbreviations (S[fin], S, VP and NP).

$$a.\ \begin{bmatrix} SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFORM\ fin \\ \textit{verb} \end{bmatrix} \\ SUBCAT\ \langle\rangle & \end{bmatrix} \end{bmatrix} \\ DTRS & \begin{bmatrix} H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle\ NP[str], \ldots \right\rangle \\ \textit{head-comp-structure} \end{bmatrix} \end{bmatrix} \Rightarrow$$

$$\begin{bmatrix} DTRS|H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle\ NP[snom], \ldots \right\rangle \end{bmatrix} \wedge$$

$$b.\ \begin{bmatrix} SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD & \begin{bmatrix} \\ \textit{verb} \end{bmatrix} \\ SUBCAT\ \langle\rangle \vee \left\langle \begin{bmatrix} \\ \textit{synsem} \end{bmatrix} \right\rangle & \end{bmatrix} \end{bmatrix} \\ DTRS & \begin{bmatrix} H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle \begin{bmatrix} \\ \textit{synsem} \end{bmatrix}, NP[str], \ldots \right\rangle \\ \textit{head-comp-structure} \end{bmatrix} \end{bmatrix} \Rightarrow$$

$$\begin{bmatrix} DTRS|H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle \begin{bmatrix} \\ \textit{synsem} \end{bmatrix}, NP[sacc], \ldots \right\rangle \end{bmatrix} \wedge$$

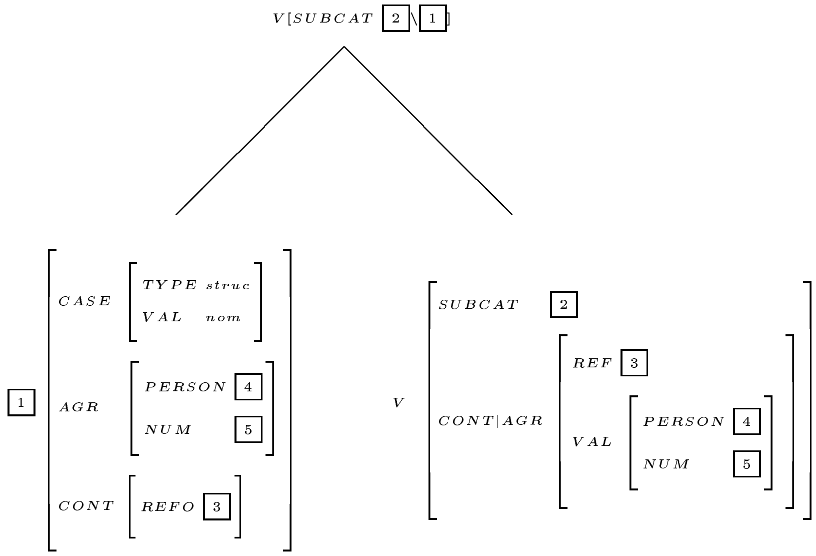
$$c.\ \begin{bmatrix} SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD & \begin{bmatrix} \\ \textit{noun} \end{bmatrix} \\ SUBCAT\ \langle\rangle & \end{bmatrix} \end{bmatrix} \\ DTRS & \begin{bmatrix} H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle \begin{bmatrix} \\ \textit{synsem} \end{bmatrix}, NP[str], \ldots \right\rangle \\ \textit{head-comp-structure} \end{bmatrix} \end{bmatrix} \Rightarrow$$

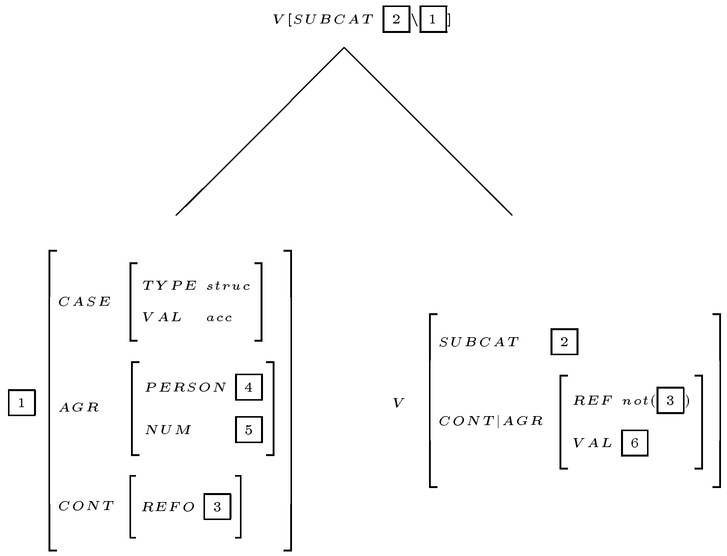
$$\begin{bmatrix} DTRS|H-DTR|SYNSEM|LOC|CAT|SUBCAT \left\langle \begin{bmatrix} \\ \textit{synsem} \end{bmatrix}, NP[sgen], \ldots \right\rangle \end{bmatrix}$$

5.2 The Case Principle of Lebeth (1994)

Lebeth (1994, p. 114) uses a case principle which assignes case without taking recourse to the position of complements in the subcat list. The principle assignes nominative to elements which agree with the subject. Complements that have structural case and do not agree receive accusative. If a complement has lexical case, then of course there is no case asignment:[7]

[7] $\boxed{2} \backslash \boxed{1} = \boxed{3},\ iff\ \boxed{2} = \boxed{3} \oplus \boxed{1}$


V[SUBCAT 2 \ 1]
1
CASE
TYPE struc
VAL nom
AGR
PERSON 4
NUM 5
CONT
REFO 3
V
SUBCAT 2
CONT|AGR
REF 3
VAL
PERSON 4
NUM 5


V[SUBCAT 2 \ 1]
1
CASE
TYPE struc
VAL acc
AGR
PERSON 4
NUM 5
CONT
REFO 3
V
SUBCAT 2
CONT|AGR
REF not(3)
VAL 6

$$V[SUBCAT\ \boxed{2} \backslash \boxed{1}]$$

$$\boxed{1}\begin{bmatrix} CASE & \begin{bmatrix} TYPE\ lex \\ VAL\ \boxed{8}\ lexical \end{bmatrix} \\ AGR & \begin{bmatrix} PERSON & \boxed{4} \\ NUM & \boxed{5} \end{bmatrix} \\ CONT & \begin{bmatrix} REFO\ \boxed{3} \end{bmatrix} \end{bmatrix} \qquad V\begin{bmatrix} SUBCAT & \boxed{2} \\ CONT|AGR & \begin{bmatrix} REF & \boxed{7} \\ VAL & \boxed{6} \end{bmatrix} \end{bmatrix}$$

5.3 Kiss (1993)

Kiss uses two methods to assign case. One is assigning case by application of the lexical rule for finite verbal entries (Kiss, 1993, p. 157):

$$\begin{bmatrix} CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFROM & inf \\ SUBJ & \boxed{1} \end{bmatrix} \\ SUBCAT & \boxed{2} \end{bmatrix} \end{bmatrix} \rightarrow \begin{bmatrix} CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFROM & fin \\ INFL & svk(\boxed{1}) \\ SUBJ & \langle\rangle \end{bmatrix} \\ SUBCAT & nom(\boxed{1}) \oplus \boxed{2} \end{bmatrix} \end{bmatrix} \tag{16}$$

If $\boxed{1}$ is the empty list, the result of applying *nom* would be the empty list, otherwise nominative is assigned to the inserted subject.

This method works fine for nominative assignment. It remains unclear how accusative is assigned.

5.4 Pollard (1994)

Pollard (1994) as well uses the distinction between structural and lexical case. He discusses the case assignment in the problem section and suggests two possible strategies. The first one assigns nominative case during the application of the SILR (compare section 5.3). Accusative has to be assigned by a default rule, which would be an extension of the basic HPSG formalism.

The second alternative is equivalent to the one proposed by Heinz and Matiasek (1994) (compare section 5.1).

5.5 The Problem

The case assignment of Heinz and Matiasek (1994) interacts with the saturation of complements, i.e., if there is a saturated head daughter which is a finite verb, then the complements on the subcat list have to be nominative and accusative, respectively.

If there are no complements to be saturated because they have been removed from the subcat list already, then there is no way to assign case.

The same holds for Pollard's account. If there are no complements to be attracted because they have been extracted by lexical rules, then there is no way to assign case.

Kiss's account does not seem to have problems with nominative assignment because the extraction applies after case assignment has taken place. But structural accusative has to be assigned either by the governing verb or by a principle which refers to subcat list positions. Moreover there are problems with subject extraction out of verbs occurring in so-called 'coherent construal'[8] (see section 6.2).

5.5.1 The ARG-S-List?

The ARG-S-List has been introduced in order to have a complete representation of the underlying argument structure. This means that for participles all verb arguments—even those which do not surface—are elements of the ARG-S list. Therefore the subject will come first on the ARG-S list and receive nominative and the second complement accusative in all environments. To prevent this, the method of case assignment just for surfacing or attracted constituents has been introduced.

5.6 Conclusion

The only solution to this problem is to stick with lexical case. With lexical case assignment one loses nice generalizations and would have to stipulate multiple entries for the different participial forms, i.e., one for passive and one for perfect constructions.

6 Argument Attraction

In the following section I will show what happens if one allows the CELR to apply to arbitrary lexical signs.[9]

6.1 Infinite Lexicons or Spurious Ambiguities

Even if we assume a version of the CELR which allows for the introduction of one element into the SLASH set only, we get problems, which I will show in the following.

Let us assume the rule in (17):

$$\begin{bmatrix} \textit{COMPS} \; \boxed{1} \oplus \left\langle \; [\textit{LOC} \; \boxed{2}, \textit{NLOC|SLASH} \; \left\{\boxed{2}\right\}] \right\rangle \oplus \boxed{3} \\ \textit{INHER|SLASH} \; \{\} \end{bmatrix} \rightarrow \begin{bmatrix} \textit{COMPS} \; \boxed{1} \oplus \boxed{3} \\ \textit{INHER|SLASH} \; \left\{\boxed{2}\right\} \end{bmatrix} \tag{17}$$

If we use auxiliaries that attract the arguments of their verbal complement such as the following auxiliary *werden*, then we will get spurious ambiguities if we allow

[8]See Bech (1955).

[9]There is a paper of Höhle (1994) dealing with the same issue as this section does. His paper contains more or less the same message: Extraction of variable subcat list parts must be forbidden explicitly.

Because he uses path equations he gets differnt output signs.

the extraction out of the variable part of the auxiliary's subcat list, i.e., $\boxed{2}$.

$$werden(future): \left[\begin{array}{ll} \textit{HEAD} & \left[\begin{array}{ll} \textit{AUX} & + \\ \textit{verb} & \end{array}\right] \\ \textit{DA} & \boxed{1} \\ \textit{SUBCAT} & \boxed{2} \oplus \left\langle \left[\begin{array}{ll} \textit{LOC}|\textit{CAT} & \left[\begin{array}{ll} \textit{HEAD} & \left[\begin{array}{ll} \textit{VFORM} & \textit{bse} \\ \textit{verb} & \end{array}\right] \\ \textit{LEX} & + \\ \textit{DA} & \boxed{1} \\ \textit{SUBCAT} & \boxed{2} \end{array}\right] \\ \textit{synsem} & \end{array}\right] \right\rangle \\ \textit{cat} & \end{array}\right] \qquad (18)$$

The lexical rule stated above will produce the following entry for *werden*:

Wrong entry for werden after applying CELR :

$$\left[\begin{array}{ll} \textit{LOC} & \left[\begin{array}{ll} \textit{CAT} & \left[\begin{array}{ll} \textit{HEAD} & \left[\begin{array}{ll} \textit{AUX} & + \\ \textit{verb} & \end{array}\right] \end{array}\right] \\ \textit{DA} & \boxed{1} \\ \textit{SUBCAT} & \boxed{4} \oplus \left\langle \left[\begin{array}{ll} \textit{LOC}|\textit{CAT} & \left[\begin{array}{ll} \textit{HEAD} & \left[\begin{array}{ll} \textit{VFORM} & \textit{bse} \\ \textit{verb} & \end{array}\right] \\ \textit{LEX} & + \\ \textit{DA} & \boxed{1} \\ \textit{SUBCAT} & \left\langle \left[\begin{array}{ll} \textit{LOC} & \boxed{3} \\ \ldots\textit{SLASH} & \left\{\boxed{3}\right\} \\ \textit{synsem} & \end{array}\right] \right\rangle \oplus \boxed{4} \end{array}\right] \\ \textit{synsem} & \end{array}\right] \right\rangle \end{array}\right] \\ \textit{NLOC} & \left[\begin{array}{ll} \textit{INHER}|\textit{SLASH} & \left\{\boxed{3}\right\} \end{array}\right] \\ \textit{synsem} & \end{array}\right] \qquad (19)$$

This results in spurious ambiguities because the sentence (20) could be analyzed as a sentence in which there is extraction out of *geholfen* or as a sentence with extraction out of *wurde*.

(20) Dem Mann wurde geholfen.

If one does not restrict the input sign to be specified SLASH {} one ends up with an infinite lexicon with many of useless auxiliary entries.

Conclusion: There has to be an exception feature that blocks the application of the CELR.

6.2 Grammars With a SUBJ Feature and Subject Insertion Lexical Rules

In many grammars for German ((Kiss, 1993), (Hinrichs and Nakazawa, 1994, p. 19), (Müller, 1998)), a subject insertion lexical rule (SILR) is used to build lexical entries for finite verbs from lexical entries of stems or base forms. These SILRs have a form similar to the one given in (16). The rule applies to verbs constructing coherently, i.e., verbs that attract the arguments of their verbal complement, as well. The output of the rule for *hat* is something like this:

$$\begin{bmatrix} HEAD & \begin{bmatrix} AUX & + \\ VFORM & fin \\ SUBJ & \langle\rangle \\ \textit{verb} & \end{bmatrix} \\ COMPS & \boxed{1} \oplus \boxed{2} \oplus \left\langle V \begin{bmatrix} HEAD & \begin{bmatrix} VFORM & ppp \\ SUBJ & \boxed{1} \\ \textit{verb} & \end{bmatrix} \\ COMPS & \boxed{2} \\ \textit{cat} & \end{bmatrix} \right\rangle \\ \textit{cat} & \end{bmatrix} \qquad (21)$$

Let us assume for the following a version of the CELR which does not apply to auxiliaries:

$$\begin{bmatrix} HEAD|AUX & - \\ COMPS & \boxed{1} \oplus \left\langle [LOC\ \boxed{2}, NLOC|SLASH\ \left\{\boxed{2}\right\}] \right\rangle \oplus \boxed{3} \\ INHER|SLASH & \{\} \end{bmatrix} \rightarrow \begin{bmatrix} COMPS & \boxed{1} \oplus \boxed{3} \\ INHER|SLASH & \left\{\boxed{2}\right\} \end{bmatrix} \qquad (22)$$

How can we provide an analysis for sentences like (23) in which the subject is topicalized?

(23) Hans hat dem Mann geholfen.

For such sentences we would need an extra rule for subject extraction because the blocking as stated above is to strict.

6.3 *von*-PPs in Passive Constructions

A *von*-PP can be used in passive constructions to specify the agent.

(24) Von wem wurde dieses Buch geschrieben?

This is usually accounted for by the specification of an optional argument in the entry for the passive auxiliary:

werden (*passive*) :

$$\begin{bmatrix} DA & \langle\rangle \\ SUBCAT & (PP[von]:\boxed{1}) \oplus \boxed{2} \oplus \left\langle \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD & \begin{bmatrix} VFORM & ppp \\ \textit{verb} & \end{bmatrix} \\ LEX & + \\ DA & \left\langle NP:\boxed{1} \right\rangle \\ SUBCAT & \boxed{2} \end{bmatrix} \end{bmatrix} \right\rangle \\ \textit{cat} & \end{bmatrix} \qquad (25)$$

In the account of Heinz and Matiasek (1994) the logical subject of the verb in *ppp*-form is the element of the DA list and can surface as a *von*-PP. Again, the *von*-phrase can be fronted. As it is not clear in which syntactic environment the *ppp*-verb will be used, because it can be used both in perfect and in passive constructions, the CELR cannot be applied to the lexical entry of the verb in *ppp*-form.

The same problem arises for other accounts for German passive that do not use lexical rules.

7 SLASH-to-Argument Attraction

In order to describe German scrambling, Pollard, Kasper, and Levine (1994) sketch an entry for SLASH-to-argument attraction verbs of a form similar to the one given below:[10]

$$\begin{bmatrix} LOCAL|CAT|SUBCAT & \left\langle \ldots, \boxed{1}\ PP, NP[SLASH\ \left\{\boxed{1}\right\}] \right\rangle \\ NONLOC|TO-BIND|SLASH & \left\{\boxed{1}\right\} \end{bmatrix} \tag{26}$$

Such an entry is used to introduce into the domain of *gesehen hat* the complement of *Film* in (27) which is extracted from the NP *einen Film* in order to be able to separate the complement from its head.

(27) , weil [über England]$_i$ jeder schon mal [einen Film $\_{i}$] gesehen hat.

Again the application of CELRs has to be blocked. It must not be allowed to extract the PP because otherwise there would be two analyses for the sentence in (28).

(28) Über England hat jeder schon mal einen Film gesehen.

The first analysis is the normal one. *Über England* is a complement of *einen Film* and percolates up the tree and is bound by the Head-Filler-Schema. The second analysis would be the one where the SLASH of *einen Film* is inserted in the subcat list of *gesehen*, but there it has been extracted already and will therefore percolate up like an ordinary SLASH element.

Again either an exception feature in the CELR has to be used or the NONLOC|-INHER|SLASH value of the inserted PP complement has to be specified {}.

8 Traces Can Do Things Lexical Rules Are Supposed to Do

The advantage that CELRs have over the standard HPSG traces is that one can restrict the application of these rules to special input categories and that it is possible to produce lexical entries whose nonlocal information differs from the information which is removed from the subcat list of the input sign. Examples for such lexical rules can be found in (Hinrichs and Nakazawa, 1994) and (Keller, 1994).

However this can be done using traces as well: One can use the SPEC-feature[11] to establish a relation to the mother which the trace is a complement of.

[10]For a discussion of this approach see (Müller, 1998; Müller, 1995, Chapter 14.3.1).

[11]Pollard and Sag (1994, p. 23) state that the SPEC feature is appropriate for functional heads only. This would have to be changed.

8.1 Functional Traces

But this is just half of the functionality the lexical rule approach provides. The nonlocal information introduced can be different from, i.e., a function of, the local value of a complement of the input sign. Just parts of the input local value can be shared. Again there is a simple trace solution for that:

$$\begin{bmatrix} \mathit{PHON} & \langle\rangle \\ \mathit{SYNSEM} & \begin{bmatrix} \mathit{LOCAL} & \boxed{1} \\ \mathit{NONLOCAL} & \begin{bmatrix} \mathit{INHER} & \begin{bmatrix} \mathit{REL} & \{\} \\ \mathit{QUE} & \{\} \\ \mathit{SLASH} & \left\{ f(\boxed{1}) \right\} \\ \mathit{EXTRA} & \{\} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \textit{lexical-sign} & \end{bmatrix} \tag{29}$$

As an example I want to show how one could implement Keller's (Keller, 1994) V2 Extraposition Lexical Rule using traces. Keller provides the following data:

(30) a. * weil Maria, sie sei krank, sagt.

b. weil Maria sagt, sie sei krank.

c. ? weil Maria, daß sie krank ist, sagt.

d. weil Maria sagt, daß sie krank ist.

(31) a. * weil Maria, sie sei krank, denkt.

b. weil Maria denkt, sie sei krank.

c. ? weil Maria, daß sie krank ist, denkt.

d. weil Maria denkt, daß sie krank ist.

He states the generalization that so-called bridge verbs can only take a V2 sentence as complement if the V2 sentence is extraposed. Lexical entries with appropriate extraposition information are produced by a lexical rule of the following form:

$$\begin{gathered} \begin{bmatrix} \mathit{SYNSEM} & \begin{bmatrix} \mathit{LOC|CAT} & \begin{bmatrix} \mathit{HEAD} & \begin{bmatrix} \mathit{BRIDGE} & + \\ \textit{verb} & \end{bmatrix} \\ \mathit{VAL} & \begin{bmatrix} \mathit{COMPS} & \boxed{1} \oplus \left\langle \; S[da\beta] \oplus \boxed{2} \right\rangle \end{bmatrix} \end{bmatrix} \\ \mathit{NONLOC} & \begin{bmatrix} \mathit{INHER|EXTRA} \; \{\} \end{bmatrix} \end{bmatrix} \\ \textit{lexical-sign} & \end{bmatrix} \rightarrow \\ \begin{bmatrix} \mathit{SYNSEM} & \begin{bmatrix} \mathit{LOC|CAT} & \begin{bmatrix} \mathit{VAL} & \begin{bmatrix} \mathit{COMPS} & \boxed{1} \oplus \boxed{2} \end{bmatrix} \end{bmatrix} \\ \mathit{NONLOC} & \begin{bmatrix} \mathit{INHER|EXTRA} \; \{S[verb-second]\} \end{bmatrix} \end{bmatrix} \\ \textit{lexical-sign} & \end{bmatrix} \end{gathered} \tag{32}$$

There are no lexical entries of bridge verbs that take verb-final sentences (marked by *daß*) in the lexicon. Therefore sentences like (30a) and (31a) are ruled out correctly. The sentences (30a) and (31a) can be analyzed using the lexical entries produced by the rule given in (32).

The equivalent trace looks as follows:

$$\begin{bmatrix} \mathit{PHON} & \langle\rangle \\ \mathit{SYNSEM} & \begin{bmatrix} \mathit{LOC} & \begin{bmatrix} \mathit{CAT} & \begin{bmatrix} \mathit{HEAD} & \begin{bmatrix} \mathit{SPEC}\ V[\mathit{BRIDGE}{+}] \\ \mathit{verb} \end{bmatrix} \\ \mathit{MARKING} & \mathit{daß} \end{bmatrix} \\ \mathit{CONT} & \boxed{1} \end{bmatrix} \\ \mathit{NONLOC} & \begin{bmatrix} \mathit{INHER} & \begin{bmatrix} \mathit{REL} & \{\} \\ \mathit{SLASH} & \{\} \\ \mathit{EXTRA} & \left\{ \begin{bmatrix} \mathit{CAT} & S[\mathit{verb-second}] \\ \mathit{CONT} & \boxed{1} \\ \mathit{loc} & \end{bmatrix} \right\} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \mathit{sign} & \end{bmatrix} \tag{33}$$

Note that such trace analyses cannot replace lexical rules which change the subcategorization frame of complements of lexical entries, like for instance the SELR of Pollard and Sag. But as far as I know, there aren't such rules in German grammars.

8.2 The TRACE Feature—Forcing Extraction or Extraposition

Pollard and Sag (1994, p. 172) state the following principle:

Principle 3 (Trace Principle) *Every trace must be subcategorized by a substantive head.*

This principle rules out the use of traces in modification constructions if adjuncts are not subcategorized for by their syntactic heads. Without such a principle, analyses for sentences like (34b) were provided.

(34) a. [Der kluge Mann]$_i$ hat $\__i$ geschlafen.

b. * [Mann]$_i$ hat der kluge $\__i$ geschlafen.

In (34b) the adjective *kluge* modifies an $\overline{N}$. If this $\overline{N}$ would be a trace, one would get the $\overline{N}$ *kluge* with an $\overline{N}$ as an element of the SLASH set. The $\overline{N}$ would be saturated by the determiner *der* and the element in the SLASH set would be bound in topic position by *Mann*.

Principle 3, however, is very informal. To distinguish traces from non-traces one needs a feature: the TRACE feature. In a system that uses traces just for topicalization, a binary feature would do. Because extraposition phenomena are nonlocal as well, one has to have a slightly more complicated value for the TRACE feature. The value is an atomic type with several subtypes which are shown in figure 3. Using the TRACE feature and the values appropriate for it one could prevent analyses for sentences like (34b) by instantiating the TRACE value of the head daughter with *no-trace*:

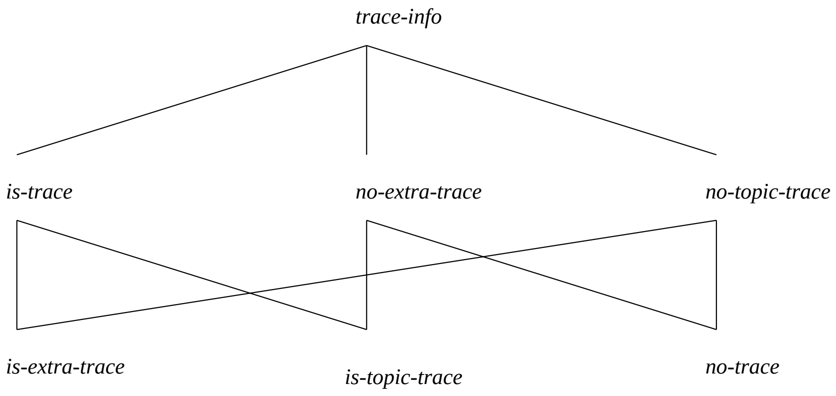


Figure 3: Subtypes of *trace-info*

Schema 1 (Head-Adjunct-Schema)

$$\begin{bmatrix} DTRS & \begin{bmatrix} HEAD-DTR|SYNSEM & \boxed{1}\begin{bmatrix} TRACE & no-trace \end{bmatrix} \\ ADJ-DTR|SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD|MOD & \boxed{1} \\ SUBCAT & \langle\rangle \end{bmatrix} \end{bmatrix} \\ \textit{head-adjunct-structure} & \end{bmatrix} \\ \textit{phrasal-sign} & \end{bmatrix}$$

The subtypes of *trace-info* can be used to force extraposition. First I will reformulate the lexical rule used by Keller.

$$\begin{bmatrix} SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} HEAD & \begin{bmatrix} BRIDGE & + \\ \textit{verb} & \end{bmatrix} \\ VAL & \begin{bmatrix} COMPS & \boxed{1} \oplus \left\langle \; S[daß] \oplus \boxed{2} \right\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \textit{lexical-sign} & \end{bmatrix} \rightarrow \tag{35}$$

$$\begin{bmatrix} SYNSEM & \begin{bmatrix} LOC|CAT & \begin{bmatrix} VAL & \begin{bmatrix} COMPS & \boxed{1} \oplus \left\langle \; S[verb-second, is-extra-trace] \oplus \boxed{2} \right\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \textit{lexical-sign} & \end{bmatrix}$$

Because of the *is-extra-trace* specification of the TRACE feature of the output sign the S[verb-second] must be extraposed. Non-trace constituents do have the TRACE value *no-trace* which does not unify with *is-extra-trace*.

9 Conclusion

I would use CELR if this were possible because an implementation without traces and with a precompiled full-form lexicon is much faster than one using traces. But the last sections showed the problems. There are solutions to some problems, but I do not consider them proper solutions because one loses generalizations.

The use of traces enables the implementor to write grammars without an extra feature for the argument structure. The binding theory can be applied to the subcat lists because these are not modified by CELRs. I have showed in the last sections that traces must be used to describe topicalization phenomena. In section 8, I provided the means one would need to implement nonlocal dependencies for extraposition.

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