PROBLEMS OF GERMAN VP COORDINATION

Martin Forst
Natural Language Engineering
Powerset/Microsoft

Christian Rohrer
Institut für Maschinelle Sprachverarbeitung
Universität Stuttgart

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Abstract

In this paper, we present the implementation in the German *ParGram* LFG of verb phrase (VP) coordinations involving conjunction reduction and/or right node raising. We show how the computationally expensive approach proposed by Maxwell & Manning (1996) can be adopted for VP coordinations in a computationally efficient way so that many of these coordinations, which previously did not receive a correct analysis, are now analyzed soundly. We also show that the new rules obviate the need for a recursive right-branching VP rule and make it possible to define a flat VP rule instead. This is desirable for a number of reasons, including the definition of both hard and soft constraints on constituent order in the VP domain (needed in particular for generation).

1 Introduction

Traditionally, generative grammarians working on German assume a binary right-branching verb phrase (VP) that ends with a binary left-branching verb complex (VC) (Haider 2003, Berman 2003, Dipper 2003). While this approach can account for most of the data including coordination data, a non-negligible portion of coordinations involving verbs with arguments or adjuncts cannot be accounted for in this view —or only by recurring to notions like "left deletion".

From a grammar development perspective, this is problematic. Mechanisms like "left deletion" being beyond the scope of current LFG parsing systems (and any other practical parsing system for that matter), coverage is of course negatively affected when certain phenomena are systematically not covered and — perhaps most problematically— a broad-coverage grammar is likely to analyze sentences that contain those phenomena in grossly erroneous ways, due to unrelated, potentially dispreferred, rules that can cover the sentence.

One appealing and formally well-defined approach to the non-constituent coordination phenomena of right node raising and conjunction reduction is the proposal by Maxwell & Manning (1996). However, although their theory is formally well-defined, the *ParGram* grammars' efficiency would be affected very adversely if it were implemented in the LFG grammar development and processing tool XLE (Crouch et al. 2009) on a general level. We therefore propose a limited implementation of their approach, targeted at capturing certain VP coordinations that involve non-constituent coordination.

In order to demonstrate that these kinds of non-constituent coordination are actually not only of theoretical interest, but that their treatment has very practical consequences for the coverage and accuracy of a computational grammar, we also provide figures and examples from corpus data that we obtained from the TIGER Corpus (Brants et al. 2002, 2003) using the treebank query tool TIGERSearch (König et al. 2003, Lezius 2002).

The remainder of this paper is organized as follows: In Section 2, we will present the various types of VP coordination that our proposal is able to capture and exemplify them with examples from the TIGER Corpus. In Section 3, we will discuss the various possible analyses, including the right-branching recursive VP rule formerly implemented in the German *ParGram* LFG, the potential abandonment of the verb complex, and the use of special coordination rules inspired by the Maxwell & Manning (1996) approach. Section 4 then discusses why our new treatment of VP coordinations makes it possible to define a flat rather than a recursive VP rule and how such a flat VP rule benefits other aspects of grammar development. Finally, Section 5 concludes.

2 Various Types of German VP Coordinations

Coordinations of VPs that can be covered by the "traditional" account are illustrated in examples (1) and (2). What characterizes them is that two VPs, participial ones in (1) and infinitival ones in (2), are

coordinated, but an additional constituent occurring to the left of the coordination is an argument of both conjuncts and hence somehow has to be distributed into them.

(1) *Nach Angaben der Polizei hatte er eine Stewardess mit einem Messer*
According to statements of the police had he a stewardess with a knife
bedroht und politisches Asyl verlangt.
threatened and political asylum demanded.
'According to the police, he had threatened a stewardess with a knife and demanded political asylum.' (TIGER sentence # 13672)

(2) *Insofern soll meine Präsenz vor allem in der Öffentlichkeit wirken und*
Insofar shall my presence above all in the public have an effect and
die Einsatzleitung bestärken.
the operation controllers encourage.
'Insofar, my presence is primarily supposed to have an effect in public and to encourage the operation controllers.' (TIGER sentence # 4878)

Coordinations of this kind are rather frequent in German newspaper corpora. Among the 48,470 TIGER Corpus sentences that are not used for evaluation (sentences 8,001 through 10,000 are commonly set aside for that purpose), 360 sentences match the TIGERSearch (König et al. 2003, Lezius 2002) query below, which describes this sort of VP coordination according to the TIGER annotation scheme (Brants & Hansen 2002, Brants et al. 2002, 2003). Note that, overall, there are only 1,503 sentences that contain CVP (co-ordinated verb phrase) constituents, so that the 360 matching sentences are indeed a considerable portion of these.

```
#s >OC #vp:[cat = "CVP"] &       // coord. VP #vp functions as a clausal object of #s
#s >HD #shd &                    // #shd functions as head of #s
#vp >CJ #vp1:[cat = "VP"] &      // #vp1 is a VP and functions as a conjunct of #vp
#vp >CJ #vp2:[cat = "VP"] &      // #vp2 is a VP and functions as a conjunct of #vp
#vp1 .* #vp2 &                   // #vp1 precedes #vp2
#vp1 >HD [T & pos != "VVIZU"] & // head of #vp1 is a terminal, but not a 'zu' inf.
#vp2 >HD [T & pos != "VVIZU"] & // head of #vp2 is a terminal, but not a 'zu' inf.
tokenarity(#vp1, 2, 200) &       // #vp1 spans between 2 and 200 terminals
tokenarity(#vp2, 2, 200) &       // #vp2 spans between 2 and 200 terminals
#vp2 >@r #r &                    // #r is the rightmost terminal of #vp2
#r .* #shd                       // #r precedes #shd
```

Another type of VP coordination can be found in examples (3) and (4). Characteristic of these coordinations is a verbal element at the right edge of the coordination that has to be distributed over the conjuncts to make the first conjunct "complete". In (3), this is the auxiliary infinitive *zu haben*; in (4), it is the modal *muß*. Note that the two distribution phenomena can co-occur, i.e., in addition to verbal elements at the right edge, there can be argument constituents to the left of the coordination that have to be distributed over the conjuncts to make the second conjunct complete. This is the case of the NP constituent *er* in (4).

(3) *Die Regierung [...] wirft ihm vor, [...] zu dem Massenmord aufgerufen und*
The goverment [...] accuses him [...] for the mass murder called and
Massaker organisiert zu haben.
massacres organized to have.
'The government [...] accuses him of having called for the mass murder [...] and of having organized massacres.' (TIGER sentence # 44943)

(4) *Doch Lafontaine weiß, daß er Schröder einbinden und seine Talente nutzen muß.*
But Lafontaine knows that he Schröder involve and his talents use must.
'But Lafontaine knows that he must involve Schröder and capitalize on his talents.' (TIGER sentence # 30327)

While these coordinations are less frequent than the first type, they are not negligible in number in newspaper corpora. 171 sentences in the non-evaluation part of the TIGER Corpus match the TIGERSearch query below, which describes coordinated VPs with right-node-raised material.

```
#s >OC #vp:[cat = "CVP"] &       // coord. VP #vp functions as a clausal object of #s
#s >HD #shd &                    // #shd functions as head of #s
#vp >CJ #vp1:[cat = "VP"] &      // #vp1 is a VP and functions as a conjunct of #vp
#vp >CJ #vp2:[cat = "VP"] &      // #vp2 is a VP and functions as a conjunct of #vp
#vp1 > #n:[] &                   // #n is some daughter of #vp1
#vp1 .* #vp2 &                   // #vp1 precedes #vp2
#vp1 >HD [T & pos != "VVIZU"] & // head of #vp1 is a terminal, but not a 'zu' inf.
#vp2 >HD [T & pos != "VVIZU"] & // head of #vp2 is a terminal, but not a 'zu' inf.
tokenarity(#vp1, 2, 200) &       // #vp1 spans between 2 and 200 terminals
tokenarity(#vp2, 2, 200) &       // #vp2 spans between 2 and 200 terminals
((#s >SB #ssb &                  // Either #s has a subject, which we'll call #sb, and
  #shd .* #ssb) |                //    #shd precedes that subject
 (#n >~ #vp2 &                   // or there is a secondary edge from #n to #vp2
  #n !>~CP #vp2))                //    but the label of that secondary edge is not CP
```

Finally, there is a substantial number of coordinations in German newspaper corpora that involve conjunction reduction or argument cluster coordination. Examples (5) and (6) illustrate this non-constituent coordination phenomenon, the latter being an instance where the distribution of an argument (*es*) from the left, the distribution of verbal elements (*geben wird*) from the right (or right node raising), and argument/adjunct cluster coordination all interact.

(5) *In den ersten vier Monaten stiegen die Exporte um 8,4 und die Importe um sechs*
In the first four months rose the exports by 8.4 and the imports by six
Prozent.
percent.
'In the first four months, the exports rose by 8.4 percent, and the imports, by six.' (TIGER sentence # 39150)

(6) *[...] daß es im Kampf gegen die PKK keine Kompromisse und für die*
[...] that it in the struggle against the PKK no compromises and for the
kurdischen Bürgerrechtler keine Zugeständnisse geben wird.
Kurdish civil right activists no concessions give will.
'[...] that there will be no compromises in the struggle against the PKK and no concessions for the Kurdish civil rights activists.' (TIGER sentence # 24221)

To estimate the frequency of argument/adjunct cluster coordination, we formulated the TIGERSearch query below. It matches 161 sentences in the non-evaluation part of the TIGER Corpus.

```
#cs:[cat = ("CS"|"CVP")] &       // #cs is a coord. clause or a coord. VP
#cs >CJ #s1:[cat = ("S"|"VP")] & // clause or VP #s1 functions as a conjunct of #cs
#cs >CJ #s2:[cat = ("S"|"VP")] & // clause or VP #s2 functions as a conjunct of #cs
#s1 >HD #s1hd:[pos = ("VVFIN"|"VVIMP"|"VVINF"|"VVIZU"|"VVPP")] &
                                 // main verb #s1hd functions as the head of #s1
#s1hd >~HD #s2 &                 // A secondary edge indicates that #s1hd also
                                 //    functions as the head of #s2
((#s1 .* #s2 &         // Either #s1 precedes #s2 and
  #s1 >@r #s1r &       //    #s1r is the rightmost terminal of #s1 and
  #s1r !>~SVP #s2 &    //    #s1r is not distributed into #s2 as a verb particle and
  #s1r !>~HD #s2 &     //    #s1r is not distributed into #s as a head and
  #s1 > #s1first &     //    #s1first is some daughter of #s1 and
  #s1first .* #s1hd & //    #s1first precedes #s1hd and
  #s1first >~ #s2) |   //    #s1first is distributed into #s2 via a secondary edge
 (#s2 .* #s1 &         // or #s2 precedes #s1 and
  #s1 >@r #s1hd))      //    #s1hd is the rightmost terminal of #s1
```

3 Possible Analyses

In this section, we discuss several possible analyses of the VP coordination phenomena introduced above. First, we briefly present the analysis implemented in previous versions of the German *ParGram* LFG. Subsequently, we present two alternatives.

3.1 Recursive right-branching VP and left-branching VC (verb complex)

The coordination facts exemplified in examples (1) and (2) are traditionally used as the strongest argument for assuming a recursive right-branching VP rule. For a long time, the German *ParGram* LFG therefore had a recursive VPx rule, which produced c-structures as the ones shown in Figures 1 and 2.[1]

The advantage of assuming such a recursive right-branching VPx rule is that the coordinations in (1) and (2) can be treated as same-category coordination under this analysis. Its disadvantage, however, is that it cannot capture coordinations that involve right-node-raised verbal elements because the verbal elements that have to be distributed into the first conjunct end up too low in the tree for this to happen. Similarly, conjunction reduction (or argument/adjunct cluster coordination) cannot be captured by the recursive right-branching VPx rule. Given that the latter two phenomena are almost as frequent as the distribution of arguments/adjuncts from the left, we consider this disadvantage serious enough to search for alternative analyses. This is particularly true since, with the "traditional" VP implementation, these sentences are either not associated with an analysis spanning the entire sentence or only analyzed erroneously. The latter is actually worse sometimes because, as a consequence of a bad analysis of the

[1] VPx is a category used to allow for the attachment of extraposed constituents under VP without allowing for their attachment under each recursive expansion of VPx. Apart from this detail, the VPx category in the German *ParGram* LFG is equivalent to the commonly assumed VP.

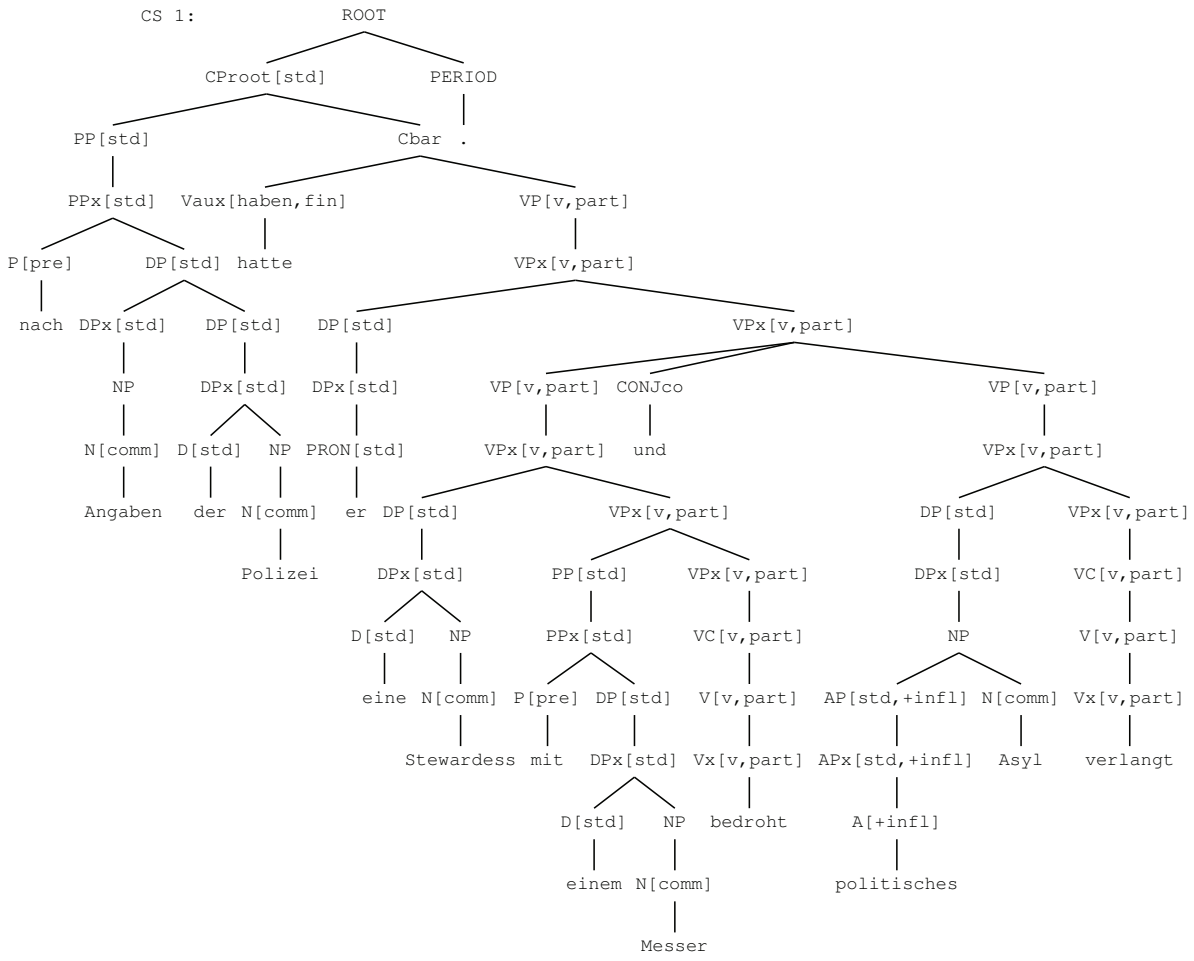


Figure 1: C-structure with recursive VPx corresponding to (1)
According to the police, he had threatened a stewardess with a knife and demanded political asylum.

coordinated verbs, large parts of the remainder of the sentence are typically analyzed erroneously, too, and the resulting analysis contains blatantly wrong predicate-argument triples.

3.2 Abandoning the verb complex (VC)

One possible way to resolve the "conflict" between argument/adjunct distribution from the left as illustrated in (1), (2), and (4) and verbal element distribution from the right as illustrated in (3) and (4) is to do away with the distinction between VPs and verbal complexes and simply assume a right-branching recursion that allows for the introduction of an argument/adjunct and a left-branching recursion for the introduction of an auxiliary or modal. The VP rule would then look as follows, where the `VPconst` macro expands to any major category that can appear in a VP.

(7)
```
VP --> { @(VPconst) VP
       | VP Vaux
       | ... }.
```

This solution, however, encounters two important problems: From a theoretical point of view, it is problematic that, with this set of VP rule variants, there is no way at all to constrain the placement of arguments such as predicative phrases, which, unlike most other kinds of arguments in German, clearly have to be adjacent to the verb. From the point of view of grammar engineering, the problem with this solution is that, as soon as a clause has more than one element in clause-final position, the rules can produce several c-structures for identical f-structures, which is undesirable for efficiency reasons and with respect to ambiguity management.

Finally, it should be noted that this solution only addresses the problem of VP coordinations involving right node raising, but not conjunction reduction. Apart from being problematic for independent reasons, it would hence only be a partial solution anyway.

3.3 Special coordination rules in the verb complex

An effective and efficient way to capture the distribution of arguments/adjuncts from the left, right node raising and conjunction reduction consists in allowing for the verb complex to expand to a coordination of VPs. In other words, a special rule for a coordinated construction is introduced, and this rule in fact produces c-structures and f-structures very similar to the ones proposed by Maxwell & Manning (1996). The main difference is that instead of allowing the coordination of partial constituents "across the board", we do this very selectively, namely for VPs, so that the effects on efficiency remain reasonable.[2]

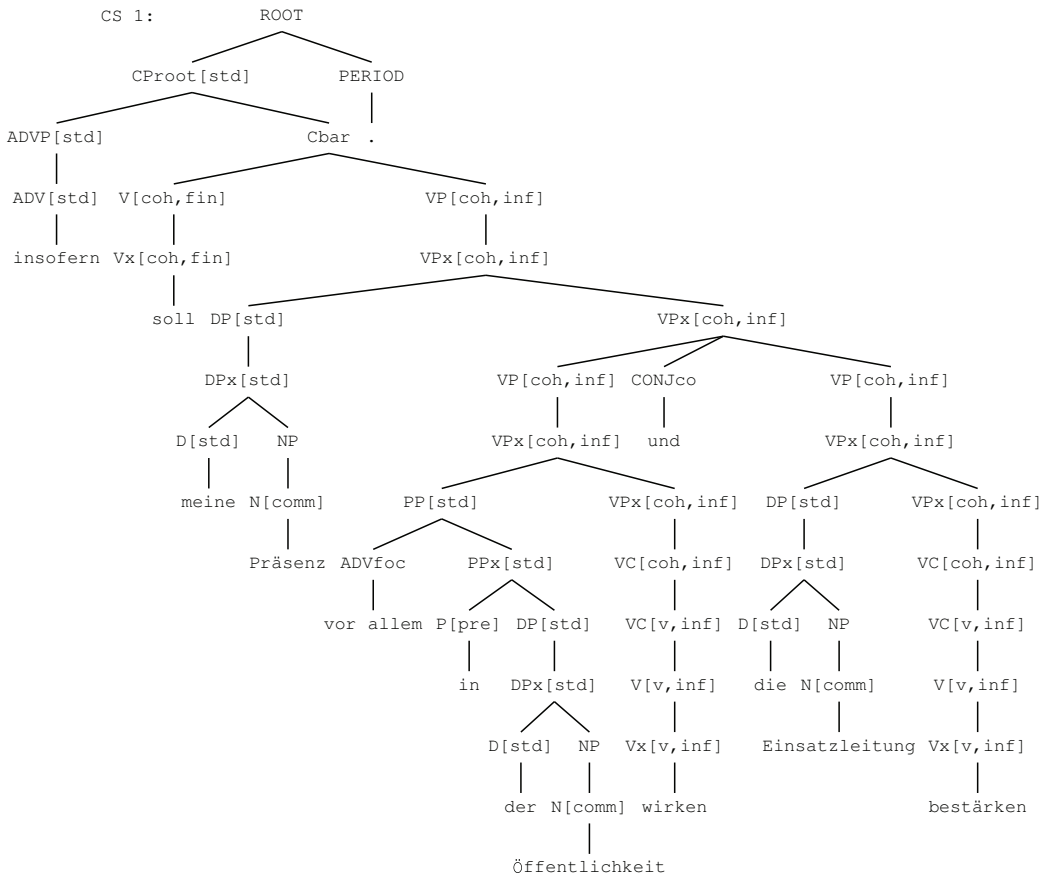
In the German *ParGram* LFG, the relevant rule part looks as follows:

(8)
```
VC --> { @(VP-COORD)
       | VC Vaux
       | ... }.
```

The grammar has always contained a macro for the coordination of VPs named `VP-COORD`, so this part is nothing new. The macro was introduced to account for idiosyncrasies of VP coordination whose treatment was not possible with the general macro for same-category coordination. It used to be called by the VP rule and covered sentences like (3) and (4) without undesirable vacuous ambiguities. By simply calling it in the VC rule rather than the VP rule, we make it possible for verbal elements to be distributed from the right over both conjuncts of a VP coordination that would traditionally be analyzed as involving "left deletion" or right node raising.

Although it may seem somewhat counterintuitive to attach a VP coordination under a VC, the rule gives rise to c-structures which, apart from this little oddity, look intuitive and from which linguistically sound f-structures are projected. Figures 3 and 4 show the c- and f-structures of (1) and (2) under the revised analysis, and Figures 5 and 6 illustrate how (3) and (4) are accounted for by the rule in (8).

[2]We are aware that right node raising and conjunction reduction do not only affect VPs. However, these phenomena are particularly frequent with VPs. Moreover, "conjunction-reduced" constituents of other categories can often be analyzed reasonably even without the deleted material, whereas the subcategorization requirements of verbs tend to make this impossible for "conjunction-reduced" VPs. Figure 7 illustrates an analysis involving a "conjunction-reduced" VP as well as an NP that arguably lacks right-node-raised material, namely *8,4 ~~Prozent~~*. Note that the "conjunction-reduced" VP is analyzed by means of a special VP coordination rule, whereas the NP *8,4* is simply analyzed as a headless NP whose semantic head needs to be recovered by post-syntactic means.



"Insofern soll meine Präsenz vor allem in der Öffentlichkeit wirken und die Einsatzleitung bestärken

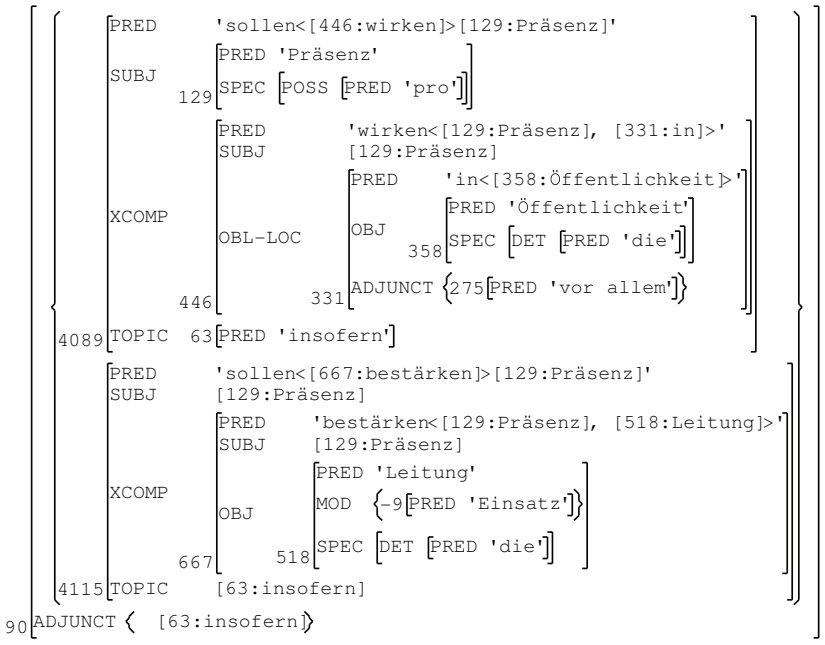
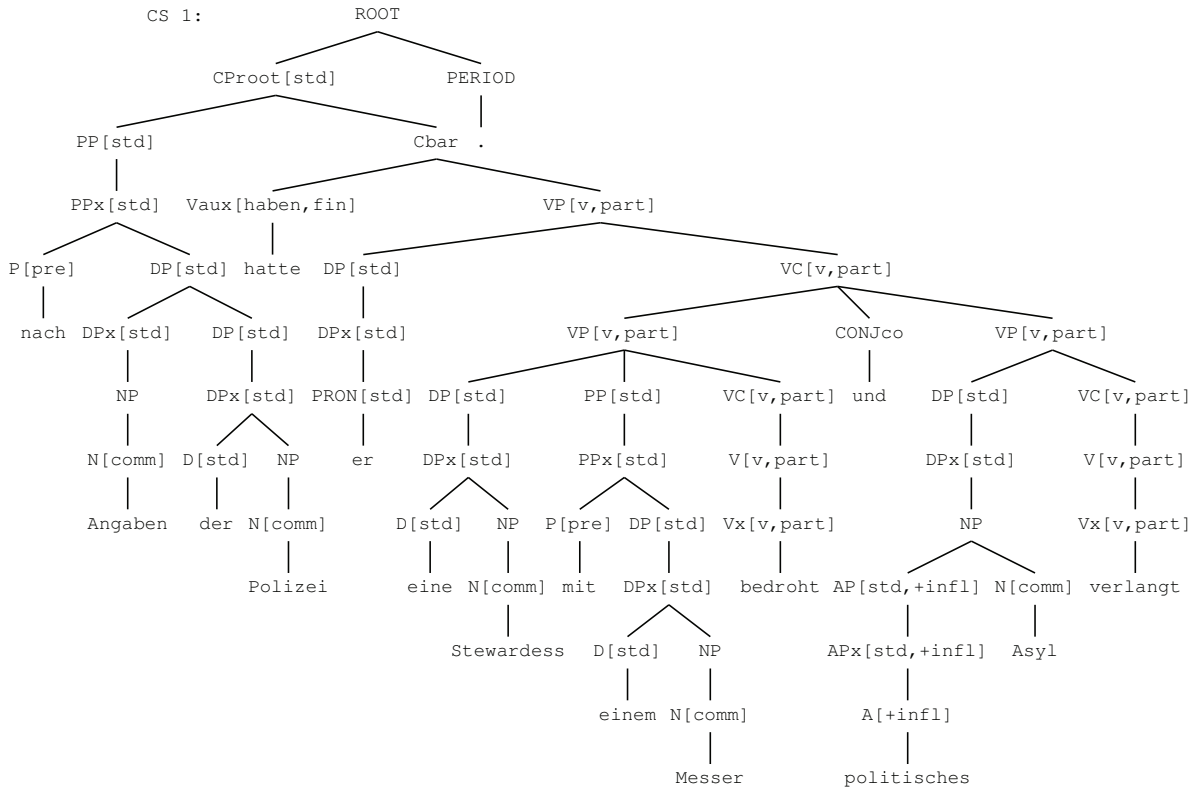


Figure 2: C-structure with recursive VPx corresponding to (2) and f-structure projected from it.
Insofar, my presence is primarily supposed to have an effect in public and to encourage the operation controllers.



"Nach Angaben der Polizei hatte er eine Stewardess mit einem Messer bedroht und politisches Asyl verlang

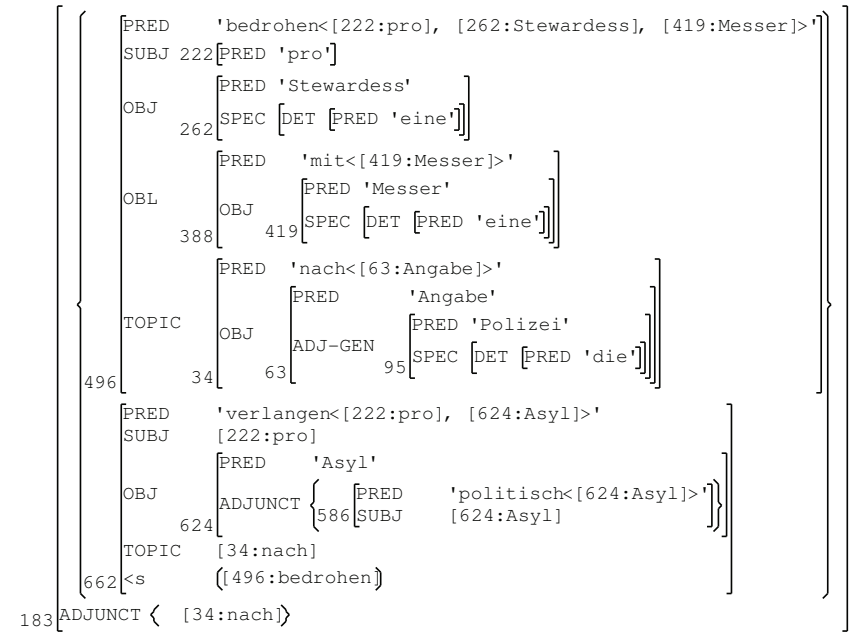
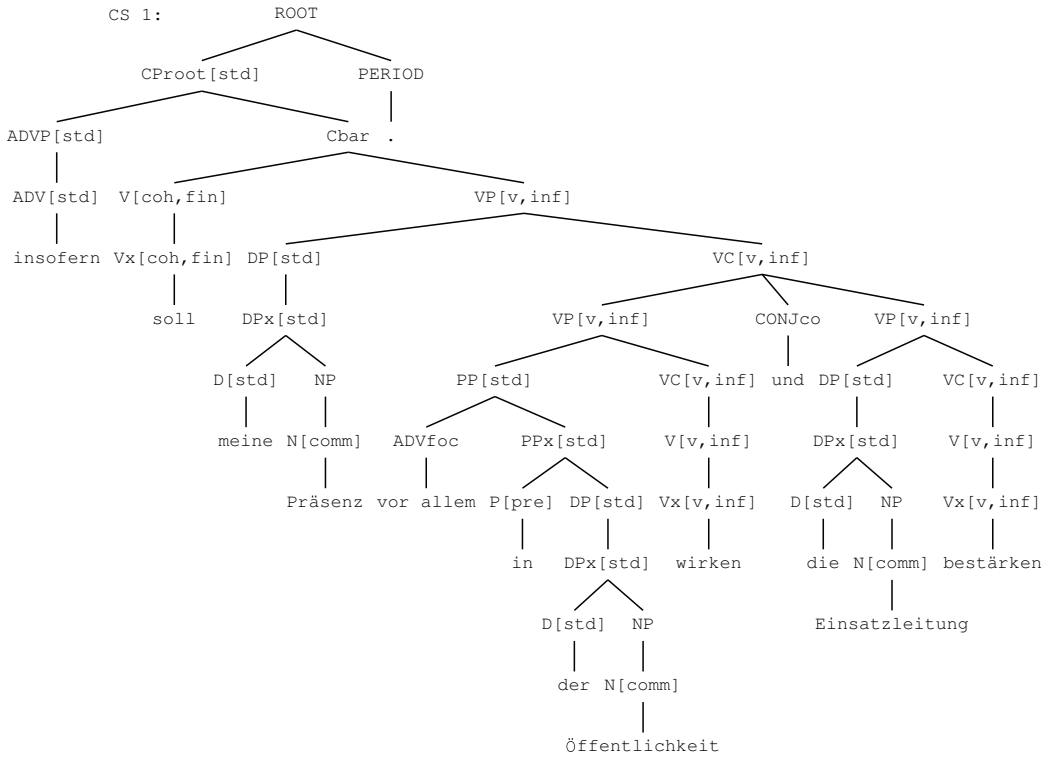


Figure 3: C-structure with VP-COORD under VC corresponding to (1) and f-structure projected from it
According to the police, he had threatened a stewardess with a knife and demanded political asylum.

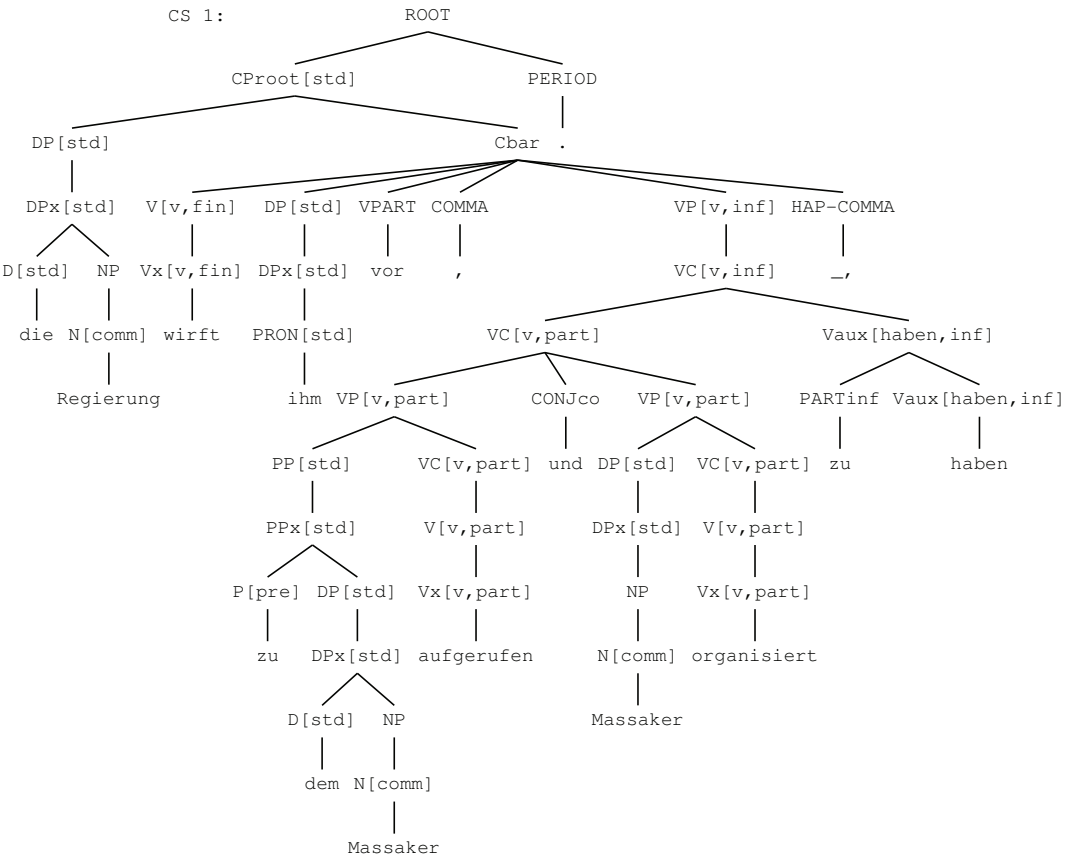


"Insofern soll meine Präsenz vor allem in der Öffentlichkeit wirken und die Einsatzleitung bestärken

```
[ PRED     'sollen<[490]>[129:Präsenz]'
  SUBJ 129 [ PRED 'Präsenz'
             SPEC [POSS [PRED 'pro']] ]
  XCOMP 446 { [ PRED       'wirken<[129:Präsenz], [331:in]>'
                SUBJ       [129:Präsenz]
                OBL-LOC    [ PRED    'in<[358:Öffentlichkeit]>'
                             OBJ 358 [ PRED 'Öffentlichkeit'
                                       SPEC [DET [PRED 'die']] ] ]
                331 [ADJUNCT {275 [PRED 'vor allem']}] ]
              [ PRED    'bestärken<[129:Präsenz], [518:Leitung]>'
                SUBJ    [129:Präsenz]
                OBJ 518 [ PRED 'Leitung'
                          MOD {-9 [PRED 'Einsatz']}
                          SPEC [DET [PRED 'die']] ] ] }
    490 [667 <s ([446:wirken])]
  ADJUNCT {63 [PRED 'insofern']}
90TOPIC    [63:insofern] ]
```

Figure 4: C-structure with VP-COORD under VC corresponding to (2) and f-structure projected from it

Insofar, my presence is primarily supposed to have an effect in public and to encourage the operation controllers.

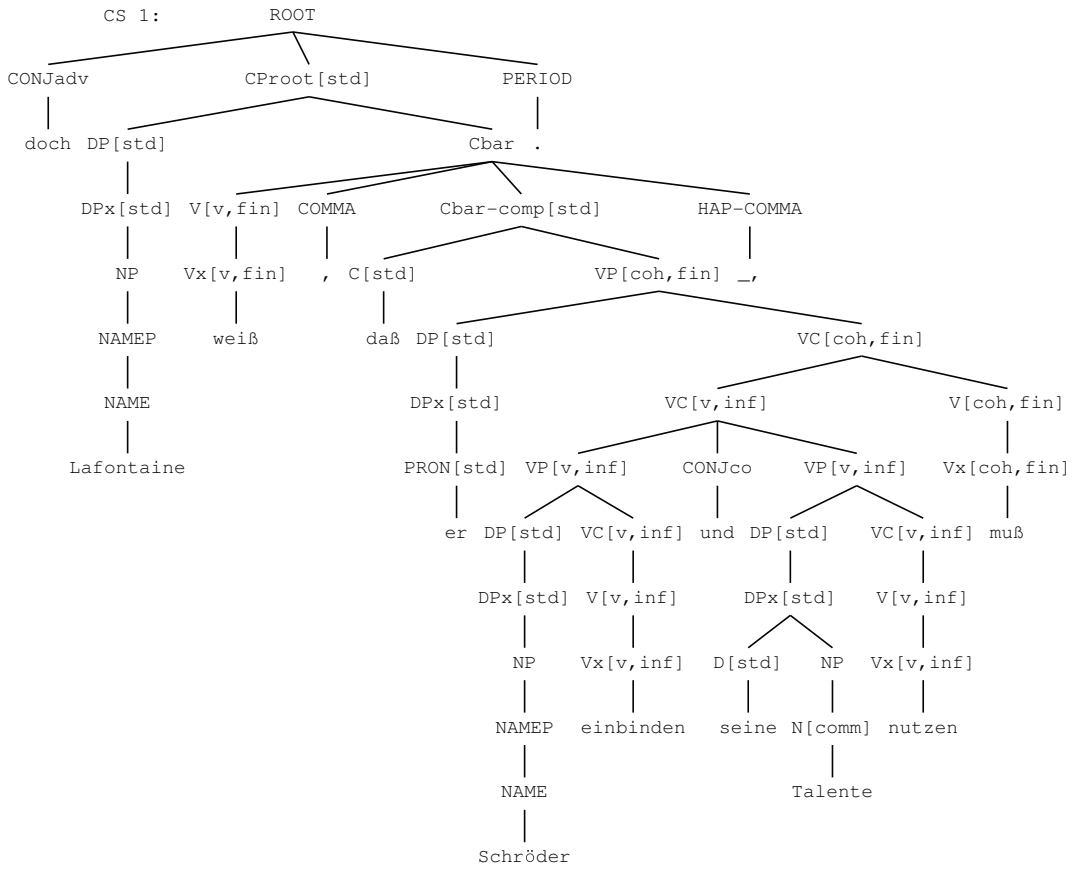


"die Regierung wirft ihm vor, zu dem Massaker aufgerufen und Massaker organisiert zu haber

```
[PRED      'werfen<[1:Regierung], [124:pro], [355]>'
 SUBJ    1 [PRED 'Regierung'
            SPEC [DET [PRED 'die']]]
 OBJ-TH  124[PRED 'pro']
 VCOMP   {318[PRED    'auf#rufen<[124:pro], [242:Massaker]>'
              SUBJ    [124:pro]
              OBL   206[PRED   'zu<[242:Massaker]>'
                        OBJ 242[PRED 'Massaker'
                                SPEC [DET [PRED 'die']]]]]
          {355[PRED    'organisieren<[124:pro], [383:Massaker]>'
              SUBJ    [124:pro]
              OBJ  383[PRED 'Massaker']
              420[<s       ([318:auf#rufen])]]
 86[TOPIC    [1:Regierung]]
```

Figure 5: C- and f-structure corresponding to (3)

The government accuses him of having called for the mass murder and of having organized massacres.



"Doch Lafontaine weiß , daß er Schröder einbinden und seine Talente nutzen muß

```
[PRED    'wissen<[61:Lafontaine], [201:müssen]>'                                  ]
[SUBJ  61[PRED 'Lafontaine']                                                      ]
[        [PRED     'müssen<[326]>[211:pro]'                                       ]
[        [SUBJ  211[PRED 'pro']                                                   ]
[        [          {   [PRED    'ein#binden<[211:pro], [251:Schröder]>']        ]
[        [          {   [SUBJ    [211:pro]                                       ]
[        [          {283[OBJ  251[PRED 'Schröder']                               ]
[COMP    [          {   [PRED    'nutzen<[211:pro], [354:Talent]>']              ]
[        [XCOMP     {   [SUBJ    [211:pro]                                       ]
[        [          {   [        [PRED 'Talent'                                  ]
[        [          {   [OBJ     [                                               ]
[        [          {   [      354[SPEC [POSS [PRED 'pro']]                      ]
[        [          {   [                                                        ]
[     201[       326{513[<s      ([283:ein#binden])                              ]
[ADJUNCT {34[PRED 'doch']}                                                        ]
93[TOPIC   [61:Lafontaine]                                                        ]
```

Figure 6: C- and f-structure corresponding to (4)

But Lafontaine knows that he must involve Schröder and capitalize on his talents.

As we have just seen, the rule disjunct that expands a VC as a coordination of VPs makes it possible to correctly analyze VP coordinations with distribution of arguments/adjuncts from the left as well as those with distribution of verbal elements from the right. What the rule disjuncts still fails to analyze, however, is the phenomenon of conjunction reduction or argument/adjunct cluster coordination, which is exemplified in (5) and (6).

Based on the observation that these coordinated argument/adjunct clusters consist of the same categories as the non-verbal material in VPs, we introduce a c-structure category called `VPargs`, which generates a flat sequence of constituents that can appear in VPs. To make sure that `VPargs` actually expands to an argument/adjunct cluster, not to a single argument/adjunct, we impose a minimal length of two such constituents, and for efficiency reasons, we impose a maximal length of three. The corresponding rule in the grammar is the following:[3]

```
(9)  VPargs --> { DP[std]
                | PP[std]
                | ADVP[std]
                | PREDP[std]
                | XPpred[std]
                }#2#3.
```

`VPargs` is introduced by a special rule for argument/adjunct cluster coordinations, which takes the following form in the grammar:[4]

```
(10) VPargs-COORD --> VPargs: ! $ ^ ;
                      [ COMMA
                        VPargs: ! $ ^; ]*
                      CONJco
                      VPargs: ! $ ^.
```

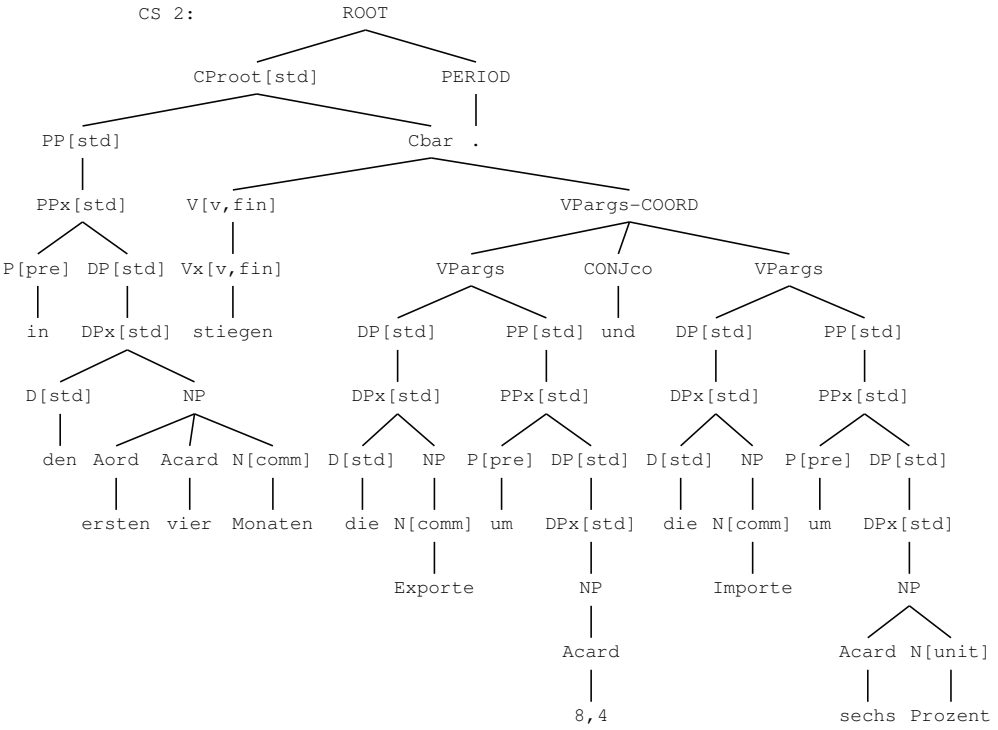
Finally, this special category is introduced in the VC rule, similarly to the coordination of VPs, so that the relevant part of the VC rule then looks as follows:

```
(11) VC --> { VPargs-COORD V
            | @(VP-COORD)
            | VC Vaux
            | ... }.
```

The two special rules above in combination with the introduction of `VPargs-COORD` in the VC rule make it possible to build up the c-structures shown in Figures 7 and 8 for (5) and (6) respectively. From these, the f-annotations in the rules project linguistically sound f-structures, as can be verified in Figures 7 and 9. Note that the latter c-structure exhibits all three VP coordination phenomena we have addressed, i.e. distribution of an argument/adjunct (*es*) from the left, distribution of verbal elements (*geben wird*) from the right, and argument/adjunct cluster coordination (or conjunction reduction).

[3]For the sake of simplicity and clarity, we omit functional annotations and linear precedence constraints which regulate constituent order.

[4]In the ASCII-based XLE notation, '^' stands for '↑', '!' stands for '↓', and '$' stands for '∈'.



"In den ersten vier Monaten stiegen die Exporte um 8,4 und die Importe um sechs Prozent

```
[ { [ PRED    'steigen<[273:Export], [403:pro]>'
    | SUBJ  273[ PRED 'Export'
    |            SPEC [DET [PRED 'die']] ]
    | OBL     369[ PRED   'um<[403:pro]>'
    |              OBJ  403[ PRED 'pro'
    |                        SPEC [NUMBER [PRED '8,4']] ] ]
    | TOPIC    34[ PRED  'in<[59:Monat]>'
    |              OBJ   59[ PRED    'Monat'
    |                        ADJUNCT { 105[ PRED   'erste<[59:Monat]>'
    |                                       SUBJ   [59:Monat] ] }
    |                        SPEC [ DET    [PRED 'die']
    |                               NUMBER [PRED 'vier'] ] ] ]
  5450
  { [ PRED    'steigen<[458:Import], [588:Prozent]>'
    | SUBJ  458[ PRED 'Import'
    |            SPEC [DET [PRED 'die']] ]
    | OBL     554[ PRED   'um<[588:Prozent]>'
    |              OBJ  588[ PRED 'Prozent'
    |                        SPEC [NUMBER [PRED 'sechs']] ] ]
    | TOPIC  4763[ TOPIC   [34:in] ] ]
  233[ ADJUNCT { [34:in] } ] ]
```

Figure 7: C- and f-structure corresponding to (5)

In the first four months, the exports rose by 8.4 percent, and the imports, by six.

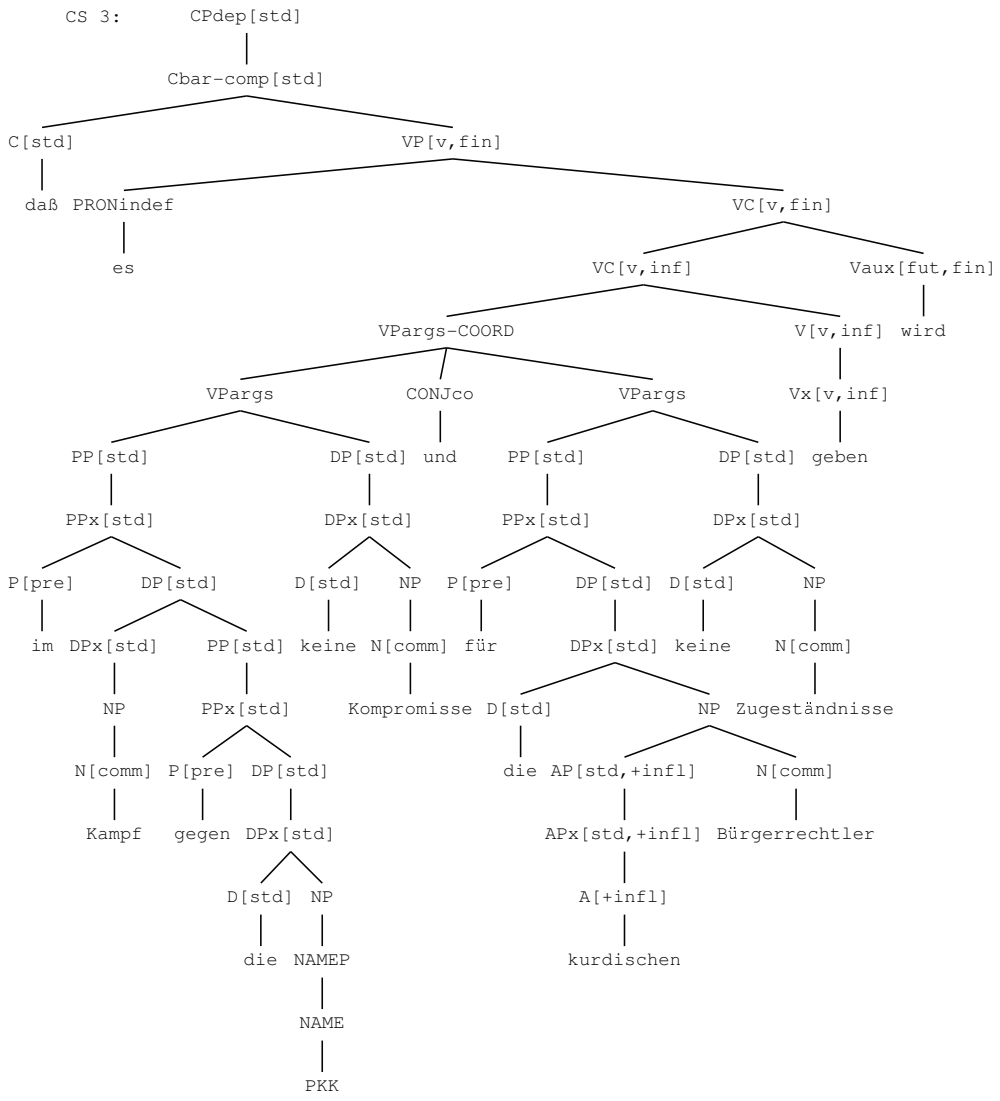


Figure 8: C-structure corresponding to (6)

that there will be no compromises in the struggle against the PKK and no concessions for the Kurdish civil rights activists

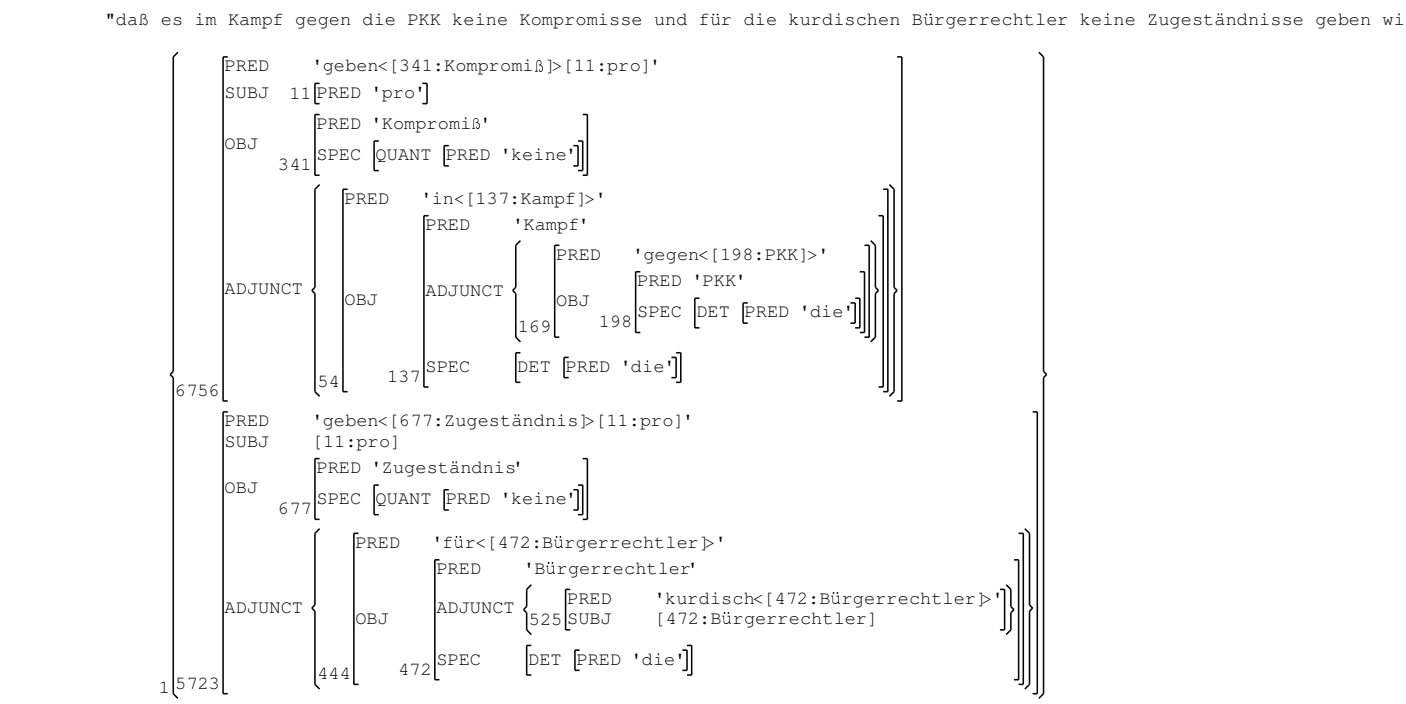


Figure 9: F-structure corresponding to (6), projected from c-structure in Figure 8
that there will be no compromises in the struggle against the PKK and no concessions for the Kurdish civil rights activists

3.4 Remaining problems

One issue that our special coordination rules cannot solve is the violation of subject-verb agreement between a distributed verb form in the plural and singular subjects in the (partial) VP conjuncts. Examples (12) and (13) exhibit this issue.

(12) *Dafür heuerten zunächst der baden-württembergische Verband, später auch andere*
For that signed at first the of Baden-Württemberg federation, later also other
Profis an.
professionals on.
'At first, the Baden-Württemberg federation signed on for that; later, other professionals did so, too.' (TIGER sentence # 9682)

(13) *Dies kündigten [...] Ursula Engelen-Kefer im "Mitteldeutschen Express" (Halle)*
This announced [...] Ursula Engelen-Kefer in the "Mitteldeutscher Express" (Halle)
und der Zweite IG-Metall-Vorsitzende Klaus Zwickel im Sender Rias an.
and the Second IG Metall President Klaus Zwickel in the radio station Rias .
'[...] Ursula Engelen-Kefer announced this in the "Mitteldeutscher Express" (Halle) and the Second President of the IG Metall, Klaus Zwickel, in the Rias radio station.' (TIGER sentence # 1034)

In (12), the verb features plural agreement, which is satisfied by the subject of the second VP conjunct, but conflicts with the subject of the first VP conjunct. In (13), the verb conflicts in number with the

subjects of both VP conjuncts.

It is well-known that subject-verb agreement in number and person, while generally being a very stable wellformedness constraint in German, is often violated in the context of coordinations. It is therefore not surprising to find violations of subject-verb agreement also in the context of (partial) VP coordinations. Furthermore, we would like to point out that all formal accounts of (partial) VP coordinations that we are aware of, including Maxwell & Manning (1996), fail to account for number and/or person mismatches between verbs and their subjects in these constructions.

Another class of coordinations that our special rules cannot deal with are the ones that Maxwell & Manning (1996) analyze using a stack. An example is given in (14).

(14) *Nach* *[...]* *stimmten* *127 799* *Dresdner* *für* *und* *58 778* *gegen* *die*
According to [...] voted 127,799 Dresdeners for and 58,778 against the
stadtnahe *Variante* *der* *A 17.*
city-adjacent variant of the A 17.
'According to [...], 127,799 Dresdeners voted for and 58,778, against the variant of the A 17 in close proximity to the city.' (TIGER sentence # 6102)

An approximate TIGERSearch query that we have run indicates that non-constituent coordinations whose analyses would require a stack are very rare: We have found fewer than 30 sentences containing these in the entire non-evaluation part of the TIGER Corpus. Now it may well be that we miss some because the secondary edges that characterize these constructions were not annotated reliably outside of S and VP coordinations. Nevertheless, we claim that right node raising from coordinated PPs, as we find it in (14), is very infrequent in comparison with right node raising from coordinated VPs.

Finally, an issue which would be easy to solve if the solution did not affect efficiency so adversely is the fact that VPs can be coordinated using just commas, i.e. without an explicit conjunction. (15) illustrates this use of a comma instead of a conjunction.

(15) *Nach* *einer* *Hochrechnung* *aus* *der* *Nacht* *kommt* *Kwasniewski* *auf* *34,8*
According to a projection from the night comes Kwasniewski up to 34.8
Prozent, *Walesa* *auf* *33,3* *Prozent* *.*
percent, Walesa up to 33.3 percent.
'According to a projection of last night, Kwasniwski achieves 34.8 percent, Walesa, 33.3 percent.' (TIGER sentence # 6251)

While this is a general problem with VP coordinations that lack an explicit conjunction, this phenomenon seems to be particularly frequent in VP coordinations involving conjunction reduction. As a consequence, we still cannot capture a large portion of these, despite the special rules we have introduced for them.

4 Further Benefit of Our Analysis: a Flat VP

By introducing special rules for (partial) VP coordinations, we obliterate the need for a recursive right-branching VP (or VPx) rule. Instead, we can now formulate a flat VP rule that attaches all arguments and adjuncts of a (non-coordinated) VP as sisters at the same level. This is highly desirable from a grammar developer's point of view, since (i) it allows for the formulation of more general rules, (ii) it makes it possible to express hard linear precedence constraints on VP arguments/adjuncts, and (iii) it facilitates the design of learning features that can act as soft constraints on the constituent order in VPs in parse or realization ranking models.

4.1 More general rules

In previous versions of the German *ParGram* LFG, clauses with the main verb in second position were captured by a very different set of rules than clauses with the main verb in clause-final position. This was motivated by the observation that the "headless" VPs in clauses with the main verb in second position could be analyzed much more efficiently by a flat rule than by the recursive right-branching VP (or VPx) rule used for the analysis of VPs with a verbal head. Now that both "headless" and headed VPs are analyzed by means of a flat rule, a lot of the rule code can be shared between the two constructions. This is desirable both conceptually, as it is a more general description of the phrase structure of German, and from an engineering point of view, as code sharing leads to better maintainability.

4.2 Hard constraints on constituent order in the VP (especially for generation)

Although the order of arguments and adjuncts in German VPs is very free, there are positional constraints on certain types of arguments. For example, PREDPs (i.e. predicative arguments) have to occur next to the VP-final verb, and the expletive subject pronoun *es* has to occur at the left edge of the VP. In previous versions of the German *ParGram* LFG, the verb-adjacent position of PREDPs was enforced by attaching a PREDP within the VC rather than the VP (or VPx) rule; no restriction on the placement of expletive pronouns was expressed.

With the flat VP rule that we can use now, it is far easier to formulate constraints on the placement of certain types of constituents within VPs. This is particularly important in the context of generation, where the order of constituents needs to be controlled relatively tightly to avoid extremely marked or even ungrammatical string realizations. The German *ParGram* LFG therefore now states linear precedence constraints on expletive pronouns, the sentential negation adverb *nicht* and PREDPs within VPs and thereby prevents extremely marked or ungrammatical string realizations from being passed to the probabilistic realization ranker associated with the grammar (Cahill et al. 2007a,b).

4.3 Capturing soft constraints in the form of learning features for a statistical model

Just like hard constraints on the constituent order in VPs can be expressed more easily with a flat VP rule, learning features (or properties) that can potentially capture soft constraints on the constituent order in VPs are easier to formulate in this case. Learning features for statistical models used for parse or realization ranking (Forst 2007a,b, Cahill et al. 2007a,b) are typically based on templates that consider certain local c- or f-structure configurations. For example, the feature template `cs_sub_rule` implemented in XLE counts the number of times the context free rule that it takes as an argument appears in the analyses or generated trees that the statistical model has to rank. With a flat VP rule, the order of constituents in VPs can be captured by local features such as `cs_sub_rule VP DP PP ADVP PP VC` or `cs_sub_rule VP DP PP PP ADVP VC`, whereas features would have to be non-local at considerable depth to capture the same orders expressed in terms of VP (or VPx) recursions.

5 Conclusions and Future Directions

We have proposed a solution for problematic cases of VP coordination in German which, to our knowledge, have not been implemented in any computational LFG so far. Our approach is inspired by the proposal of Maxwell & Manning (1996), and just like that approach, captures argument cluster coordination (or conjunction reduction) and many instances of right node raising. Unlike the approach of Maxwell & Manning (1996), which is a general theory of non-constituent coordination, our solution is targeted at problematic cases of VP coordination. As a result of this, it is less general and admittedly

fails to capture right node raising from categories other than VP, but it is also far more efficient computationally and hence suitable for implementation. By modifying the grammar in the way described above, we have improved both coverage and parse quality (83.45% F-score with the new rules as opposed to 82.98% previously), without adversely affecting efficiency. As a welcome side effect, the replacement of the recursive VPx rule by a flat VP rule makes it possible to formulate more general rules and easier to express both hard and soft constraints on constituent order in the VP domain.

In future work, we will examine in greater detail examples of coordination which Maxwell & Manning (1996) analyze using a stack, like, e.g., (14). Preliminary experiments indicate that it is possible to obtain the semantically intended f-structures for these coordinations by distributing the DP in the PP at the right edge using f-annotations. We will try to find ways to make such rules more general without sacrificing efficiency.

Finally, another research topic we want to pursue is the type of right node raising illustrated by (16).

(16) *Die Regierung begrüßte und die Opposition kritisierte gestern nach der Sitzung*
The government welcomed and the opposition criticized yesterday after the meeting
die Entscheidung der Regierung.
the decision of the government.
'Yesterday after the meeting, the government welcomed and the opposition criticized the decision of the government.'

Our preliminary solution covers most cases of right node raising where the raised constituent needs to be distributed into a CProot conjunct. However, it tends to overgenerate because the boundary between the end of the second CProot conjunct and the beginning of the raised constituent(s) is difficult to determine. We intend to collect more data in order to find an empirical basis for the restrictions to be introduced.

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Martin Forst
martin.forst@microsoft.com
Natural Language Engineering
Powerset/Microsoft
475 Brannan St
San Francisco, CA 94110
USA

Christian Rohrer
rohrer@ims.uni-stuttgart.de
IMS
University of Stuttgart
Azenbergstr.12
70174 Stuttgart
Germany