Translating the XTAG English Grammar to HPSG

Yuka Tateisi†, Kentaro Torisawa†, Yusuke Miyao†, and Jun'ichi Tsujii†‡
†Department of Information Science, Graduate School of Science, University of Tokyo*
‡CCL, UMIST, U. K.
E-mail: {yucca, torisawa, yusuke, tsujii}@is.s.u-tokyo.ac.jp

1 Introduction

We describe the development of XHPSG, a large-scale English grammar in the HPSG formalism translated from the XTAG grammar (The XTAG Research Group, 1995). Our goal is to obtain a large-scale, linguistically sound grammar for our HPSG parser (Makino et al., 1998) with a relatively small workload. For this purpose, we try to make an HPSG grammar equivalent to the XTAG grammar in the strong sense where we preserve the structures and the linguistic analysis of the XTAG grammar.

To guarantee the equivalence of the XHPSG and XTAG grammars, the following conditions must be satisfied: 1) An XTAG elementary tree is translated to an XHPSG lexical item that translates back to the original elementary tree by applying the schemata and principles; 2) No XHPSG lexical item translates back to a tree other than the original XTAG elementary tree; 3) Substitution and adjunction allowed in the original grammar, and no other opeations, are simulated in the XHPSG parsing.

We not only use the HPSG formalism to express the linguistic analyses of the XTAG grammar, but also preserve, as much as possible, the general framework of the linguistic analyses given in the standard HPSG (Pollard and Sag, 1994). We use the standard HPSG schemata and the principles that are concerned with syntax, and translate the XTAG elementary trees into lexical feature structures so that they satisfy the conditions 1), 2) and 3) with them. Given that the XTAG features are used for controlling the substitution and adjunction, the condition 3) is reduced to the problem of whether or not all the XTAG features can be mapped to HPSG feature structures so that their values are properly propageted by the application of those schemata and principles.

*This work is partially founded by Japan Society for the Promotion of Science (JSPS-RFTF96P00502).

2 Translation

We start with the standard HPSG feature structure and schemata[1] with slight modification and addition. As for principles, we use phonology-, head-feature-, valence-, non-local feature-, spec- and marker-principles.

We separate the translations to two steps. First, we translate the tree structure of elementary trees to HPSG feature structures. Second, we map the XTAG feature into the HPSG structure.

2.1 Translation of the tree structure

In most initial trees, labels of the nodes on the trunk (the path from the anchor to the root) are the projections of that of the lexical anchor. On the other hand, in HPSG, labels are expressed by a part of the `HEAD` and the `VALENCE` features. The `HEAD` feature corresponds to the projection of a category. For example, VP is expressed as a structure whose `HEAD` is *verb* and `COMPS` is saturated and S is expressed as a structure whose `HEAD` is *verb* and both `COMPS` and `SUBJ` is saturated (Figure 1). Thus, if no features are concerned, the nodes on the trunk corresponds to the `HEAD` feature[2] and we can construct the lexical feature structure corresponding to an initial tree by translating the label of the nodes on

[1] Refer to (Pollard and Sag, 1994) for the meaning of the standard HPSG features and schemata. We use the following abbreviations for feature names: `SS=SYNSEM`, `LOC=LOCAL`, `NONLOC=NONLOCAL`, `VAL=VALENCE`, `MARK=MARKING`.

[2] In a few initial trees whose label of the root is different from that of the anchor, we set the `HEAD` feature according to the root node because of the substitution.

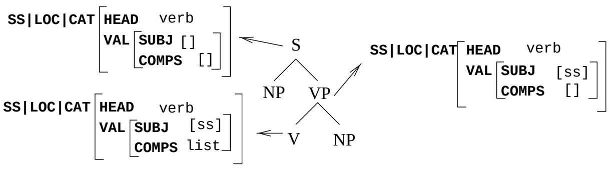

Figure 1: Correspondence between node labels and feature structures

the trunk into the HEAD features and remaining nodes into SUBJ, COMPS or SLASH features according to the syntactic role of the nodes.

For example, α_1 in Fig 2 shows the tree for a transitive verb *like*. As an HPSG schema cor-

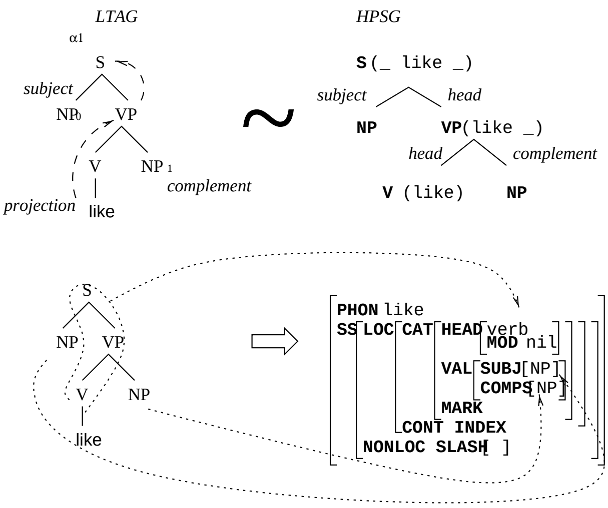

Figure 2: Translation of verb *like*

responds to one branching of the tree, the tree can be re-constructed if a proper schema is selected for each branching. In this case, applying head-complement, and head-subject in this order will restore the shape of a tree and properly project the information contained in the anchor to the root of the tree[3].

In auxiliary trees, we translate the anchor to the HEAD and leaf node other than the foot node to an element of either SUBJ, COMPS, or SLASH list, as in initial trees. However, as an auxiliary tree adjoins to a node of another tree, the label and the structure of the adjoined tree must be preserved after the adjunction. Therefore, in the application of a schema corresponding to a branching just above the foot node, the HEAD,VAL and SLASH must be preserved (Figure 3). Considering this property and the fact that

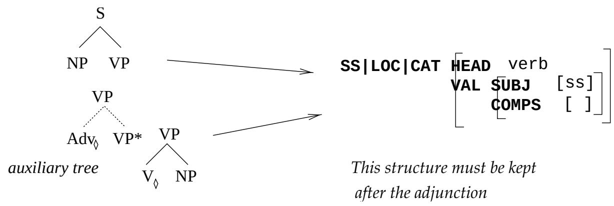

Figure 3: Adjunction

the auxiliary tree selects the node it adjoins, it seems natural to put the foot node into the MOD or SPEC feature so that the head-adjunct or head-marker schema will be applied to form the branching just above the foot node in a way that the auxiliary tree becomes the adjunct or the marker (Figure 4). As adjunction involves the

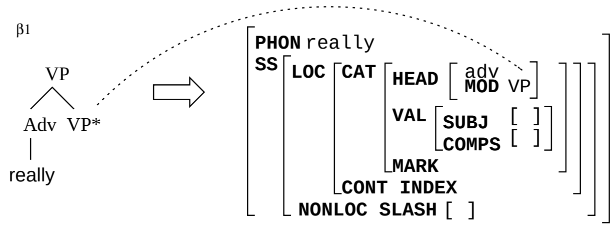

Figure 4: Translation of modifiers

propagation of other feature values, the translation of an auxiliary trees is re-examined in section 2.2.

2.2 Translation of the feature and the auxiliary trees

Generally, the HPSG features propagate from the daughters to the mother as in Table 1[4].

We put the XTAG features that have an equivalent in the HEAD features of the standard HPSG into XHPSG HEAD features. We call these XTAG features HEAD' features. We observed that the values of HEAD' features are propagated from the node defined as the head-daughter in section 2.1 on the branching that is

[3]The specification of schemata presented in (Pollard and Sag, 1994) ensures that the schemata are applied in proper order. For example, the condition on head-subject schema that the COMPS of the head daughter must be empty ensures that the subject comes above the complements on the tree structure.

[4]In exceptional cases, the propagation is explicitly marked in the lexical item

Table 1: Propagation of HPSG features

	Schema				
Feature	head-subj	head-comp	head-adj	head-mark	head-fill
HEAD	H	H	H	H	H
MARKING	H	H	H	n	H
INDEX	A	H	e	H	H
SLASH	e	e	e	e	U

H:the value propagates from head-daughter to the mother n:the value propagates from head-daughter to the mother e:the value propagates from either daughter A:the value must agree between both daughters U:the value of the feature on the head-daughter unifies the non-head daughter

not the one just above the foot node of an auxiliary tree. We put the *agr* feature into INDEX feature and *trace* into the SLASH feature.

Among the remaining features, the ones whose value propagates in the same way as the HEAD' feature values are also put into the XHPSG HEAD feature, and the others are put into the MARKING feature. Table 2 shows where the XTAG features are put into in the XHPSG feature structure. Now, we re-examine

Table 2: Correspondence of XTAG and XHPSG features

XTAG feature	XHPSG feature
assign–case, assign–comp, case*, extracted*, inv*, mainv*, mode*, passive, perfect, pred, progressive, pron, tense*	HEAD
card, comp, const, decrease, definite, gen, neg, quan, sub-conj, wh	MARKING
agr	INDEX
trace	SLASH

The features marked with * has a counterpart HEAD feature in the standard HPSG analysis.

the translation of tree structure regarding foot nodes. We determine the schema to be applied to the branching above the foot node as follows: If the auxiliary tree changes the value of the HEAD feature on adjunction, we apply the head-complement schema on the branching just above the foot node. In this case, the foot node becomes a complement just as in the case of substitution node[5] (Figure 5); If the auxiliary tree does not change the value of the HEAD node but changes the value of the MARKING feature on

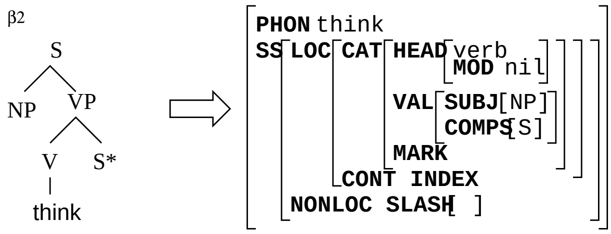

Figure 5: Translation of verbs that take a sentential complement

adjunction, we apply the head-marker schema on the branching just above the foot node. In this case, the foot node becomes the head to be selected by the SPEC feature of the lexical feature structure corresponding to the auxiliary tree (Figure 6); Otherwise, we apply the head-

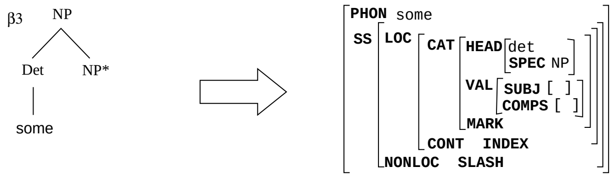

Figure 6: Translation of determiners

modifier schema on the branching just above the foot node. In this case, the foot node becomes the head to be selected by the MOD feature of the lexical feature structure corresponding to the auxiliary tree [6] (Figure 4).

3 Problems

Though in most cases the abovementioned translation works, there are a few exceptional cases. In this section, we mention two cases. The first one is a treatment of bar level, the second is predicatives.

3.1 Bar level

As mentioned in section 2.1, bar-level is not explicitly marked in the standard HPSG (see Figure 1), but implicitly stated in VALENCE features. In consequence, there is no distinction between a word who has no arguments and the phrase just consists of that word.

[5]The tree structure of the tree that this kind of auxiliary tree adjoins to is kept by letting the appropiriate part of the VALENCE feature structure-share between the head and the complement.

[6]In the latter two cases, the tree structure of the tree that the auxiliary tree adjoins to is kept by the valence principle and the head-marker (head-adjunct) schema.

This caused a problem when modifiers are involved. For example, there is no way to prevent a noun-modifying adjective from modifying an NP as there is no distinction between N with no arguments and NP.

To solve the problem we introduced features named `XP` and `ASSIGN_XP`. `XP` is used for restrict the modifiee's bar-level. `ASSIGN_XP` is used by a modifier to assign a bar-level to a phrase generated as a result of modification.

3.2 Predicatives and small clause

In XTAG analysis, a predicative noun[7] has a tree whose root is labeled S and the copula *be* has an auxiliary that adjoins to the tree. We assigned a head feature `verb` to a predicative noun (see the footnote in section 2.1). However, we could not allow the extraction of the predicative noun, because it would be the head that is extracted. We splitted the lexical entry of *be* to handle the extraction.

4 Implementation

We have translated the syntactic lexicon of the XTAG grammar version 1.1 and implemented the translated grammar in LiLFeS language (Makino et al., 1998). We assumed only binary branching, and splitted the schemata according to whether the head is on the left or on the right.

Currently we have verified our grammar partially in the sense that XHPSG grammar generates the structures equivalent to the elementary trees and the trees constructed with one or less adjunction. For the general cases, we are currently working on constructing a structure equivalent to the derivation tree for XTAG parsing in XHPSG. The derivation trees will enable us to easily compare the parsing results between the original and the translated grammars to check the validity of XHPSG in a practical sense.

We optimized the grammar by pre-compiation (Torisawa and Tsujii, 1996) and measured the parsing time of the ATIS corpus using the two-phased parsing of the precompiled XHPSG. The average user time was 1.12 seconds on Alpha Station (400MHz CPU, 4GB main memory). We expect a futher speedup of the parsing by packing feature structures (Miyao et al., 1998).

[7]adjective and preposition also

5 Conclusion and Future Work

We translated the XTAG grammar to get a wide-coverage grammar in the HPSG formalism. By assigning an HPSG schema to a branching of XTAG trees, we have shown that the branching in XTAG trees can be licensed by the standard HPSG schemata and principles.

We are also interested in comparing our result to the HPSG English grammar being developed at Stanford University (CSLI, 1998) and to the CCG English grammar converted from XTAG grammar (Doran and Srinivas, to appear).

6 Acknowledgment

We are grateful to Prof. Aravind Joshi and the members of the XTAG group for their valuable helps and suggestions.

References

CSLI. 1998. English Resource Grammar Online. available in `http://hpsg.stanford.edu/hpsg/ergo.html`.

Christine Doran and B. Srinivas. to appear. Developing a wide-coverage CCG system. CSLI lecture notes edited by A. Abeille and O. Rambow.

Takaki Makino, Minoru Yoshida, Kentaro Torisawa, and Jun'ichi Tsujii. 1998. LiLFeS—towards a practical hpsg parser. to appear in Proc. COLING—ACL '98.

Yusuke Miyao, Kentaro Torisawa, Yuka Tateisi, and Jun'ichi Tsujii. 1998. Packing of feature structures for optimizing the hpsg-style grammar translated from TAG. submitted to TAG+ workshop.

Carl J. Pollard and Ivan A. Sag. 1994. *Head-Driven Phrase Structure Grammar*. University of Chicago Press.

The XTAG Research Group. 1995. A lexicalized tree adjoining grammar for english. Technical Report IRCS Research Report 95-03, IRCS, University of Pennsylvania. available in `http://www.cis.upenn.edu/~xtag/tech-report/tech-report.html`.

Kentaro Torisawa and Jun'ichi Tsujii. 1996. Computing phrasal-signs in HPSG prior to parsing. In *Proc. Coling 96*, pages 949–955.