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日独音声翻訳における意味レベルの変換処理について

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あらまし　音声翻訳システム ASURA の日本語－ドイツ語変換処理について述べる。日独変換部は、日本語解析処理結果の素性構造をドイツ語生成への入力として適切なドイツ語側の素性構造に変形する。日独変換のためのプロダクション形式の規則が素性構造書き換えシステム上で適用される。本稿では、開発過程で生じたいくつかの問題とそこから得られた将来の研究への示唆について議論する。まず、変換処理が実行されるレベルについて検討する。－変換される素性構造中のシンボルはどのように解釈されるべきか? 変換と生成の境界をどのように定義すべきか? 次に、変換処理における中間言語の利用可能性について検討する。また、意意味表現上の種々の問題について考察する。解析結果に欠落している情報に起因する問題も時おり生ずる。適切な意味形式が不確定な場合もある。最後に、現システムのもつ様々なアドホックな側面について検討する。多くの場合、書き換え処理系のもつ素性構造のタイプシステムを活用することによって、より一般性が得られる見通しがある。しかし、他の問題の解決には外部知識による処理が必要と思われる。

和文キーワード　音声翻訳, 機械翻訳, 言語変換, 日本語－ドイツ語

Semantic-level Transfer in Japanese-German Speech Translation: Some Experiences

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The Japanese-German transfer component of the ASURA speech-to-speech translation system transforms feature structures produced by Japanese analysis into modified feature structures suitable for input to German generation. The production-style rules which compose the J-G component are applied by the Feature Structure Rewriting System (RWS). This paper discusses several issues which arose during rule development and their implications for future work. First, we examine the level at which transfer operates: How should the symbols in transferred feature structures be interpreted? How should one define the boundary between transfer and generation? Second, we consider the possible use of language-neutral symbols in transfer. Third, we consider several issues of semantic representation. Sometimes problems arose because information was missing in the analysis output. In other cases, the proper semantic format was uncertain. Finally, we examine various *ad hoc* aspects of the current system. In many cases, greater generality can be achieved by taking full advantage of the RWS' typing system for feature structures. Other problems, however, may require extensive knowledge processing.

英文 key words　speech translation, machine translation, language transfer, Japanese-German

1 Introduction

The Japanese-German transfer component of the ASURA speech-to-speech translation system transforms feature structures produced by Japanese analysis into modified feature structures suitable for input to German generation. The production-style rules which compose the J-G component are applied by the same engine used for Japanese-English transfer in ASURA, the Feature Structure Rewriting System (RWS) [1], [5].

The Japanese-German rules correctly transfer twelve scripted dialogs concerning conference registration, with a total of 262 utterances. They also cover numerous variations of the same sentences used in the international joint experiment toward interpreting telephony, carried out on January 28, 1993 by ATR, Siemens AG, and Carnegie Mellon University. However, because the aim was early exploration rather than robustness or coverage, there has been no attempt yet to harden the current ruleset by experimenting with any other input sentences. Further, within this limited corpus, transfer input and output were strictly controlled: transfer accepted analysis output prepared in advance from a fixed set of scripted Japanese input sentences, and delivered output agreed in advance, so that the German generation component [7] could produce preagreed translations.

This paper discusses several issues which arose during rule development and their implications for future work. Emphasis is on areas in which our present treatment has been incomplete or unsatisfactory.

First, we examine the level at which transfer operates: How are the symbols in feature structures now interpreted, and what changes are possible and desirable? How should one define the boundary between transfer and analysis and generation?

Second, we consider the possible use of language-neutral symbols in transfer. The aim is to minimize the number of transfer rules, and to enable some rule sharing among transfer components for different target languages.

Third, we consider several issues of semantic representation. Sometimes problems arose because information — often thematic information — was missing or insufficient in the analysis output. In other cases, all the necessary information was present, but its proper presentation or formatting was uncertain, e.g. for representing prepositional relations.

Finally, we examine various *ad hoc* aspects of the current system. In many cases, greater generality can be achieved in the future by taking full advantage of the RWS' typing system for feature structures. Other problems, however, may require extensive knowledge processing.

Before beginning our discussion, we briefly introduce the Japanese-German transfer component and its place in ASURA.

2 Overview of Transfer

ASURA contains a transfer-based machine translation system. Thus it carries out translation in three main stages:

- *Analysis* takes a source-language string as input and produces as output a feature structure (the *anout*) which remains close to the structure of the source expression, and whose symbols remain source-language symbols (e.g. 会議-N, *kaigi-N*, "conference").
- *Transfer* receives the anout as input and delivers as output a modified feature structure (the *transout*) whose structure is that of the target language, and whose symbols are target language symbols (e.g. KONFERENZ-N).
- *Generation* can then transform the transout into a target-language syntactic structure (the *genout*). *Morphology*, usually considered part of generation, will finally transform the genout into a target language string.

2.1 Typed Feature Structures

The RWS transfer engine transforms an input feature structure by successively applying transfer rules. The engine finds applicable transfer rules through a combination of special indexing mechanisms, unification-based pattern matching, and procedural testing.

In addition to standard mechanisms for handling variables during pattern matching, the RWS contains facilities for typing variables. This capacity was under development during production of the Japanese-German system, and thus could not be used for the work reported here. However, we will recommend its future use, so we provide a brief description.

Using the system function DEFFSTYPE, a hierarchy of types can be defined. :HUMAN, for instance, can be defined as a subtype of :CREATURE, which might in turn be a subtype of :CONCRETE-OBJECT [1]. If one then uses a type as a prefix for a variable, unification will be permitted only for a feature structure of the right type.

2.2 Phases in Transfer

Transfer in ASURA has three main internal phases, which we can call pre-transfer, main-transfer, and post-transfer.

2.2.1 Main-transfer

Main-transfer is the replacement of source-language symbols by target-language symbols. 会議-N (*kaigi-N*) for example, is replaced by KONFERENZ-N for German generation. All source-language symbols must be replaced in this way; and in fact, a large percentage of the rules in the present transfer ruleset are for this purpose.[1]

2.2.2 Pre-transfer

Pre-transfer makes various preparations for main-transfer. In general, it makes transformations which can be specified most easily if they are specified in terms of source-language elements. In the present design, among other functions, pre-transfer must

- supply pronouns and other elided or "missing" elements;
- recognize idioms and replace them by single symbols. For example, if the pattern ホテル の 手配 is found, it is replaced by a single symbol ホテルの手配-1. This symbol can then be replaced by HOTELBUCHUNG-N ("hotel bookings") during main-transfer.
- recognize illocutionary acts, such as REQUEST, INFORM, QUESTIONIF, etc.;
- assign values for pragmatic factors like POLITENESS and INTIMACY.

2.2.3 Post-transfer

Post-transfer performs various structural adjustments after the symbol replacement performed during main-transfer. Generally, these are adjustments which are easiest to specify in terms of target-language elements. Among other functions, post-transfer must

- make some word-sense disambiguations by examining the local target-language context. For instance, 含む-1 (*fukumu*, "include") is normally translated by ENTHALTEN-V, but becomes UMFASSEN-V just in case the subject is KONFERENZ-N;
- supply possessive determiners (*mein, Ihr*) for nouns like *Name* and *Adresse* which lack such determiners in Japanese;
- supply indication of future tense where only present (non-past) tense appears in the original Japanese, e.g. 登録用紙は至急送らせていただきます (*Touroku-youshi o shikyuu okurasete-itadakimasu*, "I'll send you a registration form/will have a registration form sent immediately") gives *Ich werde Ihnen sofort ein Anmeldeformular schicken.*
- supply indication of aspect in a few cases, e.g. to differentiate between the two possible forms of the German passive (*wird gemacht* vs. *ist gemacht*);
- replace Japanese particle *no* using appropriate German prepositions for noun noun modification — e.g. 会議の参加料 (*kaigi no sanka-ryou*, "attendance fee for the conference") becomes *Teilnahmegebuehr fuer die Konferenz.*

In these cases, post-transfer supplies information needed for translation into fluent German but missing in the Japanese source. But post-transfer also makes numerous adjustments which are not directly related to translation; these are intended to permit more regular, economical, or convenient formulation of the rules which generate German syntax.

For example, consider sentences like *Ich moechte gehen* ("I'd like to go"), often discussed in terms of equi-deletion in the transformational literature: at the logical or "deep structure" level, the speaker is both the EXPR of DESIRE and the AGEN of GEHEN-V; but in surface expression, the speaker is mentioned only once. German syntax rules can be written most simply if the transfer output, too, mentions the speaker only once. Thus a certain post-transfer rule is designed to delete the EXPR feature and its value from the matrix verb (e.g. DESIRE) in such cases.

By now it should be clear that the transfer stage of translation is broadly defined in ASURA: pre-transfer and post-transfer do jobs which might be done by analysis or generation in other systems. Having given an overview of the system, we can now go on to discuss the issues listed above.

3 Level of Transfer

Following current practice at ATR, this paper's title describes the Japanese-German transfer component as a "se-

[1] A small number of language-independent symbols appear in the analysis output: DESIRE, OBLIGATION, NECESSITY, and a few others. It is not necessary for transfer to replace these symbols, since generation can use them as they are. See below regarding the possible use of more such symbols in future versions of ASURA.

mantic level" transfer system. But what does this phrase mean? Let us examine the level at which transfer operates.

The feature structures received and delivered by transfer mix a few purely semantic terminal symbols (NECESSITY, OBLIGATION, NEGATE) with a majority of terminal symbols bearing part-of-speech labels (GEHEN-V, KONFERENZ-N).

Presently, the symbol-to-word mapping is one-to-one. That is, only one German word is supplied during generation to express a given transout symbol, and it always respects the part-of-speech label. The symbol GEHEN-V, for instance, is always expressed using the verb *gehen*. So the suffixed symbols presently represent dictionary forms of meaning-bearing *syntactic* objects, rather than purely semantic objects. (Of course, transfer can explicitly change parts of speech when it transforms input structures into output structures. But the point is that parts of speech are kept unless explicitly changed in this way.)

Thus the most accurate description of the current transfer system's level might be "syntactic-semantic" transfer: most of the symbols which transfer manipulates carry syntactic constraints, but a few do not. The symbols without syntactic constraints are derived from idiomatic Japanese constructions expressing illocutionary force (e.g. REQUEST), modality (DESIRE, POSSIBILITY, OBLIGATION, NECESSITY), etc. These may thus be expressed by target structures quite different from the source structures, even without explicit transformation during transfer. And these are the symbols which justify the description "semantic transfer".

The one-symbol-one-word generation policy was adopted for practical rather than theoretical reasons: it simplified processing during early stages of experimentation with ASURA. In future versions of the system, different policies might be adopted. The suffixed symbols could be interpreted more abstractly: they could be understood as indications of the original part of speech in the source, but not as restrictions on choice of expression. Generation, that is, could freely vary the part of speech as long as the entire utterance remained well-formed. Or a changed policy could go even further toward semantic interpretation of these symbols: during generation, not only free choice of part-of-speech but also free choice of lexical item could be allowed.

Of course, if generation ambiguity is allowed in the future, it will be necessary to provide mechanisms for choosing among competing genouts. Such mechanisms are difficult to design; but the naturalness of the output could justify the effort. [3] (page 137) gives an excellent discussion of this tradeoff.

3.1 Dividing the Work

The issue of transfer level is in part a question about how the work should be divided among ASURA's components. As mentioned, transfer in ASURA is broadly defined: it performs tasks that might be performed by analysis or generation in other systems. Disambiguation, for instance, might be viewed as a job for analysis, rather than for transfer (or even pre-transfer). However, during the preparation of the Japanese-German transfer system, analysis was almost fixed; so most practical issues related to the interface between transfer and generation.

In general, the current German generation grammar is more economical and linguistically motivated than the English generation grammar for ASURA [8], in which convenience, speed, coverage, and modularity were stressed instead. (For German, an HPSG-like design was adopted. See [7].)

However, in some cases, the economy and principle which were gained in German syntax were lost in Japanese-German transfer: additional transfer rules or subphases often became necessary to provide the most convenient input for syntax, some of them *ad hoc*. The general tendency, when in doubt, was to complicate transfer to clarify generation.

For example, generation produces *auf Englisch* (where the noun lacks a determiner), but *ins Englische* (where the contracted determiner *das* is present). In order to give generation its usual signal for using or not using a determiner, transfer now assigns definiteness values to language noun symbols (ENGLISCH-N) according to the relevant prepositional symbols (AUF-LOC-P, IN-DIR-P). But transfer should in general operate on semantic symbols; and in this case, it seems unlikely that there is any real semantic difference between the two mentions of ENGLISCH-N. More likely, the usages differ only idiomatically depending on syntactic and lexical context. If so, perhaps the context-sensitive alternation should be handled by generation rather than transfer.

A second example: German does not distinguish the meanings which in Japanese are expressed using postpositions *made* and *made ni* ("until" and "by" in English): both are expressed using preposition *bis*. Should transfer neutralize this semantic difference (which appears as a difference between feature names in the anout)? Or should the semantic difference remain, so that generation must produce identical output for two different representations

(i.e., must provide a many-to-one mapping)? Presently, transfer does neutralize the two.

A third example: The current syntax provides determiners only for common nouns. Months usually require determiners in our corpus, as in *ab dem vierten August.* Thus transfer now specifies months as common nouns (by providing the appropriate semantic format). However, this date construction may again be idiomatic, and thus a candidate for special handling in syntax. (The date expression is not a normal ordinal expression — were there three previous Augusts? Rather, it is clear that the original meaning is "the fourth *day* of August". The determiner is probably that of the noun *Tag,* which is now conventionally elided.)

In such cases, the transfer output, which already has many syntactic qualities, comes to look more and more like a deep syntactic representation rather than a shallow semantic one. In the future, it will be worthwhile to clarify the depth at which transfer operates and to define as sharply as possible the line between transfer and its neighbors.

4 Avoiding Unnecessary Transfer

No matter how transfer symbols are interpreted in the future, perhaps a more language-independent representation can be considered while retaining the transfer paradigm.

Presently, a lexical symbol like 会議-N (*kaigi-N,* "conference") is transferred to a symbol like KONFERENZ-N. But when direct translation is possible (as it usually is within our corpus) this step is unnecessary. Analysis could instead produce a "neutral" symbol like *CONFERENCE-N, and generation could accept this as input without change. ("Neutral" here means "usable for one or more languages, but not necessarily all languages". The set of neutral semantic symbols could be developed step by step: new symbols could be added whenever necessary.)[2] A large number of the current transfer rules would then simply disappear: the transfer component for both Japanese-English and Japanese-German would shrink.

Of course, not all transfer rules can disappear, because direct translation is not always possible. The target language may prefer a more precise symbol, or a more general symbol, or a semantic reorganization involving several symbols: in such cases, the transfer component must go to work. But if transfer works only when necessary, it should work faster and its task may be clarified.

Further, since the remaining rules would be written in terms of neutral symbols, some of them might be usable for several target languages, especially when targets are as similar as English and German. It might therefore become possible to share some rules among transfer systems.

[2] A given symbol S1 may not be directly expressible in a given language L1; so the symbol set is not exactly an interlingua. However, it will be possible to examine the *subset* of symbols which can be directly expressed in language L1, or the *intersection* between the respective subsets of L1 and L2.

5 Semantic Representation

We now turn to semantic representation issues which arose during development. Sometimes not enough information is present to enable necessary syntactic choices. Sometimes information is all there, but its proper format is uncertain.

5.1 Missing Semantic Information

Additional semantic information sometimes seems necessary in order to permit generation to make necessary choices. Thematic information — information concerning focus and presupposition — often seems to be involved.

5.1.1 Precedence

The most obvious case relates to *surface ordering* (precedence) in German. Transfer currently gives generation no information regarding ordering. Generation should thus produce all possible orderings; but this result was unacceptable, so generation temporarily introduced a fixed ordering into its subcategorization statements [7].

5.1.2 Kein

There is a similar problem with our treatment of *kein:* we receive no thematic information from analysis which would allow us to distinguish *Es gibt nicht ein Rabatt* ("There isn't a discount") from *Es gibt keinen Rabatt* ("There is no discount"). Thus, where the *kein* pattern is desired, we produce it *ad hoc* according to the specific surrounding symbols.[3]

5.1.3 The Copula

As a final, more extended example of problems arising from missing thematic information, consider relations with or without the copula. On the logical level (and ignoring thematic differences), the following two utterances should per-

[3] In the transout, we distinguish the two patterns using the scope of the relation NEGATE: it dominates the main verb (ES_GEBEN-IDIOM) in the first case, but dominates only its OBJE value RABATT-N in the second case.

haps be represented identically: (1) *ein weites Forschungsgebiet* ("a broad research field") (2) *ein Forschungsgebiet, das weit ist* ("a research field which is broad"). But once again, we did need to control the choice between these two outputs; so distinctive transout structures were needed. We adopted the following conventions:

```
[[parm !X7[[parm !X4[]]
           [restr [[reln Forschungsgebiet-n]
                   [entity !X4]]]]
 [restr [[reln weit-a]
         [obje !X7]]]]]

weites Forschungsgebiet
-----------------------------------------------

[[parm !X7[[parm !X4[]]
           [restr [[reln Forschungsgebiet-n]
                   [entity !X4]]]]
 [restr [[reln sein-v] ;<<<<<<<COPULA
         [tense ...]
         etc.
         [obje !X7]
         [iden [[reln weit-a]
                [obje !X7]]]]]]]

Forschungsgebiet, das weit ist
```

The relative clause representation is derived from the representation for an independent clause, *Das Forschungsgebiet ist weit* ("The research field is broad"), in which the copula is likewise present. And that representation is in turn consistent with those used in the Japanese anout, where the Japanese copula *da* is similarly shown as a relation. However, all of these inclusions of the copula introduce syntactic elements into a representation level which was intended to remain semantic.

5.2 Problems with Semantic Format

We have seen that problems sometimes occur when not enough semantic information is provided. In other cases, all of the necessary information is present, but its format, scoping, etc. may be uncertain or inconsistent.

5.2.1 Prepositional Relations

The most important format problem concerns the representation of prepositional relations. In the current system, adjunct prepositional phrases are often represented using specially defined features. For instance, *Ich esse in dem Zimmer* ("I eat in the room") would be represented using the feature SLOC ("spatial location") as follows:

```
[[reln essen-v]
 [tense ...]
 ...
 [agen !X7[[label *speaker*]]]
 [sloc [[parm !X4[]]
        [restr [[reln Zimmer-n]
                [entity !X4]]]]]]
```

But if there is a special feature for the meaning "in", why not one for "outside of"? We are tempted to allow a new feature (in effect, a new deep case) for every valence-bound or adjunct preposition. But then syntax must handle a large and uncertain set of case representations; and the generality and robustness of the generation grammar is damaged.

Instead, a small and fixed set of features representing deep case should contain a large and more flexible set of relations as values. At the same time, the distinction between valence-bound and adjunct prepositional relations should be clarified: valence-bound prepositional expressions should be represented via deep cases (i.e. dedicated features); and adjunct expressions can be collected under a single deep case, e.g. ADJUNCTS. If there are several adjuncts, the value of the ADJUNCTS feature would be a conjoined expression.

5.2.2 Other Semantic Representation Problems

We can briefly mention a few more problems in semantic representation:

- We are uncertain about the proper representation for modification of NEGATE (e.g. for *ueberhaupt nicht* ("not at all"), *nicht viel* ("not much")).
- Our treatment of relations between clauses is inexact: the imprecise representation of *no de* as CAUSE gives one example: 会議の案内書をお送り致しますので、それをご覧下さい ("I'll send the Conference Announcement to you, *so* please have a look at it"). For the present, we have chosen to express the symbol using a full stop in German: *Ich werde Ihnen die Konferenzankuendigung schicken. Bitte werfen Sie einen Blick hinein!*
- The scope of modifiers is often debatable. Consider for instance *Als Anmeldegebuehr werden fuenfunddreissigtausend Yen pro Person verlangt* (from 登録

費としてお一人三万五千円が必要です, "As the registration fee, thirty-five thousand yen per person is necessary"). Analysis views *tourokuhi to shite* ("as the registration fee") as a modifier of the top-level verb *hitsuyo desu* ("is necessary"). For German, the phrase was instead seen as a modifier of *Yen*.

- We use a specialized representation to indicate, for German noun symbols, the definiteness or determiner, number, and owner if any: an INDEX feature is included as part of the noun symbol pattern. It can be considered shorthand for a more semantically consistent but less convenient representation. We are in any case unsure about the proper representation.

  The INDEX feature is included along with the features PARM and RESTR, which together denote the semantic structure of common nouns. PARM names an unrestricted variable, e.g. !V[], and RESTR indicates the restrictions on its range, in the manner of the logical operator SUCH-THAT. Thus the following expression denotes a variable !V such that the relation JAHR-N is true of !V — that is, a year. Further, for this particular instance of the class of years, DETERM, NUMBER, and OWNER have the values shown.

```
[[PARM !V[]]
 [RESTR [[RELN Jahr-n]
         [ENTITY !V]]]
 [INDEX [[DETERM DEFART]
         [NUMBER SING]
         [OWNER [[LABEL *UNKNOWN*]]]]]]
```

6 Ad Hoc Aspects of the Present Transfer System

We now examine various *ad hoc* aspects of the current system. In many cases, greater generality can be achieved in the future by exploiting the RWS' mechanisms for typing feature structures. In other cases, extensive reasoning — expert systems or other knowledge-based processing — will be required.

6.1 Possible Generalizations Using Types

We first discuss possible uses of typed feature structures to reduce the *ad hoc* character of several sorts of transfer rules. Typing facilities were still incomplete and thus unavailable during our development period.

6.1.1 Disambiguations

In several cases, a Japanese expression has only one translation in our corpus, but would have more potential translations in a larger corpus. We now ignore such potential ambiguity.

In the future, instead of translating input symbols unconditionally, translations can be made sensitive to the symbols in the local context. For maximum generality, such pattern matching can use typed variables rather than constant symbols.

A few examples of current *ad hoc* translations:

```
待つ -1      (''wait'')      --> erwarten-v
方 -2        (''person'')    --> Leute-n
書く -1      (''write'')     --> stehen-v
聞く -3      (''ask'')       --> wenden-v
取る -1      (''take'')      --> bekommen-v
発表する -1 (''present (v.)'')
 /zero object        --> (etwas) vortragen-v
 /non-zero object    --> (Vortrag-n) halten-v
```

6.1.2 Other Opportunities for Typing

Other possible uses of the type system for greater generality:

- The Japanese particle *no* presents an especially difficult and common disambiguation problem. Analysis retains the information that *no* appeared in the source by using the special relation symbol の - 連体修飾. In our transfer system, this symbol is replaced by the general-purpose relator MODIFY (which is expressed as a genitive construction) in the default case; or by specific prepositional symbols, depending on the specific word symbols in the context. For example, we now rewrite MODIFY as FUER-P if the related symbols are TEILNAHMEGEBUEHR-N and KONFERENZ-N, thus translating 会議の参加料 ("the attendance fee for the conference") as *die Teilnahmegebuehr fuer die Konferenz*. In the future, type specifications of the related symbols should be used instead.

- We must sometimes provide German possessive determiners for words like *Name* and *Adresse* when determiners are absent in the source. Presently, in specifying the symbols requiring possessive modifiers; we mention the specific symbols NAME-N, ADDRESS-N, PHONE_NUMBER-N. A type specification, e.g. :PERSONAL-INFO, should be used instead.

- Numerous rules move TENSE, WH elements, or other features according to the preference of the German generator. These rules presently mention specific semantic symbols. For instance, the TENSE movement rules mention specific "abstract verbs" like OBLIGATION, POSSIBILITY, etc. Types, e.g. :MODAL, should be used.

6.2 Remaining Hard Problems

We should not give the impression that every problem with generality can be solved using typed features. Several well-known difficulties in Japanese-German or Japanese-English translation may require extensive knowledge processing. Presently, we rely on temporary fixes: heuristics which are greatly oversimplified, or patches which we fully realize are *ad hoc*. In these cases, we do not pretend to solve the problems in question; instead, we simulate their solution, providing nothing more than placeholders ("hooks") for future programs. Let us briefly survey some hard problems and our temporary methods of handling or avoiding them.

6.2.1 Definiteness and Number

Most nouns in our corpus are either definite or indefinite and either singular or plural throughout the corpus. For these nouns, we treat definiteness and number as fixed attributes of the semantic symbol. The few case in which both definite and indefinite or both singular and plural occur for a single noun are handled by *ad hoc* rules which assign definiteness or number based on specific symbols in the context.

6.2.2 Tense

Several German target sentences should ideally use the future tense. But of course the Japanese source sentences employ only the present (non-past) tense. We hoped that adverbials in the context might supply sufficient clues to select future tense, but a study produced disappointing results: almost all adverbials which occurred with the relevant verbs in our corpus could indicate other tenses equally well.

Thus we adopted a simpler heuristic: future tense is now given only for relations dominated by illocutionary force type PROMISE. This IFT, in turn, is produced by analysis only when the source contains *-sasete itadakimasu* (lit. "I will have it done"), e.g. in 登録用紙は至急送らせていただきます ("I'll send you a registration form/will have a registration form sent immediately"), giving *Ich werde Ihnen sofort ein Anmeldeformular schicken.* Of course, the problem of determining the proper target tense may in general be very complex. (Aspect, now used only to distinguish between German passive with *sein* and passive with *werden*, will present a similar problem. The present aspect rules are quite *ad hoc*.)

6.2.3 Intimacy

German needs an indication of the degree of intimacy of an utterance to distinguish between second person pronouns *Sie* and *du*, but presently there is no such indication in the analysis results. (Politeness is indicated, but this is a different matter.) Thus we have simply written a transfer rule giving a default INTIMACY of LOW (giving *Sie*) for every utterance. This is in fact a realistic assumption for the present corpus.

6.2.4 Politeness

ASURA's treatment of politeness needs study. Currently, analysis identifies and lists politeness markers, but does not assign a politeness degree. This assignment is made by transfer — rather crudely, at present. Following the method developed for Japanese-English transfer, PRAG POLITENESS DEGREE is determined by counting the number of explicit politeness markers: degree 1 means "one explicit politeness marker is present". But of course this measurement method largely depends on the length of an utterance, and ignores qualitative differences.

6.2.5 Possessive Determiners

Often the German target requires possessive determiners (*mein*, *Ihr*) but the Japanese source has no determiners at all. Our method of supplying these determiners is temporary. We now break the job into two phases:

First, as already mentioned, we mark noun-type symbols which require possessives, e.g. NAME-N, ADDRESS-N, PHONE_NUMBER-N. (We assign [[label *OWNER*]] as a temporary value of the INDEX OWNER path of such symbols.) We have already recommended possible methods of generalizing this pre-marking phase.

Second, we must identify the specific owner in the current utterance, overwriting the temporary marker. We temporarily use a very simple heuristic: if the IFT is INFORM, *OWNER* becomes *SPEAKER*; else it becomes *HEARER*. This heuristic is not unreasonable, and works well in our limited corpus; but it will certainly fail in larger corpora, especially when there are several parties to the discourse.

7 Conclusions

To summarize our discussion issue by issue:

- Level of transfer: Although we follow current practice in describing the transfer system as "semantic-level", "syntactic-semantic" might be a more accurate description. However, the present one-symbol-one-word generation policy can be liberalized if mechanisms are provided for choosing among competing generation results. In this case, transfer symbols would receive a more semantic and less syntactic interpretation.

- Dividing the work: Some of the economy and principle gained through the development of a linguistically-motivated German generation grammar have been lost in transfer: additional transfer rules or subphases sometimes became necessary to provide the most convenient input for syntax, some of them *ad hoc*. The resulting transfer output sometimes resembles a deep syntactic representation rather than a shallow semantic one. In the future, we should clarify the depth at which transfer operates and define more sharply the line between transfer and its neighbors.

- Avoiding unnecessary transfer: It may be possible to eliminate many transfer rules by allowing analysis to produce "neutral", or quasi-interlingual, symbols which can be passed directly to generation. Remaining transfer rules written in terms of neutral symbols might be shared among several transfer systems.

- Semantic representation: We surveyed several semantic representation issues which arose during development. The lack of thematic information was a particular problem, e.g. for determining surface order or scope of negation, or for distinguishing important constructions related to the copula. We also noted several cases in which the proper semantic format was uncertain, especially relating to the representation of prepositional relations.

- *Ad hoc* aspects of the system: We noted many chances to generalize transfer rules through the use of typed feature structures. However, we also listed a number of remaining problems which may require extensive knowledge processing: the determination of the proper definiteness, number, and possessor to enable choice of German determiners; the specification of tense and aspect; and the choice of levels of intimacy and politeness.

Our goal has been to make a first exploration of the problems of Japanese-German transfer using the RWS technology. Thus we concentrated on finding problems. We did raise many issues; but, encouragingly, many of them can be addressed within the current technology.

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