

## Zero Pronouns in Dialogue Translation between Japanese and German/English

Michael Paul    Kazuhide Yamamoto    Osamu Furuse

ATR Interpreting Telecommunications Research Laboratories

e-mail: {paul,yamamoto,furuse}@itl.atr.co.jp

### 1 Introduction

Within the context of Transfer-Driven Machine-Translation (TDMT) we are concerned with spoken-language translation of bi-lingual dialogues of Japanese and German/English speaking participants. In this paper we will describe ongoing work on the translation using Japanese as the input language. One characteristic of Japanese is the frequent omission of subjects or objects within an utterance (zero pronouns). However, such omitted entities can be recovered by checking the pragmatic, semantic and syntactic environment in which a given verb is used, as well for the source language (J), as for the target language (E/G).

The outline of the paper is as follows. After a characterization of zero pronouns we will give a short overview of the TDMT framework and describe what kind of knowledge can be used to recover zero pronouns and how these information can be incorporated into the current system.

### 2 Zero Pronouns

One characteristic of natural language is the frequent omission of entities, which can be understood through context and out-of-context knowledge [Yoshimoto 88]. Thus, for any natural language system it is important to deal with such kind of omitted information. Especially in a spoken-language translation system from Japanese to any language with a more mandatory nature of verb case, like English or German, the problem of these *zero pronouns* arises frequently. Thus the detection and interpretation of such referential expressions is very important for an appropriate translation of successive utterances during a conversation.

Zero pronouns can be classified into the categories *intra-sentential*, *inter-sentential* and *extra-sentential*. In the *intra-sentential* case clues within the current sentence can be used to find the correct antecedents of the omitted entities.

References to entities, which are mentioned earlier in the conversation are called *inter-sentential*. In contrast to these anaphoric pronouns the *extra-sentential* ones are zero pronouns, which refer to contextual entities outside the current discourse.

### 3 Resolution Mechanisms

Several approaches have been proposed in order to deal with the different types of references. The main knowledge sources used in these methods are either the pragmatic and semantic conditions in which a sentence predicate is used or a kind of "short-term" memory, which enables the system to handle the reference resolution to earlier mentioned entities.

The dominant approach concerning the tracking down of entities during the discourse is the *centering* method [Grosz et al. 83]. It computes the coherence between sequential utterances by monitoring the variation of local focus between these utterances. For each recently mentioned entity a salience is computed in order to refer to the most plausible one in the actual context. Especially recent publications in this area [Takada & Doi 94], or [Okumura & Tamura 96] show a promising progress in handling *inter-sentential* references.

Other approaches rely on semantic attributes and the pragmatic use of the sentence verb. In [Kudo & Tomokiyo 93] the particularities of Japanese co-predicates are analyzed in order to resolve the personal zero pronouns within the current sentence. [Dohsaka 94] interprets the pragmatic conditions of the use of honorific expressions. The anaphora resolution method described in [Nakaiwa & Shirai 96] is based on verbal semantic attributes and pragmatic constraints such as modal expressions and types of conjunctions.

The analysis of the above mentioned approaches shows, that the handling of referential pronouns

during dialogue translations requires the use of various knowledge sources in order to achieve an accurate context-adaptive translation.

#### 4 TDMT Framework

TDMT achieves a multi-lingual spoken-language translation, which is based on a *constituent boundary parsing* method (CBP) in an example-based framework [Furuse & Iida 96]. The input sentence is incrementally parsed by matching meaningful units of linguistic structure (patterns) using a chart parsing algorithm. Given a set of translation examples TDMT tries to find the “closest” examples to the structured input using a *semantic distance calculation* (SDC) [Sumita & Iida 92]. By simulating the translation of the closest examples the empirical transfer knowledge is applied to the analyzed source structure, resulting in a corresponding target structure, which is used to generate the translation (cf. Figure 1).

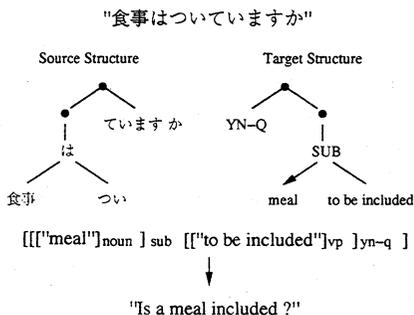


Figure 1: Translation example

#### 5 Incorporation into TDMT

So far we used an *ad hoc* solution for the handling of zero pronouns, namely the introduction of default pronominal entities during the application of transfer knowledge based on syntactic restrictions of the sentence predicate, which are used during generation, whenever such an entity is missing in the transfer result. But these kind of default resolution is limited to intra-sentential references and its accuracy is not sufficient.

However, combining various aspects of the approaches described in section 3 an accurate handling of the zero pronouns resolution in TDMT can be achieved as listed in figure 2.

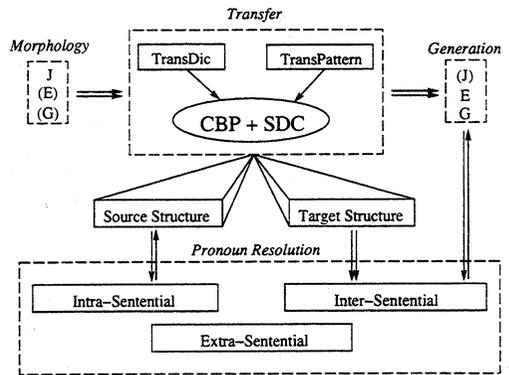


Figure 2: Zero pronoun resolution in TDMT

In our approach we apply different resolution mechanisms to the source language and to the target language. There we choose the approaches, which are most appropriate for the pragmatic, semantic and grammatical characteristics of the respective language.

##### 5.1 Source Language (J)

The referential expression, which is inserted into the translation (substituting the zero pronoun), has to agree in *person*, *number* and (especially in German) *gender* with the antecedent, e.g. personal pronouns like “he” (*er*), “we” (*wir*) or demonstrative pronoun like “this” (*dieser/diese/dieses*).

Because this grammatical information of the Japanese predicate is not indicated morphologically, we have to rely on intra-sentential clues and discourse information for the interpretation of omitted entities in the source structure.

In Japanese the pragmatic function of the sentence predicate can be interpreted in order to decide about the omitted personal references. Honorific expressions like *いらっしゃる* stress the focus of the sentence to the hearer, whereas humble predicates (*させていただきたい, さしあげる*) are used by the speaker to refer to him/herself as the subject of the sentence. Furthermore information can be yielded by the interpretation of the modality (*なければならぬ* (duty), *ことができる* (permission), *しましょう* (invitation), *思う* (belief), *お願いします* (request), etc.), the deictic use of the predicate (*やる, くれる, もらう*) and final conjunction forms (*のですが*). Additionally we can use domain knowledge about the discourse

environment (physical positions, etc.) and participants (gender, social role of speaker/hearer, etc.) in order to disambiguate, whether the reference is the speaker, hearer or another person.

## 5.2 Target Language (E/G)

However concerning the inter-sentential references, we have to know what kinds of entities are mentioned in the previous discourse. One possible approach for this task could be the centering method. In this theory the reference interpretation is based on the ordering of the recently mentioned entities according to their degree of salience. For Japanese [Kameyama 86] proposed the salience ordering below using the Japanese particles は, が, を and へ as focus operators: TOPIC(は) > SUB(は/が) > OBJ<sub>2</sub>(を) > OBJ(を) > others

This kind of approach could be applied as well to the source as to the target language. However in TDMT the translation of the input sentence is based on the empirical knowledge obtained during the processing of the training data, e.g. depending on the matched examples a Japanese input phrase marked with へ could be translated as the indirect object or it could be treated as the focused element of the target sentence as well. Because of this possible shift of focus information the inter-sentential resolution in TDMT has to use the information contained in the non-Japanese source and target structures.

During translation it is not always necessary to recover each zero pronoun, which occurs in the Japanese input. Which references are required for the translation depends on the grammatical and semantical environment in which the sentence predicate of the target sentence is used. Thus the inter-sentential anaphora resolution is triggered by syntactic conditions of the target language.

Given the transfer result we use verb complement informations in order to check, whether the syntactic requirements of the analyzed sentence predicate are fulfilled in the target structure. The transitivity of the verb enables us to detect omitted entities, which are not recovered by the zero pronoun resolution of the source language. In the case of such an under-specification we have to start the resolution process using the information about the inter-sentential reference candidates. The decision, which reference is se-

lected out of (possibly) multiple candidates, can be made using a scoring function taking into account as well the salience values of the tracked objects as the coherence between the candidates and the omitted case slot based on a semantic model of the analyzed verb. Thus we can insert an adequate pronoun for the omitted entity in the generation input.

The verb complement information can be used to recover transfer errors as well. Due to the lack of examples the transfer mechanism could apply inappropriate transfer knowledge yielding in an over-specification, e.g. multiple objects, in the target structure. Again the syntactical restrictions of the verb cause the disambiguation of the multiple candidates according to the semantical environment in which the predicate is used.

## 6 Application

As an illustration of the proposed zero pronoun resolution we give an example chosen from our travel conversation domain.

$S_{1J}$  "宿泊の予約を お願いしたいんですが"  
 Ø-SUB shukuhaku-no yoyaku-wo  
 lodging-COP reservation-ACC  
 onegai shitaindesuga  
 request want to do

In this sentence the subject is omitted. However the interpretation of the speech-act *request* (お願い) can resolve the intra-sentential reference to the speaker. Thus the subject "I" (*ich*) is used for the generation of the translation.

$T_{1E}$  "I'd like to make a reservation for a room."  
 OBJ[reservation]<sub>3P,SG</sub>  
 $T_{1G}$  "Ich hätte gerne eine Reservierung der  
 Übernachtung."  
 OBJ[Reservierung]<sub>3P,SG,FEM</sub>

The focused elements of the non-Japanese utterances and their grammatical attributes are listed below the respective sentences.

$S_{2E}$  "What kind of room would you like?"  
 OBJ[room]<sub>3P,SG</sub>  
 OBJ[reservation]<sub>3P,SG</sub>  
 $S_{2G}$  "Was für ein Zimmer wünschen Sie?"  
 OBJ[Zimmer]<sub>3P,SG,NTR</sub>  
 OBJ[Reservierung]<sub>3P,SG,FEM</sub>

T<sub>2J</sub> "どのような部屋を御希望ですか"

donoyoo-na heya-wo gokiboo desu ka

In this question the focus of the discourse moved to the object "room" (*Zimmer*).

S<sub>3J</sub> "一泊八千円から一万円ぐらいでお願いしたいんですが"

Ø-SUB Ø-OBJ ippaku hassen en kara ichi-  
1-night 8000 yen from 10000  
man en gurai-de onegai shitaindesuga  
yen about-COP request want to do

The speaker is resolved as the omitted subject in the source based on the final conjunction form. The direct object, however, which is forced by the transitivity of the English verb "have" (analogously in German) is not specified in the target structure. A reference to one of the candidates has to be found. Because more recent mentioned entities can be identified easier by the participants (higher degree of salience), the reference "room" is used instead of "reservation".

T<sub>3E</sub> "I'd like to have  $\bar{ii}$  from eight thousand yen to about ten thousand yen a night."

T<sub>3G</sub> "Ich möchte  $\bar{es}$  von achttausend Yen pro Nacht bis circa zehntausend Yen."

In English the translation of this example would be the same. But in German the referencing pronoun is "es" (neutral) for the noun "Zimmer" (room), whereas it is "sie" (feminine) for "Reservierung" (reservation), which is chosen as the reference in the following sentence because of semantic restrictions of the verb "do" (*machen*).

S<sub>4J</sub> "すぐできますか"

Ø-SUB Ø-OBJ sugu dekimasu ka  
soon POL-can do question

T<sub>4E</sub> "Can you soon do  $\bar{ii}$ ?"

T<sub>4G</sub> "Können Sie  $\bar{sie}$  sofort machen?"

## 7 Summary

We proposed a method for the resolution of omitted entities during the translation of bi-lingual conversations, which takes into account the pragmatic, semantic and syntactic characteristics of both dialogue languages.

## Acknowledgement

We would like to thank Naoya Arakawa (ATR) for his support and helpful personal communications.

## References

- [Dohsaka 94] K. Dohsaka. *Identifying the Referents of Japanese Zero Pronouns based on Pragmatic Condition Interpretation*. Trans. of IPS Japan, 35(5):768-778, 1994.
- [Furuse & Iida 96] O. Furuse and H. Iida. *Incremental Translation Utilizing Constituent Boundary Patterns*. In: Proc. of the 16th COLING, pp. 412-417, Copenhagen, Denmark, 1996.
- [Grosz et al. 83] B.J. Grosz, A.K. Joshi, and S. Weinstein. *Providing a unified account of definite noun phrases in discourse*. In: Proc. of the 21th ACL, pp. 44-50, Cambridge, MA, 1983.
- [Kameyama 86] M. Kameyama. *A Property-Sharing Constraint in Centering*. In: Proc. of the 24th ACL, pp. 200-206, New York, 1986.
- [Kudo & Tomokiyo 93] I. Kudo and M. Tomokiyo. *An Ellipsis-Resolution Mechanism by Using Japanese Predicate Particularity*. IEICE Trans, J76-D-II:624-635, 1993.
- [Nakaiwa & Shirai 96] H. Nakaiwa and S. Shirai. *Anaphora Resolution of Japanese Zero Pronouns with Deictic Reference*. In: Proc. of the 16th COLING, pp. 812-817, Copenhagen, Denmark, 1996.
- [Okumura & Tamura 96] M. Okumura and K. Tamura. *Zero Pronoun Resolution in Japanese Discourse Based on Centering Theory*. In: Proc. of the 16th COLING, pp. 871-876, Copenhagen, Denmark, 1996.
- [Sumita & Iida 92] E. Sumita and H. Iida. *Example-based Transfer of Japanese Adnominal Particles into English*. IEICE Tr., E75-D No.4:585-594, 1992.
- [Takada & Doi 94] S. Takada and N. Doi. *Centering in Japanese: A Step Towards Better Interpretation of Pronouns and Zero-Pronouns*. In: Proc. of the 15th COLING, pp. 1115-1156, Kyoto, Japan, 1994.
- [Yoshimoto 88] K. Yoshimoto. *Identifying Zero Pronouns in Japanese Dialogue*. In: Proc. of the 12th COLING, pp. 779-784, Budapest, Hungary, 1988.