



## A DIALOG ANALYSIS USING INFORMATION OF THE PREVIOUS SENTENCE

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### ABSTRACT

This paper proposes a dialog analyzing method that stores and uses some pieces of information in a certain local context, in order to solve actual problems. First, the authors examined English dialog corpora in order to find constraints in natural conversations. It has been found that more than 70 percent of the content of ellipses in the corpora that must be recovered when translating into Japanese, can be extracted from the last sentence uttered by the other person just preceding the current sentence. The authors then implemented a dialog analyzing method on an English-to-Japanese translation system that handles written texts. The method used memorizes and utilizes a local context constructed by both the current sentence and the last sentence of just the previous utterance by the other person. Last, the authors examined the feasibility of the proposed model by translating other English dialog corpora, transcriptions of telephone conversations. It has been found that the model generates appropriate Japanese translations in some linguistic phenomena that are relating to discourse, such as Ellipsis, Polysemy disambiguation, and Selection of Japanese TOPIC/SUBJECT particles 'wa' and 'ga.'

### 1 INTRODUCTION

Machine Translation (MT) systems at present usually do not treat contextual information. They translate each sentence independently. The reason that the MT systems can actually be used without context is that text types, handled at this stage, are like machine operation manuals, and sentences in them are relatively independent from each other. However, context research is getting more important. Recently some prototype systems are trying to handle conversations or dialogs, which are carried out between human and human, or human and machine. Some systems translate conversation into other languages, and some systems use natural language for database retrieval. [1, 2, 3]

In conversation, speakers generally talk assuming that hearers make up for the unspoken information using background knowledge and context. The fact that many ellipsis occur in a conversation exemplifies this. Ideally, systems should treat all the context information in the entire conversation when handling a sentence. However, doing so is difficult and inefficient in most cases. That is because analyzing a sentence does not necessarily require being aware

of all the context information. In addition, in spite of many efforts by previous researchers [4, 5, 6, 7, 8, 9], no one is yet confident concerning what kind of information MT systems at present should use to treat actual problems in translation. The authors therefore studied a range of a text that MT systems should consider, and actual information to treat as context, in order to effectively improve qualities achieved by MT systems. This paper presents a dialog analyzing method which utilize the local context which is constructed by the current sentence and and the last sentence uttered by the the other person just preceding the current sentences.

### 2 A LOCAL CONTEXT IN DIALOG

This section describes the authors' examination on an effective range of a text that is directly related to a specific contextual phenomenon in a natural dialog. The authors selected ellipsis from many linguistic phenomena, which are related to context. The authors examined two hundred and thirty four (234) English dialogs, which included five thousand eight hundred and thirty (5,830) sentences in total. They are selected from English texts for foreign language study, transcriptions of actual dialogs between English native speakers, and so on. They do not include broken expressions or too extreme ellipsis.

The following is a typical dialog of the corpora. In the dialog, 'A' and 'B' represent two people who talk with each other. The mark, such as '1-A-01-1,' is the sentence ID. This is a combination of a dialog ID, speaker ID, turn ID, and sentence number in the same turn. Here, 'turn' means a continuous utterance by the same person. The ID '1-A-01-1' indicates the first sentence in the first utterance (turn) by person A in Dialog 1. In Dialog 1, words or phrases in parenthesis are elements omitted from the actual dialog. The results exemplifies the expectation that ellipsis generally occurs where the hearer can recover the content using information in a limited range of the text.

The corpora were translated into Japanese as naturally as possible. The authors gave not one-to-one translations, but translations which are thought of as being natural Japanese dialogs in general situations. For example, 'Because' in double parenthesis in 1-B-04-1 is usually needless in English, but it is natural to add the corresponding word in the corresponding Japanese sentence to clarify that this

### Dialog 1

- 1-A-01-1: Who did Mary invite to the party?  
1-B-01-1: (Mary invited) Susan and Ariel.  
1-A-02-1: And who will come?  
1-B-02-1: Susan (will come).  
1-A-03-1: Who did you say?  
1-B-03-1: (I said) Susan.  
1-B-03-2: Well, may I have time?  
1-A-04-1: (It's) Seven thirty.  
1-A-04-2: Are you leaving now?  
1-B-04-1: No, ((because)) I've already bought a present for her.  
1-A-05-1: How much did it cost you?  
1-B-05-1: (It cost) Seven (dollars) thirty (cents).

sentence gives the reason for something.

Next, the authors compared ellipsis positions in the English and Japanese corpora in order to examine language difference of ellipsis. After the comparison, it turned out that more than ninety one (91) percent of the omitted elements in English are also omitted in Japanese. This result shows that English and Japanese have similar ellipsis conditions. This seems to be natural, because ellipsis is a communication method to omit elements which are already known to both speaker and hearer, and put a focus on more important new information. This is one of the reasons that the MT system without context information at present can be used to some extent.

However, needless to say, each language has individual ellipsis conditions. A typical example is 'counters,' which are used in number expressions. In both Dialogs 2 and 3, person B's answers are just 'Nine,' which is a natural way of expressing the concept in English. On the other hand, an answer which consists of only a number is generally unacceptable in Japanese. Japanese language needs 'counters' after numbers. Words and phrases in double square parenthesis correspond to counters in Japanese.

### Dialog 2

- 2-A-01-1: What time did you go to bed last night?  
2-B-01-1: (I went to bed at) Nine [[o'clock]] (last night).

### Dialog 3

- 3-A-01-1: How many letters did you write before that?  
3-B-01-1: (I wrote) Nine [[letters]].

The authors then examined positions, where contents of ellipsis exist. After comparison of the original English corpora and the Japanese translation, the authors found contents of six hundred and ten (610) ellipsis in English have to be recovered, when translating them into Japanese. More than seventy (70) percent of them have their contents in the last sentence of just the previous utterance made by the other person. This result shows the importance of the local context. Note that the local context is not just constructed by the current and the previous sentences. The 'turns' of a dialog play an important role. This examination was done for only one contextual phenomenon 'ellipsis,' but the authors think that the result shows the local context play the most important role for contextual phenomena in general.

## 3 METHOD IMPLEMENTATION

This section presents how the authors integrated a context handling method on an English-to-Japanese MT system, and then show how to recover the ellipsis in dialogs.

### 3.1 Local Context Handling Method in an MT

The integrated MT system handles written sentences one by one, but when translating the current sentence, the system utilizes some pieces of contextual information, which is beyond the sentence limit. The information includes (1) Background knowledge and (2) The local context information. For (1) Background knowledge, the authors take four factors into consideration; (1-A) Specific situations during the conversation, (1-B) number of participants, (1-C) conversation theme, and (1-D) roles and relations of the participants. For example, Formal speech at a conference and a telephone conversation are examples of (1-A). In the case of a usual telephone conversation, the value of (1-B) is 'two'. Question and answer on how to make a hotel reservation is an example of (1-C). In the case of the hotel reservations, (1-D) concerns a traveler and a clerk.

For (2) The local context information, the authors use three classes; (2-A) Sentence positions in the entire conversation, (2-B) Speaker, and (2-C) The kinds of each utterance. (2-C) includes (2-C-1) Sentence type that indicates speaker's attitudes, and (2-C-2) Focus of sentences. (2-C-1) distinguishes interrogative, imperative, or affirmative sentences. Matrix predicates in YES/NO interrogatives and WH-words in WH interrogatives are examples of (2-C-2)

The context handling module consists of three kinds of global memories (Fig. 1). The first is a 'background information memory' which is mainly used for reference. This memory keeps (1) Background knowledge. When beginning to process a new dialog, the system sets the information on this memory. The information is renewed when any of these items are changed, not each time the system processes a sentence. The other two memories are a 'Current Speaker's memory' and a 'Previous Speaker's memory.' They keep (2) The local context information. The information on them is changed each time the system processes individual sentence.

The sentence analyzing and generating modules for the MT system utilizes all the information on the three memories. For Example, when beginning to process each sentence, the system sets 'Speaker' and 'Position of utterance' in the 'Current Speaker's memory.' The items 'Sentence type' and 'Focus of sentences' are set when they are recognized in the analyzing module. When the speaker changes, the system copies the information on the 'Current Speaker's memory' to the 'Previous Speaker's memory.'

### 3.2 Ellipsis Recovering in English

In Dialog 1, almost all the omitted elements in English can also be omitted in Japanese, as mentioned. However, the corresponding word to 'Because' in sentence 1-B-04-1 should be added in a natural Japanese. When translating the sentence, the system recognizes the previous sentence is an in-

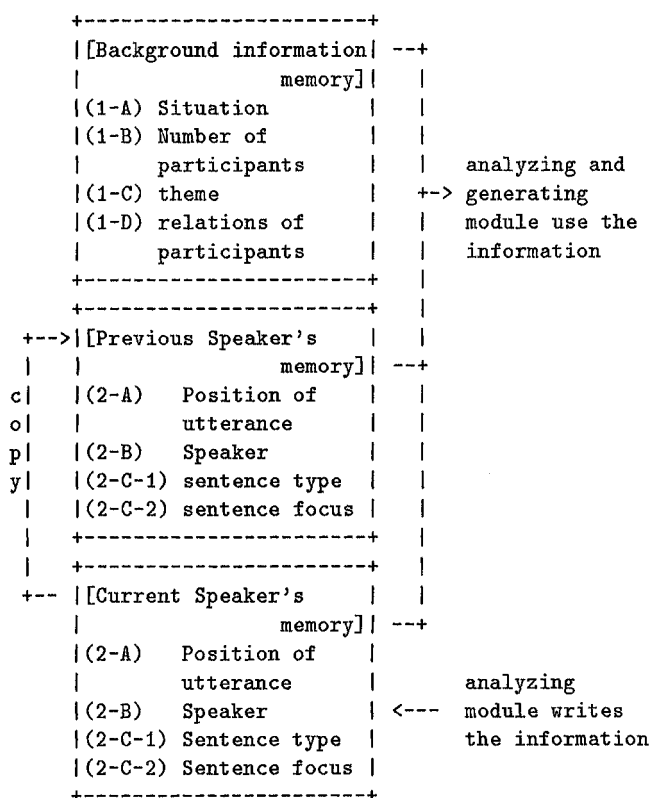


Figure 1: Three memories for Context Information

interrogative sentence and its focus is the verb 'leave.' After comparison of the verb and the matrix verb 'buy' in the current sentence, the system judges that these two are in different concept classes, and that the current sentence gives the reason for the answer. Consequently, the system adds to the current sentence the Japanese word corresponding to the English word 'Because,' and generates a Japanese sentence corresponding to it.

Japanese translations of Dialogs 2 and 3 need 'counters,' as described before. When generating sentences 2-B-01-1 and 3-B-01-1, the system recognize the previous sentences are WH interrogative sentence, and the head words of foci, WH phrases in these cases, are "time" and "letters," respectively. Consequently, when generating the English phrases 'nine' in the two sentences, the generation module makes up for the 'counters,' that is "o'clock" and "letters," respectively, and then generates the Japanese sentences corresponding to them.

## 4 DIALOG TRANSLATION

The integrated English-to-Japanese MT system was applied other linguistic phenomena in order to examine the feasibility of the local context handling method. The test used other corpora than the ones which are used for ellipsis examination. Values in the items on 'background memory' in this case are as follows: (1-A) Conversation on telephone. (1-B)

Two. (1-C) Query about conference and the answer. (1-D) (a) a person who wants to know about the conference, and (b) a clerk at the conference office. In the following dialogs, A is a person who wants to apply to the conference, and B is a clerk at the conference office. E shows English and J shows Japanese.

### 4.1 English Words Disambiguation

This section explains how this method disambiguates English words. Dialogs 4 and 5 are both the beginning of telephone conversations. Let us compare two 'this's in these dialogs. The system recognizes the 'this's are in the first utterances of the dialogs from the 'Position of utterance' information on the memories. Since 'this' in Dialog 4 is in an interrogative sentence by person A, the word indicates the other side of the telephone line, that is the conference office. The Japanese word corresponding to 'this' in this case is 'sochira' (its original meaning is 'your side'). On the contrary, 'this' in Dialog 5 is in an affirmative sentence by person B, who is a clerk at the conference. In this case, the word indicates the office side. The corresponding Japanese word is 'kochira' (its original meaning is 'my side'). The Japanese generation module utilizes the 'Speaker' and 'Sentence type' information on the memories, and select an appropriate Japanese word from the two for each case.

#### Dialog 4

4-A-01-1 E: Hello.  
 J: Moshi-moshi  
 4-A-01-2 E: Is this the Conference office?  
 J: Sochira wa kaigi-jimukyoku  
 (your side) (TOPIC) (conference office)  
 desu-ka?  
 (be+QUESTION)

#### Dialog 5

5-B-01-1 E: Hello.  
 J: Moshi-moshi  
 5-B-01-2 E: This is the Conference office.  
 J: Kochira wa kaigi-jimukyoku desu.  
 (my side) (TOPIC) (conference office) (be)

### 4.2 Noun Phrase Ellipsis in Japanese

In Japanese, even subjects and direct objects of transitive verbs are naturally omitted, when they can be recovered from background and context. An explicit expression of these elements is usually interpreted as giving emphasis to the speech. In Dialog 6, both persons A and B understand to whom person B should send the application form (That is, to person A). The system recognizes this from the information on the memories, because 'the number of persons' is two and there is no other third person in the conversation. It is therefore possible to omit 'me' in 'Please send me' in person A's utterance 6-A-08-3. In addition, ellipsis of noun phrases in Japanese is influenced by honorific expressions in Japanese [10]. In the case of this sentence, the Japanese phrase which corresponds to 'please send,' contains modal information that suggests the person to whom the application form should be sent is in the speaker's side. Consequently, the system decides to omit the word 'me' in

the phrase.

#### Dialog 6

- 6-A-08-3 E: Then please send me the application form.  
J: Soredewa moushikomni-youshi wo  
(then) (application form) (OBJECT)  
soufu-shite kudasai.  
(send) (please)
- 6-B-09-1 E: Yes, I understand.  
J: Hai, Wakarimashita.  
(Yes) (Understood+POLITE)

### 4.3 Selection of two Japanese postpositions

Japanese language has two particles, 'WA' and 'GA.' Both of them are used as a case marker to express the subject or a topic phrase. English does not have any grammatical elements corresponding to them, so their appropriate treatment is an important issue for English-to-Japanese MT systems. Many research efforts have concentrated on use of the two particles. The most basic analysis of the difference between the two is as follows. 'WA' is used to express old information, which is already understood by both speakers and hearers. 'GA' expresses new information, which is not yet understood by hearers. From the viewpoint of interrogative sentences, the following are pointed out: (a) When a subject is an interrogative word, 'GA' is used as the subject marker. (b) The focus phrase in the replying sentence, which corresponds to the interrogative phrase, 'GA' is also used.

When treating Sentence 7-A-05-2, the Japanese generation module looks up the memories and recognizes that this sentence includes the interrogative word 'which.' Consequently, the module generates the Japanese particle 'GA' to show the subject. When treating the next sentence, the system recognizes that the previous sentence was a WH interrogative sentence. This information causes the Japanese generation module also selects the particle 'GA,' when generating the subject phrase.

#### Dialog 7

- 7-A-05-2 E: Which hotel is closer to the conference hall?  
J: Dochira no Hotel GA kaijou ni  
(which) (of) (SUBJECT) (hall) (to)  
chikai nodesu ka?  
(near) (be) (QUESTION)
- 7-B-06-1 E: The Kyoto Prince Hotel is closer to the conference hall.  
J: Kyoto Prince Hotel GA  
(SUBJECT)  
kaijou ni chikai desu.  
(hall) (to) (near) (be)

## 5 CONCLUSION

The authors first examined an effective range of text for recovering contents of ellipsis in dialogs. It turned out that the local context that is constructed by both the current

sentence and the last sentence of just the previous utterance by the other person is the most important. Note that the local context is not just constructed by the current and previous sentences. The 'turns' of each speaker are took into consideration. Next, the authors implemented a context handling method in an English-to-Japanese MT system. Results showed that the method was effective for uses in some issues in dialog translation, such as (1) ellipsis recovering in English, (2) Polysemy disambiguation, (3) Noun phrase ellipsis in Japanese, and (4) Selection of Japanese postpositions 'wa' and 'ga.'

The important point is the local context used is simple and effective in actual problems in Machine Translation. Context is thought of as an information flow in a sense. The authors believe that this kind of local context structure will be a basic element in the context flow. In addition, the authors are planning to research how to map sentence types on a speakers attitudes appropriately.

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