Dialogue Model and Associative Processing

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1. Introduction

A dialogue is controlled by many factors. Among them, cohesion between two consecutive utterances, which are called "utterance pairs" is salient. The first year we constructed an overall model of the structure of the Question and Answer pairs ,whose relationships are of great importance, from the semantic point of view. The model is intended to be useful for recognizing diversified patterns of Q-A pairs based on presuppositions underlying questions.

The second year we applied the model to generation of cooperative answers. In a similar way of formalizing diversified patterns of Q-A pairs, we formalize the process of generating cooperative answers. In the process, we have noticed that there is a pattern of answers which could not be generated by an algorithmic procedure, unlike other answer patterns. We refer this case as "suggestions for speaker's creating answer",and we have taken an example-based approach to preparing an association mechanism for replying questions in this kind of situation.

This year we have been pursuing a dialogue control scheme in the case where a system does not have plan inference rules and can not recognize users' goals or plans. We have chosen the natural language interface for information retrieval as an example of such a kind of dialogues. In this case, the "goal-plan" approach does not work as the dialogue control. In other words, it is almost impossible for the system to maintain the coherence of a dialogue. We propose a method for generating adequate answers to users' requests which prompt the users to clarify what they are seeking. The method is based on "the users' interests" instead of the users' goals.

2. The model of the structure of the Question and Answer pairs

The most straightforward answer to a question, which we call "normal answer", is to echo the question with necessary syntactic modifications. In actual dialogues, however, we often return answers of various patterns. As a result of the analyses of dialogue examples, we have concluded that two primary factors cause the diversification of relationships between Q-A.

One factor is discrepancy or contradiction in the presuppositions of questions. We assume several propositions to be true and assume that a hearer believes these propositions to be true as well. (Here, a speaker means the participant who asks a question and a hearer means the one who replies to it.) Such propositions are called presuppositions in questions. If one of the presuppositions is not compatible with the hearer's knowledge or belief, the reply can not be a normal answer.

The presuppositions are classified into two categories. They are semantic ones, which are concerned with the propositional contents of a question, and pragmatic ones, which require "Enough amount of knowledge of hearer" and "Enough amount of information in questions". One of the semantic presuppositions is Existential presupposition. The objects which are introduced in the questions in "definite forms", that is to say, the objects described with specific properties actually exist. Consider the question:"How much is the map in Chinese?" Speaker presupposes that "there is a map in Chinese here". The answer "We don't have Chinese maps here." informs the speaker that the presupposition is not satisfied. The response type of such response is called "indication of misunderstanding".

Another is cooperation of participants. In order to reply cooperatively, we often add the related information to a normal answer. In this case, responses might convey some background related to the normal answers instead of the normal answer themselves so that the person who asked the question can clearly understand the situation.

Consider the question:"Can I go to the hotel by car?" and the response: "I'm sorry, the hotel has no parking area." In this example, the normal answer is :"No, you can't go to the hotel by car". The actual response conveys the information which is related to the normal answer via "reason" relationship. We call the process of generating such indirect answers which are rhetorically related to the normal answer "rhetorical development".

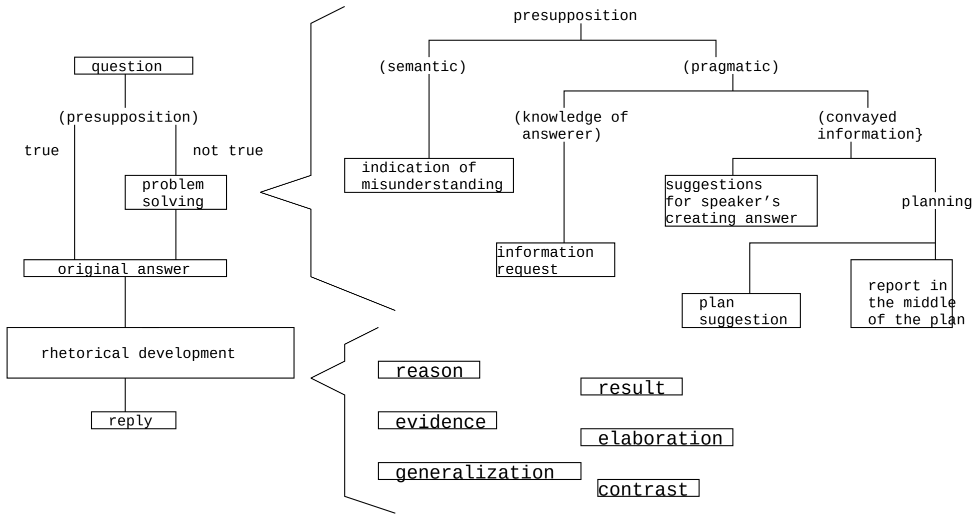

Fig.1 The model of the relationships between Q-A

Fig.1 shows the model of the relationships between Q-A. The formalization is illustrated with the following example pair. "From when may I use the air-conditioner?" "It doesn't work". In this example, the Factual presupposition, which is one of the semantic presupposition, does not hold. That is to say, "speaker can not use the air-conditioner". Then the direct information which hearer wants to inform to speaker is "You can not use the air-conditioner." We call such direct information "direct answer". The direct answers are either the normal answers or inferred responses caused by the discrepancy in the presuppositions in the questions. In this case, the direct answer is replaced with the statement:"The air-conditioner doesn't work" which is related via "reson" relationship.

In order to verify the effectiveness of the model, we are applying the model to prediction of answer types, which are classified in the model. A lot of domain knowledge is necessary for recognizing the diversified patterns of answers. Making use of the model,however, the types of answers can be predicted from superficial information of questions and answers. Identification of the answer types is the first step toward a deep understanding of answers .

3. Generation model of cooperative answers

In a similar way to formalizing diversified patterns of Q-A pairs, we formalized the model of generating cooperative answers. In the process of formalization, we have noticed that there is a pattern of answers which could not be generated by an algorithmic procedure, unlike other answer patterns. We refer this case as "suggestions for speaker's creating answer".

One of the pragmatic presuppositions in speaker's inquiry to a hearer is that the hearer has enough knowledge for answering the question. The following utterance R1 is an example of the answers which arise from the contradiction of the pragmatic presupposition. We call such a response "suggestive knowledge for speaker's creating an answer".

Q1: Kujira ha honyu-rui desuka.

(Is a whale mammal?)

R1: Kodomo ha umimasuyone.

(It breeds babies, doesn't it?)

The "suggestions for speaker's creating answer" should be relevant to supporting the process of speaker's inference for creating an answer to his own question.

R2 is another example of "suggestions for speaker's creating an answer" to Q2. Here the speaker may be able to infer a reply to his own question Q2 by referring the hearer's utterance R2, who also has no idea about the answer.

Q2: Sanzenin no sanpai kyaku ha hotondo jyosei desuka.

(Are most worshipers of Sanzenin women?)

R2: Jyakkouin no sanpai kyaku ha hotondo jyosei desu.

(Most worshipers of Jyakkouin are women.)

As before, it is considered to be difficult to figure out an algorithmic procedure for generating such a kind of answers. Then we have taken an example-based approach to preparing an association mechanism for replying questions in this kind of situation.

We proposed a model of generating answers based on the association mechanism which exploit dialogue examples. We examined the flexibility of the method by the experiment of retrieving a similar instance from a database of old temples in Japan. Then, we applyed the mechanism to the generation of 'suggestions for speaker's creating an answer'.

Our method firstly evaluates the viewpoint for a given question and retrieves a Q-A pair whose question is conceptually similar to the given question from the example-base of dialogues based on the viewpoint. Then it modifies the answer part of the example pair to generate an answer appropriate to the given question in an assumed situation.

In this method, semantic structures of utterances are represented by an extended case structure. They are composed of predicates, attributes of predicates and case elements. The attributes of predicates represent modal information or pragmatic information of the predicates. We consider fourteen types of information as the values of the attributes such as State, Possible, Cause, Guess and Past. We are currently sorting out the type of cases as follows; Agent, Object, Tense, Location, Tool, Degree, Cause and Comparison. The following expressions are examples of the semantic structure of question R3 and question R4.

R3: Hiroshima made donokuraide ikemasuka.

<(iku possible),((Location,(”genzaichi”,Hiroshima)),(Degree,HOW))>

R4: Hiko-ki to Shinkansen ha dochira ga toku desuka.

<(tokudearu state),((Object,(WHICH,Hiko-ki,Shinkansen)))>

Here, context processing problems such as anaphoric reference and elliptical case elements are supposed to have been resolved. The example-base of dialogues consists of Q-A pairs, where utterances are represented in the form of the semantic structures. Although the example-base has a flat structure now, it should be systematized in future for efficient reference.

The similarities between given questions and example questions in the example-base of dialogues are evaluated by the conceptual similarities between their predicates, attributes and case elements. In order to define the measure of the similarity between predicates, we are constructing the hierarchical tree of predicates. The measure between two predicates is defined by using the distance between them on the tree. The similarities between two case elements are also evaluated by using the distance between them on the hierarchical tree of nouns.

4. Dialogue control method without plan recognition

Until now, the types of dialogues which have been studied are more or less based on ”goal-plan” framework. The ”goal-plan” approach, however, does not work in some dialogues even if they are practical. A typical example of such dialogues is natural language interface of information retrieval. Because users often retrieve data from data base in a cooperative and incremental fashion in the situations where users have no clear specification of the data. Hence, it is so hard for the system to recognize users' goals and plans. We proposed a control method for such dialogues. Here, we refer this type of dialogue (i.e. dialogues which are not based on ”goal-plan” framework) as ”creative thinking support types” . On the other hand, we call the ordinary plan-based dialogue ”task-centered performative types”.

We have investigated the diffenrence in the characteristics of the two types of dialogues. As a result, the model of the process of generating cooperative answers described above is applied to the local control which is very important in the control of ”creative thinking support types”. In broader aspects, the method is based on ”the users' interests” instead of the users' goals.

The degree of users' interests is observed from two points of view. One is users' interests in the aspects of a domain such as ”health”, ”taste” in a cooking data base. The other is users' interests in the individual concepts independent of aspects. In order to observe the users' interests, the concepts of the domain are structureed in two ways. One way is that the concepts are classified into aspects of the domain and thesauri are constructed from the concepts of every aspect. The other is that the domain is covered with some Neighboring concepts into which similar or associated concepts are collected independent of aspects. The concepts in users' utterances are expansively considered to mean the Neighboring concepts to which they belong. Then in the Neighboring concepts, the concepts which belong to the aspects in which users are interested are considered to match users' intentions. Systems select and inform the informations which belong to the Neighboring concepts or aspects in which users are interested at that time.

5. Conclusion

We have investigated a recognition model, a generation model and a control scheme for dialogues based on cohesion between two consecutive utterances. We have ended up with the proposal of the dialogue control mechanism which is not based on "goal-plan" framework. We will test the feasibility of our models by applying it to the natural language interface of information retrieval.