Improvement of Automatic Generation Method of the Reply Sentence by Inductive Learning Using Common Portions on E-mail

Satoshi Uematsu, Kenji Araki, *Member, IEEE,* and Koji Tochinai

Abstract--We performed informational exchange and understanding of an intention using E-mail in daily life. However, the generation of reply sentences to E-mail takes a lot of time and labors. In order to solve this problem, a demand of the system which generates automatically the reply sentences to the received mail is increasing. In this paper, we propose an automatic generation method of the reply sentences by Inductive Learning [1] using common portions on e-mail. This system learns the way how to reply to the received mail. When a similar received mail inputted to the system, the system generates several reply sentences from the results of the learning. This system generates the reply sentences to a similar received mail for reducing a cost of labor and time. This system uses a received mail as an input and output reply sentences. We evaluated this system by two kinds of value. One is recall evaluated by a rate of a received mail which is applied generation rules to a received mail inputted to the system. The another is precision evaluated by a rate of reply sentences which is generated to reply sentences without any errors. For the experiment, we use 100 pairs of received mail and reply sentences. In results of this experiment, the more received mail and reply sentence to it increase, the better a recall is. Finally, recall became about 80 %. This is due to increase of generation rule. However, precision remains about 50 %. And generated reply sentences are not perfect. We consider that this is due to the way of acquiring generation rules and the way of a selecting generation rule.

I. Introduction

THE system which generates reply sentences to a received mail is able to be regarded as an application of a dialogue system. However, in previous researches [2][3], the rule which generates a response sentence need to be given beforehand and incorporated.

For example, ELIZA [4] is the most famous dialogue system. ELIZA pays attention to keywords in the dialogue of the other party and reply by applying the rule. Although ELIZA has many rules containing correspondences between input and reply, those are effective to only limited domain. And QA TRACK [6] in TREC (Text REtrieval Conference) and FAQ Finder [7][8][9] in question-answer dialogue system for inquiring to database. Above researches contains the question-answer dialogue system under the leadership of system [10] [11] and the leadership of system and user [12]. However, when we would like to reflect the user's intention or preference, above mentioned system which prepares rules for responding is not able to respond to it smoothly. Moreover, the system needs much labor and time to prepare rules, and preparing rules depend on specific domain strongly and it is shortage of objectivity.

Therefore, to solve this problem, we propose a method by Inductive Learning which acquires generation rules from examples. Using this method, we consider that this system is able to solve the remarkable problems in the analytic system. For example, our system is able to treat the unexpected situations and user's intentions for responding even if conventional analytic systems are not able to .Because, our proposal method acquire a rule from a example, it is not necessary to restrict a situations and the system reflects user's intention. Also, a problem that analytic system needs to much labor and time for making rules is not cleared. Our proposal method by Inductive Learning acquires rule automatically from a example, so this system reduce the labor and time for making rules.

We explain the way to acquire rules. In our system, a pair of received mail and a reply sentence inputted to the system is saved in text data. These are carried out morphological analysis using Juman [5] and changed into a form which is a word sequence added a part of speech. The latest pair of received mail and a reply sentence inputted is compared with all pairs saved in text data.

First, system compares the latest received mail inputted to the system with a received mail saved in text data. If the same word sequence containing several independent words are found in each mail, the system acquires the same word sequence. Next, the system compares reply sentence latest inputted with a reply sentence which is saved in text data. If

This work is partially supported by the Grants from the Government subsidy for aiding scientific researches (No.14658097) of the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Satoshi Uematsu and Araki Kenji are with the Graduate School of Engineering, Hokkaido University, Kita 13 Nishi 8, Kita-ku, Sapporo, Hokkaido, 060-8628, Japan.
(e-mail: {uematsu, araki}@media.eng.hokudai.ac.jp)

Koji Tochinai is with the Graduate School of Business Administration, Hokkai Gakuen University, Asahimachi 4-1-40, Toyphira-ku, Sapporo, Hokkaido, 062-8605, Japan.
(e-mail:tochinai@econ.hokkai-s-u.ac.jp)

The ISBN number for this conference is 1-86467-114-9.

the same word sequence which contained a independent word exist in each, the system acquire a same word sequence. Finally, the same word sequences of received mail and reply sentence are acquired as a generation rule.

The system automatically generates reply sentences to a received mail using a acquired generation rule. If several generation rules are able to apply to a received mail, the system calculates certain degree of several generation rules and selects one of them. In the performance of certain degree, we use three parameters for it. They are CF, EF and AG.CF is a number of correct generations. EF is a number of erroneous generations. AG is a score of agreement on received mail and a generation rule. A generation rule has CF and EF. They are counted when the generation rule is applied.

II. PROCESSING OUTLINE

In this paper, a received mail means the mail which is sent to the first author and a reply sentence means a response for the received mail. The procedure of our proposed method consists of a generation process, a proofread process, a feedback process and a learning process. A user inputs the received mail written by Japanese. Here, ordinary Japanese sentence are expressed by three kinds of characters: Kanji, Kana and Katakana. Kana is a Japanese phonographic character and has about fifty kinds. Katakana is a square form of Kana and it is a syllable character made from Kanji. Kanji is an ideographic character and has about several thousands kinds. A morphological analysis is carried out using Juman to the inputted received mail. Juman is a tool for the morphological analysis of Japanese. Using this analysis, a received mail is converted into the form of a word strings which are added a part of speech. In the generation process, a reply sentence is generated using the acquired generation rule. When there are two or more than available generation rules, the system selects and uses the generation rules with the highest value of a certain degree. After the first generation rule application, if application of the generation rule is still more possible, additional application of a generation rule is performed. A user judges whether the generated reply sentence is correct or not. Proofread process is carried out when the reply sentence is not generated or the reply sentence has errors. Otherwise, the proofread processing is not carried out. In proofread process, a user completes the correct reply sentences. In feedback process, the generation rule which was able to be used without modification is increased its certain degree. Moreover, the generation rule which made deletion and correction is lowered its certain degree. By this feedback processing, it is increase to use the correct generation rule and it is decrease to use the mistaken generation rule after this process. The morphological analysis to the reply sentence is carried out using Juman. A generation rule is acquired by comparing a pair of the received mails inputted to the system and its reply sentences with a pair of the saved received mail and its reply sentence. Here, a pair of received mail and its reply sentence which were inputted previous are saved in text data. This system repeats these processes and improvement.

Fig.1 shows the flow of processing. Fig.1 is explained as below mentioned.

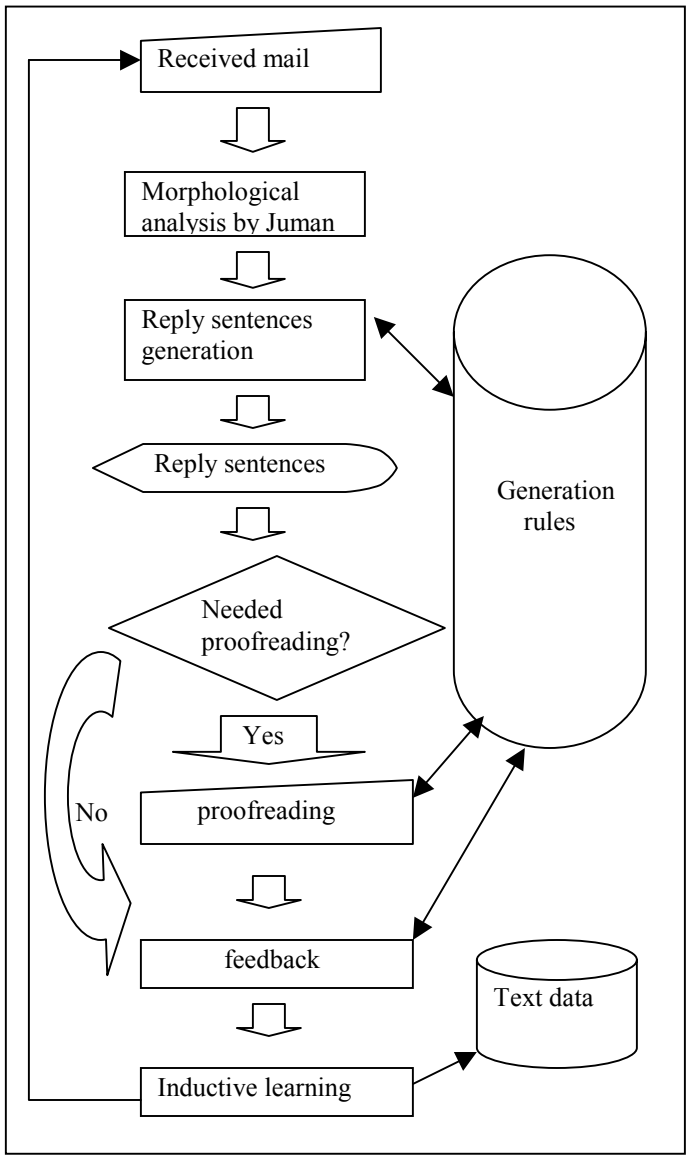

Fig.1: The flow of processing

A. Acquisition Processing of a Generation rule

The latest pair of received mail and reply sentences are compared with the pair of received mail and reply sentence which are saved in text data. When there is a word sequences with a part of speech containing the independent words which are matched with each, these are acquired as a generation rule. Moreover, our system acquired only a part of speech of an independent word if a part of speech of an independent word is matched and the word is not matched.

A generation rule has four parts.

1. received part (this part is acquired by matching a received mail latest inputted with a received mail which is saved in text data)
2. reply part (this part is acquired by matching inputted reply sentences with reply sentences which are saved in data)
3. CF part (this is the number of correct application)
4. EF part (this is the number of erroneous application)

(Refer to Fig.3)

In Fig.2 and Fig.3, the slash means a word separation and the colon expressed a word sequence with a part of speech . Left of the colon expressed a word and right of the colon expressed a part of speech of the word.

In Fig.2, the underline parts in received mail and a generation rule express the matching of written words and whose parts of speech. And the wavy line parts in received mail and a generation rule expressed the matching of a part of speech of the word. Moreover, when all the receive parts of a generation rule are in agreement with a sentence in the received mail, the generation rule can be applied. Furthermore, A sentence in a received mail is applied generation rules with the number of asterisk in the first generation rule's reply part. However, there are conditions of additional application at this time. It is that all the parts of speech before the part to substitute are matched.

B. A Certain Degree of Generation Rule

A certain degree of a generation rule is calculated in the following formulas.

$$\text{Certain degree} = \alpha \times CF + \beta \times EF + \gamma \times AG \quad \cdots\cdots (1)$$

CF: the number of correct application
EF: the number of erroneous application
AG: part of speech agreement score
In this research, the agreement is set up as fellows
α=3 : β= 5 : γ=2

In calculation of a certain degree, specific gravity was put on the number of times erroneous application rather than the specific gravity of the number of times of correct application. Because we would like to choose a generation rule as few errors as possible. Moreover, our system used AG for a calculation of certain degree to judge the agreement between the sentences in a received mail and a receive part of a generation rule. Therefore, in the setup of coefficients , β was made larger than α. The coefficient of a part of speech agreement score was set 2 for making part of speech agreement reflect to some extent, although specific gravity does not set like the number of times of correct application, or the number of times of erroneous application.

(received mail) (first application)
/ eiga : noun / tte : particle / nani : noun / ga : particle / sukidesu : adjective / ka : particle / ? : symbol /

(generation rule)
(received) / eiga : noun / _ /* : noun/ _ /* : adjective/
(reply) / boku : noun / wa : particle / _ / * : noun /

(generated reply sentence)
boku wa *
(second application)
(third application)

(omission)

Fig .2: Example of generation rule application

(received mail input)
/ donna : demonstative / eiga : noun / ga : particle / sukina : adjective / no : particle / ? : symbol /

(received mail in text data)
/ eiga : noun / wa : particle /nani : noun / ga : particle / sukidesu : adjective / ka : particle / ? : symbol /

(a part of agreement)
/ eiga : noun / _ / * : adjective / * : particle/_

(reply sentence input)
/ boku : noun / wa :particle / suspense : noun / kei : noun / ga : particle / suki : adjective / ka : particle / na : particle / . : period /

(reply sentence in text data)
/ boku : noun / wa : particle / drama : noun / ga : particle / sukida : adjective / yo : particle / . : period /

(a part of agreement)
/ boku : noun / wa : particle / _ / * : adjective / * : particle/ _

(generation rule)
(receive) / eiga : noun / _ / * : adjective / * : particle /_
(reply) / boku : noun / wa : particle / _ / * : adjective / * : particle/_

Fig .3: Example of acquiring generation rule

III. EXPERIMENT

A. Result of Experiment

The data used for an experiment was chosen 100 sets from the pair of the mail which was actually received and the sentence which replied to the received mail. Our system is evaluated using recall and precision. Each value is calculated in the following formulas. An acquired number of generation rules of transitions are shown in Fig. 4. Transition of recall and precision are shown in Fig. 5.

$$recall = \frac{\text{the number of received mail applied generation rule}}{\text{the number of received mail inputted to the systeml}} \quad \cdots\cdots (2)$$

$$precision = \frac{\text{the number of correct application}}{\text{the number of generation rule application}} \quad \cdots\cdots (3)$$

B. Evaluation Method

Calculation of recall is performed per mail. When at least one generation rule is applied to the sentence in a received mail inputted to the system, the number of received mail applied generation rule is counted. The precision is classified into the following four kinds. 1, 2 and 3 are judged as correct application, and 4 is judged as erroneous application.

1. Generated reply sentence is correct
2. Generated reply sentence has a part of error
3. Generated reply sentence adding to is no problem to the reply sentences such as greeting
4. Generated reply sentence has any errors

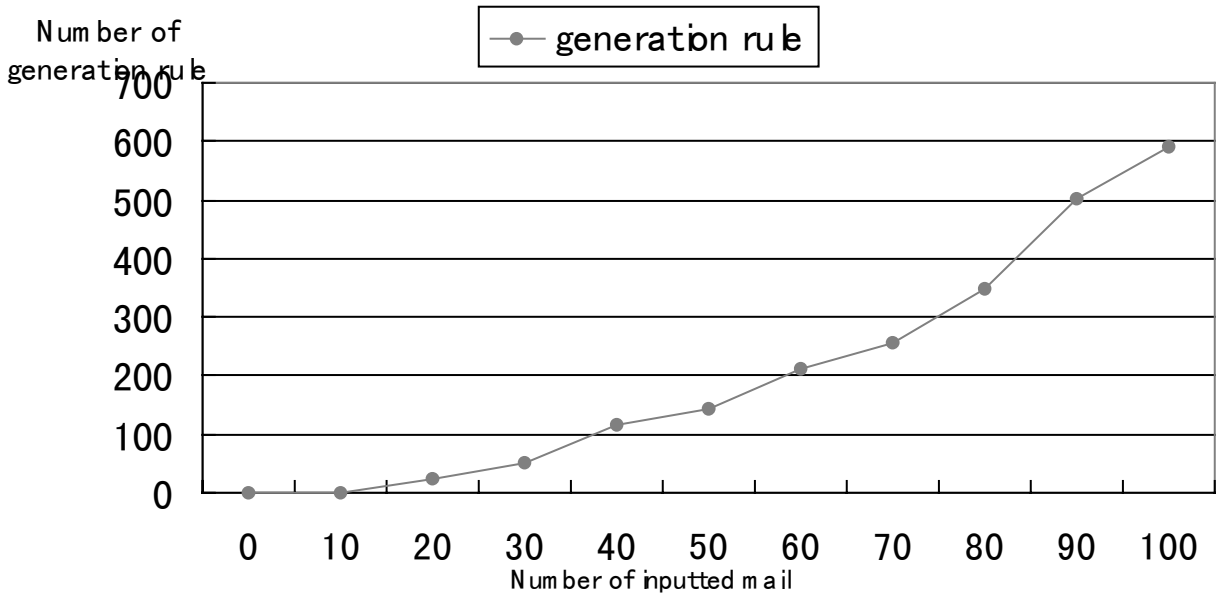

Fig. 4: A gained number of a generation rule of transitions

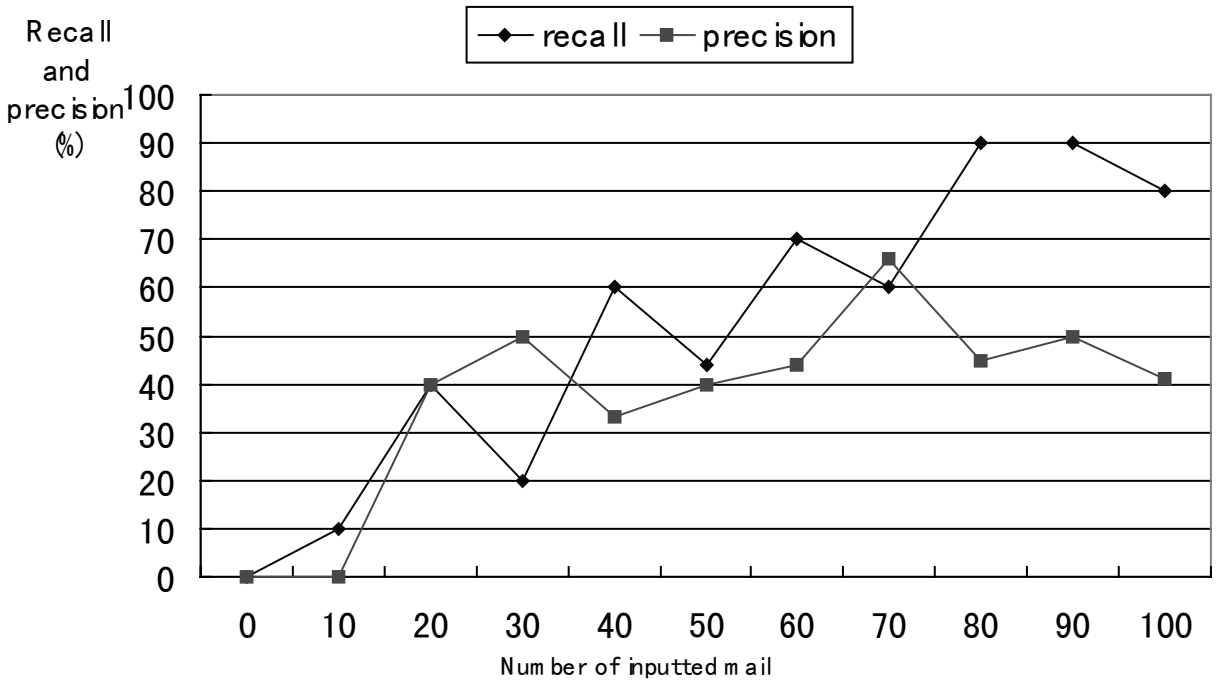

Fig.5: Transitions of recall and precision

IV. CONSIDERATION

The gained generation rule became 581 pieces as a result of the experiment. It turned out that the number of acquired generation rules had increased like an exponential function. Because the latest pair of a received mail and reply sentences is compared with all pairs saved in text data. Moreover, the recall became 80% and the precision became 41%. It turns out that the recall is increasing while the gained generation rules increases. In the beginning of a experiment, the rate of a recall is low. Because we started a experiment with empty generation rule. However, when the number of generation rules is over 100, a recall increased rapidly. Compared with it, the direction of precision did not come to exceed 50% irrespective of increase of a generation rule (refer to Table 1). Some causes are able to be considered to these inaccuracies. Many generation rules with any errors are contained in all gained generation rule. Our system is not able to choose a generation rule appropriately. Because our system correlated a sentence in a received mail with a sentence in the reply sentences when our system had acquired a generation rule. Therefore, it is necessary to consider which sentences are strongly related. We consider that the selection of the generation rule is mistaken because of lack of a parameter in the calculation of the certain degree. In order to solve this, statistical information such as frequency of appearance is needed to our system.

The total number of generation	78 times
Generated reply sentence is correct	25 times
Generated reply sentence has a part of error	6 times
Generated reply sentence adding to is no problem to the reply sentence	4 times
Generated reply sentence has any errors	43 times

Table 1: Application of Generation rule in detail

V. CONCLUSION

In our system, the recall increased with a number of inputs and became about 90 % finally. However, the precision remained about 50 % finally. Though, our system is able to generate reply sentences to a received mail, the generated reply sentences are not always correct and perfect. This is due to the imperfect acquisition and application method of a generation rule. For a future work, we will improve our system not to acquire erroneous generation rule and to select correct generation rule for a received mail. We will add correspondences between sentences in a received mail and reply sentences to learning process in our system in order to reduce erroneous generation rules. Moreover, to select generation rule appropriately we will add frequency of appearance to a generation rule.

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