Generation of NAZOKAKE Based on Classification of Its Structures

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Abstract: *NAZOKAKE is Japanese word plays. This paper considers some kinds of NAZOKAKE structures and mentions the system that generates NAZOKAKE words based on the relation between words and pronunciations of words, i.e., one of the NAZOKAKE structures. The present NAZOKAKE generating system has database consisting of a set of words, their pronunciations, related words and their relation degrees, which are determined by subjects experiments. Some NAZOKAKE words are generated according to inputted ODAI, the theme of NAZOKAKE. This paper also mentions the experiments in which some amateur subjects and experienced subjects evaluate generated NAZOKAKE words. The experimental results show that understandable and unpredictable NAZOKAKE words are generated.*

1. Introduction

Humor is one of important subjects in artificial intelligence [1] since only human has a sense of humor and understanding of humor is one of human intelligent behaviors. Studies on the structure of humor and factors which make human interesting are worthful to understand human recognition and intelligent behaviors.

The study field of humor is mainly classified into two subfields, verbally expressed humor and nonverbally expressed humor. The former uses language such as the generation of puns or interesting stories, and the latter uses visual effects by pantomime or funny gestures. There are some studies on verbally expressed humor [2][3]. In these studies, however, humorous puns are generated not from the humor itself point of view but from the grammatical and pronunciation point of view.

Our previous study [4] tries to generate NAZOKAKE, which is one of Japanese wordplays. This paper overviews NAZOKAKE from the viewpoint of its structure. That is, NAZOKAKE is classified into three types of structures according to the relation between words in NAZOKAKE. And this study constructs the NAZOKAKE generation system which generates NAZOKAKE based on one of three types of structures. The system has database on the relation between words. In the experiments NAZOKAKEs generated by the system are evaluated by amateur subjects and experienced subjects. The latter subjects are members of the RAKUGO club in University of Tsukuba.

2. NAZOKAKE and Its structure

NAZOKAKE is one of Japanese wordplays, which has the form, ""A" *to kakete* "B" *to toku. Sono kokoro ha* "$C(C')$"", in Japanese. This form has the meaning, "There is some relation between words "A" and "B". Why? Because "$C(C')$"". For example, "There is some relation between "teacher" and "turtle". Why? Because "he/she taught us (tortoise)"." A NAZOKAKE usually uses 4 words, "A", "B", "C" and "C'". Given an ODAI word "A", which is the theme of a NAZOKAKE, and three other words "B","C"and "C'"are searched, then a

NAZOKAKE is expressed in the form, ""A" *to kakete* "B" *to toku. Sono kokoro ha* "$C(C')$"".

Given the first sentence of a NAZOKAKE, ""A" *to kakete* "B" *to toku* (There is some relation between "A" and "B")", any relation between "A" and "B" is not usually found. However when words "C"and "C'" are given in the form "*Sono kokoro ha* "$C(C')$"", unexpected relation between "A" and "B" is found from the relation between "A" and "C", and the relation between "B"and "C'".

Almost all NAZOKAKEs are classified into three types of structures by considering the relation among words. In this chapter three types of structures are shown.

2.1 Structure of type 1
Fig. 1 shows the structure of type 1. Type 1 is defined based on the shape of a Chinese character.
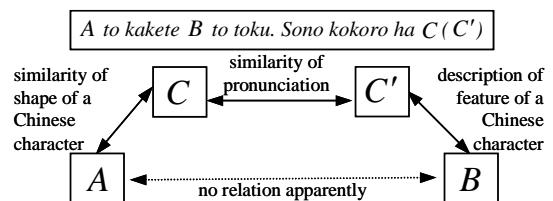

Fig.1   Structure of type 1

Ex1) [5]
逢うとかけて衣の綻びととく。
″au″ to kakete ″kinu no hokorobi″ to toku.
そのこころは糸で縫う。
sono   kokoro ha ″ito de nuu″.

Example 1 means "there is some relation between "to see" and "a rent in a garment". Because "sew (a rent) with thread "".

In example 1, a Chinese character "逢"(to see) with a character "糸"(thread) is a character "縫"(to sew) as shown in Fig. 2.

Fig.2   Explanation of example 1

Furthermore, this NAZOKAKE means that when we have "衣の綻び"(a rent in a garment), we "sew it with tread".

Although "逢"(to see) and "衣の綻び"(a rent in a garment) have no relation apparently, this NAZOKAKE shows the relation "糸で縫う"(to sew with thread) between them.

2.2 Structure of type 2
Fig. 3 shows the structure of type 2. Type 2 is defined based on the position of one character in words.
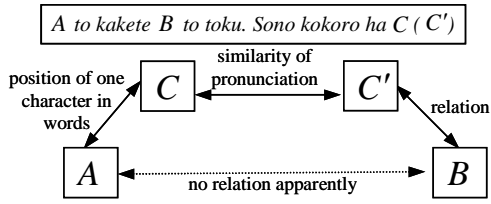
A *to kakete* B *to toku. Sono kokoro ha* C (C')

Fig.3   Structure of type 2

Ex2) [6]

（いろはの）ろの字とかけて野辺の朝露と解く。
″(iroha no) ro no ji″ to kakete ″nobe no asatuyu″ to toku.

そのこころは葉（は）の上にある。
sono kokoro ha ″ha (ha) no ue ni aru″.

Example 2 means "there is some relation between a Japanese hiragana letter "ro" and "morning dew in the fields". Because both are "on the leaf/ha (Japanese letter)"".

A Japanese letter "ろ(ro)" is written **on** a Japanese letter "は (ha)". Japanese letters are usually written longwise as shown in Fig.4 (a), and "いろは" is the Japanese alphabet. Furthermore, leaves are wet with the morning dew as shown in Fig.4 (b). That is, morning dew is on leaves. In Japanese, "leaf" means "葉(ha)".
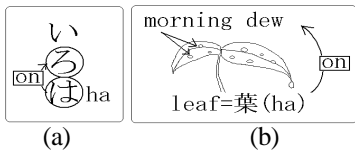

Fig.4   Explanation of example 2

Although a Japanese letter "ろ" in the Japanese alphabet "いろは" and "morning dew in the fields" have no relation apparently, this NAZOKAKE shows the relation "葉（は）の上にある"(on the leaf/"は") between them.

2.3 Structure of type 3

Fig. 5 shows the structure of type 3. Type 3 is defined based on neither the shape of a Chinese character nor the position of character in words but the meaning and pronunciation of words.
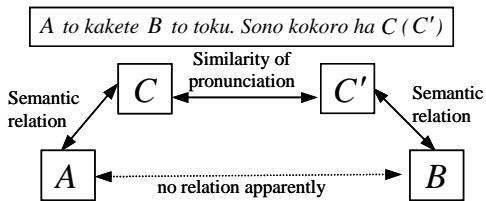

A *to kakete* B *to toku. Sono kokoro ha* C (C')

Fig.5   Structure of type 3

Ex3) [7]

台風とかけて血液型とときます。
″taifuu″ to kakete ″ketuekigata″ to tokimasu.

そのこころは大型（Ｏ型）もあります。
sono kokoro ha ″oogata (oogata) ″ mo arimasu.

Example 3 means ""Typhoon" and a "blood type" have some relation. Because we have a "large scale" typhoon and the blood of the "O-type"".

In example 3, there are two semantic relations between "typhoon" and "large scale", and between "blood type" and "O-type". In addition, there is phonological similarity between "large scale" and "O-type" because both are pronounced as "oogata" in Japanese. Although a "typhoon" and the "blood type" have no relation apparently, this NAZOKAKE shows the relation between them using words "large scale" and "O-type".

Hereafter the NAZOKAKE generation system which generates NAZOKAKE classified in type 3 is mentioned since NAZOKAKE in type 3 is most popular among those in three types.

3.   NAZOKAKE Generation System
3.1 Structure of system

Figure 6 shows the structure of the system. An ODAI word is given to the system. The system outputs some NAZOKAKEs concerned with the ODAI word based on the similarity of pronunciation and the relation among words which are reserved in the database of the system.
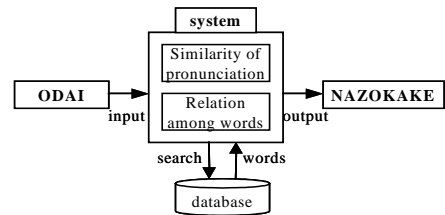

Fig.6   Structure of system

3.2 Data and database

The database of the system has the *pronunciation* of each word and *relation degrees* between related words as shown in Fig. 7. In this figure, "雨"(rain in English), "カエル"(frog), "降る"(to fall), "傘"(umbrella) have pronunciations "ame", "kaeru", "furu" and "kasa", respectively. And relation degrees between "雨" and "カエル", between "雨" and "降る", and between "雨" and "傘" are also shown.
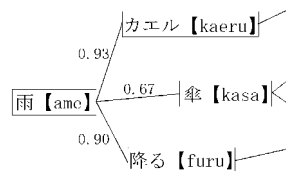

Fig.7   Structure of database

3.3 Determination of relation degree

The *relation degree* between two words is fixed, which has a numerical value in [0,1] and is determined by the subject experiment. The details are mentioned in 4.2.

3.4 Process of NAZOKAKE generation

The system generates NAZOKAKE "" A " *to kakete* " B " *to toku. Sono kokoro ha* " $C(C')$ "" as follows.

Step1: The system regards an inputted word " A " as an ODAI word, and searches " A " in the database.
Step2: If the system finds " A ", then the system tries to search " C " again, which is related to " A ".
Step3: The system searches " C' " of which pronunciation is similar to that of " C ".
Step4: The system searches " B " which is related to " C' ".

If the system finds all 4 words A , B , C and C' in step1 through step4, a NAZOKAKE with them is outputted.

3.5 Similarity of pronunciation

The system chooses "C'" by considering the similarity of pronunciation in step 3 mentioned in 3.4, which is defined by the difference between the string of letters in "C" and that of letters in "C'". If the system compares the string of letters in "C" and that in "C'" and both are completely the same, the similarity of pronunciation of "C" and "C'" is defined to be 1. If there is only one different letter between two strings of letters in "C" and "C'", the system has the similarity of pronunciation based on phonemic similarity shown in Table1, which is defined referring to [2]. In this paper the similarity of phoneme among different letters is regarded as the similarity of pronunciation among words. If the similarity of pronunciation of "C" and "C'" is not less than 0.6, the system estimates that "C" and "C'" have the same pronunciation.

Table 1　Phonemic similarity

Compared phonemes	Similarity of phoneme
b,d,g	0.9
p,t,k	0.9
m,n,N	0.9
h,s	0.8
a,o,u	0.7
e,i	0.7
s,z	0.6
b,p	0.6
d,t	0.6
g,k	0.6
other vowels	0.5
other consonants	0.1
a phoneme missing or adding	0.1

3.6 Range of related degree

As mentioned in 3.4, when the system finds "C" and "B", the system considers the relation between "A" and "C" and the relation between "B" and "C'". In NAZOKAKE, "C" and "C'" are key words because they are answers and punch lines in NAZOKAKE, and human does not feel the NAZOKAKE interesting till "C" and "C'" are shown. If the relation degree between "A" and "C" or between "B" and "C'" is very high, NAZOKAKE has not **unpredictability** and a punch line is predicted easily because "A" and "C" or "B" and "C'" are closely linked. On the other hand if the relation degree is very low, NAZOKAKE has not **understandability** and a punch line is not understood because two words are linked too weakly. In either case NAZOKAKE is not interesting. Therefore, the system has the range of the relation degree and generates NAZOKAKE by choosing words of which relation degree is within the range so that generated NAZOKAKE has both unpredictability and understandability.

4.　Evaluation of system

4.1 Subjects experiments

The subjects experiments are performed to evaluate the system. The experiments have three steps, (1) the determination of the relation degree, (2) the determination of the range of the relation degree, and (3) the evaluation of the system.

4.2 Determination of relation degree

In our previous system, the relation degree is determined under some rules [4]. Therefore, varieties of NAZOKAKEs are rarely obtained. In this paper the relation degree is determined by the subjects experiments in order to reflect the diversity of human thinking. Six subjects are presented a pair of words and evaluate their relation degree with a 5-point scale.

　　1:linked weakly
　　2:linked rather weakly
　　3:neutral
　　4:linked rather closely
　　5:linked closely

Evaluation results are scored by taking an average among six subjects and each score is normalized. Table 2 shows some examples of the relation degree.

Table 2　Example of relation degree

pair of words ＼ subjects	A	B	C	D	E	F	AVR	VALUE
news paper - print	3	3	2	3	2	4	2.83	0.57
bat - base ball	5	5	5	4	5	4	4.67	0.93
river - bridge	4	4	4	4	3	2	3.50	0.70

4.3 Determination of relation degree range

The range of the relation degree is analyzed in order to generate unpredictable and understandable NAZOKAKEs. In order to determine the relation degree range, four subjects evaluate NAZOKAKEs with a 5-point scale, which are generated by the system with the database obtained by 4.2.

　　1:dull
　　2:rather dull
　　3:neutral
　　4:rather interesting
　　5:interesting

The number of generated NAZOKAKEs depends on the range of the relation degree. It is very hard for the subjects to evaluate many NAZOKAKEs, while a large number of generated NAZOKAKEs are needed to evaluate the system. Therefore, the range of the relation degree is determined considering both the number of generated NAZOKAKEs and the ratio of interesting NAZOKAKEs. Table 3 shows part of results about the total number of generated NAZOKAKEs (4 (subjects) × the number of generated NAZOKAKEs) and the ratio of interesting NAZOKAKE to all generated ones within each range of the relation degree.

Table 3　Total number of generated NAZOKAKEs and ratio of interesting NAZOKAKEs

U＼L	0.50		0.55		0.60		0.65		0.70		0.75		0.80		
1.00	356	30.6%	292	30.5%	276	30.1%	224	29.9%	188	31.4%	108	26.9%	96	28.1%	‥
0.95	332	32.5%	272	32.0%	256	32.0%	196	31.6%	164	32.2%	96	32.3%	84	32.1%	‥
0.90	272	32.7%	220	32.7%	204	32.4%	160	34.4%	124	36.3%	56	32.1%	84	19.0%	‥
0.85	204	31.4%	160	30.6%	148	30.4%	116	28.4%	84	31.0%	24	16.7%	16	12.5%	‥
0.80	148	27.7%	112	29.5%	100	27.0%	68	26.5%	40	25.0%	8	12.5%			⋮
0.75	92	27.2%	60	30.0%	48	27.1%	24	29.2%	8	12.5%					
0.70	68	29.4%	48	31.3%	36	27.8%	8	25.0%		U:upper limit					
0.65	8	25.0%	4	50.0%						L:lower limit					
0.60	8	25.0%			⋮		⋮		⋮						

According to Table 3, the highest ratio 50.0% is obtained in range [0.55,0.65] . However the total number of outputted NAZOKAKEs is only 4. Therefore, this range isn't suitable for the evaluation of the system. The second highest ratio 36.3% is obtained in the range [0.70,0.90] and the total number of outputs is 124. This paper considers the range [0.70,0.90] suitable and uses it as the range of the relation degree.

4.4 System evaluation

Twenty nine subjects evaluate 31 NAZOKAKEs generated by the system one by one with a 5-point scale from the following three viewpoints, where the range of the relation degree is fixed at [0.70,0.90] .

A: Whether the presented NAZOKAKE has unpredictability or not
　　1:predictable
　　2:rather predictable
　　3:neutral
　　4:rather unpredictable
　　5:unpredictable
B: Whether the presented NAZOKAKE is understandable or not
　　1:not understandable

2:rather not understandable
3:neutral
4:rather understandable
5:understandable

C: Whether the presented NAZOKAKE is interesting or not as a whole
    1:dull
    2:rather dull
    3:neutral
    4:rather interesting
    5:interesting

Moreover, if there are "very interesting" NAZOKAKEs, subjects are asked to mark them.

Five RAKUGO club members in the University of Tsukuba perform other experiments, who are experienced in generating NAZOKAKE in RAKUGO show. They are presented all NAZOKAKEs generated by the system for each ODAI word regardless of the relation degree and asked to choose the most interesting NAZOKAKE with its reason.

4.5 Experimental results

The evaluation results are shown in Table 4, and the number of subjects with each evaluation average is shown in Fig. 8-10.

In viewpoint A "unpredictability", the evaluation average among 29 subjects is 3.0, and the ratio of good NAZOKAKEs with evaluation 4 or 5 to all NAZOKAKEs is 37.3%. In viewpoint B "understandability", the evaluation average is 3.7, and the ratio of good NAZOKAKEs to all NAZOKAKEs is 55.6%. In viewpoint C evaluation average is 2.6, which is lower than 3.0 (neutral). But some NAZOKAKEs are evaluated "interesting" or marked as "very interesting".

By comparing RAKUGO club members' evaluations and other subjects' evaluations, there is significantly different (5%) in only viewpoint B. In RAKUGO show, RAKUGO performers show NAZOKAKEs **in the talking style**. Therefore, RAKUGO club members evaluate "understandability" of NAZOKAKE by both situations in which they read NAZOKAKEs and in which they listen to NAZOKAKE.

There is a personal difference in the evaluation results. Some subjects give low evaluations to outputted NAZOKAKEs, but some other subjects give rather high evaluations to them. Almost allsubjects think that the generation of NAZOKAKE is very difficult even for human. Therefore, they are surprised at NAZOKAKE generation by a computer. Although the evaluation average of all subjects is not very high, the system has ability to generate interesting NAZOKAKEs from these considerations.

There are two types of remarks in the evaluation by the RAKUGO club members. One is the positive reasons why they choose NAZOKAKEs as the interesting one. The other is the negative reasons why they pass over NAZOKAKEs. The positive ones include "unpredictability", "skillfulness", "the situation can be imagined easily", "the situation can be expressed easily", and "the NAZOKAKE becomes more interesting by adding more words". The negative ones are "too commonplace", "too unpredictable", "hard to understand", and "phonological problem".

These remarks are useful for the construction of the system which disregards "too commonplace" NAZOKAKEs or "too unpredictable" NAZOKAKEs. As for the phonological problem, other experimental studies are necessary for the generation of interesting NAZOKAKEs.

Table 4   Evaluation average

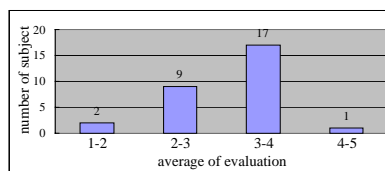|	number of subject	evalution viewpoints		
		A	B	C
RAKUGO club member	5	3.0	3.2	2.5
other subjects	24	3.0	3.7	2.6
all subjetcs	29	3.0	3.6	2.6

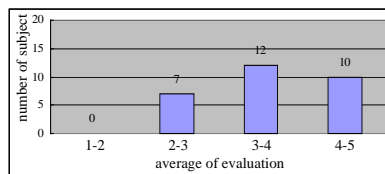Fig. 8   evaluation of unpredictability

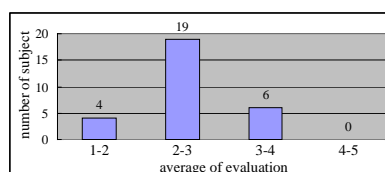
Fig. 9   evaluation of understandability

Fig. 10   evaluation of interesting

4.6 Example of NAZOKAKE

Some outputted NAZOKAKEs are shown below.

"Shinbun" to kakete "tetsudou" to toku. Sono kokoro ha "kishya".

This means "There is some relation between a "newspaper" and a "railroad". Because a "train" and a "reporter"". In Japanese, both "train" and "reporter" are pronounced "kishya".

5. Conclusions

In this paper, NAZOKAKEs are classified into three types of structures according to the relation between words. And the NAZOKAKE generation system is constructed based on one of the structures, i.e., based on the semantic relation between words and the similarity of pronunciation. The experimental results show that understandable and unpredictable NAZOKAKEs are generated and that the average of evaluations of generated NAZOKAKEs by the subjects is rather good. The RAKUGO club members show both positive evaluations and negative evaluations which are useful for the improvement of the system.

In a future the presented system is improved to generate NAZOKAKE, which is as rich in expression as the one which RAKUGO performers do. It is necessary to consider the form of expression of NAZOKAKE and other factors to make NAZOKAKE more interesting.

6. References

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