METONYMY INTERPRETATION USING X NO Y EXAMPLES

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We developed an example-based method of metonymy interpretation. One advantages of this method is that a hand-built database of metonymy is not necessary because it instead uses examples in the form “Noun X no Noun Y (Noun Y of Noun X).” Another advantage is that we will be able to interpret newly-coined metonymic sentences by using a new corpus. We experimented with metonymy interpretation and obtained a precision rate of 66% when using this method.

Key words: metonymy, ellipsis, example-based method, corpus

1. INTRODUCTION

This paper describes a new Japanese metonymy interpretation method using the example-based method (Nagao 1984; Murata and Nagao 1997; Murata et al. 1999b; Murata et al. 1999a). Metonymy is a metaphorical expression in which the name of something is substituted for another thing associated with the thing named. For example, in the Japanese sentence of “boku ga torusutoi wo yomu (I read Tolstoi),” the word “torusutoi (Tolstoi)” is a metonymic word. In this case, the word “torusutoi (Tolstoi)” means a book written by him “torusutoi no hon (Tolstoi’s book).” The actual meaning “torusutoi no hon (Tolstoi’s book)” is replaced by the abbreviated expression “torusutoi (Tolstoi).” In this paper we call an abbreviated word such as “torusutoi (Tolstoi)” a source word, and call the word it replaces — in this case, “torusutoi no hon (Tolstoi’s book)” — a target word.

Metonymy has conventionally been interpreted by using a hand-built database that includes relationships between source words and target words, such as a special knowledge base of metonymy, and a semantic network (Iverson and Helmrich 1992; Fass 1988). Relationships between source words and target words are diverse, however, and it is not easy to make a detailed database. This paper therefore describes a method that instead interprets metonymy by using examples in the form of noun phrases such as “Noun X no Noun Y (Noun Y of Noun X)” and “Noun X Noun Y.” When we interpret a source word “torusutoi (Tolstoi)” in the sentence “boku ga torusutoi wo yomu (I read Tolstoi),” for example, we gather two sets of nouns from examples in the form of “torusutoi no Noun Y (Noun Y of Tolstoi)” and examples in the form of “Noun Z wo yomu (read Noun Z).” We select a noun “shousetsu (novel)” included in both sets, Noun Y and Noun Z, and judge that the source word “torusutoi (Tolstoi)” means the target word “torusutoi no shousetsu (Tolstoi’s novel).” Two advantages of this method are that a special knowledge of metonymy is not necessary because we use examples and that we can interpret newly-coined metonymic sentences by using a new corpus.

Most metonymies are considered elliptical expressions, such that “I read Tolstoi” is considered the elliptical expression of the literal sentence “I read Tolstoi’s novel.” We have developed an example-based method for ellipsis resolution and in previous work have used it in the resolution of indirect anaphora (Murata et al. 1999b), in pronoun resolution (Murata et al. 1999a) and in the resolution of verb ellipsis (Murata and Nagao 1997). In that work, examples were used as the semantic restriction. Consider the following example of indirect anaphora resolution (Murata et al. 1999b). “I went into an old house last night. The roof was leaking badly and ...” indicates that “the roof” is associated with “an old house.” In
### Table 1. Metonymic Relationships

| Relationship            | Metonymic Sentence   | Interpretation                        |
|------------------------|----------------------|---------------------------------------|
|                        | (the source word)    | (the target word)                     |
| **Author-book**        | \(boku \text{ ga } torusutoi \text{ wo } yomu.\) | \(torusutoi \text{ no shōsetsu.}\) |
|                        | (I read Tolstoi)     | (Tolstoi) (of) (a novel)              |
|                        | (The source word)    | (The target word)                     |
| **Maker-product**      | \(boku \text{ ga } ferrari \text{ ni } noru\) | \(ferrari \text{ no kuru~ma}\)        |
|                        | (I) subj (Ferrari) obj (drive) | (Ferrari) (of) (a car) |
|                        | (The source word)    | (The target word)                     |
| **Container-content**  | \(boku \text{ ga } nabe \text{ wo } taberu\) | \(nabe \text{ ryori}\)                |
|                        | (I) subj (a pot) obj (eat) | (a pot) (food) |
|                        | (The source word)    | (The target word)                     |
| **Agent-attachment**   | \(tsume-eri \text{ ga } aruite kuru}\) | \(tsume-eri \text{ no gakusei}\)     |
|                        | (A stand-up collar subj (come walking)) | (A stand-up collar (of) (a student) |
|                        | (The source word)    | (The target word)                     |
| **Agent-neighbor**     | \(hamusando \text{ ga } kanjo \text{ wo } haruu}\) | \(hamusando \text{ no kyu~ku}\)     |
|                        | (A ham sandwich subj (a bill) obj (pay) | (A ham sandwich (of) (a customer) |
|                        | (The source word)    | (The target word)                     |
| **Place-thing**        | \(boku \text{ ga } niv~u \text{ wo } haku.\) | \(niv~u \text{ no gomi}\)          |
|                        | (I) subj (a garden) obj (sweep) | (a garden) (of) (a rubbish) |
|                        | (The source word)    | (The target word)                     |

In this case we used “the roof of a house” in the form of “Noun X of Noun Y” as examples and restricted the antecedent of “the roof” to “a house.” The metonymy interpretation method described in the present paper is very similar to that indirect anaphora resolution method in that it uses the examples in the form of “Noun X of Noun Y” as the semantic restriction. A valuable contribution of this paper is that it shows that metonymies can be resolved by the method used in ellipsis resolution.

## 2. METONYMY

There are many kinds of metonymic relationships, such as “author-book” and “container-content,” and some are listed and illustrated in Table 1.

We explain metonymy using the following example.

\(boku \text{ ga } torusutoi \text{ wo } yomu.\) (I read Tolstoi.)

This is a metonymic sentence using an “author-book” relationship. If we interpret the sentence “boku ga torusutoi wo yomu (I read Tolstoi)” literally, it ridiculously means that one reads “torusutoi” himself. The word “torusutoi (Tolstoi),” which is an author’s name, denotes a novel written by him. This sentence means “boku ga torusutoi no hon wo yomu (I read Tolstoi’s book)”.

In the work described in this paper we dealt only with metonymy, not with metaphor. The reason is as follows. Metaphor is affected by the context, so metaphor interpretation is difficult. But metonymy, which is based on the associative relationship between words, can be interpreted easily by using only simple information such as the relationships between
3. EXAMPLE-BASED METONYMY INTERPRETATION

3.1. Metonymy and Examples in the form of “Noun X of Noun Y”

Metonymy is a writing technique based on replacement. In the sentence “boku ga torusutoi wo yomu (I read Tolstoi)” the target word “shousetsu (a novel)” is replaced by the source word “torusutoi (Tolstoi)”. But it is not simple replacement. “shousetsu (a novel)” does not generically refer to all novels, but to a certain novel “torusutoi no shousetsu (Tolstoi’s novel).” It can be thought that in “boku ga torusutoi wo yomu (I read Tolstoi)”, the relationship of “author-book” is recognized by unspoken agreement and that “shousetsu (a novel)” in “torusutoi no shousetsu (Tolstoi’s novel)” is omitted.

Many metonymic sentences could thus be interpreted by inferring an elliptical target word having a certain relationship to a source word. Because source and target words in metonymy have a relationship, such as the “author-book” relationship, we can search for the target word by using the source word.

This paper, thus describes a method by which metonymy is interpreted by using the relationships between words to infer an elliptical word. We search for these relationships by using examples, and the ones we use are of the following kinds:

- “Noun X no Noun Y (Noun Y of Noun X)”
- “Noun X Noun Y (Noun X Noun Y)”

The relationships between Noun X and Noun Y in “Noun X no Noun Y” include almost all the relationships of metonymy, so examples in the form of “Noun X no Noun Y” can be used in metonymy interpretation. (Note that the Japanese particle “no” has many meanings. It is semantically similar to the English preposition “of” but has many more meanings. It can, for example, express the meanings of “at,” “in,” “for,” “with,” “by,” and many other noun-noun relationships.) Metonymy is interpreted by gathering as examples noun phrases in the form of “Noun X no Noun Y,” selecting the most appropriate word among their Noun Ys, and substituting it in the metonymy sentence. In some cases, however, we make noun phrases without using the particle “no.” The phrase “nabe no ryori (food of a pot),” for example, is not used but instead the phrase “nabe ryori (pot food)” is generally used, as in the metonymic sentence “boku ga nabe ryori no taberu (I eat a pot),” which means “boku ga nabe no ryori wo taberu (I eat pot food).” In order to deal with such cases, we also use compound nouns “Noun X Noun Y” as examples in metonymy interpretation.

3.2. Example-Based Metonymy Interpretation

Metonymy detection cannot be separated from metaphor interpretation because after we detect non-literal sentences, we must distinguish metonymic sentences from metaphorical sentences. But as mentioned in Section 2, we did not handle metaphor interpretation in the work reported here. Therefore we did not handle metonymy detection and simply assumed that the input sentences were metonymic sentences. Metonymy interpretation was performed as follows.

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1 When we use our method in English, we should use not only “Noun X of Noun Y” and “Noun X’s Noun Y” but also “Noun X in Noun Y,” “Noun X on Noun Y,” “Noun X for Noun Y” and so on.
1. We specified a source word ("Noun X") by using a case frame dictionary.
2. We gathered from a corpus examples in the forms of “Noun X no Noun Y (Noun Y of Noun X)” and “Noun X Noun Y” that included the source word “Noun X” and we got as candidate target words many Noun Ys.
3. We selected one of these candidates as the target word by using semantic restriction of the verb and using the frequency of Noun Y.

**Specification of the source word.** Our method uses a case frame dictionary to specify the source word. An input sentence is transformed by a morphological analyzer and a syntactic analyzer into the following structure.

“Noun + Case-Particle”, “Noun + Case-Particle”, \ldots , “Predicative-Verb”

We compare such a structure to a case frame of the verb, and check whether or not each of the nouns satisfies the semantic restriction in the case frame dictionary. We judge that the source word is the noun that does not satisfy the semantic restriction.

Let us specify the source word in the following metonymic sentence.

boku ga torusutoi wo yomu.

(1) subj-case (Tolstoi) obj-case (read)

(I read Tolstoi.)

Suppose that the case frame of “yomu (read)” is as follows.

\{human\} subj-case particle, \{book, newspaper, novel\} obj-case particle, \{read\}

We check the semantic satisfaction of each case element by comparing the input and the case frame. Because “boku (I)” in the subjective-case of the input is a human being, this word satisfies the semantic restriction. “torusutoi (Tolstoi)” in the objective-case does not belong to the book, newspaper, or novel category, so it does not satisfy the semantic restriction. Therefore, we judge that “torusutoi (Tolstoi)” in the objective-case is the source target.

**Extraction of Target Word Candidates.** We gather from a corpus sentences including the source word (“Noun X”) and transform them into syntactically tagged data by using a syntactic analyzer. We consider as examples containing candidate target words examples in the form of “Noun X no Noun Y” and “Noun X Noun Y.” We consider the frequency of any candidate target word to be the number of examples containing that word.

We also gather from the corpus sentences including the verb (“Verb W”) acting on Noun X in the metonymic sentence and transform them into syntactic structures by syntactic analysis. We extract examples in the form of “Noun Z Case-Particle Verb W,” and use Noun Z in selecting a candidate. This selection process is explained in the following section.

Consider, for example, the following metonymic sentence.

boku ga torusutoi wo yomu.

(1) subj-case (Tolstoi) obj-case (read)

(I read Tolstoi.)

We first gather examples containing candidate target words. Having already found that the source word is “torusutoi (Tolstoi),” we gather from the corpus all the sentences that include “torusutoi (Tolstoi)” and transform them into syntactic structures by using a syntactic analyzer. Here, we suppose that sentences that include the phrase “torusutoi no shousetsu (Tolstoi’s novel)” exist. We extract from them a noun “shousetsu (novel),” which is modified by words “torusutoi no (Tolstoi’s)”, among them as a candidate of the target word. In this way we extract all of the Noun Ys by using examples in the forms “torusutoi no Noun Y (Tolstoi’s Noun Y)” and “torusutoi Noun Y (Tolstoi Noun Y)” and consider them as candidate target words. We also gather examples in the form of “Noun Z wo yomu (read Noun Z)” from a corpus for semantic restriction of the verb (Verb W), we transform them into
syntactic structures by using a syntactic analyzer, and extract all of the Noun Zs in order to use them to define the semantic restrictions of the verb (Verb W).

Selection of the Target Word. Finally, we select the target word from the candidates (Noun Ys) by using the semantic restrictions of the verb (Verb W) and the frequency of the various Noun Ys.

We first select those candidates satisfying the semantic restrictions in a verb’s case frame dictionary because the sentence representing a metonymy interpretation should be literal. We then select from this subset of candidates those belonging to a set of Noun Zs, which is extracted for the semantic restrictions of the verb (Verb W) in the previous procedure. Finally, we use the frequencies of the candidate words (Noun Ys) to select one of them.

However, if this selection were based only on the frequency of the candidate itself, however, a candidate strongly linked to an infrequent source word might fail to be selected as the target word. To decrease the likelihood of such an error, we also use the frequency of the super-ordinate word in an is-a hierarchy. When the super-ordinate word of a candidate word is also a candidate word, we weighted the frequency of each candidate word and added to it the frequency of its super-ordinate word. We define the frequency of the super-ordinate word of a candidate word as the total number of occurrences of all its super-ordinate words. We think this can compensate the frequency of a subordinate candidate word having a low frequency. In the work reported in this paper we added 1.5 times the frequency of a candidate word to that of its super-ordinate word and selected as the desired target word the candidate word having the highest total frequency. (We have no evidence to show whether this weighting factor is always good.)

For an example of how this method is used, consider again the metonymic sentence

boku ga toerusutoi wo yomu.
(I read Tolstoi.)

Suppose that the candidate target words gathered in the extraction were “shousetsu (a novel)-11,” “sakuhin (a literary product)-3,” “izoku (a bereaved family)-1,” “eikyou (an influence)-1.” (The numbers represent the frequencies.) First we eliminate candidate words such as “izoku (a bereaved family)” and “eikyou (an influence)” that do not satisfy the semantic restriction of the case frame dictionary and do not belong to the set of Noun Zs gathered using the verb (Verb W). We then calculate each super-ordinate word frequency, add it to 1.5 times the frequency of its subordinate candidate word, and select as the target word the one having the highest total frequency. In this case, only “shousetsu (a novel)” and “sakuhin (a literary product)” have such a relationship between a subordinate word and a super-ordinate word. Therefore, the super-ordinate word frequency of “shousetsu (a novel)”, which has “sakuhin (a literary product)” as a super-ordinate word, is 3 (= 3 × 1), and the other super-ordinate word frequencies are 0. As a result, the total frequencies of “shousetsu (a novel)” and “sakuhin (a literary product),” which satisfy the semantic restriction, are respectively 19.5 (11 × 1.5 + 3) and 4.5 (3 × 1.5 + 0). We select as the target word the word

If X is a kind of Y, then Y is a super-ordinate word of X and X is a subordinate word of Y. For example, because “man” is a kind of “animal”, “animal” is a super-ordinate word of “man” and “man” is a subordinate word of “animal.”

In the experiment reported in Section 3, the best accuracy was obtained when the weighting factor was 1.5, and weighting factors of 1 and 2 each resulted in only one additional error. When the super-ordinate word frequency was not used there were three additional errors.

In this case, “hon (a book),” “shousetsu (a novel),” “sakuhin (a literary product)” and so on were gathered as Noun Z, the semantic restriction of the verb (Verb W). So the two candidates, “shousetsu (a novel)” and “sakuhin (a literary product),” satisfied the semantic restriction of the verb (Verb W).
4. EXPERIMENTS AND DISCUSSION

4.1. Experiments

We carried out experiments on 41 metonymic sentences from some textbooks (Nakamura 1977; Yamanashi 1988). We used as a case frame dictionary the NTT dictionary (Ikehara et al. 1997), used as a morphological analyzer JUMAN (Kurohashi and Nagao 1998), and used as a syntactic analyzer KNP (Kurohashi and Nagao 1994). Our corpus consisted of newspaper articles collected over a period of three years. We also used the NTT dictionary to find the relationships between super-ordinate and subordinate words. The experimental results are listed in Table 2, and some of the correctly interpreted metonymic sentences are reproduced in Table 3.

4.2. Discussion

In the experiment, six of the 41 input sentences were judged not to be metonymic sentences. This was because each case element of these sentences satisfied the semantic restrictions of the case frame dictionary. Although these sentences, such as “boku ga niwa wo haku. (I sweep the garden.)” are classified as metonymic sentences in textbooks, they are generally thought to be interpreted literally. We correctly interpreted 23 of the remaining 35 sentences, including the interesting sentence “heian jinguu ga mankai da (Heian Shrine is in full-bloom)” interpreted as “heian jinguu no sakura ga mankai da (Cherry blossoms in Heian Shrine are in full-bloom).” (Heian Shrine is in Kyoto, the beautiful ancient capital in Japan. The cherry blossoms are lovely in spring.)

Our method correctly interpreted 23 of the 41 input sentences. Among the 41 input sentences treated as metonymy expressions in textbooks, however, 6 could be interpreted literally. Thus, our method correctly analyzed 23 cases of 35 metonymic expressions (66%) that could not be analyzed correctly by the former NLP systems.

Next, we examine problems clarified in the experiment.
Table 3. Examples of correctly interpreted metonymic sentences.

| Metonymic Sentence | Interpretation Sentence |
|--------------------|-------------------------|
| boku ga yuumin wo kiku | (I) subj (Yuming) obj (listen to) (I listen to Yuming.) |
| boku ga yuumin no uta wo kiku | (I) subj (Yuming) (of) (song) obj (listen to) (I listen to the song of Yuming.) |
| boku ga fodo ni noru | (I) subj (Ford) obj (drive) (I drive a Ford) |
| boku ga fodo no kuruma ni noru | (I) subj (Ford) (of) (a car) obj (drive) (I drive a car of Ford) |
| heian jinguu ga mankai da | (Heian Shrine) subj (full-bloom) (be) (Heian Shrine is full-bloomed.) |
| heian jinguu no sakura ga mankai da | (Heian Shrine) (of) (cherry blossoms) subj (full-bloom) (be) (Cherry blossoms in Heian Shrine are in full-bloom.) |
| boku ga nabe wo taberu | (I) subj (pot) obj (eat) (I eat a pot) |
| boku ga nabe ryori wo taberu | (I) subj (pot) (food) obj (eat) (I eat hot-pot food) |
| shiro-bai ga shansha wo taiho-su (a white motorbike) subj (a lawbreaker) obj (arrest) | shiro-bai keikan ga shansha wo taiho-su (a white motorbike) (a policeman) subj (a lawbreaker) obj (arrest) (A white motorbike policeman arrests a lawbreaker.) |

There were some cases of misinterpretation because the input sentence included a verb or a noun, that was not in the case frame dictionary or noun dictionary, such as “gennari suru (be fed up)” and “Yoshimoto Banana.” And the sentence “boku ga isshou bin no sake wo nomu. (I drink a one-sho bottle (of liquor))” was misinterpreted because there were few examples and the correct target word was not among them. The examples gathered in the analysis of this sentence were “rappanomi (drinking from a bottle)-1,” “raberu (label)-1,” and “sen (a cap)-1.” The correct target word, “sake (liquor),” was not among them. This problem can be overcome by enlarging the corpus from which the examples are extracted.

5. CONCLUSION

This paper described a method for interpreting metonymic sentences by using examples. A metonymic sentence is considered a sentence from which a target word is absent. Because the Japanese particle “no (of)” can be used to express almost all possible relationships between a metonym (source word) and the omitted target word, we interpret a metonymic sentence by using examples in the form “Noun X no Noun Y” to identify the omitted target word rather than by using a hand-built database on knowledge of metonymy to identify it. Specifically,

1. We specify a source word (“Noun X”) by using a case frame dictionary.
2. We gather from a corpus examples in the forms of “Noun X no Noun Y (Noun Y of Noun X)” and “Noun X Noun Y” that include “Noun X” (the source word), and from these examples we get multiple Noun Ys as candidate target words.
3. We select one candidate as the desired target word by using the semantic restriction of the verb (Verb W) and the frequency of Noun Y.
Evaluating this method experimentally, we found that it correctly interpreted 23 of 35 metonymic sentences (66%).

Two advantages of this method are that a hand-built metonymy database is not necessary and that we will be able to interpret newly-coined metonymic sentences by using a new corpus.

It is unfortunately necessary to extract metonymic sentences by using some other system, because this method cannot distinguish metonymic sentences from metaphorical sentences and literal sentences. And this method cannot interpret the metonymic sentence properly, when the corpus contains few examples that include the source word.

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