International Journal of Database Theory and Application
Vol.10, No.8 (2017), pp.31-42
http://dx.doi.org/10.14257/ijdta.2017.10.8.04

Role Conversion Considering Its Context and Syntactic Property

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Abstract

Semantic Role Labeling (SRL) is to determine the relationship between predicates and their arguments in a sentence. In order to determine the semantic roles, a large amount of corpus with annotated semantic roles is required. Nowadays the most widely used semantic corpus is Proposition Bank (PropBank) which is semantically annotated over the predicate and argument structure. But the Korean version of the PropBank could not be widely used because the corpus has limitation in size and be different from its original English version in its usability. To solve these problems, we also used another semantic tagged corpus, built by Sejong Plan, which is nation-wide Korean corpus construction project. However, the task of corpus construction with semantic roles defined in PropBank and Sejong is much time-consuming and these corpora use their own role sets. They finally require a way of converting one role to other side role(s). In this paper, we propose a method for automatically converting the roles. First, we use similarity between a given noun argument word to find a new role and noun words appearing in the example sentences of candidate roles. Second, we extract suffix of the argument word and estimate closeness between the suffix and candidate roles. Finally, the predicate itself is used for selection,that is we calculate the closeness between the predicate and the candidate roles. With these, the role is decided among multiple candidate roles. In the experiment, we convert 491 arguments automatically and about 78% of them show the agreement with manually annotated arguments.

***Keywords**: Semantic role, Automatic conversion, Semantic role conversion, Similarity estimation, Probability table*

1. Introduction

Semantic Role Labeling is a process that determines the relationship between the meanings of predicate-arguments in sentences [1]. A large number of corpora that are tagged with semantic roles are necessary for Semantic Role Labeling [2]. In Korean, many studies that uilize the corpus that defined as semantic role at Sejong Plan [3][4]. But the world-wide most commonly used corpus is the Proposition Bank (hereafter termed "PropBank") [5].

PropBank refers to a corpus in which the predicate-argument structure is tagged. This corpus was mainly constructed in English and Chinese. However, the Korean PropBank has much fewer learning materials than the corpus of English and Chinese so that its accuracy is relatively low, and the use of the Korean PropBank for semantic role labeling may cause many problems as the special characteristics of the Korean language are not reflected. To solve this problem, we used the tagged Sejong corpus (to be termed "Sejong"), defined in the Sejong Plan, which specializes in Korean [6]. Construction of the Sejong sense-tagged corpus is important as a research related to the semantic role

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ISSN: 2005-4270 IJDTA

decisions of Korean have, in the main, used the Sejong sense system. However, significant time and cost have been spent on constructing the PropBank semantic role and Sejong semantic role tagged corpora as the work is conducted manually. Considering this, a new method is necessary to automatically convert the new sense-tagged corpus to the existing sense-tagged corpus.

To achieve this, a method to automatically convert the argument tagged with Sejong semantic role to the Korean PropBank semantic role is presented in [7]. Methods of measuring the mean degree of similarity between the concept of the trunk-based on the measurement method [8][9], information content (IC) measurement method [10][11], the defective hybrid measurement of two methods [12-15] could be considered as a tool for converting roles. For the automatic conversion, Argument sense similarity estimation, which is the subject of the semantic role change, is calculated in [7]. Conversion is made against specific semantic roles from the existing data by identifying the semantic role of words whose sense is similar to the converting argument. In this case, only the argument itself is considered, and its context information is excluded. A problem existed as the hierarchical structure information was not reflected in the automatic conversion method for the proposed semantic role.

In this study, the similarity between argument words was calculated by giving a weight for each level against the length of the path of the noun class that is formed, like each tree, through reflection of the hierarchical structure of the two nouns. Based on the results of the calculation, the automatic conversion method that considered both a Josa and the predicate, which are assumed to have had a close relationship with the argument word, is presented.

In chapter 2, the interrelationship between the Propbank and Sejong semantic role is investigated, and a method to automatically convert the Propbank to Sejong semantic role is provided in chapter 3. In chapter 4, the result of the comparison between corpus tagged with the use of the semantic role conversion method proposed here and corpus tagged by the existing users are explained. Finally, chapter 5 contains the conclusion and future research.

2. Interrelationship between the PropBank and Sejong Semantic Roles

The sense tagged corpus constructed in [16] was tagged with the PropBank semantic roles and the Sejong semantic roles. [Table 1] shows the mapping satatus of the PropBank semantic roles, which are extracted from 10,263 Korean PropBank sentences, to the Sejong semantic roles. Each line of [Table 1] shows the PropBank semantic role, Sejong semantic role, and the percentage count and weight of the candidate Sejong semantic role that is mapped onto the PropBank semantic role.

Table 1. PropBank Semantic Role and Sejong Candidate Semantic Role

PropBank	Sejong	Count(%)
ARG0	AGT	6172(76%)
ARG1	THM	19912(90%)
ARG2	FNS	1119(26%)
	GOL	1067(24%)
	EFF	826(19%)

ARG3	GOL	544(60%)
M-ADV	EFF	551(69%)
	CNT	161(20%)
M-CAU	EFF	487(81%)
M-CND	EFF	36(32%)
	CNT	30(27%)
M-DIR	DIR	195(80%)
M-DIS	EFF	120(43%)
	CNT	82(29%)
M-EXT	CRT	330(52%)
	EFF	199(31%)
M-INS	INS	794(97%)
M-LOC	LOC	3274(86%)
M-MNR	INS	1470(75%)
M-PRD	INS	159(50%)
	EFF	95(30%)
M-PRP	PUR	146(91%)
M-TMP	LOC	1107(78%)

The relationship between the PropBank and Sejong semantic roles is reanalyzed as more detailed analysis was necessary using more data than the 3,759 that were previously used for the final analysis. When the Sejong Candidate semantic role is 1:1, like ARG0, ARG1, and M-CAU, the semantic role is determined immediately, but there is ambiguity when the candidate semantic role is plural as in ARG2, M-ADV, and M-CND. To solve this ambiguity, Similarity Estimation is calculated using the weight of the level of noun class of the argument of each semantic role. By converting this to the value of the combination probability table, the semantic role is finally determined through calculation between the PropBank semantic role that is subject to the conversion and the Sejong Candidate semantic role.

3. Automatic Conversion of Semantic Role

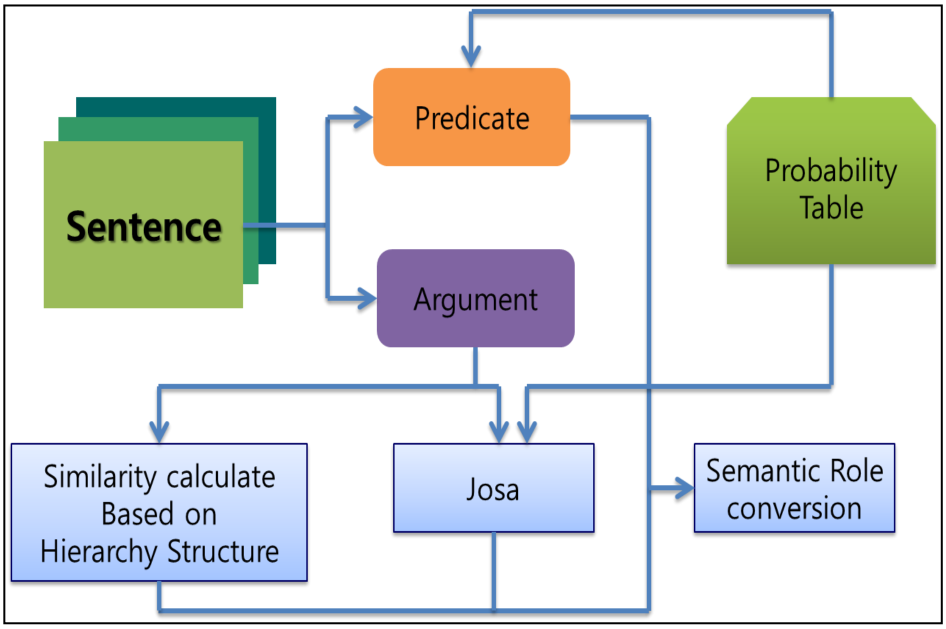


Figure 1. Process of Conversion of Semantic Role

Figure 1 shows the process of automatic conversion of the semantic role from the PropBank to Sejong. Sentences are divided into argument and predicate. The semantic role in [17] is converted by calculating the similarity between the argument that has a semantic role, which is subject to conversion, and the other argument, which has the conversion candidate semantic role. However, the accuracy of this method is low as it only compares the similarity of the argument itself, but does not consider the contents in their context. Nor does it apply noun hierarchical information. When the argument is used as a subject or object, semantic role conversion is simple as the PropBank semantic role and Sejong semantic role have 1:1 mapping; however, there is a different semantic role according to the Josa and predicate in the case of adverbial Josa. As a result, to calculate the similarity between the semantic role that is subject to conversion and the candidate semantic role, a weight should be assigned to each level by reflecting the noun hierarchical structure information for the argument. Furthermore, accurate semantic role conversion can be conducted using the predicate of the argument and the semantic role combination table of Josa.

3.1. Calculation of Distance between Noun Class with Use of Weight for Each Level

Figure 2 shows the hierarchical structure of the CBL1, and each number provides information related to the location within the concept system, which is the higher concept and step information. The digits of the concept number show the steps, and the number with a final digit deleted is included in the higher concept. In Figure 2., as a higher concept of 1112, which shows jo-jic ‘Organization,’ 11 is gu-chea ‘Concreteness’ as a higher concept than the 111, which indicates ju-chea ‘Main agent.’

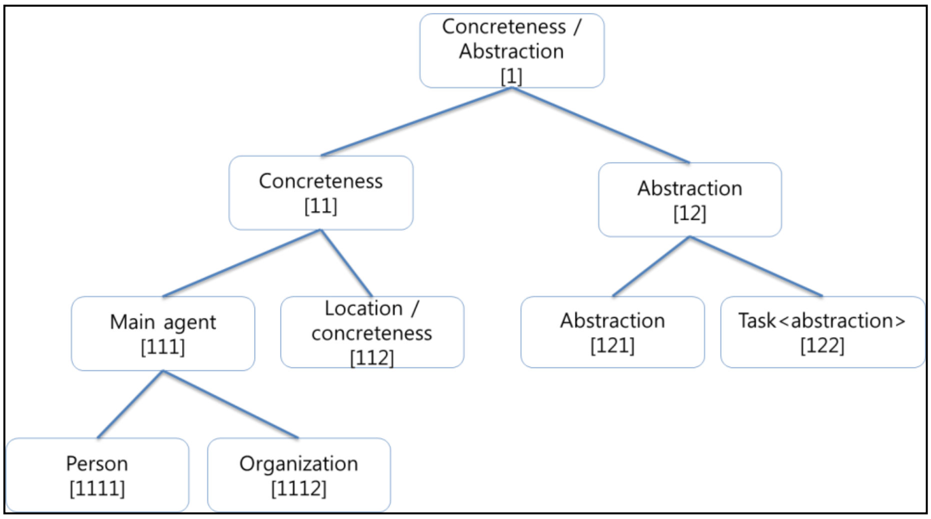


Figure 2. Koeran Noun Lexical Semantic Network(CBL1)

This study calculates the similarity by applying the weight for each level between the noun classes. When the hierarchical structure is not considered, the edge between 1112 and 111, between 111 and 11, and between 11 and 112 is calculated to acquire the value 3. As the number of the class reduces, the class becomes higher. By using this, weight is applied to reduce the similarity value for each level of class of the noun that has a tree structure. When the top class differs, the value is calculated by reducing the similarity value by 1 and by 1/2 as it goes to the lower class. By providing weight, the calculation of similarity between classes 112 and 1112 resulted in 0.375. The formula to calculate the distance between each class is as in the following Figure 3.

Most significant link's length = m
Level's size = n
Scale factor = l (l >1)
➔ Link's length = m/l^{n-1}

Figure 3. Calculation of the Distance between Classes with Reflection of the Level on the Hierarchical Structure

3.2. Probability Table Predicate with the Use of Josa Information

Normal sentences are composed of arguments and predicates. When the argument is used as a subject or object, it is mapped with 1:1 ratio between PropBank ARG0 and ARG1 and between Sejong AGT and THM. In the case of an adverb that has a subject and object, the semantic role is tagged using a completely different method according to the Josa and predicate of the argument.

hea-byeon(beach)[verb-impaired common noun]+ -eh[adverb Josa] LOC(LOC)
hea-byeon(beach)[verb-impaired common noun]+ -ro[adverb Josa] ARG3(GOL)
hea-byeon(beach)[verb-impaired common noun]+ -eseo[adverb Josa] ARG2(SRC)

Figure 4. Semantic Role Corpus according to Josa and Argument

Figure 4 shows that the PropBank semantic role and Sejong semantic role are converted in a completely different way according to the Josa and predicate of the argument. When the Josa -ro is tagged to the noun hea-byeon ‘beach’ and predicate, and when -eh is tagged to the ARG3 and GOL, which shows the arrival point, M-LOC and LOC, which indicate location, are mapped. When -eseo is tagged, it is mapped as ARG2 and SRC, which indicate the starting point. As such, the semantic role is determined in a completely different way according to the Josa and predicate, and the accuracy decreases. To accurately define the semantic role, this study provides a combination probability table that contains information about each Josa and predicate.

To prepare data for the table, this study uses a syntax tagged corpus prepared by the Electronics and Telecommunications Research Institute (ETRI) to tag semantic role for the predicate-argument of 12,000 sentences. Following this semantic role tagging, the probability table is constructed with 4,414 tables for verbs and Josa is constructed with 241 tables. Each table stores information about the Sejong semantic roles that are used for the 12,000 data sentences.

Table 2. Probability Relation of Josa -eh and -gachi

Josa	Sejong Semantic Role	Probability
-eh	LOC	0.43
	GOL	0.26
-gachi	EFF	0.56
	FNS	0.06
	COM	0.17

Table 2 shows part of the probability table that contains information about the Josa -eh and gachi. The Josa -eh is used as LOC, which indicates the location in the Sejong semantic Role, and GOL, which indicates the arrival point. The result shows that Josa -eh is often used for location and for the arrival point according to the arrival point. The Josa -gachi ‘together’ is used as an EFF, which indicates effector, FNS, which indicates the status of the result, and COM, which indicates a companion and shows that this is used as an effector.

Table 3. Probability Relation of Verbs 'Be Based' and 'See'

Predicate	Sejong Semantic Role	Probability
Be based	THM	0.33
	LOC	0.67
See	AGT	0.12
	THM	0.51
	LOC	0.14

Table 3 shows a higher semantic role in the probability table of the verbs 'be based' and 'see.' 'Be based' uses LOC, which often indicates location for the Sejong semantic role. In the case of 'See,' mapping was conducted for AGT, which indicates agent, THM, which indicates object, and LOC, which indicates location, and it shows that this is used as a meaning of the object. Accordingly, the semantic role can be used differently according to the argument, Josa, and predicate of the probability table, and is necessary for the semantic role conversion of the argument.

3.3. Method of Automatic Conversion of Heterogeneous Semantic Role Tagging with Reflection of Noun Hierarchical Structure

Let us assume that the PropBank semantic role, which is subject to conversion, is Prop and the two conversion candidate Sejong semantic roles are S1 and S2. Let us also assume that the Prop and S1 groups are Dset1 and the Prop and S2 groups are Dset. The value that only contains P is termed p.

(1) The concept number of each word is determined by applying the words included in the value result from the value that is tagged to Dset1 and Dset2 by applying them to the hierarchical concept system.

(2) To automatically convert the semantic role, which is tagged to P, to S1 or S2, five groups are generated by randomly selecting 150 numbers from the numbers tagged to each Sejong semantic role.

(3) Taking the words included in Group 1 as test data, Similarity Estimation between the words included in Groups 2, 3, 4, and 5 is calculated. In the same way, Similarity Estimation is calculated for other words of other groups.

(4) Let us assume that the two calculated values of Similarity Estimation are R1 and R2.

(5) Take the value from the predicate that is tagged to Dset 1 and the combination probability table of Josa. In the same way, take the values for Dset 2.

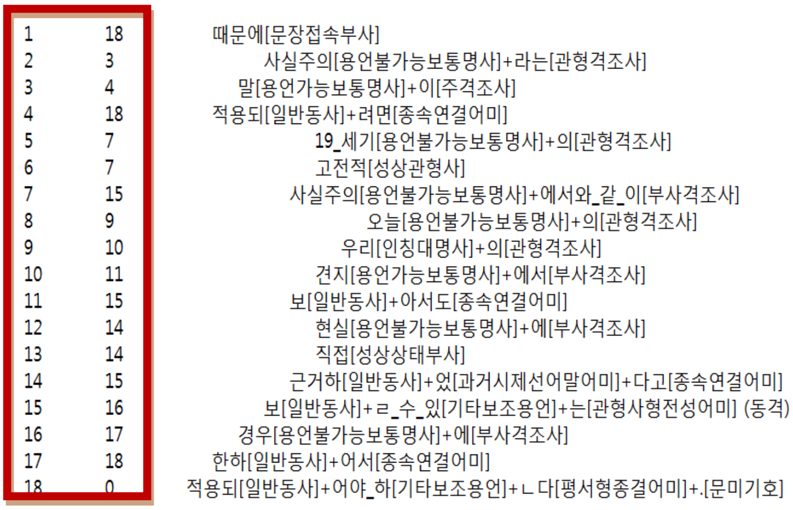
(6) Add the probability value of R1 to Dset1 and do the same for R2 and Dset2.

(7) Convert the semantic role to the group that has the smallest value from the result of summation.

The purpose of randomly selecting 150 sentences is to test using the same numbers as the result, which may deflect to one direction when there is a large difference in the relation analysis from the PropBank semantic role to the Sejong semantic role.

4. Test

This study uses the Syntax Tagged Corpus prepared by the ETRI as the sentence data to investigate the relationship to the predicate-argument. To conduct a test, a sentence is used as an example: “For this reason, to use the word ‘Realism,’ it should be used when it is viewed as based on the actual situation according to our views as it is in the classical realism of the 19th century.” A test for semantic role conversion is conducted using the method described in Chapter 4.



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1    18     때문에[문장접속부사]
2    3            사실주의[용언불가능보통명사]+라는[관형격조사]
3    4        말[용언가능보통명사]+이[주격조사]
4    18     적용되[일반동사]+려면[종속연결어미]
5    7                    19_세기[용언불가능보통명사]+의[관형격조사]
6    7                    고전적[성상관형사]
7    15               사실주의[용언불가능보통명사]+에서와_같_이[부사격조사]
8    9                          오늘[용언불가능보통명사]+의[관형격조사]
9    10                     우리[인칭대명사]+의[관형격조사]
10   11                   견지[용언가능보통명사]+에서[부사격조사]
11   15               보[일반동사]+아서도[종속연결어미]
12   14                   현실[용언불가능보통명사]+에[부사격조사]
13   14                   직접[성상상태부사]
14   15               근거하[일반동사]+었[과거시제선어말어미]+다고[종속연결어미]
15   16           보[일반동사]+ㄹ_수_있[기타보조용언]+는[관형사형전성어미] (동격)
16   17       경우[용언불가능보통명사]+에[부사격조사]
17   18     한하[일반동사]+어서[종속연결어미]
18   0    적용되[일반동사]+어야_하[기타보조용언]+ㄴ다[평서형종결어미]+.[문미기호]
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Figure 5. Example of Predicate – Argument Relation

In Figure. 5, the interdependency relation between argument and predicate is expressed with two indexes where the first index for each line is the sequence of word-phrase and the second index is the sequence of interdependent word-phrase. It is expressed that word-phrase is under an interdependent relation when the first and second indices from each line are the same as each other. As an example, the arguments “Because,” “If it is to be applied,” and “Provided that” have a relation to the predicate “It should be applied.” If it is separate to the argument and predicate in consideration of the interdependency between the argument and predicate to convert such a semantic role of the argument, the result comes as in Table 4. The argument is separated into noun + Josa, and each argument is tagged with a PropBank semantic role.

As in Table 4., the PropBank semantic role and Sejong semantic role are mapped at a ratio of 1:1 in the mal + -e, and geon-ji + -eso and semantic role is converted to ARG1(THM), LOC(LOC). However, semantic role conversion, with the use of the semantic role similarity estimation and probability table, is necessary as the PropBank semantic role and Sejong semantic role are mapped at a ratio of 1:N in the hyun-sil + -eh, and kyung-wu + -eh. When the values are added through calculation of the similarity between the PropBank semantic role and Sejong semantic role for each argument and by the use of predicate and complex Josa probability tables, the result emerges as in Table 5.

According to Table 5, hyunsil + eh is ARG2(LOC), sasiljueui + ehseowa gachi is ADV(EFF), and gyeongwoo + eh is ARG2(LOC), taking the smallest value, and the PropBank semantic role is converted to each Sejong semantic role.

Table 4. Example of Result of Separation of Argument and Predicate

Argument	Semantic Role	Sejong Candidate Semantic Role
mal + -e	ARG1	THM
geon-ji + -eseo	M-LOC	LOC
hyun-sil + -eh	ARG2	FNS, GOL, LOC
sasilhueui + ehseowa gachi	ADV	EFF, CNT
gyeongwoo + -eh	ARG2	FNS, GOL, LOC

Table 5. Semantic Role Calculation Results using Predicate and Josa Probability Table

Argument	PropBank	Sejong	Predicate	Sum
hyun-sil + -eh	ARG2	GOL	Be based	0.483
hyun-sil + -eh	ARG2	FNS	Be based	0.55
hyun-sil + -eh	ARG2	LOC	Be based	0.274
sasilhueui + ehseowa gachi	ADV	EFF	See	0.05
sasilhueui + ehseowa gachi	ADV	CNT	See	0.16
gyeongwoo + -eh	ARG2	GOL	Limit	0.26
gyeongwoo + -eh	ARG2	FNS	Limit	0.34
gyeongwoo + -eh	ARG2	LOC	Limit	0.15

Table 6. The Result of Similarity between the User-tagged Corpus and the Automatic Tagged Corpus

Argument	User-tagged	Automatic-tagged	Result
mal + -e	ARG1(THM)	ARG1(THM)	○
geon-ji + -eseo	M-LOC(LOC)	M-LOC(LOC)	○
hyun-sil + -eh	ARG2(LOC)	ARG2(LOC)	○
sasilhueui + ehseowa gachi	M-ADV(EFF)	M-ADV(EFF)	○
gyeongwoo + -eh	ARG2(CRT)	ARG2(LOC)	X

Table 6. shows the results of similarity between the user-tagged corpus and the other corpus in which the automatic conversion method is applied. The latter showed four similarities and one difference compared to the manually tagged corpus.

We showed 78% of agreement between manual tagging and automatic conversion after experiment with 100 ETRI sentences.

5. Conclusions

In this paper, we propose an automatic conversion of semantic roles from PropBank to Sejong corpus to recover the problem caused from original manual annotation work. We also build probability relation tables of Josas and predicates to decide accurate semantic roles. To convert PropBank semantic roles to Sejong semantic roles, firstly we should calculate the similarity between semantic roles to be converted and the candidate semantic roles by using hierarchical structure with weights of its level. Then we decide the final semantic role by using the josa and predicate tables. For the experiment, we compared manually annotated roles and automatically converted roles. About 78% of roles are correctly converted when 100 test data are used.

For the future, we have a plan to develop a methodology to automatically annotate the PropBank semantic role and Sejong semantic role. And besides nouns, josas, and their predicates, other constituents of the sentence will be utilized for the more accurate semantic role labeling system.

Acknowledgments

This paper is a revised and expanded version of a paper entitled “Automatic Semantic Role Conversion based on Word Similarity and Statistics” [17] presented at SIT 2016, Jeju, Korea, December 21-23.

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and future Planning (2015R1A2A2A01007333), and by Hallym University Research Fund, 2015 (HRF-201512-013).

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