A Computational Implementation of Resolving Korean Plural Pronouns

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There are three third-person plural pronouns in Korean. This paper proposes that the constraint on the antecedent for each plural pronoun is different, and thus in creating the antecedent for a plural pronoun, the relevant constraint must be taken into account. This paper also shows how to implement the method of resolving Korean plural pronouns on the computer, using DCG grammar. The grammar contains information about gap threading and DRS threading. The method of summation based on constraints is used to construct the antecedent for a plural pronoun computationally.

Key words: third-person plural pronouns, Korean discourse, DRT, constraints on referents, DCG, summation method, computational pronoun resolution

1. Introduction

There have been many works on how to find the referent of singular pronouns in English sentence[1], whereas few attempts were made to resolve plural pronouns in Korean discourse computationally. This paper will be a small stepping stone to the resolution of plural pronouns in that it aims to resolve third-person plural pronouns in Korean on the basis of information about constraints on them, and to implement a method of

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[1] For syntactic account of how to resolve singular pronouns in a single English sentence, see Chomsky 1981, Evans 1980, Lees and Klima 1963, and Wasow 1975. In addition, for the interpretation of singular pronouns with relation to quantifiers in the framework of situation semantics, see the following works: Barwise and Perry 1983, Devlin 1991, and Gawron and Peters 1990. Furthermore, for the approach that uses pragmatic factors such as viewpoint and empathy in resolving singular pronouns, see Cantrall (1974), Fludernik (1993), Kuno and Kaburaki (1977), and Zribi-Hertz (1989).

resolving them on the computer, using Prolog programming language.

1.1. Glance at Korean Syntax

Let us first look at the structure of a Korean sentence briefly before we consider third-person plural pronouns in Korean. While English is an SVO language, Korean is an SOV language. Let us take a look at the following example.[2]

(1) Susan-i   kwiyewun   sonyen-eykey
        nom   cute   boy dat
    chayk-ul cwuessta.
    book-acc gave
    'Susan gave a book to a cute boy.'

As shown in (1), a verb occurs after an object, and a case marker attaches to an NP. An indefinite determiner does not appear before a common noun. Thus, the tree structure for the above example sentence is as illustrated in (2).

(2)
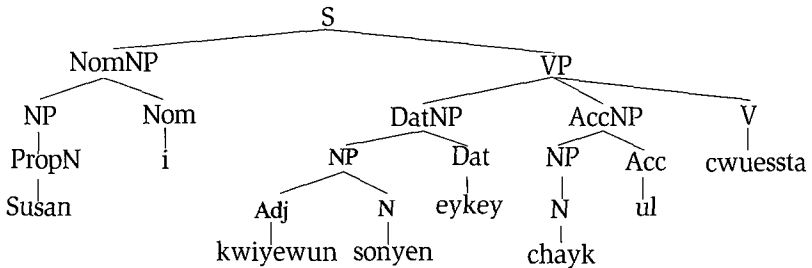
In this paper, the structure of a Korean sentence is added as an argument in the framework of DCG (Definite Clause Grammar).[3] For example, the

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2) The abbreviations used in the glosses are as follows:
   nom: nominative case marker   acc: accusative case marker
   dat: dative case marker   top: topic marker
   postp: postposition   relclm: relative clause marker
   hum: human property   fem: female property
   nonhum: nonhuman property   hon: honorific property

3) For information about DCG, see Covington 1994, Gal et al. 1991, Gazdar and Mellish 1989,

grammar for the VP in sentence (1) is roughly as shown in (3).[4]

(3) vp(vp/[DatNP,AccNP,V],...) --> datnp(DatNP,...),
                                    accnp(AccNP,...),
                                    v(V,...).

1.2. Third-Person Plural Pronouns

There are three third-person plural pronouns in Korean. Depending on the property of a group, a different plural pronoun is used to refer to the group. The plural pronoun *kutul* generally refers to a group composed of human beings, whereas the plural pronoun *kunyetul* specifically refers to a female human group. Since female human beings are a subset of human beings, the pronoun *kutul* may also be used in the case where the pronoun *kunyetul* is used. The plural pronoun *kukestul* refers to a group composed of nonhuman entities. The table in (4) shows a classification of the three plural pronouns on the basis of the features such as [±human] and [±female].

(4) Classification of Third-Person Plural Pronouns in Korean[5]

Plural Pronoun	Features
kutul	+human
kunyetul	+human, +female
kukestul	-human

The organization of this paper is as follows: in Section 2 plural pronouns are analyzed in the context of discourse, and a method of resolving them is proposed and explained. Section 3 gives a detailed analysis of the researcher's computational implementation of resolving plural pronouns. Section 4 discusses the cases to which the resolution method proposed in this paper does not seem to apply at first sight.

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and Pereira and Shieber 1987.

4) Irrelevant arguments are disregarded here.

5) Because the first-person and second-person plural pronouns are not relevant to this paper, they are not treated here.

Section 5 presents an area to which the computational implementation can be extended through the addition of constraints. Section 6 mentions a remaining issue on which deeper research needs to be conducted. Finally, Section 7 sums up the contributions this paper has made and mentions a possible application.

2. A Proposal for the Resolution of Plural Pronouns

2.1. Plural Pronouns in Discourse

In order to understand how the system of plural pronouns works, let us consider the three plural pronouns one by one in the context of discourse.

First, the discourse in which the plural pronoun *kutul* appears is shown in (5).

(5) a. John-i   phathi-ey   Mary-lul   teylikokassta.
         nom   party-postp   acc   took
    b. kutul-un   culkepkey   chwumchwuessta.
       they(hum)-top   pleasantly   danced
       'John took Mary to a party. They danced pleasantly.'

The plural pronoun *kutul* in (5b) refers to the group of human beings whose members are *John* and *Mary*. The NP *phathi* cannot be included in the group which acts as the antecedent for the plural pronoun *kutul* because the NP does not refer to a human being.

Second, let us look at the discourse in which the plural pronoun *kunyetul* appears.

(6) a. Susan-eykey chayk-ul   pillyecwu-n
           dat   book-acc   lend relclm
       akassi-ka   sanchaykhanta.
       young lady-nom   takes a walk
    b. kunyetul-un   sosel-ul   cohahanta.
       they(fem)-top   fiction-acc   like
       'A young lady who lent a book to Susan takes a walk. They like fiction.'

Since the plural pronoun *kunyetul* refers to the group of people whose gender is female, only the group comprising *Susan* and *akassi* can be its antecedent in discourse (6). When the plural pronoun *kutul* instead of the pronoun *kunyetul* is used in (6b), the discourse is also coherent. Because both *Susan* and *akassi* are human beings, the plural pronoun *kutul* can resolve to the group consisting of them.

On the other hand, if the plural pronoun *kunyetul* replaces the plural pronoun *kutul* in (5b), the discourse in (5) becomes incoherent. In this case it is not possible to construct a group comprised of only female human beings because just one female human being (that is, *Mary*) is available in the discourse. Thus, the plural pronoun *kunyetul* cannot resolve under this situation.

Finally, the discourse where the plural pronoun *kukestul* occurs is shown in (7).

(7) a. Bill-i   nayngcangko-lul   sassta.
          nom   refrigerator-acc   bought
    b. Nancy-ka   seythakki-lul   sassta.
          nom   washer-acc   bought
    c. kukestul-un   mwukewessta.
      they(nonhum)-top   were heavy
    'Bill bought a refrigerator. Nancy bought a washer. They were heavy.'

In the above discourse the plural pronoun *kukestul* resolves to a group of nonhuman beings (i.e., *nayngcangko* and *seythakki*). No other group can be the antecedent for the pronoun.

2.2. The Proposal

I propose that in order to resolve third-person plural pronouns appearing in Korean discourse, information about constraints on them and about properties of their possible antecedents must be used. Although the method of summation is mentioned to resolve a plural pronoun in English within the framework of DRT (Discourse Representation Theory) (cf. Kamp 1981; Kamp and Reyle 1993), the theory has a serious problem in that it does not provide a method to select the antecedent for a plural pronoun among many possible combinations of accessible NPs. For example,

DRT incorrectly predicts that each DRS (Discourse Representation Structure) illustrated in (8) may be an interpretation of the discourse shown in (7).[6]

(8) (a)

x y z w U
Bill(x)
Nancy(y)
nayngcangko(z)
seythakki(w)
sassta(x,z)
sassta(y,w)
U=z ⊕ w
mwukewessta(U)

(b)

x y z w U
Bill(x)
Nancy(y)
nayngcangko(z)
seythakki(w)
sassta(x,z)
sassta(y,w)
U=x ⊕ y ⊕ z
mwukewessta(U)

(c)

x y z w U
Bill(x)
Nancy(y)
nayngcangko(z)
seythakki(w)
sassta(x,z)
sassta(y,w)
U=y ⊕ z ⊕ w
mwukewessta(U)

(d)

x y z w U
Bill(x)
Nancy(y)
nayngcangko(z)
seythakki(w)
sassta(x,z)
sassta(y,w)
U=x ⊕ y ⊕ z ⊕ w
mwukewessta(U)

Among the DRSs shown in (8), only the one in (8a) correctly represents discourse (7). The reason many incorrect interpretations come out in DRT is that in resolving a plural pronoun, the theory does not use information about constraints related to the pronoun. On the contrary, if such information together with properties related to discourse referents is used according to the researcher's proposal, only correct interpretation can be obtained, as illustrated in (9).

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6) According to DRT, the total number of possible DRSs that represent the discourse in (7) is actually eleven $(11={_4}C_4+{_4}C_3+{_4}C_2)$ since four discourse referents are available.

(9)

x y z w U
Bill(x) human(x) male(x) Nancy(y) human(y) female(y) nayngcangko(z) nonhuman(z) seythakki(w) nonhuman(w) sassta(x,z) sassta(y,w) U=z ⊕ w mwukewessta(U)

In DRS (9), only nonhuman entities are included in the antecedent for the plural pronoun *kukestul* on the basis of the constraint on the pronoun.

The computational implementation of the researcher carries out the proposal on the computer by filtering out discourse referents that cannot be the antecedent for a plural pronoun through the use of constraints on the pronoun and available discourse referents. In the implementation of the resolution of plural pronouns, a DRS is represented as a Prolog list which has two members. The first member is a list whose members are discourse referents, and the second member is a list which has discourse conditions as its members. The antecedent for a plural pronoun is also a list whose members are discourse referents which satisfy the constraints on the plural pronoun. Thus, in the computational implementation, the DRS form that corresponds to (9) is as illustrated in (10).

(10) [[X,Y,Z,W],
        [named(X,bill),human(X),male(X),
          named(Y,nancy),human(Y),female(Y),
          nayngcangko(Z),nonhuman(Z),
          seythakki(W),nonhuman(W),
          sassta(X,Z),
          sassta(Y,W),
          mwukewessta([Z,W])]]

In (10) the Prolog variables X, Y, Z, and W refer to the entities that were mentioned in discourse (7), namely, *Bill, Nancy, nayngcangko,* and

seythakki, respectively. For each referent, its property is specified (for example, nonhuman(W)). The result of resolving the plural pronoun in (7c) on the basis of properties related to entities is indicated by [Z,W]. This means that the plural pronoun refers to the group consisting of Z and W (that is, *nayngcangko* and *seythakki*).

3. Computational Implementation of Plural Pronoun Resolution

The implementation of the way the plural pronouns resolve is partly based on Chapter 7 of Cooper et al. 1994.[7] By incorporating information about the structure of a sentence in DCG[8], the computational implementation shows that if a sentence in a discourse is syntactically grammatical but semantically unacceptable (for example, when a plural pronoun cannot be resolved), the DRS for the whole discourse is not constructed.[9]

3.1. Input and Output of the Resolution System

The implemented system takes as input the sentences in a discourse. For example, in the case of discourse (7), the input in Prolog is as illustrated in (11).[10]

(11) [[bill,i,nayngcangko,lul,sassta],[nancy,ka,seythakki,lul,sassta], [kukestul,un,mwukewessta]]

As shown in the above input, the whole discourse as well as each sentence in the discourse is represented as a Prolog list.

The system returns as output the syntactic structure for the sentences

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7) In that chapter, however, only the resolution of singular pronouns in English is dealt with.

8) The reasons DCG is used in the computational implementation are as follows:
  (a) The parsing of each sentence occurring in a discourse can be done efficiently.
  (b) The tree structure of a sentence can be displayed neatly.
  (c) Information about constraints, gaps, and threading can be represented as a single argument.
  (d) DCG in Prolog is similar to Context-Free Grammar(CFG) used in theoretical linguistics.

9) For a sample run of this case, look at the appendix.

10) For the Prolog programming language, see Bratko (2001), Clocksin and Mellish (1987), O'Keefe (1990), and Sterling and Shapiro (1994).

in a discourse and the DRS for the discourse, if a plural pronoun can resolve in the given discourse. On the contrary, if the plural pronoun cannot resolve, no DRS is produced.

3.2. Treatment of a Gap

A gap may appear in a sentence occurring within a relative clause. In the implementation, the gap information is passed from one constituent to another constituent by the argument carrying the gap information, as shown in (12).

(12) s(...,GapIn-GapOut,...) --> nomnp(...,GapIn-GapMid,...),
                                        vp(...,GapMid-GapOut,...).

For example, let us consider how to treat the gap that appears in a relative clause of sentence (13).[11]

(13) Susan-eykey   chayk-ul   pillyecwu-n
              dat   book-acc   lend   relclm
     akassi-ka   sanchaykhanta.
     young lady-nom   takes a walk
     'A young lady who lent a book to Susan takes a walk.'

As illustrated in (13), the sentence in a relative clause is followed by a relative clause marker and then by the head noun in Korean. This array of constituents is in the reverse order of the corresponding constituents in English. The sentence in (13) is treated by the grammar in (14).

(14) a. s(s/[NomNP,VP],GapIn-GapOut,...) -->
                          nomnp(NomNP,GapIn-GapMid,...),
                          vp(VP,GapMid-GapOut,...).
     b. nomnp(nomnp/[OptRelCl,NP,NomCase],Gap-Gap,...) -->
                          optrelcl(OptRelCl,[]-[],...),
                          np(NP,...),
                          nomcase(NomCase).

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11) The sentence in (13) is the same as the sentence in (6a). It is repeated here for expository purpose.

   c. optrelcl(relcl/[RelS,RelClM],[]-[],...) -->
                rels(RelS,[cat(relnomnp),X]-[],...),
                relclm(RelClM,...).
   d. rels(rels/[RelNomNP,VP],GapIn-GapOut,...) -->
                relnomnp(RelNomNP,GapIn-GapMid,...),
                vp(VP,GapMid-GapOut,...).
   e. relnomnp(relnomnp/gap,[cat(relnomnp),X]-[],...) -->
                [].

The argument '[cat(relnomnp),X]-[]' appearing in (14c) means that a gap occurs in a subject NP of a relative clause. This gap is filled by a head noun as shown in (14b). Thus, no gap occurs in the constituent consisting of a relative clause and its head noun.

3.3. Constraints on Discourse Referents

Just a common noun in Korean corresponds to an indefinite NP in English. A common noun always introduces a new discourse referent to a current DRS. In addition, the constraints on a common noun are added in the discourse conditions of the current DRS. For example, the entry for the common noun *chayk* 'book' is as shown in (15).

   (15) noun(n/chayk, Glob-Glob,
        [Dom,Constr]-[[X|Dom],[chayk(X),nonhuman(X)|Constr]],
            X^chayk(X)) --> [chayk].

The second argument 'Glob-Glob' means that the common noun adds a discourse referent to a local DRS, not to a global DRS. By the third argument it is meant that the discourse referent for the common noun is added to the domain of the local DRS, and the constraints on the discourse referent such as 'chayk(X)' and 'nonhuman(X)' are added to the discourse conditions of the local DRS. The constraint 'nonhuman(X)' plays an important role in deciding whether the discourse referent X can be included in the antecedent for a plural pronoun.

A proper noun introduces a new discourse referent and constraints on the discourse referent to the global DRS, only if the discourse referent does not already exist there. In the lexical entry for the proper noun 'Mary', which is shown in (16), the predicate 'check_add/3' takes such a role.

(16) proper_noun(propn/mary,GlobIn-GlobOut,DRS-DRS,X) -->
        [mary],
        {check_add(X,[named(X,mary),human(X),female(X)],
                GlobIn,GlobOut)}.

During the collection of the discourse referent which can be included in the antecedent for a plural pronoun, the constraints such as 'human(X)' and 'female(X)' shown in (16) are taken into account.

3.4. Computational Resolution of Plural Pronouns

A pronoun does not introduce a new discourse referent. In the case of a singular pronoun, its antecedent is a discourse referent that was introduced into a DRS and that satisfies the constraint on the singular pronoun. On the other hand, in order to resolve a plural pronoun it is necessary to collect all discourse referents that meet the constraint on the plural pronoun.

Let us first consider how to resolve the plural pronoun *kutul*. This pronoun refers to a group composed of human beings. To create the antecedent for the pronoun, the discourse referents that satisfy the constraint 'human(X)' in both the local DRS and the global DRS are collected. Thus, the lexical entry for the plural pronoun *kutul* is as shown in (17).

(17) pronoun(pronoun/kutul,Glob-Glob,DRS-DRS,Xs) -->
        [kutul],
        { check(X,[human(X)],DRS); check(X,[human(X)],Glob) },
        { check(Y,[human(Y)],DRS); check(Y,[human(Y)],Glob) },
        {X \== Y},
        {append([X],[Y],Xs)}.

As illustrated in the above entry, the plural pronoun *kutul* resolves to a list whose members are discourse referents that have the property of 'human'.

Second, the resolution of the plural pronoun *kunyetul* is very similar to that of the pronoun *kutul*. Since the pronoun *kunyetul* refers to a group consisting of female human beings, the discourse referent which can be included in the antecedent for the pronoun must have the property of 'human' and 'female'. The lexical entry for the plural pronoun *kunyetul*

is as illustrated in (18).

(18) pronoun(pronoun/kunyetul,Glob-Glob,DRS-DRS,Xs) -->
    [kunyetul],
    { check(X,[human(X),female(X)],DRS);
      check(X,[human(X),female(X)],Glob) },
    { check(Y,[human(Y),female(Y)],DRS);
      check(Y,[human(Y),female(Y)],Glob) },
    {X \== Y},
    {append([X],[Y],Xs)}.

When comparing the two lexical entries in (17) and (18), it can be recognized that the constraint on the plural pronoun *kunyetul* is stricter than that on the pronoun *kutul*. As a result of this, the discourse referents which can be included in the antecedent for the pronoun *kunyetul* can also be included in the antecedent for the pronoun *kutul*. Therefore, the plural pronoun *kutul* can be used in the position where the plural pronoun *kunyetul* is used, but not vice versa.[12]

Finally, the plural pronoun *kukestul* resolves to a group consisting of nonhuman beings. Thus, the discourse referents which can be included in the antecedent for the pronoun *kukestul* must have the property of 'nonhuman'. The lexical entry for the pronoun *kukestul*, which is illustrated in (19), shows this constraint.

(19) pronoun(pronoun/kukestul,Glob-Glob,DRS-DRS,Xs) -->
    [kukestul],
    { check(X,[nonhuman(X)],DRS); check(X,[nonhuman(X)],Glob) },
    { check(Y,[nonhuman(Y)],DRS); check(Y,[nonhuman(Y)],Glob) },
    {X \== Y},
    {append([X],[Y],Xs)}.

On the basis of information about above-mentioned constraints on each plural pronoun and properties of discourse referents, the implemented system correctly resolves plural pronouns, as illustrated in (20), which is a sample run of the discourse that has appeared in (6).

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12) When the pronoun *kutul* is used in the position where the pronoun *kunyetul* can be used, the former conveys less information about its antecedent than the latter.

(20) | ?- const_drs([[susan,eykey,chayk,ul,pillyecwu,n,akassi,ka,
                       sanchaykhanta],
                     [kunyetul,un,sosel,ul,cohahanta]],DRS).

```
s
|__nomnp
|  |__relcl
|  |  |__rels
|  |  |  |__relnomnp <gap>
|  |  |  |__vp
|  |  |      |__datnp
|  |  |      |  |__np
|  |  |      |  |  |__propn <susan>
|  |  |      |  |__dat <eykey>
|  |  |      |__accnp
|  |  |      |  |__np
|  |  |      |  |  |__n <chayk>
|  |  |      |  |__acc <ul>
|  |  |      |__v <pillyecwu>
|  |  |__relclm <n>
|  |__np
|  |  |__n <akassi>
|  |__nom <ka>
|__vp
    |__advp <optional>
    |__v <sanchaykhanta>
s
|__topnp
|  |__np
|  |  |__pronoun <kunyetul>
|  |__topmarker <un>
|__vp
    |__accnp
    |  |__np
    |  |  |__n <sosel>
    |  |__acc <ul>
    |__v <cohahanta>
```

DRS = [[_A,_B,_C,_D],
         [named(_A,susan),human(_A),female(_A),
         cohahanta([_C,_A],_B),
         sosel(_B),nonhuman(_B),
         sanchaykhanta(_C),
         akassi(_C),human(_C),female(_C),
         pillyecwu(_C,_D,_A),
         chayk(_D),nonhuman(_D)]]

As specified by 'cohahanta([_C,_A],_B),' the plural pronoun *kunyetul* in (6b) correctly resolves to the group of female people (that is, *Susan* and *akassi*).

4. Apparent Counterexamples

Let us look at the cases that seem to be (but, actually are not) counterexamples to the proposed method of resolving plural pronouns in Korean discourse based on information about constraints on them.

4.1. Personification

Depending on the context of discourse, it is possible to personify an entity that is not a human being.

(21) saca-tul-un   kutul-uy   citoca-lul   chwungsilhi   ttalunta.
     lion-plural-top they(hum)-gen leader-acc   faithfully   follow
     'Lions follow their leader faithfully.'

In sentence (21), lions, which belong to an animal, are referred to by the plural pronoun *kutul*. At first sight, the sentence seems to be a counterexample to the proposed approach in that the plural pronoun resolves to nonhuman entities. But, I claim that sentence (21) is not a real counterexample. In the sentence lions are personified by a narrator. Since they are personified, they can naturally resolve to the pronoun *kutul*, which refers to a group of people.

It depends on the perspective or viewpoint of a narrator whether an entity is personified or not in discourse. Thus, the phenomenon of personification is a subjective matter. If the viewpoint of a narrator about

a certain entity appearing in discourse is incorporated in the current approach using the feature [+personified], the resolution of a plural pronoun related to personification can also be treated.

4.2. Derogatory-Expression

When a narrator has an antipathy towards a group of people, they may be referred to by the plural pronoun *kukestul* that resolves to a group of nonhuman entities.

(22) Soojin-kwa Jongho,   kukestul-un   yaksok-ul   an   cikhinta.
             and   they(nonhum)-top promise-acc not   keep
        'As for Soojin and Jongho, they don't keep a promise.'

At first glance, the sentence in (22) appears to be a counterexample to the proposed approach since people are referred to by the plural pronoun *kukestul*. But, the sentence is not a real counterexample. The reason is that the narrator of sentence (22) doesn't like *Soojin* and *Jongho*, and regard them as nonhuman beings by referring to them through the use of the plural pronoun *kukestul*. This means that the attitude or feeling of a narrator toward a group of people mentioned in discourse has an effect on the choice of plural pronoun that refers to them. If these factors are incorporated in the current approach using the feature [+derogatory], the resolution of a plural pronoun that is used as a derogatory expression can also be explained clearly.

5. Further Study

Due to honorification phenomenon occurring in Korean discourse, the honorific plural pronoun *kupwuntul* is used when a narrator shows respect to a group of people mentioned in discourse.

(23) a. Hong sacang-nim-kwa   Min   sacang-nim-i
            president-hon-and   president-hon-nom
         Jung   pwucang-ul   taytonghako
            department director-acc   being accompanied by
         Soklisan-ulo   ttenasiessta.
         Mount Sokli-postp   left(hon)

b. kupwuntul-un   tungsan-ul   cohahasinta.
    they(hon)-top   mountain climbing-acc   like(hon)
'President Hong and president Min left for Mount Sokli, being
accompanied by department director Jung. They like mountain
climbing.'

The honorific plural pronoun *kupwuntul* in sentence (23b) refers to the
group of two people (that is, *president Hong* and *president Min*). The
reason is that only these two people are honored in sentence (23a) by the
narrator of discourse (23). Honorification in Korean depends on factors
such as social rank, seniority, kinship, and characteristics of the group to
which people who are involved in discourse belong. If these factors are
taken into consideration, the proposed approach can deal with the
resolution of the honorific plural pronoun properly. When the feature [±
honorific] is added to account for the honorific plural pronoun, the
system of plural pronouns in Korean is as illustrated in (24).

(24)

Plural Pronoun	Features
kutul	+human, -honorific
kunyetul	+human, +female, -honorific
kupwuntul	+human, +honorific
kukestul	-human, -honorific

6. Remaining Issue

The method of DRS threading by which the output DRS for the
previous sentence is the input DRS for the following sentence, and the
method of summation by which discourse referents are collected on the
basis of the information about constraints on plural pronouns cannot deal
with all types of plural pronoun resolution. Let us consider the discourse
shown in (25).

(25) a. Sue-ka   kukcang-eyse   Bill-ul   manassta.
        nom   theater-postp   acc   met
    b. John-i   phathi-ey   Mary-lul   teylikokassta.
        nom   party-postp   acc   took

c. kutul-un   cengcang-ul   hayessta.
   they(hum)-top   full dress-acc   did
   'Sue met Bill at a theater. John took Mary to a party. They were in
   full dress.'

As SDRT (Segmented Discourse Representation Theory)[13] predicts, the plural pronoun *kutul* in (25c) resolves to a group composed of *John* and *Mary* or to a group consisting of *Sue, Bill, John,* and *Mary.* No other group can be the antecedent for the pronoun. Within the current implementation, however, besides these two groups, any group whose members are collected from those four persons can be regarded as the antecedent for the plural pronoun *kutul.* To treat this type of resolution the construction of a more refined and hierarchical DRS based on the classification of events mentioned in discourse must be developed.

7. Concluding Remarks

In this paper I have shown that by means of DRS threading, the discourse referents that are available to the resolution of a plural pronoun are determined. I have also shown that the constraints on a plural pronoun play a decisive role in the selection of the discourse referents which can be included in the antecedent for the plural pronoun. Among the available discourse referents, only those that meet the constraint on a certain plural pronoun can be included in the antecedent for the pronoun.

The computational implementation explained and demonstrated in this paper has successfully embodied this idea by incorporating the relevant constraints in the lexical entry for a common noun, a proper noun, and a plural pronoun.

Therefore, this paper has shown a method of resolving plural pronouns appearing in Korean discourse linguistically and computationally. The method of resolving plural pronouns on the basis of constraints on them may also be applied without substantial modification to the resolution of definite NPs such as *ku tositul* 'the cities', *ku aitul* 'the children' and so on.

---

13) For a detailed explanation of SDRT, see Asher (1993).

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Appendix A: Part of Prolog Code

This Prolog code is a part of source code that implements the idea of resolving Korean plural pronouns, using DCG grammar. The code contains information about gap threading and DRS threading.

```
/*  ------  Main Predicate for DRS Construction  ------  */
% construct_drs/2 accepts a list of sentences, and then returns the
% structure trees for the sentences and DRS for the discourse

const_drs(Discourse,DRS) :-
      construct_drs3(Discourse,[[],[]]-GlobOut,[[],[]]-DRSOut),
      merge_drs(GlobOut,DRSOut,DRS).
      % combines global DRS and local DRS into whole DRS

construct_drs3([],Glob-Glob,DRS-DRS).
construct_drs3([Sent|Disc],GlobIn-GlobOut,DRSIn-DRSOut) :-
      const_drs_sent(Sent,GlobIn-GlobMid,DRSIn-DRSMid),
      construct_drs3(Disc,GlobMid-GlobOut,DRSMid-DRSOut).
const_drs_sent(Sent,GlobIn-GlobOut,DRSIn-DRSOut) :-
      s(Tree,[]-[],GlobIn-GlobOut,DRSIn-DRSOut,Sent,[]),
```

```
writetree(Tree),nl.

merge_drs([Dom1,Constr1],[Dom2,Constr2],[Dom,Constr]) :-
      append(Dom1,Dom2,Dom),
      append(Constr1,Constr2,Constr).
```

```
/* ================================================================
                              GRAMMAR
   ============================================================== */
```

```
/* --------------------------------------------------------------
                              Sentence
   ------------------------------------------------------------ */
s(s/[NomNP,VP],GapIn-GapOut,            % NomNP is a constituent
      GlobIn-GlobOut,                   % comprised of NP and
      DRSIn-DRSOut) -->                 % a nominative case marker
            nomnp(NomNP,GapIn-GapMid,
                    GlobIn-GlobMid,
                    DRSIn-DRSMid,
                    X),
            vp(VP,GapMid-GapOut,
                    GlobMid-GlobOut,
                    DRSMid-DRSOut,
                    X^_Formula).
```

```
/* --------------------------------------------------------------
                            Noun Phrase
   ------------------------------------------------------------ */
np(np/[Noun],                           % NP may dominate a common
      GlobIn-GlobOut,                   % noun alone in Korean
      DRSIn-DRSOut,
      X) -->
            noun(Noun,
                    GlobIn-GlobOut,
                    DRSIn-DRSOut,
                    X^_).
np(np/[ProNoun],                        % NP dominates a pronoun
      GlobIn-GlobOut,
```

```
                DRSIn-DRSOut,
                X) -->
                     pronoun(ProNoun,
                               GlobIn-GlobOut,
                               DRSIn-DRSOut,
                               X).
np(np/[ProperNoun],                      % NP dominates a proper noun
        GlobIn-GlobOut,
        DRSIn-DRSOut,
        X) -->
             proper_noun(ProperNoun,
                         GlobIn-GlobOut,
                         DRSIn-DRSOut,
                         X).


/* ---------------------------------------------------------------
                          Verb Phrase
   ------------------------------------------------------------- */
vp(vp/[AccNP,TransV],GapIn-GapOut,
        GlobIn-GlobOut,
        DRSIn-DRSOut,
        X^Formula) -->
             accnp(AccNP,GapIn-GapOut,
                         GlobIn-GlobMid,
                         DRSin-DRSMid,
                         Y),
                  trans_verb(TransV,            % a transitive verb
                             GlobMid-GlobOut,    % takes two arguments
                             DRSMid-DRSOut,      % (namely, a subject
                             Y^X^Formula).       % and an object)


/* ===============================================================
                          LEXICON
   =========================================================== */


/* ---------------------------------------------------------------
                         Common Noun
   ------------------------------------------------------------- */
```

```
% The discourse referent for a common noun and the information
% about properties of the common noun are added to the local DRS


noun(n/sosel,                                  % fiction
        Glob-Glob,
        [Dom,Constr]-[[X|Dom],[sosel(X),nonhuman(X)|Constr]],
        X^sosel(X)) ->
                    [sosel].


/* ----------------------------------------------------------------
                        Transitive Verb
   -------------------------------------------------------------- */
trans_verb(v/sassta,                           % bought
        Glob-Glob,
        [Dom,Constr]-[Dom,[sassta(X,Y)|Constr]],
        Y^X^sassta(X,Y)) ->
                    [sassta].
```

Appendix B: Sample Run

For the sake of easy understanding, the input discourse is listed together
with English gloss, and the output DRS is formatted.

------------------------ **Coherent Discourse**   ------------------------
a. Bill-i   nayngcangko-lul   sassta.
    nom   refrigerator-acc   bought
b. Nancy-ka   seythakki-lul   sassta.
      nom   washer-acc   bought
c. kutul-un   kukestul-ul   philyolohayessta.
    they(hum)-top   they(nonhum)-acc   needed
'Bill bought a refrigerator. Nancy bought a washer. They needed them.'

```
| ?- const_drs([[bill,i,nayngcangko,lul,sassta],
                [nancy,ka,seythakki-,lul,sassta],
                [kutul,un,kukestul,ul,philyolohayessta]],DRS).
s
 |__nomnp
```

```
|  |__relcl <optional>
|  |__np
|  |  |__propn <bill>
|  |__nom <i>
|__vp
   |__accnp
   |  |__np
   |  |  |__n <nayngcangko>
   |  |__acc <lul>
   |__v <sassta>
s
 |__nomnp
 |  |__relcl <optional>
 |  |__np
 |  |  |__propn <nancy>
 |  |__nom <ka>
 |__vp
    |__accnp
    |  |__np
    |  |  |__n <seythakki>
    |  |__acc <lul>
    |__v <sassta>
s
 |__topnp
 |  |__np
 |  |  |__pronoun <kutul>
 |  |__topmarker <un>
 |__vp
    |__accnp
    |  |__np
    |  |  |__pronoun <kukestul>
    |  |__acc <ul>
    |__v <philyolohayessta>

DRS = [    [_A,_B,_C,_D],
           [named(_A,nancy),human(_A),female(_A),
           named(_B,bill),human(_B),male(_B),
           philyolohayessta([_A,_B],[_C,_D]),
           sassta(_A,_C),
```

```
seythakki(_C),nonhuman(_C),
sassta(_B,_D),
nayngcangko(_D),nonhuman(_D) ] ] ?
```

yes
| ?-

------------------------------   **Incoherent Discourse**   ------------------------

a. John-i   phathi-ey   Mary-lul   teylikokassta.
   nom   party-postp   acc   took
b. # kunyetul-un   culkepkey   chwumchwuessta.
   they(fem)-top   pleasantly   danced
'John took Mary to a party. They(?) danced pleasantly.'

Since the plural pronoun *kunyetul* cannot resolve in the discourse, the DRS
for the discourse is not constructed as shown below.

```
| ?- const_drs([[john,i,phathi,ey,mary,lul,teylikokassta],
                [kunyetul,un,culkepkey,chwumchwuessta]],DRS).
s
|__nomnp
|  |__relcl <optional>
|  |__np
|  |  |__propn <john>
|  |__nom <i>
|__vp
   |__postph
   |  |__np
   |  |  |__n <phathi>
   |  |__posp <ey>
   |__accnp
   |  |__np
   |  |  |__propn <mary>
   |  |__acc <lul>
   |__v <teylikokassta>
```

no
| ?-

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