Patterns of Temporal Adverbials and Their Modification of Verbs in Complex Sentences of Korean Weather News

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This paper classifies and analyzes the patterns of the occurrence of temporal adverbials in complex sentences that appear in the domain of Korean weather news and then suggests the ways to determine whether these adverbials modify the main verb or the verb in the embedded clause. It also implements these methods in the computer programming language Prolog and shows a sample run for each pattern of the occurrence of temporal adverbials. Since weather situations are closely related to time, the analysis of these adverbials is helpful in doing machine translation of complex sentences containing them into English correctly.

Key words: temporal adverbials, complex sentence, corpus of Korean weather news, implementation of modification of verbs, Prolog programming language

1. Introduction

(LOB) Corpus, the Brown Corpus, and the Longman-Lancaster Corpus. Mair (1995) analyzed the types of verb complements that follow the verb *help* by using the LOB Corpus and the Freiburg-Lancaster-Oslo-Bergen (FLOB) Corpus.

In line with this tendency, this paper first shows the patterns of the occurrence of temporal adverbials in complex sentences that occur in the domain of Korean weather news on the basis of the corpus collected from that domain. In the restricted domain of weather news temporal adverbials indicating a time point or the duration of time frequently occur. When a temporal adverbial occurs in simple sentences that consist of a single clause, it modifies the verb of these sentences. On the other hand, when a temporal adverbial occurs in complex sentences that consist of a main clause and an embedded clause, the question of whether the adverbial modifies the main verb or the embedded verb arises. This paper presents the method of recognizing the verb a temporal adverbial in a complex sentence modifies with regard to each pattern of its occurrence. Furthermore, it implements this method on a computer on the basis of Prolog programming language and demonstrates a sample run for each pattern.

The organization of this paper is as follows. Section 2 explains the collection of Korean weather news from various daily newspapers. In section 3 nine patterns of the occurrence of a temporal adverbial in a complex sentence are presented, and the explanation of its modification of a verb in each pattern is also made. In addition, the characteristics that can be drawn from these patterns are discussed. In section 4 the methods of finding the verb a temporal adverbial modifies in a complex sentence are implemented based on Prolog, and sample runs are shown. Finally, in section 5 concluding remarks are made, and the usefulness of the analysis of temporal adverbials to the machine translation of Korean weather news into English is mentioned.

2. Collected Korean Weather News

Weather varies time to time and thus temporal adverbials frequently occur in the domain of the news conveying weather situations. The corpus of Korean weather news was built on the basis of various sources as shown in Table 1.
Table 1. Data of Collected Korean Weather News

<table>
<thead>
<tr>
<th>Sources</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The Herald Business, The Korea Economic Daily</td>
<td></td>
</tr>
<tr>
<td>Maeli Business Newspaper, The Hankyoreh</td>
<td></td>
</tr>
<tr>
<td>Munhwa Daily Newspaper, Joongang Daily Newspaper</td>
<td></td>
</tr>
<tr>
<td>Kyunghyang Newspaper, Chosun Daily Newspaper</td>
<td></td>
</tr>
<tr>
<td>Hankook Daily Newspaper, Donga Daily Newspaper</td>
<td></td>
</tr>
<tr>
<td>Kookmin Daily Newspaper</td>
<td></td>
</tr>
<tr>
<td>Period</td>
<td>January 2002 - December 2003</td>
</tr>
<tr>
<td>Number of Sentences</td>
<td>1,045</td>
</tr>
<tr>
<td>Number of Words</td>
<td>18,927</td>
</tr>
</tbody>
</table>

Since complex sentences containing temporal adverbials do not appear in the weather news that is provided only through a web site, articles on weather news appearing in many daily newspapers were collected. The collected weather news covers the period of January 2002 to December 2003 and contains 1,045 sentences in total. In the corpus a total of 18,927 words occurs and thus the average length of sentences is 18.1 (18,927/1,045).

In the collected weather news a total of 243 complex sentences that contain a temporal adverbial appears. An example is illustrated in (1).1)

(1) Kisangcheng-un 28-il malk-un hanul-kwa Meteorological Administration(MA)-top day clear-mod sky-and sinsenha-n palam-i pwu-nun cenhyengcek-in kaul nalssi-nun fresh-mod wind-nom blow-mod typical fall weather-top 9-wel haswun-pwuthe kanungha-l kes-ulo yeypohayss-ta. September latter part-from possible-fut thing-comp forecast(pst)-dec ‘Meteorological Administration(MA) forecast on the 28th that typical fall weather with clear skies and fresh winds would be possible from late September.’ [Munhwa Daily Newspaper: August 29, 2003]

1) In the glosses the following abbreviations are used.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>top</td>
<td>topic</td>
</tr>
<tr>
<td>mod</td>
<td>modifier</td>
</tr>
<tr>
<td>nom</td>
<td>nominative</td>
</tr>
<tr>
<td>fut</td>
<td>future</td>
</tr>
<tr>
<td>ptp</td>
<td>postposition</td>
</tr>
<tr>
<td>pst</td>
<td>past</td>
</tr>
<tr>
<td>comp</td>
<td>complementizer</td>
</tr>
<tr>
<td>gen</td>
<td>genitive</td>
</tr>
</tbody>
</table>
In sentence (1) the temporal adverbial 28-il occurs in the main clause and modifies the main verb yeypohayss-ta, whereas the adverbial 9-wel haswan-pwuthe occurs in the embedded clause and modifies the verb kanungha-l. It is important to recognize the verb a temporal adverbial modifies in complex sentences that occur in the corpus of Korean weather news in order to catch the meaning of these sentences and translate them into English correctly.

3. Patterns of the Occurrence of Temporal Adverbials

Depending on whether a temporal adverbial occurs once or twice in a complex sentence, whether it appears in the main clause, whether the embedded clause is surrounded by double quotation marks, and whether the main clause follows the embedded clause, there are diverse patterns of its occurrence as illustrated in Table 2.  

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Skeleton</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MS+TA1+DQ (...) TA2 ... DQ</td>
<td>66</td>
<td>27.1%</td>
</tr>
<tr>
<td>2</td>
<td>MS+DQ+TA ... DQ</td>
<td>38</td>
<td>15.6%</td>
</tr>
<tr>
<td>3</td>
<td>MS+DQ ... TA ... DQ ...</td>
<td>31</td>
<td>12.8%</td>
</tr>
<tr>
<td>4</td>
<td>MS+TA+DQ ... DQ</td>
<td>14</td>
<td>5.8%</td>
</tr>
<tr>
<td>5</td>
<td>MS+DQ+TA1 ... DQ+CP+TA2 ...</td>
<td>6</td>
<td>2.5%</td>
</tr>
<tr>
<td>6</td>
<td>MS+TA ...</td>
<td>41</td>
<td>16.9%</td>
</tr>
<tr>
<td>7</td>
<td>MS (...) ES ... TA ... CP</td>
<td>26</td>
<td>10.7%</td>
</tr>
<tr>
<td>8</td>
<td>... TA ... MS+MV</td>
<td>13</td>
<td>5.3%</td>
</tr>
<tr>
<td>9</td>
<td>MS+TA1 ... TA2 ... CP</td>
<td>8</td>
<td>3.3%</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>243</td>
<td>100%</td>
</tr>
</tbody>
</table>

As shown in Table 2, 243 complex sentences that contain a temporal adverbial and appear in the collected Korean weather news can be classified into nine patterns. In Korean weather news the part enclosed by

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2) The abbreviations used in the table are as follows:

- **MS**: Main Subject
- **TA**: Temporal Adverbial
- **CP**: Complementizer
- **ES**: Embedded Subject
- **DQ**: Double Quotation Mark
- **MV**: Main Verb
double quotation marks indicates an embedded clause. Nearly 64% of 243 complex sentences (that is, those sentences that belong to Pattern 1-5) have double quotation marks. The pattern of a complex sentence that occurs most frequently is Pattern 1, in which two temporal adverbials are contained and one of them appears before a double quotation mark. The pattern that occurs second most frequently is Pattern 6, in which double quotation marks do not appear and only one temporal adverbial appears immediately after the main subject. The pattern that occurs least frequently is Pattern 5, in which one temporal adverbial appears in an embedded clause and the other temporal adverbial appears immediately after a complementizer that indicates the end of an embedded clause.

Let us look at the nine patterns one by one with examples and discuss their characteristics.

First, in Pattern 1 one temporal adverbial appears after the main subject but before the embedded clause in which the other temporal adverbial appears, and the embedded clause is enclosed by double quotation marks as shown in (2).

(2) Kisangcheng-un 3-il “4-il-ey-nun cenkwuk-ey nwun ttonun MA-top day day-ptp-top whole nation-ptp snow or pi-ka cokum nayli-myense sewul-uy achim kion-i rain-nom a little fall-ptp Seoul-gen morning temperature-nom yengha 4-to-kkaci olaka-l kes”-ilako yeypohayss-ta. below zero degree-to go up-fut thing-comp forecast(pst)-dec ‘Meteorological Administration forecast on the 3rd that as snow or rain would fall a little in the whole nation on the 4th, the morning temperature in Seoul would go up to 4 degrees below zero.’ [Hankook Daily Newspaper: January 4, 2002]

In this type of complex sentences the temporal adverbial that modifies a main verb is clearly recognized thanks to the occurrence of double quotation marks. That is, the temporal adverbial that appears outside the marks modifies the main verb yeypohayss-ta. In other words, the temporal adverbial appearing inside the marks cannot modify the main verb.

Second, in Pattern 5 one of two temporal adverbials appears after the complementizer as illustrated in (3).
(3) Kisangcheng-un “11-il ceoycwuto-wa namhayan cipang-ul MA-top day Jeju Island-and southern coast province-acc cwungsim-ulo chendwung-kwa penkay-lul tongpanha-n center-tpn thunder-and lightning-acc accompany-mod manh-un pi-ka o-keyss-ta”ko 10-il yeypohayss-ta. much-mod rain-nom come-fut-dec-comp day forecast(pst)-dec ‘Meteorological Administration forecast on the 10th that much rain accompanied by thunder and lightning would center around Jeju Island and provinces in the southern coast on the 11th.’ [Joongang Daily Newspaper. August 11, 2003]

In sentence (3) the temporal adverbial 10-il appears after the complementizer ko and modifies the main verb. The reason is that the complementizer marks the end of an embedded clause and any temporal adverbial that appears after the complementizer cannot modify the embedded verb.

As illustrated in (2) and (3), the difference between the sentences of Pattern 1 and those of Pattern 5 is that in the former cases the temporal adverbial that modifies the main verb appears before the embedded clause, but in the latter cases it appears after the clause. Despite this small difference, the percentage of Pattern 1 in the collected corpus of weather news is far higher than that of Pattern 5 as shown in Table 2. This result shows that newspaper reporters have a strong tendency to place the time point of a weather forecast before the predicted contents in a complex sentence.

Third, in Pattern 2 only one temporal adverbial appears in a complex sentence, and it appears before other constituents within an embedded clause enclosed by double quotation marks as shown in (4).

(4) Kisangcheng kwankyeyca-nun “5-il-ey sewul-uy MA person concerned-top day-tpn Seoul-gen achim choycekion-i yengha 11-to, morning lowest temperature-nom below zero degree nac choykion-i yengha 4-to-anphakk-ey day highest temperature-nom below zero degree-around-tpn memwulu-l kes'-'ilako yeysanghayss-ta. stay-mod thing-comp predict(pst)-dec ‘The person concerned with MA predicted that on the 5th the morning
low in Seoul would stay around 11 degrees below zero and day high around 4 degrees below zero."
[Donga Daily Newspaper: January 2, 2003]

In sentence (4) the temporal adverbial 5-il-ey modifies the embedded verb mumwulu since the adverbial appears in the embedded clause. In this pattern the embedded clause begins with a temporal adverbial.

Fourth, in Pattern 3 one temporal adverbial appears in a complex sentence whose embedded clause is enclosed by double quotation marks like Pattern 2. The adverbial, however, does not appear initially in the embedded clause as illustrated in (5).

(5) Kisangcheng-un "pi ttaymwuney cenpancekin kion-un
MA-top rain due to overall temperature-top
nacaci-keyss-ciman ceycwuto-ey-nun 11-il pam-ey
drop-fut-tp Jeju Island-tp-top day night-tp
yeltayya-ka yeysangtoynta”-ko palkhyess-ta.
tropical night-nom be predicted(dec)-comp reveal(pst)-dec
‘MA revealed that due to rain the overall temperature would drop, but in Jeju Island a tropical night phenomenon is expected in the night of the 11th.’
[Maeil Business Newspaper: August 10, 2003]

In sentence (5) the temporal adverbial 11-il pam-ey appears in the embedded clause and thus modifies the embedded verb yeysangtoynta. But the adverbial does not appear initially in the clause unlike sentence (4).

The difference between Pattern 2 and Pattern 3 is that in the former case the only temporal adverbial appearing in a complex sentence occurs initially in an embedded clause, whereas in the latter case it does not. The complex sentences of Pattern 2 occur more frequently than those of Pattern 3 in the collected corpus of Korean weather news as shown in Table 2. This result shows that the time to which weather conditions are related is regarded as more important than any other elements appearing in an embedded clause.

Fifth, in Pattern 4 only one temporal adverbial appears in a complex sentence, and it appears before an opening double quotation mark (namely, “) as shown in (6).
In sentence (6) the temporal adverbial 27-il appears outside double quotation marks and thus modifies the main verb yeypohayss-ta. In the collected corpus of Korean weather news, however, the pattern illustrated in (7) is not found.

(7) MS+DQ ... DQ ... TA

In this pattern the only temporal adverbial in a complex sentence appears after the closing double quotation mark (that is, ”). It follows from this that a temporal adverbial has a very strong tendency to appear before an opening double quotation mark when it is the only temporal adverbial in a complex sentence and appears outside double quotation marks.

When the four patterns such as Pattern 1, Pattern 4, Pattern 5, and the pattern in (7) are compared closely as shown in Table 3, a more general conclusion is drawn.

<table>
<thead>
<tr>
<th>Table 3. Comparison of Four Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skeleton</strong></td>
</tr>
<tr>
<td><strong>Double Occurrence</strong></td>
</tr>
<tr>
<td>MS+TA1+DQ (...) TA2 ... DQ (Pattern 1)</td>
</tr>
<tr>
<td>MS+DQ+TA1 ... DQ+CP+TA2... (Pattern 5)</td>
</tr>
<tr>
<td><strong>Single Occurrence</strong></td>
</tr>
<tr>
<td>MS+TA+DQ ... DQ (Pattern 4)</td>
</tr>
<tr>
<td>MS+DQ ... DQ ... TA (Pattern in (7))</td>
</tr>
</tbody>
</table>
The percentage of Pattern 1 is higher than that of Pattern 5. In these two patterns two temporal adverbials appear: one in a main clause and the other in an embedded clause. In addition, the percentage of Pattern 4 is higher than that of the pattern in (7). In these two patterns no temporal adverbial appears in an embedded clause. In four patterns shown in Table 3 a temporal adverbial tends to appear before double quotation marks rather than after them. Thus, when a temporal adverbial appears in a main clause, it is more likely to appear before double quotation marks than after them, irrespective of whether or not another temporal adverbial appears inside them.

Sixth, in Pattern 6 a temporal adverbial appears immediately after the main subject of a complex sentence that contains no double quotation marks as illustrated in (8).

(8) Kisangcheng-un taum-tal-ey taycheylo malk-un
   MA-top next-month-ppp on the whole clear-mod
   nalssi-ka ieci-l kes-ulo naytapwass-ta.
   weather-nom last-fut thing-comp foresee(pst)-dec
   ‘MA foresaw that next month clear weather would last on the whole.’
   [Kookmin Daily Newspaper: April 19, 2002]

In sentence (8) the temporal adverbial \textit{taum-tal-ey} seems to belong to the main clause or the embedded clause at first sight since it appears on the boundary between the two clauses. A closer look at the sentence, however, shows that the temporal adverbial cannot modify the main verb \textit{naytapwass-ta} due to the conflict of tenses related to the two words. That is, the adverbial can modify a verb with future tense, but the main verb has past tense. Thus, it can modify only the embedded verb.

In some cases the information on whether a temporal adverbial refers to a time point or the duration of time plays an important role in finding out the verb the adverbial modifies as shown in (9).

(9) Kisangcheng-un 16-il naynay kion-i yenghakwen-ey
   MA-top day throughout temperature-nom subzero range-ppp
   memwulu-l kes-ulo yeypohayss-ta.
   stay-fut thing-comp forecast(pst)-dec
   ‘MA forecast that throughout the 16th the temperature would stay
below zero.
[The Korea Economic Daily: February 16, 2002]

In (9) the temporal adverbial 16-il nay-nay refers to the duration of time and can modify the embedded verb memwulu. The main verbs of complex sentences that appear in Korean weather news are yeypo-hayss-ta ‘forecast’, yeysanghayss-ta ‘predicted’, palkhyess-ta ‘revealed’, kwanchukhayss-ta ‘observed’, naytapwass-ta ‘foresaw’ cenmanghayss-ta ‘predicted’, and so on.

These verbs are compatible with the temporal adverbials that refer to a time point. Thus, when a temporal adverbial that refers to the duration of time appears in the complex sentences that belong to Pattern 6, the adverbial modifies the embedded verb, not the main verb.

In other cases the information obtained from a complex sentence itself is not sufficient in resolving the ambiguity of modification by a temporal adverbial as shown in (10).

(10) Kisangcheng-un 10-il-ey cwungpwucipang-ey pi-ka MA-top day-pty mid province-pty rain-nom nayli-l kes-i-lako kwanchukhayss-ta.
fall-fut thing-cop-comp observe(pst)-dec
‘MA observed that on the 10th rain would fall in the mid provinces.’
[Chosun Daily Newspaper: August 8, 2003]

The sentence in (10) does not provide any decisive clue to the clarification of whether the temporal adverbial 10-il-ey modifies the embedded verb or the main verb. In other words, the adverbial can modify either verb when just the sentence is examined. But, the information outside the complex sentence is helpful in this case. Since the sentence appears in the article of a newspaper published on the 8th, and the temporal adverbial used in the sentence refers to future from the viewpoint of the published date, the adverbial in the sentence can modify only the verb with future tense (namely, the embedded verb). Thus, in this case the published date of a newspaper article must be consulted in order to select the verb modified by a temporal adverbial correctly.

Furthermore, there are cases in which the selection of the verb modified by a temporal adverbial in a complex sentence is not possible on the basis of the information obtained from the sentence and the pub-
lished date of a newspaper article.

(11) Kisangcheng-un cinantal 26-il cangma-ka kkuthnass-ta-ko
    MA-top last month day rainy season-nom end(pst)-dec-comp
    kongsikcekulo palphyohayss-ta.
    officially pronounce(pst)-dec
    'MA pronounced officially that the rainy season ended on the 26th of
    last month.'
    [Munhwa Daily Newspaper: August 18, 2003]

In complex sentence (11) the temporal adverbial cinantal 26-il refers to
a time point that precedes the published date of the newspaper article.
This means that the adverbial can modify a verb with past tense. In the
sentence both the embedded verb and the main verb have past tense. It
follows from this that the adverbial can modify both verbs. The English
sentence in the gloss has structural ambiguity since the temporal adver­
bial on the 26th of last month can modify both the main verb pro­
nounced and the embedded verb ended. Consequently, the English sen­
tence in the gloss is a correct translation of the complex Korean sen­
tence that has ambiguity. Thus, there are cases in which the ambiguity
existing in complex sentences that appear in Korean weather news is
carried over into English complex sentences without being resolved.
Seventh, in Pattern 9 two temporal adverbials appear between the
main subject and the complementizer that marks the end of an em­
bedded clause in a complex sentence as illustrated in (12).

(12) Kisangcheng-un 23-il cekiap-uy yenghyang-ulo
    MA-top day low pressure-gen influence-ptp
    24-il ocen-ey taypwupwun-uy cipang-ey pi-ka
    day morning-ptp most-gen province-ptp rain-nom
    o-l kes-ulo cenmanghayss-ta.
    come-fut thing-comp predict(pst)-dec
    'MA predicted on the 23rd that due to the influence of low pressure,
    rain would fall in most of provinces in the morning of the 24th.'
    [The Hankyoreh: June 24, 2003]

In sentence (12) two temporal adverbials 23-il and 24-il ocen-ey appear
before the complementizer. In this case the former modifies the main
verb and the latter the embedded verb. This applies even to the case in which two temporal adverbials appear adjacently before a complementizer in a complex sentence as shown in (13).

(13) Kisangcheng-un 26-il 27-il pam-kkaci hwangsa-ka
MA-top day day night-ppp yellow sand-nom
hanpanto-ey yenghyang-ul michi-l kes-ulo
Korean Peninsula-ppp influence-acc exert-fut thing-comp
naytapwass-ta.
foresee(pst)-dec
'MA foresaw on the 26th that yellow sand would have an influence on the Korean Peninsula till the night of the 27th.'
[Munhwa Daily Newspaper: March 27, 2003]

In sentence (13) two temporal adverbials 26-il and 27-il pam-kkaci appear consecutively between the main subject and the embedded subject. Even in this situation the preceding adverbial modifies the main verb, whereas the following adverbial the embedded verb. It follows from this that temporal adverbials cannot modify verbs cross-dependently as illustrated in Figure 1.

![Figure 1. Prohibited Modification of Verbs](#)

The above figure illustrates that the first temporal adverbial TA1 cannot modify the embedded verb EV and the second temporal adverbial TA2 cannot modify the main verb MV.

Therefore, when two temporal adverbials appear between the main subject and the complementizer in a complex sentence that does not have double quotation marks, their modification of verbs has the form of nested dependency as illustrated in Figure 2.
Patterns of Temporal Adverbials and Their Modification of Verbs

Figure 2. Allowed Modification of Verbs

Figure 2 shows that the first temporal adverbial modifies the main verb, and the second one the embedded verb.

Eighth, in Pattern 7 only one temporal adverbial appears in a complex sentence that contains no double quotation marks, and it occurs between the embedded subject and the complementizer as shown in (14).

(14) Kisangcheng-un cangma-censen-uy yenghyang-ulo 40-eyse
     MA-top rainy season-front-gen influence-ppp ptp
     100-millimithe-uy manh-un pi-ka 18-il cenkwuk-ey
     mm-gen much-mod rain-nom day whole nation-ppp
     nayli-keyss-ta-ko yeypohayss-ta.
     fall-fut-dec-comp forecast(pst)-dec
‘MA forecast that due to the influence of rainy season front, on the 18th much rain of 40-100mm would fall in the whole nation.’
[Kyunghyang Newspaper: July 17, 2003]

In sentence (14) the temporal adverbial 18-il appears between the embedded subject pi-ka and the complementizer ko. In this case the adverbial occurs clearly inside the embedded clause and thus it can modify only the embedded verb nayli. Consequently, in sentences of Pattern 7 the temporal adverbial modifies the embedded verb, not the main verb.

Finally, in Pattern 8 one temporal adverbial appears in a complex sentence whose embedded clause precedes the main clause as illustrated in (15).

(15) Tayselcwwuypo-ka naylyeci-n cennampwuk
     heavy snowfall watch-nom be issued-mod Chulla Nampuk
     cipang-ey 30-il 5-eyse 10-seyntimithe-uy nwun-i
     province-ppp day ptp cm-gen snow-nom
     te nayli-l kes-ulo kisangcheng-un naytapwass-ta.
     more fall-fut thing-comp MA-top foresee(pst)-dec
'MA foresaw that on the 30th snow of 5-10cm would fall more in Chulla Nampuk province for which a heavy snowfall watch was issued.'

[Maeil Business Newspaper: January 29, 2003]

In sentence (15) the embedded clause appears before the main clause, and a temporal adverbial occurs in the embedded clause. Thus, the temporal adverbial 30-il modifies the embedded verb nayli, not the main verb naytapwass. When the embedded clause precedes the main clause in a complex sentence that occurs in the corpus of Korean weather news, the sentence does not contain double quotation marks. The reason is that due to the precedence of the embedded clause, the scope of the clause is clearly recognized.

The cases in which a temporal adverbial appears in an embedded clause and modifies an embedded verb are much more common than those in which a temporal adverbial appears in a main clause and modifies a main verb as illustrated in Table 4.

<table>
<thead>
<tr>
<th>Table 4. Comparison of Modification Cases&lt;sup&gt;3)&lt;/sup&gt;</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modification of Only an Embedded Verb</td>
<td>108</td>
</tr>
<tr>
<td>Modification of Only a Main Verb</td>
<td>14</td>
</tr>
<tr>
<td>Modification of Both an Embedded Verb and a Main Verb</td>
<td>80</td>
</tr>
</tbody>
</table>

In Table 4, the cases in which only one temporal adverbial appears in a complex sentence and modifies an embedded verb occur approximately 8 times more frequently than those in which only one temporal adverbial appears in a complex sentence and modifies a main verb. In addition, the cases in which two temporal adverbials appear in a complex sentence and modify an embedded verb and a main verb respectively are about 6 times more frequent than those in which only a main verb is modified by a temporal adverbial. In the complex sentence of Korean weather news the embedded clause conveys the contents of weather situations themselves, whereas the main clause conveys the information on

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3) The data from sentences of Pattern 6 is not included in the table since in the pattern a temporal adverbial may modify an embedded verb or a main verb.
the supply of weather situations. Therefore, the time related to weather situations themselves is much more frequently specified than the time related to the supply of weather situations in Korean weather news.

4. Capturing Modification by Temporal Adverbials on a Computer

As discussed in the previous section, there are nine patterns with regard to the occurrence of temporal adverbials and their modification of verbs in complex sentences. In this section let us implement the way to decide whether a temporal adverbial occurring in a complex sentence modifies a main verb or an embedded verb on the basis of Prolog programming language.4)

First, when a complex sentence contains double quotation marks and a temporal adverbial appears inside the marks, the adverbial modifies the embedded verb as illustrated in Figure 3.

![Figure 3. Modification of a Verb within Double Quotation Marks](image)

This kind of modification occurs in sentences of Pattern 1, Pattern 2, Pattern 3, and Pattern 5. This case is encoded in Prolog as shown in (16).

(16) modify(TA, EV, Sent) :-
    contain(Sent, DQs),
    temporal_adverbial(TA),
    appear_inside(TA, DQs),
    verb(EV),
    appear_inside(EV, DQs).

For example, when the sentence in (4) is fed as the input sentence, the

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output is as shown in (17).

(17) ?- modify(o_il_ey,V,
[kisangcheng,kwankyeyca,nun,odq,o_il_ey,sewul,uy,achim,
choycekion,i,yengha,sipil,to,nac,choykokion,i,yengha,sa,
to,anphakk,ey,memwulul,kes,cdq,ilako,yeysanghayssta]).

\[ V = \text{memwulul} \]

The output shows that the temporal adverbial appearing in the input sentence modifies the verb occurring inside the double quotation marks (namely, the embedded verb).

Second, when a complex sentence contains double quotation marks and a temporal adverbial appears outside the marks, the adverbial modifies the main verb as illustrated in Figure 4.

![Figure 4. Modification of a Verb outside Double Quotation Marks](image)

In Figure (4a) a temporal adverbial appears before double quotation marks, whereas in Figure (4b) it appears after them. In both cases a temporal adverbial appears outside double quotation marks and modifies the main verb. The kind of modification shown in Figure (4a) occurs in sentences of Pattern 1 and Pattern 4, and that of modification in Figure (4b) occurs in sentences of Pattern 5. These kinds of modification are captured in Prolog as shown in (18).

(18) modify(TA,MV,Sent) :-
    contain(Sent,DQs),

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For example, when the sentence in (6) is given as the input sentence, the output is as illustrated in (19).

(19) ?- modify(isipchil_il,V,  
[kisangcheng,un,isipchil_il,odq,cekiap,i,mwulleka,myen,  
maywu,chan,taylyuk_kokiap,uy,yenghyang,ulo,kion,i,  
ku_n,phok,ulo,telecikeyssta,cdq,ko,yeypohayssta]).

V = yeypohayssta

The output in (19) shows that the temporal adverbial isipchil_il that appears outside the double quotation marks modifies the main verb yeypohayssta, which also appears outside the marks.

Third, when double quotation marks do not occur in a complex sentence, and only one temporal adverbial appears after both the main subject and the embedded subject, the adverbial modifies the embedded verb as illustrated in Figure 5.

\[
\begin{array}{ccccccc}
  & MS & (\ldots) & ES & \ldots & TA & \ldots & EV & (\ldots) & CP \\
\end{array}
\]

Figure 5. Modification of a Verb after a Main Subject and an Embedded Subject

The kind of modification illustrated in Figure 5 occurs in sentences of Pattern 7 and is captured in Prolog as shown in (20).

(20) modify(TA,EV,Sent) :-  
\ + member(odq,Sent),  
temporal_adverbial(TA),  
main_subj(MS),  
emb_subj(ES),  
precede(MS,ES),
precede(ES,TA),
verb(EV),
comp(CP),
precede(EV,CP).

For example, when the sentence in (14) is given as the input sentence, the output is as illustrated in (21).

(21) ?- modify(sipphal_ip,V,
[kisangcheng,un,cangma_censen,uy,yenghyang,ulo,sasip, eyse,payk_millimithe,uy,manh_un,pi,ka,sipphal_ip, cenkwuk,ey,naylikeyssta,ko,yeypohayssta]).

V = naylikeyssta

The output in (21) shows that the temporal adverbial sipphal_ip occurring after both the main subject and the embedded subject in a complex sentence that does not have double quotation marks modifies the embedded verb naylikeyssta, which precedes the complementizer ko.

Fourth, when the embedded clause precedes the main clause, and one temporal adverbial appears in the embedded clause of a complex sentence that does not have double quotation marks, the adverbial modifies the embedded verb as illustrated in Figure 6.

![Figure 6. Modification of a Verb in a Scrambled Complex Sentence](image)

The kind of modification illustrated in Figure 6 occurs in sentences of Pattern 8 and is captured in Prolog as shown in (22).

(22) modify(TA,EV,Sent) :-
    "+ member(odq,Sent),
    comp(CP),
    main_subj(MS),
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\[ \text{precedes}(CP,MS), \]
\[ \text{temporal\_adverbial}(TA), \]
\[ \text{precedes}(TA,CP), \]
\[ \text{verb}(EV), \]
\[ \text{precedes}(EV,CP). \]

For example, when the sentence in (15) is fed into a computer as the input sentence, the output is as illustrated in (23).

\[(23) \ ? \ - \ \text{modify}(\text{samsip\_il},V,\]
\[ \text{[tayselcwuypo,ka,naylyeci\_n,cennampwuk,cipang,ey,}\]
\[ \text{samsip\_il,o,eyse,sip\_seynthimithe,uy,nwun,i,te,naylil,}\]
\[ \text{kes,ulo,kisangcheng,un,naytapwassta]}). \]
\[ V = \text{naylil} \]

The output in (23) shows that the temporal adverbial \textit{samsip\_il} modifies the embedded verb \textit{naylil} in a scrambled complex sentence whose embedded clause precedes the main clause.

Fifth, when two temporal adverbials appear before a complementizer, the preceding adverbial modifies the main verb, and the following one the embedded verb as shown in Figure 7.

\[ \text{Figure 7. Modification of Verbs by Two Temporal Adverbials} \]

The kind of modification illustrated in Figure 7 occurs in sentences of Pattern 9 and is captured in Prolog as shown in (24).

\[(24) \ (a) \ \text{modify}(TA1,MV,Sent) :- \]
\[ \text{\ + member(odq,Sent),} \]
\[ \text{comp(CP),} \]
\[ \text{temporal\_adverbial(TA1),} \]
\[ \text{temporal\_adverbial(TA2),} \]
precede(TA1,TA2),
verb(MV),
precede(CP,MV).
(b) modify(TA2,EV,Sent) :-

 \ + member(odq,Sent),
comp(CP),
temporal_adverbial(TA1),
temporal_adverbial(TA2),
precede(TA1,TA2),
verb(EV),
precede(EV,CP).

The Prolog code in (24a) indicates that the preceding adverbial modifies
the main verb, and the code in (24b) indicates that the following adver­
bial modifies the embedded verb. For example, when the sentence in
(12) is given as the input sentence, the output can be (25a) or (25b), de­
pending on the query.

(25) (a) ?- modify(isipsam_il,V,

 \ [kisangcheng,un,isipsam_il,cekiap,uy,yenghyang,ulo,
isipsa_il_ocen_ey,taypwupwun,uy,cipang,ey,pi,ka,
 \ ol,kes,ulo,cenmanghaysstal]).

 V = cenmanghayssta
(b) ?- modify(isipsa_il_ocen_ey,V,

 \ [kisangcheng,un,isipsam_il,cekiap,uy,yenghyang,ulo,
isipsa_il_ocen_ey,taypwupwun,uy,cipang,ey,pi,ka,
 \ ol,kes,ulo,cenmanghaysstal]).

 V = ol

The query in (25a) asks which verb is modified by the temporal adver­
bial isipsam_il in the input sentence, whereas the query in (25b) asks
which verb is modified by the temporal adverbial isipsa_il_ocen_ey in
the same sentence.

Finally, when only one temporal adverbial appears immediately after
the main subject in a complex sentence that does not have double quo­
tation marks, its modification of a verb varies. This kind of modification
occurs in sentences of Pattern 6.

When a temporal adverbial refers to a point of future time or the duration of time, it modifies the embedded verb. This case is coded in Prolog as illustrated in (26).

(26) `modify(TA, EV, Sent) :-`
    `- member(odq, Sent),`
    `- main_subj(MS),`
    `- temporal_adverbial(TA),`
    `- immediately_precede(MS, TA),`
    `(has_duration_feature(TA);`
    `- has_future_time_point(TA)),`
    `- comp(CP),`
    `- verb(EV),`
    `- precede(EV, CP).`

The outputs for the sentences in (8) and (9), which belong to this case, are illustrated in (27a) and (27b), respectively.

(27) (a) `?- modify(taum_tal_ey, V,`
        `[kisangcheng, un, taum_tal_ey, taycheylo, malk_un,`
        `nalssi, ka, iecil, kes, ulo, naytapwassta].`
        `V = iecil`
(b) `?- modify(sipyuk_il_naynay, V,`
        `[kisangcheng, un, sipyuk_il_naynay, kioni, yenghakwen, ey,`
        `memwulul, kes, ulo, yeypohayssta].`
        `V = memwulul`

When a temporal adverbial in a complex sentence refers to a point of time that cannot be judged to be future by the adverbial itself, the information on the published date of a newspaper article in which the sentence appears is used.

(28) `modify(TA, EV, Sent) :-`
    `- member(odq, Sent),`
    `- main_subj(MS),`
The Prolog code in (28) has a part that checks whether the published date of a sentence is earlier than the date indicated by a temporal adverbial that appears in the sentence. The output for the sentence in (10), which is an example of this case, is illustrated in (29).

(29) ?- modify(sip_il_ey,V, [kisangcheng,un,sip_il_ey,cwungpwucipang_ey,pi,ka,naylil, kes,i,lako,kwanchukhayssta]).

V = naylil

When the tense of the embedded verb is past, and the date indicated by a temporal adverbial in a complex sentence is earlier than the published date of the sentence or refers to a point of past time, the adverbial can modify the embedded verb or the main verb. This case is coded in Prolog as shown in (30).

(30) (a) modify(TA,EV,Sent) :- \
+ member(odq,Sent),
main_subj(MS),
temporal_adverbial(TA),
immediately_precede(MS,TA),
((referring_date(TA,Date1),
published_date(Sent,Date2),
earlier(Date2,Date1)),
has_past_time_point(TA)),
comp(CP),
verb(EV),
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\[
\text{tense}(\text{EV}, \text{past}), \\
\text{precede}(\text{EV}, \text{CP}), \\
(b) \text{modify}(\text{TA}, \text{MV}, \text{Sent}) :- \\
\quad \text{\+ member}(\text{odq}, \text{Sent}), \\
\quad \text{main}\_\text{subj}(\text{MS}), \\
\quad \text{temporal}\_\text{adverbial}(\text{TA}), \\
\quad \text{immediately}\_\text{precede}(\text{MS}, \text{TA}), \\
\quad ((\text{referring}\_\text{date}(\text{TA}, \text{Date1}), \\
\quad \text{published}\_\text{date}(\text{Sent}, \text{Date2}), \\
\quad \text{earlier}(\text{Date1}, \text{Date2})); \\
\quad \text{has}_\text{past}_\text{time}_\text{point}(\text{TA}), \\
\quad \text{verb}(\text{MV}), \\
\quad \text{precede}(\text{CP}, \text{MV}).
\]

Thus, in this case the modification of a verb by a temporal adverbial remains ambiguous. This is reflected in the output for the sentence in (11) as illustrated in (31).

\[
(31) \text{- modify(cinantal_isipyuk_il, V,} \\
\quad [\text{kisangcheng, un, cinantal_isipyuk_il, cangma, ka,} \\
\quad \text{kkuthnassta, ko, kongsikcekulo, palphyohayssta}]. \\
\]

\[
V = \text{kkuthnassta} ; \\
V = \text{palphyohayssta}
\]

The answer to the query in (31) shows that the temporal adverbial may modify the embedded verb \textit{kkuthnassta} or the main verb \textit{palphyohayssta}.

5. Concluding Remarks

In this paper we have shown that there are nine patterns in the occurrence of temporal adverbials in a complex sentence that occurs in Korean weather news. In these patterns the cases in which a temporal adverbial modifies the embedded verb are much more frequent than those in which a temporal adverbial modifies the main verb. This result shows that the time related to weather situations themselves is more fre-
quently specified than the time related to the forecast of weather news. In addition, when a temporal adverbial modifies the main verb, the adverbial has a strong tendency to appear before the embedded clause. This tendency means that when the need to specify the forecasting time of weather news arises, it is more emphasized than weather situations.

The discussion on the types of modification of a verb by a temporal adverbial in a complex sentence and the computational implementation of them contribute to the correct translation of complex sentences that occur in Korean weather news into English on a computer. Without recognizing the verb a temporal adverbial modifies, the meaning of Korean complex sentences is not obtained properly and thus the correct translation of them into English is not achieved.

Therefore, this paper is useful in that it has successfully captured the modification relationship between a temporal adverbial and a verb in a complex sentence linguistically and computationally based on the patterns of the occurrence of the adverbial in the corpus of Korean weather news.

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