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# Representation of Temporal Relationship Among Events

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***Abstract***— Representation and Reasoning about a temporal information became a crucial aspect for many of the natural language process applications namely question answering system temporal summarization etc., Temporal information exists majorly in two forms i.e either in in the form of qualitative nature or quantitative. Temporal information extraction is vital to project the relation among the events that occur in any scenario. This information intern enables to answer queries about date, duration and other temporal nature of events. This paper focus on automatic extraction and representation of temporal relation among the events. Few attributes of TIMEML tags namely <SLINK> and <TLINK> are used to retrieve temporal information among events. Reasoning was applied to retrieve the unknown information from the known ones. Experiments were conducted on TIMEML corpus and the results obtained from the experiments were found to be encouraging.

***Keywords***- *TIMEML, Natural Language Processing, Temporal Information processing*

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## I. INTRODUCTION

One of the key advances presented in TimeML is the LINK tag. This will tell about the temporal relationship between the events. The set of LINK tags encode the various relations that exist between the temporal elements. TIMEML can do effective stamping with link tag. The link tag capture the both anchoring and ordering relationship as well as subordinating between events. These links represent the relationship holding between the events and times, or between an event and a time. There are two types of link tags.

- TLINK : Temporal Link representing the temporal relationship holding between events or between an event and a time;
- SLINK : Subordination Link used for contexts introducing relations between two events or an event and a signal.

In TIMEML demonstration of relationship between the events are going were done manually which is time taking and labor intensive in nature. Human intelligence is needed for annotation of temporal relationship among the events in natural language text. The annotation means tagging of the information using TLINK and SLINK tags. A TLINK or Temporal Link represents the temporal relationship holding between events, times, or between an event and a time. Whereas SLINK uses the Allen's interval algebra [1] for representing the relation between the events.

The remaining part of the paper is ordered as follows section 2 describes the related work. Section 3 describes a method for automatic extraction of temporal relation between the events. Experiments and results are depicted in section 4. Concluding remarks are projected in section 5 of the paper.

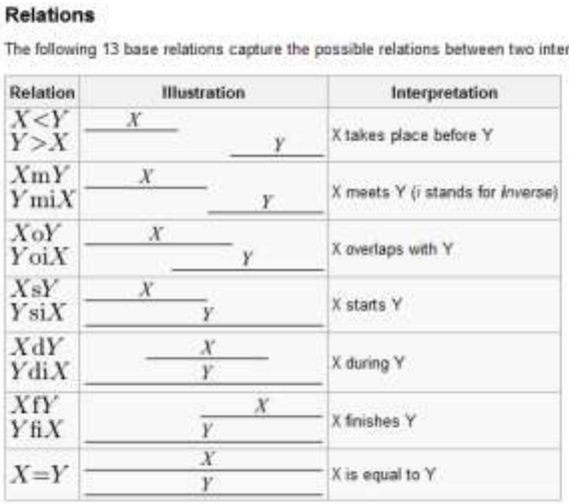
## II. RELATED WORK

Regardless of specific details of the target temporal relations, most researchers have approached the problem of temporal identification (event/event or event/time) by using supervised learning of a classifier but this sacrifices recall by ignoring interactions due to transitivity [8]. They use probabilistic inference to jointly solve all three TempEval tasks. Allen's interval algebra is a calculus for temporal reasoning that was introduced by [1][2]. The calculus defines possible relations between time intervals and provides a composition table that can be used as a basis for reasoning about temporal descriptions of events by using of thirteen relations in allens algebra.

Relations between intervals are formalized as sets of base relations. For example consider the following sentence

(1) During dinner, Peter reads newspaper. Afterwards, he goes to bed.

Analyzing and formalizing the sentence (1) with Allen's Interval Algebra is projected the following relations among the events: newspaper {d,s,f}, dinner, dinner{< , m} bed. The description of the relations is depicted in figure 1.



**Relations**

The following 13 base relations capture the possible relations between two intervals.

| Relation | Illustration | Interpretation |
|---|---|---|
| $X<Y$ $Y>X$ | X Y | X takes place before Y |
| $XmY$ $YmiX$ | X Y | X meets Y (i stands for *inverse*) |
| $XoY$ $YoiX$ | X Y | X overlaps with Y |
| $XsY$ $YsiX$ | X Y | X starts Y |
| $XdY$ $YdiX$ | X Y | X during Y |
| $XfY$ $YfiX$ | X Y | X finishes Y |
| $X=Y$ | X Y | X is equal to Y |

Figure 1: 13 Relations between two intervals

*A. Discovering Temporal Relations*

Besides temporal entity, natural language text contains ample temporal information and relations, which require additional processing. In logic, relation is commonly used as a reference. In this section, we first address classification of temporal relations and then outline methods in discovering them. Relations are classified into absolute and relative relations [5][6]. The role of absolute temporal relations is to position event occurrences on a time line. These relations depict the beginning or ending time bounds of an occurrence or its relevance to a reference time.
For example,

(2) "two days before last Friday"

Sentence "(2)" depicts an absolute relation indicated by "before". Absolute relations are further classified into definite, indefinite and combined relations. Definite relations include ON, BEGIN, END and ONGOING, indefinite relations PAST and FUTURE and combined relation CONTINUED.

TIMEML can do effectively time stamping with LINK tag, presented in the following subsections. The set of LINK tags encode the various relations that exist between the temporal elements of a document, as well as establishing ordering between events directly.

*B. TLINK*

TLINK symbolizes the time-based association holding between events or between an event and a time and establishes a link between the involved entities, making explicit if they obtain any one of the Allen's 13 relations stated in figure 1.

The syntax for TLINK is given below.

attributes ::= (eventInstanceID | timeID) [signalID] (relatedtoEvent| relatedtoTime) relType [magnitude]
eventInstanceID ::= ei<integer>
timeID ::= t<integer>
signalID ::= s<integer>
relatedToEvent ::= ei<integer>
relatedToTime ::= t<integer>
relType ::= 'BEFORE' | 'AFTER' | 'INCLUDES' | 'IS_INCLUDED' | 'HOLDS' 'SIMULTANEOUS' | 'IAFTER' | 'IBEFORE' | 'IDENTITY' | 'BEGINS' | 'ENDS' | 'BEGUN_BY' | 'ENDED_BY'
magnitude ::= t<integer>

To illustrate the function of this Tlink[9], let us return to the sentence above, now adding the annotation of the TLINK, which orders the two events mentioned in the sentence, with a magnitude denoted by value of the temporal expression. Consider the following sentence

(3) Mary left 3 days before the attack.
<TLINK eventInstanceID="ei1" signalID="s1" relatedToEvent="ei2" relType="BEFORE" magnitude="t1"/>

This link composes two assertions:

- Maryleaving is referred with event id e1, and attack as e2. Event e1 is ordered before the event e2

- The interval separating these events has a magnitude equal to the value of the temporal expression, t1.

*C. SLINK*

SLINK[9] or Subordination Link is used for contexts introducing relations between two events, or an event and a signal of the following sort:

1. Modal: Relation introduced mostly by modal verbs (should, could, would, etc.) and events that introduce a reference to a possible world; these are mainly referred as I_STATEs:

2. Factive: Certain verbs introduce an entailment (or presupposition) of the argument's veracity. They include words like forget in the tensed complement, regret, manage:

3. Counterfactive: The event introduces a presupposition about the non-veracity of its argument:
forget (to), unable to (in past tense), prevent, cancel, avoid, decline, etc.

4. Evidential: Evidential relations are introduced by REPORTING or PERCEPTION:

5. Negative evidential: Introduced by REPORTING and some PERCEPTION events conveying negative polarity:

6. Negative: Introduced only by negative particles (not, nor, neither, etc.), which are marked as SIGNALs, with respect to the events they are modifying:

The specification for the SLINK relation is given below:
attributes ::= [eventInstanceID] (subordinatedEvent | subordinatedEventInstance) [signalID] relType [polarity]
eventInstanceID ::= ei<integer>
subordinatedEvent ::= e<integer>
subordinatedEventInstance ::= ei<integer>
signalID ::= s<integer>

relType ::= ’MODAL’ | ’NEGATIVE’ | ’EVIDENTIAL’ |
’NEG_EVIDENTIAL’ | ’FACTIVE’ |
’COUNTER_FACTIVE’

For example the tagging of SLINK to the following sentence “(4)” is depicted below.

(4) Bill wants to teach on Monday.

```
Bill
<EVENT eid="e1" class="I_STATE" tense="PRESENT"
aspect="NONE">
wants
</EVENT>
<MAKEINSTANCE eiid="ei1" eventID="e1"/>
<SLINK eventInstanceID="ei1" signalID="s1"
subordinatedEvent="e2" relType="MODAL"/>
<SIGNAL sid="s1">
to
</SIGNAL>
<EVENT eid="e2" class="OCCURRENCE" tense="NONE"
aspect="NONE">
teach
</EVENT>
<MAKEINSTANCE eiid="ei2" eventID="e2"/>
<SIGNAL sid="s2">
on
</SIGNAL>
<TIMEX3 tid="t1" type="DATE" temporalFunction="true"
value="XXXX-WXX-1">
Monday
</TIMEX3>
<TLINK eventInstanceID="ei2" relatedToTime="t1"
relType="IS_INCLUDED"/>
```

### D. S2T - From SLINK to TLINK

The purpose of S2T is to create new TLINKs from previously annotated SLINKs. Often, there are temporal relationships between the participants of SLINKs that are not captured by the human annotator. These relationships are thought to be given when the SLINK is created, but S2T actually generates the appropriate TLINK. Of the six SLINK relation types, only factive, evidential, and modal links are eligible for TLINK creation. S2T uses several rules to create the TLINKs based on tense and aspect information of the participating event instances. In some cases, information provided by Slinket, helps in the creation of TLINKs by providing information on the syntax pattern used to create the SLINK. In order to make use of syntax rules, the SLINKs must be created by Slinket[7].

## III. PROPOSED SYSTEM

The existing system involves the representation of temporal relation between events manually. The tagging or annotation of temporal information was done manually. The annotation is based on human intelligence. The tagging of TLINK and SLINK are based on “Allen’s interval algebra”. Allen's interval algebra is a calculus for temporal reasoning that was introduced by [1][2][3]. The calculus defines possible relations between time intervals and provides a composition table that can be used as a basis for reasoning about temporal descriptions of events.

A method had been developed that can extract and uncovers all the relations most likely directly implied by the text not to predict the most probable relations. The annotation of relation between temporal events has to be automated. The task of extracting and representation has to be done automatically.

In the model proposed the text is given as input that converts and annotate them to xml form. These annotation is done automatically. For the annotation the TLINK and SLINK tags of TIMEML were used. From the attributes marked in these tags events and signal are retrieved automatically by using pattern matching methods. Then the events and signals are represented in the form of “EVENT SIGNAL EVENT”. “Make instance “ids of the tags were used to build the relations among the events. From them event ids are identified to extract and represent events. The events are represented along with their relationship which is based on Allen’s interval algebra.

Automatic extraction and representation of relationship among events eases the overhead of going through the whole output again and again for required result. Advantages include: retrieving answer passages with relative or underspecified dates, discarding temporally inaccurate answers and capturing the ordering of events via signal words. The significant improvement in applications of this domain can in fact be achieved by integrating temporal context reasoning, participate in a TLINK by means of their corresponding event instance IDs.

## IV. EXPERIMENTAL RESULTS

Experiments were conducted on the TMEML corpus. TIMEML corpus[8][9] consist of 183 news documents that has been annotated manually. The same corpus is given as input to our model for the extraction and representation of events and times. One new contribution made in the work is to find the temporal relation among the events. Explicit temporal relations are retrieved automatically. A reasoning algorithm is applied to reason out the unknown relations from the known ones.

Looking at the specific class results, *reporting* obtained the best results. This is due to the fact that 80% of *reporting* events are represented by lemmas “say” and “report” with POS “VBD” and “VBZ”. *Occurrence, perception, aspectual* and *i state* obtained classification results over 50%..

For example consider a news document from TIMEML corpora

“On the other hand, it's turning out to be another very bad financial week for Asia. The financial assistance from the World Bank and the International Monetary Fund are not helping. In the last twenty four hours, the value of the Indonesian stock market has fallen by twelve percent. The Indonesian currency has lost twenty six percent of its value. In

Singapore, stocks hit a five year low. In the Philippines, a four year low. And in Hong Kong, a three percent drop. More problems in Hong Kong for a place, for an economy, that many experts thought was once invincible. Here's ABC's Jim Laurie. Not that long ago, before the Chinese takeover, the news about real estate here was that the sky was the limit the highest prices in the world. So when Wong Kwan spent seventy million dollars for this house, he thought it was a great deal. He sold the property to five buyers and said he'd double his money. In Hong Kong, is always belongs to the seller's market. Now with new construction under way, three of his buyers have backed out. And Wong Kwan will be lucky to break even. All across Hong Kong, the property market has crashed. Pamela Pak owns eight condominiums here. Pak can't find buyers. She estimates her properties, worth a hundred thirty million dollars in October, are worth only half that now. They believe ah it will be always up going up and up ah forever. Nobody believe this anymore. Of all of Asia's economies, Hong Kong is the most robust. But in the past three months, stocks have plunged, interest rates have soared and the downturn all across Asia means that people are not spending here. Hotels are only thirty percent full. You can get seventy percent discounts at the shopping malls. Three thousand dollar pearls for eight hundred dollars. A two hundred dollar wool jacket for fifty dollars. Still, there are few buyers. And at the big brokerage houses, after ten years of boom, they're talking about layoffs. I think that the mood is fairly gloomy, and I think it's not going to change for a couple of years. So for Hong Kong, it's time, as investment bankers like to say, to reposition. To either hold on tight or get out, as much of Asia goes into recession. Jim Laurie, ABC News, Hong Kong."

Processing activity is performed on the above text to retrieve the events and times. The relation among the events are derived whose picture is depicted in the window shown in figure 2.

FIGURE 2: EVENT-SIGNAL-EVENT RELATION

Thus obtained results are evaluated for the precision, recall and F measure. It showed that the proposed method resulted a precision of 84.2%, Recall of 81.2% and an F measure of 82.6%.

## V. CONCLUSIONS

Automatic extraction and representation of events and times plays a prominent role in many of the natural language processing applications. The temporal relation exist in explicit form or implicit form. Explicit relations are retrieved based on the attributed information obtained through the tags. Implicit information is obtained by applying reasoning activity on existing information. A contribution has been made in automatic extraction of temporal relations among the events. Experiments were conducted on TIMEML corpora. The results were matching almost with the human annotated information. Precision, Recall and F measure of the obtained results were found to be encouraging.

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## BIOGRAPHIES

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