

# Feature Representations and Logical Compatibility between Temporal Adverbs and Aspects

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## Abstract

*In this paper, we propose clear-cut definitions to distinct temporal adverbs and provide descriptive features for each class of temporal adverbs. By adopting the corpus-based approach and measuring time points in temporal axis, the temporal adverbs listed in Lu & Ma 1999 are revised and reclassified into four main classes namely, time, frequency, duration, and time manner. The descriptive features suffice to discriminate temporal relations and to predict logical compatibility between temporal adverbs and aspects.*

## 1 Introduction

There are about 130 temporal adverbs in Mandarin Chinese. Lu & Ma classify the temporal adverbs into two groups, speaking-time related adverbs (abbr: ST-related adverbs, 定時時間副詞) and reference-time related adverbs (abbr: RT-related adverbs, 不定時時間副詞). The ST-related adverbs consist of 27 temporal adverbs, which are subdivided into three subclasses. In the class of RT-related adverbs, 104 temporal adverbs are listed and subdivided into 18 subclasses. Lu and Ma's subdivision of temporal adverbs based upon aspects of situations. However, the subdivision is vague and the definition is ambiguous. For example, *cengjing* 曾經, *ceng* 曾, *yeyi* 業已 and *yejing* 業經 are grouped into two different subclasses of ST-related adverbs. The former two *cengjing* and *ceng* are grouped into the same subclass, which express the actions or situations have been existed or happened before speaking time. The later two *yeyi* and *yejing* are grouped into the same subclass, which indicate the actions or situations have been completed or occurred. In fact, it is difficult to differentiate the actions or situations that have been 'happened' from those 'completed', especially when the situation type is achievement with SHORTLY-PRECEDE( $t_1, t_2$ ) or NEARLY-EQUAL ( $t_1, t_2$ ).<sup>1</sup> Moreover, temporal adverbs may not have the same syntactic behaviour even though they are classified into the same subclass. For instance, the ST-related adverbs *cong* 從, *conglai* 從來, *zhijin* 至今, *xianglai* 向來, *sulai* 素來, *lilai* 歷來, *su* 素, and *yixiang* 一向 are grouped into the same subclass. When co-occurring with aspect markers *le* 了, *guo* 過 and *zhe* 著, *cong*, *conglai* and *zhijin* are incompatible with *le* and *zhe*; however, *xianglai*, *sulai*, *lilai*, *su* and *yixiang* are incompatible with *le* and *guo*. The cause of the difference in the compatibility of temporal adverbs with aspects will be also under discussion.

In this paper, we propose clear-cut definitions and provide descriptive features for each subclass of temporal adverbs. The descriptive features help to define temporal relations and to predict the compatibilities between temporal adverbs and aspect markers.

<sup>1</sup> The terms SHORTLY-PRECEDE( $t_1, t_2$ ) and NEARLY-EQUAL( $t_1, t_2$ ) are mentioned by Yang & Bateman (2002: 1130-31). The predicate SHORTLY-PRECEDE( $t_1, t_2$ ) indicates that the time point  $t_1$  only shortly precedes the time point  $t_2$ . The predicated NEARLY-EQUAL( $t_1, t_2$ ) indicates that the time point  $t_1$  lies close to the time point  $t_2$ . Applying the terms to the explanation of achievements,  $t_1$  can be treated as Yang & Bateman's  $t_i$ , the event initial time, and as Smith's (1991) I, initial points, and  $t_2$  can be regarded as Yang & Bateman's  $t_f$ , the event finishing time, and as Smith's F, final points. Yang & Bateman's expression of the predicates used to express temporal relations are altered from Allen 1984.

## 2 Literature Review and Methodology

To make a clear-cut differentiation, we use the Academia Sinica Balanced Corpus (Sinica Corpus) and adopt the corpus-based approach to analyze Mandarin Chinese temporal adverbs. Time points in temporal axis will be used to define the temporal relations of the temporal adverbs in Lu & Ma 1999.

Smith (1991) discusses aspectual systems in language. She illustrates each situation type and viewpoint type with temporal schema. Below are the temporal schemata of Mandarin Chinese aspectual markers *le*, *guo* and *zhe*, which are represented by symbols I, F, F+1, .... and /.<sup>2</sup>

- (1) Temporal schema fore the *-le* Perfective (Smith 1991: 348)<sup>3</sup>

I        F  
/        / (RVC)

- (2) The Mandarin *-guo* perfective viewpoint (Smith 1991: 353)

I ....F F+1  
/        /

- (3) The *-zhe* viewpoint (Smith 1991: 363)

I.....  
////<sub>State</sub>

Klein (1994) points out five temporal features and notes TT, TU and TSit. TT, topic time, is the time span to which the speaker's claim on the occasion is confined. TU is time of utterance, which is the time at which the utterance is made. TSit is time of situation, which presents the time at which event occurs.

In addition to Smith's and Klein's temporal terminology of time points and time interval, the event modules in the framework MARVS (Module-Attribute Representation of Verbal Semantics) proposed by Huang *et al* (2000) can be also applied to analyze temporal relations of temporal adverbs. Event modules are the basic building blocks of the event contour. Five event modules stand alone or in combination, including Boundary, Punctuality, Process, State and Stage. The event module Boundary is defined as an event module that can be identified with a temporal point and must be regarded as a whole (including complete Event), which is adopted in this paper to define the notion of Boundary Point.

Yang & Bateman further discuss the semantic temporal relations of aspect system and propose principled semantic conditions for aspect combination. In their opinion, Chinese aspect system is actually composed of both aspect morphemes (*-le*, *-zhe*, *-guo*, etc.) and aspect adverbials. Moreover, they propose that the Chinese aspect system has basically seventeen simple primary aspect forms. These simple primary aspect forms belong to the three subsystems of perfective, imperfective or future-existing according to the semantic properties in individual cases. Some simple primary aspect forms can combine to form an aspect of secondary type if their temporal attributes are in harmony. The temporal relation of the combination is represented graphically by time point  $t_i$ ,  $t_r$ ,  $t_e$  and  $t_s$ .<sup>4</sup>

In this paper, we adopt the terms proposed in the research above to help us clarify the temporal relation of each subclass of the temporal adverbs listed in Lu & Ma. We use the notations of ST, RT, ET, BP, Start and End to define temporal relations. Each respectively denotes the speaking time, the reference time, the event time, the boundary point, the start point of the event, and the end point of the event. For instances, the temporal features for *le*, *guo* and *zhe* are defined as follows in our system which are compatible with the notions of (Smith 1991).

*le*:  $BP \leq ST$ , which means the prominent boundary point of the referred event precedes the speaking time.

*guo*:  $End < ST$ , which means the end point of the referred event precedes the speaking time.

*zhe*:  $ET = RT$ , which means the referred event time overlaps with the speaking time.

<sup>2</sup> I and F indicate initial and final points. F+1 indicates a stage distinct from the final stage. The dots indicate internal stages and the slashes indicate the interval process.

<sup>3</sup> RVC is the abbreviation of Resultative Verb Complements.

<sup>4</sup> As the second footnote mentions,  $t_i$  is the event initial time and  $t_r$  is the event finishing time. The symbols  $t_e$  and  $t_s$  is the reference time and the speaking time respectively.

### 3 Temporal Relations and Compatibilities between Temporal Adverbs and Aspects

Temporal adverbs in Lu and Ma are divided into two classes, ST-related adverbs and RT-related adverbs, according to the time point of the situation referred to. The ST-related adverbs establish constraints between event time (ET) and speaking time (ST), but the RT-related adverbs establish constraints between ET and reference time (RT). For example, the ST-related adverb *cengjing* only denotes events or situations happened or existed before ST. Precisely speaking, the end points of events are prior to ST. For example, the sentence *wo shangci cengjing jieshao guo* 我上次曾經介紹過 ‘I have introduced it last time.’ is grammatical; however, *\*wo xiaci/mingtien cengjing jieshao guo* 我\*下次/明天曾經介紹過 ‘I have introduced it next time/tomorrow.’ is ungrammatical. The RT-related adverb *yijing* 已經 is used to refer to events happened or existed before either a certain specific time, an event or ST. For instance, the sentences *shang libaiwu wo yijing chuguo le* 上禮拜五我已經出國了 ‘I have gone abroad last Friday.’ and *xia libaiwu wo yijing chuguo le* 下禮拜五我已經出國了 ‘I have been abroad next Friday.’ are both grammatical even though *xia libaiwu* is a future specific time.

Lu & Ma divide ST-related adverbs into three subclasses and RT-related adverbs into eighteen subclasses. Three subclasses of ST-related adverbs are subdivided into nine sub-subclasses. Eighteen subclasses of RT-related adverbs are subdivided into thirty sub-subclasses. By looking up Sinica Corpus, we find some RT-related adverbs in Lu & Ma’s classification behave like ST-related adverbs. Some temporal adverbs denote the order of events, which establish constraints only between ET. Furthermore, some temporal adverbs refer to habitual situations, which are not concerned with temporal relations. Therefore, our classification of temporal adverbs is somewhat different and revised from that of Lu & Ma’s. In this paper, temporal adverbs are divided into four classes according to temporal relations. More detailed sub-classification will be introduced in the sections below.

#### 3.1 Temporal Relations and Compatibilities between ST-related Adverbs and Aspects

In our classification, ST-related adverbs are classified into eleven subclasses. Each subclass is characterized and represented by its temporal features and is assigned one semantic type of Time, Duration, or Frequency. Table 1 shows the temporal features of each subclass.

Temporal Adverbs	Temporal Relation	Semantic Role
<i>cengjing</i> 曾經, <i>ceng</i> 曾	End<ST	time
<i>yeyi</i> 業已, <i>yejing</i> 業經	End≤ST	time
<i>zhongyu</i> 終於, <i>bijing</i> 畢竟, <i>daodi</i> 到底	End≤ST	time
<i>xianxing</i> 先行	Start<ST	time
<i>zaori</i> 早日, <i>jizao</i> 及早, <i>chenzao</i> 趁早	ST<Start	time
<i>zhongjiang</i> 終將, <i>zhongjiu</i> 終久, <i>zhonggui</i> 終歸, <i>zonggu</i> 總歸, <i>bijiang</i> 必將, <i>chizao</i> 遲早, <i>zaowan</i> 早晚	ST<BP	time
<i>zhongjiu</i> 終究	End≤ST	time
<i>cong</i> 從, <i>conglai</i> 從來, <i>zhijin</i> 至今, <i>xianglai</i> 向來, <i>sulai</i> 素來, <i>lilai</i> 歷來, <i>su</i> 素, <i>yixiang</i> 一向	Start<ST	duration
<i>zhan</i> 暫, <i>zhanqie</i> 暫且, <i>guqie</i> 姑且, <i>quanqie</i> 權且, <i>qie</i> 且	ET=ST	duration
<i>yongyuan</i> 永遠, <i>yong</i> 永, <i>shizhong</i> 始終, <i>zhi</i> 直	ET=ST	duration
<i>yidu</i> 一度	BP<ST	frequency

Table 1 Temporal Relation and Semantic Role of Each Subclass of ST-related Adverbs

For instance, *cengjing* and *ceng* are grouped into the same subclass of ST-related adverbs. Since they denote the actions or situations that have been existed or happened before ST, the end points of the situations will precede ST. Thus the temporal relation of *cengjing* and *ceng* is defined as End<ST.

The temporal features clearly point out the relations among these ST-related adverbs. Furthermore, these temporal features can predict and verify correctness of co-occurrences of temporal adverbs and aspectual markers, *le*, *guo* and *zhe*, by unifying the temporal features of them. The temporal features of

*le*, *guo* and *zhe* are  $BP \leq ST$ ,  $End < ST$ , and  $ET = RT$  respectively. If the corpus data shows the sentence is grammatical after combination, its combination of temporal relation will be in harmony; otherwise, there may be something wrong with the temporal relations or some other essential factors bringing out the incompatibility. Vice versa, we assume that by detecting the harmony of the combination of temporal relations between temporal adverbs and aspects, we can predicate whether the temporal adverb is compatible with *le*, *guo* and *zhe* or not. Here we take example by *cengjing* and *ceng*. The corpus data in Sinica Corpus shows the combination of *cengjing* with *le*, *guo* and *zhe* as below:

(4) *cengjing* co-occurs with *le*, *guo* and *zhe*

a. 我們的通信曾經給了她很大的快樂

*women de tongxin cengjing gei ta henda de kuaile*

She had been very happy while we lettered each other.

b. 我們曾經提過

*women cengjing ti guo*

we had mentioned before

c. 曾經提著小包袱

*cengjing ti zhe xiao baofu*

ever carried little backpack

The combination of *cengjing* with *le*, *guo* and *zhe* is grammatical so that we conclude the temporal relation of *cengjing* is correct and assign the semantic role of time, not frequency nor duration, to the subclass of *cengjing* and *ceng*. Vice versa, from the observation of the temporal relations of *le*, *guo*, *zhe* and *cengjing*, the temporal relation of *cengjing* is compatible with that of *le*, *guo* and *zhe* respectively. Thus before looking the corpus data up in Sinica Corpus, we predict the co-occurrence of *cengjing* with *le*, *guo* and *zhe* respectively is grammatical. The grammatical sentences 4a, 4b and 4c prove our hypothesis and prediction correct.

Temporal adverbs classified into the same subclass with the same temporal relation may not have the same syntactic behaviours. For instance, *cong*, *conglai*, *zhijin*, *xianglai*, *sulai*, *lilai*, *su*, and *yixiang* are grouped into the same subclass and assigned the semantic role of duration. The temporal relation of these temporal adverbs is defined as  $Start < ST$ . We find *cong*, *conglai* and *zhijin* are incompatible with *le* and *zhe*; however, *xianglai*, *sulai*, *lilai*, *su* and *yixiang* are incompatible with *le* and *guo*. Although this subclass of ST-related adverbs has the same temporal relation, their compatibility with aspectual markers is somewhat different. The Sinica Corpus sentences below reveal that *cong*, *conglai* and *zhijin* are usually in negative sentences. The feature [+NEG] brings about the different syntactic behaviours.

(5) 好像這件事從沒發生過

*hoaxing zhejian shicong mei fasheng guo*

It seems this thing haven't happened before.

(6) 從來不會逃避

*conglai buhui taobi*

never evade

(7) 至今尚未出現在他生命中

*zhijin shangwei chuxian zai ta shengming zhong*

haven't appeared in his life

Temporal adverbs usually co-occur with aspects. The compatibility of temporal adverbs with aspect markers can testify the correctness of temporal relations. Therefore, not only temporal feature representations of temporal adverbs and aspects are discussed but also the co-relations between temporal adverbs and aspects are our concerns. Below is the reversion of Table 1, including the compatibility of temporal adverbs with aspects. The symbol asterisk stands for ungrammaticality.

Semantic Role	Temporal Adverbs	Temporal Relation	Compatibility with <i>le</i> , <i>guo</i> and <i>zhe</i>
time	<i>cengjing</i> 曾經, <i>ceng</i> 曾	$End < ST$	<i>le guo zhe</i>
time	<i>yeyi</i> 業已, <i>yejing</i> 業經	$End \leq ST$	<i>le guo zhe</i>
time	<i>zhongyu</i> 終於, <i>bijing</i> 畢竟, <i>daodi</i> 到底	$End \leq ST$	<i>le guo zhe</i>

time	<i>xianxing</i> 先行	Start<ST	<i>le guo *zhe</i>
time	<i>zaori</i> 早日, <i>jizao</i> 及早, <i>chenzao</i> 趁早	ST<Start	* <i>le *guo *zhe</i>
time	<i>zhongjiang</i> 終將, <i>zhongjiu</i> 終久, <i>zhonggui</i> 終歸, <i>zonggu</i> 總歸, <i>bijiang</i> 必將, <i>chizao</i> 遲早, <i>zaowan</i> 早晚	ST<BP	* <i>le *guo *zhe</i>
time	<i>zhongjiu</i> 終究	End≤ST	<i>le guo zhe</i>
duration	<i>cong</i> 從(+NEG), <i>conglai</i> 從來(+NEG), <i>zhijin</i> 至今(+NEG), <i>xianglai</i> 向來, <i>sulai</i> 素來, <i>lilai</i> 歷來, <i>su</i> 素, <i>yixiang</i> 一向	Start<ST	+NEG: * <i>le guo *zhe</i> others: * <i>le *guo zhe</i>
duration	<i>zhan</i> 暫, <i>zhanqie</i> 暫且, <i>guqie</i> 姑且, <i>quanqie</i> 權且, <i>qie</i> 且	ET=ST	<i>le *guo zhe</i>
duration	<i>yongyuan</i> 永遠, <i>yong</i> 永, <i>shizhong</i> 始終, <i>zhi</i> 直	ET=ST	<i>le *guo zhe</i>
frequency	<i>yidu</i> 一度	BP<ST	<i>le guo *zhe</i>

Table 2 Temporal Relation and Compatibility between ST-related Adverbs and Aspects

### 3.2 Temporal Relations and Compatibilities between RT-related Adverbs and Aspects

By adopting the corpus-based approach and applying the analysis of time points in temporal axis, Table 3 is the sub-classification of RT-related adverbs.

Semantic Role	Temporal Adverbs	Temporal Relation	Compatibility with <i>le, guo</i> and <i>zhe</i>
time	<i>yijing</i> 已經, <i>yi</i> 已, <i>zaoyi</i> 早已, <i>zaojiu</i> 早就, <i>dou</i> 都	BP<RT	<i>le guo zhe</i>
time	<i>gang</i> 剛, <i>ganggang</i> 剛剛, <i>cai</i> 才	BP≤RT	<i>le guo zhe</i>
time	<i>xian</i> 先, <i>yuxian</i> 預先, <i>shixian</i> 事先	BP≤RT	<i>le guo zhe</i>
time	<i>jijiang</i> 即將, <i>jiangyao</i> 將要, <i>jiuyao</i> 就要, <i>kuai</i> 快, <i>xingjiang</i> 行將	ST<RT<Start	* <i>le *guo *zhe</i>
time	<i>like</i> 立刻, <i>liji</i> 立即, <i>jike</i> 即刻, <i>mashang</i> 馬上, <i>ganjin</i> 趕緊, <i>gankuai</i> 趕快, <i>ganmang</i> 趕忙, <i>lianmang</i> 連忙, <i>jimang</i> 急忙, <i>jiu</i> 就, <i>bian</i> 便, <i>dangji</i> 當即	RT≤Start	<i>le *guo zhe</i>
time	<i>dunshi</i> 頓時, <i>dengshi</i> 登時, <i>shashi</i> 霎時, <i>lishi</i> 立時, <i>yixia(zi)</i> 一下(子)	RT≤Start	<i>le *guo zhe</i>
time	<i>turan(jian)</i> 突然(間), <i>zouran</i> 驟然, <i>mengran(jian)</i> 猛然(間), <i>mengdi</i> 猛地, <i>modi</i> 驀地	RT≤Start	<i>le *guo zhe</i>
duration	<i>zheng</i> 正, <i>zhengzai</i> 正在, <i>zai</i> 在	ET=RT	* <i>le *guo zhe</i>
duration	<i>hai</i> 還, <i>haishi</i> 還是, <i>reng</i> 仍, <i>rengran</i> 仍然, <i>rengjiu</i> 仍舊, <i>yiran</i> 依然, <i>yijiu</i> 依舊, <i>zhaojiu</i> 照舊, <i>zhaoyang</i> 照樣, <i>zhaochang</i> 照常	BP≤RT	<i>le guo zhe</i>

Table 3 Temporal Relation and Compatibility between RT-related Adverbs and Aspects

The RT-related adverb *yijing* represents actions or situations have been finished, happened or existed before a certain specific time, another action or situation. The BP of the situation denoted by *yijing* must precede RT; therefore, its temporal relation is BP<RT. Sinica Corpus data point *yijing* is compatible with aspect markers.

- (8) 一定已經打破了紀錄  
*yiding yijing dapo le jilu*  
 have certainly broken the record
- (9) 已經吃過飯  
*yijing chiguo fan*  
 have had a meal
- (10) 蛇已經咬著他了  
*she yijing yao zhe ta le*  
 A snake has bitten him.

We find the combination of temporal relations of some classes and that of aspect markers are contradictory to corpus data. The temporal adverbs classified in the subclasses with *like*, *dunshi* and *turan(jian)* present situations or events happen immediately after ST or another situations. The temporal relation of them is defined as  $RT \leq \text{Start}$ . The corpus data show that these RT-related adverbs are incompatible with *guo*; however, their temporal relation  $RT \leq \text{Start}$  is compatible with *guo*. Sentence 11 points out the relation of *like* between RT and ST:

- (11) 他一聽到消息，立刻回了電話  
*ta yi tingdao xiaoxi like hui le dianhua*  
 He immediately called back when he got the news.

In sentence 11, RT is *ta yi tingdao xiaoxi* and ST is the present. The temporal relation of *like* in sentence 11 is defined as  $RT \leq \text{Start} < \text{ST}$ , which is compatible with aspect markers *le*, *guo* and *zhe*. However, the corpus data show that *guo* is not compatible with *like*. The temporal relation  $RT \leq \text{Start}$  focuses on start points of events while the aspect marker *guo* focuses on end points of events. One event can be viewed as whole or as different parts. When it is viewed as whole, the temporal relation is defined by BP. When it is viewed as different parts, its temporal relation is defined by either the start point or end point. Since Start is the focus of the temporal relation  $RT \leq \text{Start}$ , the aspect marker *guo* pointing out End is incompatible with it. Thus the RT-related adverbs divided into the same subclasses with *like*, *dunshi* and *turan(jian)* are actually incompatible with *guo* even though their temporal relations seems compatible.

### 3.3 Temporal Relations and Compatibilities between Successive-related Adverbs and Aspects

In Lu & Ma's classification, some temporal adverbs are neither ST-related adverbs nor RT-related. These temporal adverbs denote the order, sequence or successive of two situations. Thus, we classify these temporal adverbs into another class, Successive-related adverbs. Table 4 lists the Successive-related adverbs and their feature representations and co-relations with aspects.

Semantic Role	Temporal Adverbs	Temporal Relation	Compatibility with <i>le</i> , <i>guo</i> and <i>zhe</i>
time	<i>xianhou</i> 先後, <i>xiangjyi</i> 相繼	$ET_1 \leq ET_2$	<i>le guo zhe</i>
time	<i>tongshi</i> 同時	$ET_1 = ET_2$	<i>le guo zhe</i>
duration	<i>ranhou</i> 然後, <i>erhou</i> 而後, <i>suihou</i> 隨後, <i>suiji</i> 隨即, <i>congci</i> 從此	$ET_1 \leq ET_2$	<i>le *guo zhe</i>

Table 4 Temporal Relation and Compatibility between Successive-related Adverbs and Aspects

Since these temporal adverbs refer to the successive of events, their temporal relations have no relation with ST and RT. They only concerns with the sequence of the event time.

### 3.4 Feature Representations and Compatibilities between other Temporal Adverbs and Aspects

Some temporal adverbs mark habitual situations or the manner of situations. Habitual situations represent that situations go on without focusing on any time points in time axis. Temporal adverbs denoting the manner of situations have no concern with temporal relations. Consequentially, these temporal adverbs are classified into another subclass in table 5.

Semantic Role	Temporal Adverbs	Features	Compatibility with <i>le</i> , <i>guo</i> and <i>zhe</i>
frequency	<i>changchang</i> 常常, <i>chang</i> 常, <i>shichang</i> 時常, <i>wangwang</i> 往往, <i>shishi</i> 時時, <i>shike</i> 時刻, <i>bushi</i> 不時, <i>meimei</i> 每每, <i>lao</i> 老, <i>zong</i> 總, <i>yizhi</i> 一直	high frequency *experience	<i>le</i> * <i>guo</i> <i>zhe</i>
frequency	<i>ouer</i> 偶爾, <i>ouer</i> 偶而, <i>jianhuo</i> 間或, <i>youshi</i> 有時	low frequency *experience	<i>le</i> * <i>guo</i> <i>zhe</i>
time manner	<i>jian</i> 漸, <i>jianjian</i> 漸漸, <i>jianci</i> 漸次, <i>zhujian</i> 逐漸, <i>rijian</i> 日漸, <i>rijian</i> 日見, <i>zhubu</i> 逐步	slowly stage change *experience	<i>le</i> * <i>guo</i> <i>zhe</i>
time manner	<i>suishi</i> 隨時	preparatory	* <i>le</i> * <i>guo</i> <i>zhe</i>
time manner	<i>anshi</i> 按時, <i>anqi</i> 按期	preparatory regular	* <i>le</i> * <i>guo</i> * <i>zhe</i>

Table 5 Feature Representation and Compatibility between other Temporal Adverbs and Aspects

## 4 Conclusion

From section 3.1 to 3.4, we classify the temporal adverbs listed in Lu & Ma into four main classes. The division of the subclasses in each main class is somewhat different from Lu & Ma's although the majority is similar. Lu & Ma's two-classes classification of temporal adverbs is vague so we adopt more detailed four-classes classification. The application of corpus-based approach helps us to testify the correctness of temporal relations. Besides, the co-relations of temporal relations between temporal adverbs and aspect markers *le*, *guo* and *zhe* can help to predict the co-occurrence of temporal adverbs with aspect markers. The feature representations of temporal relations are helpful to assign semantic roles to temporal adverbs in Sinica Treebank.

In future work, the subclasses of temporal adverbs may be subdivided into sub-subclasses. Temporal relations or other linguistic factors can be further applied to explain why certain classes of temporal adverbs can co-occur grammatically while certain classes cannot.

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## Website Resources

- MARVS. <http://corpus.ling.sinica.edu.tw/course/marvs/index.html>
- Sinica Corpus. <http://www.sinica.edu.tw/SinicaCorpus/index.html>
- Sinica Treebank. <http://turing.iis.sinica.edu.tw/treesearch/>