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# Semantic relation identification for consecutive predicative constituents in Chinese

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## Abstract

In this paper, we propose a general methodology for designing semantic role/relation system. Based on this methodology, we establish a succinct semantic relation system for consecutive predicative constituents for Chinese, which includes serial verb construction, discourse construction, and other constructions describing serial events. This semantic relation system has 13 middle-level classes and 24 fine-grained sub-classes in contrast to conventional complex classification schemes and meets the uniqueness and completeness criteria of semantic relation identification. We conduct experiments on our system by training four annotators in 1 h to label 200 sentences extracted from Sinica Treebank and HIT-CDTB. With the help of our predesigned feature-based decision tree and a connective markers checklist, the annotators attain a 73% consistency with the reference standard annotation and substantial agreement by Cohen's kappa coefficient for middle-level labeling. By analyzing the labeling error types, we slightly revise our classification scheme and propose six methods to improve the classification and labeling system, hoping to achieve even better agreement in the future.

**Keywords:** Semantic relation identification, Semantic roles, Feature-based semantic relation system, Serial verb construction, Discourse construction, Discourse relation recognition

## 1 Introduction

Essential to natural language understanding are the processes of part-of-speech tagging, parsing, and semantic relation identification. In this paper, our objective is to clarify the relations between consecutive predicative constituents (abbreviated CPCs), which include serial verb construction (abbreviated SVC), discourse construction, and other constructions describing serial events in Chinese text and to find a good and workable semantic relation system for semantic role/relation labeling tasks. As a consequence, a methodology of semantic role/relation design methodology was also established.

Chinese has various constructions to juxtapose two predicative constituents, such as compounding, coordinate constructions, serial verb constructions, and discourse constructions. Each CPC may be with/without an overt syntactic marking of the semantic relation between the described events, for example, 戰敗投降 *zhàn bài tóu xiáng*

'defeated and surrendered'. Whereas in English the conjunction *and* is used to mark a simple coordination or temporal succession between VPs, in Chinese, the two VP constituents are simply adjoined. CPCs may occur in a simple sentence, as shown in (1a) and (1b), and are termed serial verb construction (Aikhenvald 2006; Lin et al. 2012; Tao 2009); that which occurs with coherent sequences of sentences as given in (1c) is called discourse construction (Hovy and Maier 1992; Prasad et al. 2008; Wolf and Gibson 2005).

- (1) a. 大人們趕著上山(V1)打虎(V2) **means-purpose**  
 dàrénmen\_gǎnzhe\_shàngshān\_dǎhǔ  
 the-adults\_hurried\_go-uphill\_hunt-the-tiger  
*The adults hurried to go uphill (V1) to hunt the tiger (V2).*
- b. 一大早上山(V1)累壞(V2)學生了 **cause-result**  
 yīdàzǎo\_shàngshān\_lèihuài\_xuéshēng\_le  
 early-in-the-morning\_go-up-hill\_tire-out\_student\_LE  
*It tired the students out (V2) to go uphill (V1) early in the morning.*
- c. 如遇下雪(V1), 一般車輛避免(V2)上山, 以免發生(V3)危險  
**condition-result** between V1 and V2; **event-avoidance** between V2 and V3  
 rú\_yù\_xiàxuě\_yībān\_chēliàng\_bìmiǎn\_shàngshān,\_yǐmiǎn\_  
 fāshēng\_wéixiǎn  
 if\_encounter\_snow\_ordinary\_vehicle\_avoid\_go-up-hill,\_lest\_  
 occur\_danger  
*If it snows (V1), it is better to avoid (V2) driving uphill lest danger occurs (V3).*

Most studies discuss different constructions separately. However, when studying semantic relations between CPCs in different constructions, it is not necessary to regard them as distinct phenomena. Zhou and Xue (2012) described four characteristics which blur the boundary between discourse construction and serial verb construction. They are as follows: (i) semi-colon is not always used to separate the sentences; (ii) in most of the cases, no explicit discourse connectives are used to denote the discourse relations; (iii) no inflectional clues to differentiate free adjuncts and main clauses; and (iv) both subject and object can be dropped in Chinese. For instance in (2), there are no essential reasons we need to separate (a) and (b) into different categories of discourse construction and serial verb construction.

- (2) a. 她丈夫車禍過世了。 **SVC**  
 tā\_zhàngfu\_chēhuò\_guòshì\_le  
 she\_husband\_car-accident\_died  
*Her husband died in a car accident.*
- b. 她丈夫車禍, 所以過世了。 **Discourse Construction**  
 tā\_zhàngfu\_chēhuò,\_suǒyǐ\_guòshì\_le  
 she\_husband\_car-accident,\_so\_died  
*Her husband met with a car accident, so died.*

In this paper, we are targeting to identify semantic relations between CPCs in Chinese. However, our proposed design methodology is applicable to develop all semantic

relation systems not limited to consecutive predicative units. To focus our studies, we exclude predicate-argument relations in our discussion and we do not account for the problem of delimiting related and unrelated two predicative constituents.

To sum up, CPCs are beyond any syntactic restriction, indicating the constructions including two events which describe the same subject or an identical topic such as discourse construction, serial verb construction, modifier–event construction (e.g., 傷重過世 *shāngzhòng guòshì* ‘seriously injured and died’), and causal event–resultative event construction (e.g., 過世留下遺產 *guòshì liúxià yíchǎn* ‘died and left a legacy’). In this paper, we aim to distinguish the relation between both inter- or intra-sentential CPCs; not only discourse construction and SVC are included but also sentences modified by a prepositional phrase or a complemental phrase are all taken into account. By following our design methodology, we integrate different surface forms of Chinese constructions from Sinica Treebank (Chen and Huang 2004) and HIT-CDTB (Zhang et al. 2014). It results in a hierarchical relation system of 24 fine-grained semantic relations, practically achieving the completeness and uniqueness criteria of relation identification.

The rest of the paper is organized as follows. In Section 2, we provide necessary background information and address the importance of design methodologies for semantic relation system. After introducing the distinction between semantic role labeling and semantic relation identification, we review the relevant literatures in Section 2.2. In Section 3, we motivate the need for a new relation system and propose a feature-based design methodology in Section 3.1. Following that, in Section 3.2, we describe the design of our semantic relation system; in Section 4, a guideline for semantic relation identification is addressed, and an experiment to verify the completeness and distinctness of subordinate relations is described and discussed in Section 5. We conclude the paper in Section 6.

## 2 Background

### 2.1 Semantic roles and semantic relations

Semantic role is the role of a dependent daughter with respect to its head constituent. On the other hand, semantic relation means relations between any two related constituents. Therefore, semantic relations have a broader coverage than head-dependent relations, since other than head-dependent relations, they also include coordinate relations and discourse relations.

Conventional text annotation, such as treebanks, might annotate syntactic dependent structures and semantic roles of constituents, such as Sinica Treebank (Chen et al. 2003). How is the semantic role of a dependent daughter determined? Usually, it is a result of considering the parameters of head constituent, dependent daughter, role marker, and phrasal/sentential pattern. By those factors, we decide a best role to describe this dependent daughter. The premise of above role assignment scheme is that there is only one semantic role for each dependent daughter and there is a limited set of predetermined semantic roles which you may choose from. Such a simple schema annotates only the semantic role of dependent daughter of head-dependent relations without considering coordinate relations and relations across sentences, such as discourse relations. Furthermore, a naïve role labeling system may cause the following problems.

First of all, each constituent may have dependent relations with multiple heads. For instance, in (3), an object of a verb-result compound in Chinese has two dependent relations. One is relation with respect to verb part and the second relation is with result part. Each bears different semantic relation. However, only single role is assigned to each dependent daughter. As a matter of fact, multiple relations commonly exist in a discourse structure, for example topic-comment chains.

- (3) 張三打破花瓶 (The vase is the patient of 打 *dǎ* ‘hit’ or theme of 破 *pò* ‘broken’.)

zhāngsān\_dǎpò\_huāpíng

Zhangsan\_hit\_broken\_vase

*Zhangsan breaks the vase.*

- (4) 花瓶打破了 (The vase is the theme of 破 *pò* ‘broken’.)

huāpíng\_dǎpò\_le

vase\_hit\_broken\_LE

*The vase was broken.*

The second problem is none-exclusiveness of semantic roles/relations. Semantic roles/relations may categorize into different feature dimensions. The relations between two constituents may be described by different categories of relations. For example in (3), the role of 花瓶 *huāpíng* ‘vase’ may be described by either dynamic relation of patient or static relation of theme. Similarly temporal relations, cause-result relations are falling into two different feature dimensions and the two relations may co-exist in CPCs. Conventionally, semantic roles may each other share the same characteristics and have idiosyncrasies. Each semantic role can be characterized by a few semantic features. The best role describing a dependent daughter is the role which matches most semantic features of the target constituent in its contextual environment (Dowty 1991). It causes competition among several possible candidate roles. Then, to determine the best role, in addition to feature matching, should each feature assign different weights in different contextual environments?

It results in a third practical problem: if a semantic role system is too complicated, it is very hard to annotate the best role/relation. Since a semantic role of a constituent is determined not only by the semantic relation with its dependent head but also by the entire contexture environment of the constituent. As we had mentioned, the major parameters for semantic role determination are head, dependent daughter, role marker, and phrasal/sentential pattern. Such criteria cause the complication of determining the best semantic role as exemplified in (5–7).

- (5) a. 張三被屠殺。 (Zhangsan is the patient of “slaughter”; it focused on the dynamic feature dimension.)

zhāngsān\_bèi\_túshā

Zhangsan\_BEI\_slaughtered

*Zhangsan was slaughtered.*

- b. 張三遭屠。 (Zhangsan is the theme of “being slaughtered”; it focused on the static feature dimension.)

zhāngsān\_zāotú

Zhangsan\_ZAO\_slaughtered  
*Zhangsan was slaughtered.*

- (6) a. 張三把牛肉軟化了 (Role marker *bǎ* delimits “beef” as a patient, i.e. instead of the main verb, *bǎ* becomes the head.)

zhāngsān\_bǎ\_niúròu\_ruǎnhuà\_le  
 Zhangsan\_BA\_beef\_soften  
*Zhangsan softened the beef.*

- b. 牛肉軟化了 (“Beef” is the theme of “soften”).

niúròu\_ruǎnhuà\_le  
 beef\_soften  
*The beef is softened.*

- (7) 他買票(V1)上車(V2)。 (Do temporal relation, condition-consequence, cause-result, or elaboration all exist between V1 and V2?)

tā\_mǎipiào\_shàngchē  
 he\_buy\_ticket\_get-on-the-bus  
*He bought a ticket (V1) and got on the bus (V2).*

A better relational system for human annotators and also for future automation should meet the criteria of uniqueness and completeness; *Uniqueness* means two CPCs may assign a semantic relation (mostly are formed by a pair of semantic roles) which best describes their semantic relation. *Completeness* means two CPCs may be assigned some semantic role(s) to describe their semantic relations. That is, semantic relations between two CPCs are best described by one of the relation labels in the system without ambiguity.

Therefore, in designing a semantic relation system for CPCs, we encounter the following problems: How many relations are needed to meet the completeness criterion, that is, are all semantic relations between CPCs covered by the proposed classification system? How to meet the uniqueness criterion, that is, achieve a unique and consistent best labeling for CPCs? In the meanwhile, should we allow multiple relations while different interpretations occur? In the following subsections, by studying the related work and summarizing previous systems and offering our viewpoints, we attempt to answer the above questions and come up with a workable design methodology and a practical semantic relation system.

## 2.2 Related works

In the late 1980s, Mann and Thompson (1988) proposed a new interpretation of rhetorical structure theory (abbreviated RST) to describe natural texts, characterizing their structure primarily in terms of relations that hold between parts of the text. By examining real data, they provided a list which enumerates those which have proven the most useful 23 relations, including circumstance, solutionhood, elaboration, background, enablement, and motivation. Continuing the RST framework, Carlson and Marcu (2001; RST-DT) in their tagging reference manual claimed 16 classes covering a total of 78 relations, including attribution, background, cause, comparison, and condition.

Hovy and Maier (1992) summarized a survey of the conclusions of approximately 30 researchers who proposed more than 400 intersegment relations in different classification systems. Hovy then suggested using just as many relations as are required for determining the major aspects of English discourse structure, that is, approximately 70 relations, organized into a hierarchy of increasing specificity. The top-level classifications are divided into three parts: *Ideational relation* is defined between adjacent segments of material as those relations that express some experience of the world about us and within our imagination, for example, circumstance, cause/result, and general condition. *Interpersonal relation* is defined as holding between adjacent segments of textual material by which the author attempts to affect the address's beliefs, attitudes, desire, and so on, by means of language, for example, interpretation and enablement. *Textual relation* is defined as holding between adjacent segments of text which exists solely due to the juxtaposition imposed by the nature of the presentation medium, for example conjunction and pre-sequence.

Miltsakaki et al. (2008) proposed four classes covering a total of 38 fine-grained relations which are annotated to the Penn Discourse Treebank (abbreviated PDTB), the largest-scale annotated corpus at the discourse level. Their relation structure is therefore most prevalent. The top-level classifications are divided into four parts: *temporal* is used when the situations described in the arguments are related temporally; *contingency* is used when the situations described in the arguments are causally influenced; *comparison* applies when a discourse relation is established between arguments in order to highlight prominent differences between the two situations; and *expansion* groups all the relations which expand the discourse and move forward its narrative or exposition.

Based on the lexically grounded approach of PDTB, Zhou and Xue (2012, 2015) presented a Chinese discourse annotation scheme and focused on the key characteristics of Chinese text which differs from English that we have mentioned in previous section. They claimed promising results on identifying a discourse relation; classifying the semantic type of explicit, implicit, or altLex; and determining the argument span. The agreements of the former are both over 95%, and the latter is over 80%.

Also based on PDTB classification, Huang et al. (2014) adopted discourse connectives to reveal explicit discourse relation in Chinese. They found there are 808 Chinese connectives which are eight times more than English connectives. Moreover, the Chinese discourse connectives have a variety of parts of speech that further deepen the difficulties of Chinese discourse relation labeling. By using semi-supervised learning method, the labeling result shows an *F*-score of 73.22%.

Zhou et al. (2014) followed the annotation scheme of PDTB and presented the first open discourse treebank for Chinese (abbreviated DTBC). They modified the PDTB sense hierarchy; three type level senses (i.e., CONTINGENCY. Inference, CONTINGENCY. Purpose and EXPANSION. Background) and two subtype level senses (i.e., EXPANSION. Conjunction. parallel and EXPANSION. Conjunction. progressive) were added to meet the needs of Chinese textual characteristics. They reported an over 90% inter-annotator agreement on discourse connective identification and an over 85% on sense annotation.

Li et al. (2014), based on the annotation of discourse connective in the Chinese discourse treebank (abbreviated CDTB), propose a three-level classification with a total

of 17 fine-grained relations. The top-level classifications are divided into causality, transition, coordination, and explanation, and the third level merely lists the corresponding connective markers belonging to the middle-level types. The CDTB annotation is done by five long-term training annotators. The result showed a 94% inter-annotator agreement on explicit or implicit identification, an 82.3% agreement on explicit connective identification, and a 74.6% on implicit connective insertion.

Regarding practical relation identification problems, Wang et al. (2010) interpreted the implicit semantic relation between N-N compounds by adopting a dynamic approach using paraphrasing verbs. Not giving a set of relation candidates, they recognized each relation of N-N compounds by collocate verbs, for example, through Chinese word sketch engine finding people **tell/seek** a 愛情故事 *àiqíng gùshì* 'love story'; and 民間故事 *mínjiān gùshì* 'folk tales' are stories that **come from/spread in** villages, then further recognize the fine-grained differences of meaning between the related compounds. On the contrary, Hong and Huang (2015) revealed the semantic relation between V-V compounds using an ontology-based conceptual classification, where three types of eventive relations, i.e., coordinate, modificational, and resultative, are predicted automatically. Xu and Huang (2014) discriminated sentences into general events, speech act, and modality types which is namely a task of event type classification.

### 3 Our semantic relation system

As given above, many classification systems for discourse relations had been established and experiments on different aspects of discourse relations were carried out. The proposed systems were proven to be sound. Unfortunately, hardly any previous mentioned systems meet the uniqueness criterion, since it is almost impossible to achieve mutually exclusivity for all relations. We agree that multi-relation interpretations between CPCs do exist but to achieve a unique annotation scheme which is also in line with the procedure of human understanding, i.e., always select the best interpretation among many possibilities. Therefore, our semantic relation system adopts a feature-based decision-making methodology described below to achieve the best labeling.

#### 3.1 Methodology for designing a semantic role system

Our proposed design methodology tries to provide a methodology for designing a semantic relation system to avoid the problems caused by conventional semantic role labeling system mentioned in the Section 2.1 and to achieve the uniqueness and completeness criteria of relation identification.

To deal with the first problem of multiple roles, we suggest labeling semantic relation between any two related constituents instead of semantic roles, i.e., each constituent may have many relations each with respect to a different related constituent.

For the problem of ambiguous role assignment caused by none-exclusiveness of semantic roles/relations, we propose a multi-level refinement and feature-based approach. A relation system should be designed in a hierarchical way from top level to bottom level. Each level of relations is differentiated by a salient feature from top to bottom to form a binary branching. For instance, the most salient

feature to differentiate CPCs relations is *+realis*. Two types of relations are divided. One is relations regarding *realis* events (facts) and another is relations regarding *irrealis* events (opinions). We then refine each type of relations into different levels of fine-grained relations according to different dimension of relation types and semantic features from different aspects. For instance, the *realis* relations can be refined according to the feature of *+intension* into relations with *purpose* and relations without *purpose*. The resulting hierarchical relation system is also formed a decision tree which is utilized to find the unique best relation among ambiguous multiple relations to achieve the uniqueness criterion. As for the criterion of completeness, we propose a corpus-based approach; each preliminary designed feature-based semantic relation system should be tested and verified by a large set of real data from corpora. New features and new relations can be added, and the preliminary system will be refined accordingly until all real data can be satisfied.

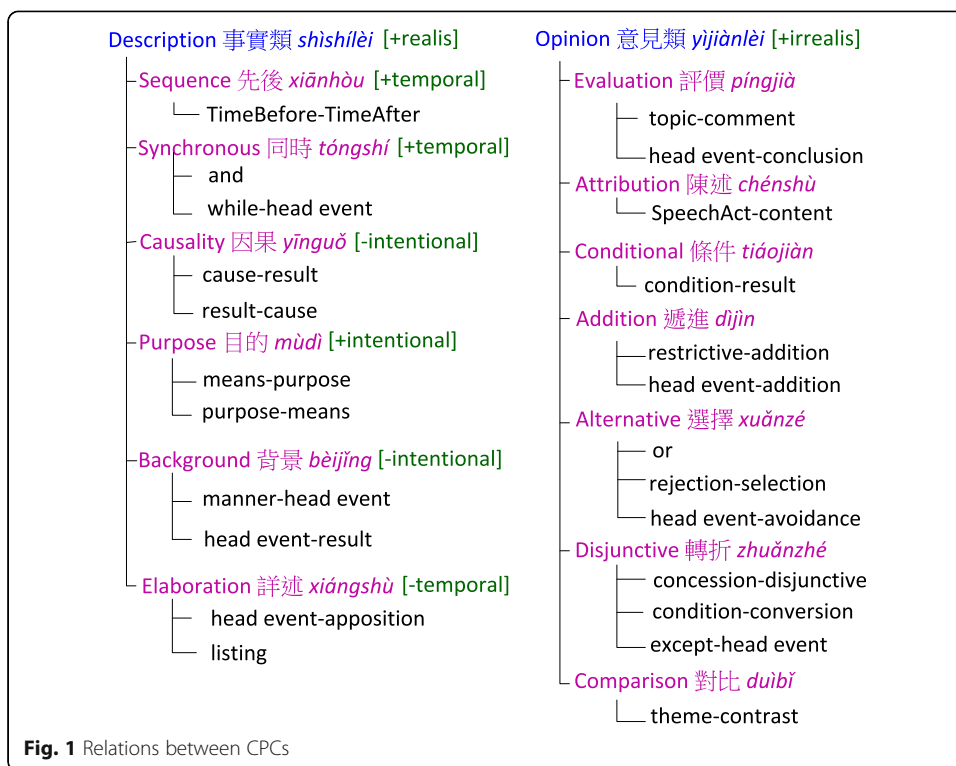
### 3.2 Our design

For the first step, we integrate and rearrange relations proposed by previous frameworks to meet the needs of Chinese syntactic and semantic constructions, including SVC and discourse constructions, and use semantic features as discriminative criteria. By combining the relations with E-HowNet (Chen et al. 2005; Chen 2011) semantic role system, which is a lexical knowledge base consisting of definitions for lexical senses, where more than 100 semantic relations are used to describe the sense relations, we then classify the possible candidate relations by observing their salient features and eliminating redundant relations as well as relations with minor differentiation features. We end up in developing a preliminary three-level semantic relation framework for CPCs as shown in Fig. 1.

The top-level classification is divided into *Description* and *Opinion* according to the feature of *realis*. *Description* is used principally to indicate that something is a statement of fact, for example in 他生病(V1)住院(V2) *tā shēngbìng zhùyùàn* ‘he was sick and stayed in the hospital’, a *cause-result* relation under *description* is revealed between V1 and V2. *Opinion* is used to express the speaker’s attitude towards something, for example, in 如果生重病(V1)就要住院(V2) *rúguǒ shēngzhòngbìng jiùyào zhùyùàn* ‘if seriously ill, one must stay in the hospital’, a *condition-result* relation is revealed between V1 and V2 to express the speaker’s attitude. Clearly, the diversity of the two top-level classes can be distinguished by the *realis* and *irrealis* moods in the grammatical category since *opinion* does not focus on a situation or action that has actually occurred. Therefore, in order to meet the uniqueness criterion, adding discrimination features such as *realis*, *intentional*, and *temporal* to each semantic relation may help to determine the primary relations between CPCs as exemplified below:

- (8)purpose[+intentional]  
 a. causality[-intentional] vs. purpose[+intentional]  
 a1. 搶劫(V1)被逮(V2)            **cause-result** vs.  
     qiǎngjié\_\_bèidǎi  
     rob\_\_be-caught  
     robbed and be caught





- a2. 蒐證(V1)舉發(V2)            **means-purpose**  
 sōuzhèng\_jǔfā  
 gather-evidence\_\_expose-one's-secret  
*gather evidence to expose one's secret*
- b. purpose[+intentional] vs. background[-intentional]
- b1. 出國(V1)留學(V2)            **means-purpose** vs.  
 chūguó\_liúxué  
 go-abroad\_\_study-abroad  
*study abroad*
- b2. 搭機(V1)前往(V2)            **manner- head event**  
 dājī\_qiánwǎng  
 take-plane\_\_leave-for  
*go by airplane*
- c. purpose[+intentional] vs. sequence[-intentional]
- c1. 整裝(V1)出門(V2)            **means-purpose** vs.  
 zhěngzhuāng\_chūmén  
 dress\_\_go-out  
*dressed to go out*
- c2. 放學(V1)回家(V2)            **TimeBefore-TimeAfter**  
 fàngxué\_huíjiā  
 leave-school\_\_go-home  
*go home after school*

Since the type of *purpose* implies an intention behind an action, it is an effective feature to distinguish it from the other types as shown in (8). Comparatively, events

labeled with *purpose* contain intention and motivation which lead the actor to pursue his act. On the contrary, the actors are less aware of what they can achieve by engaging in an action related with *causality*, *background*, or *sequence* relation types.

As illustrated below, *and* and *listing* are other subordinate types discriminated by the temporal feature.

(9) *and* [+temporal] vs. *listing* [-temporal]

- a. 忽然宣佈(V1)關閉機場, 也下令(V2)禁止所有集會活動 ***and*** vs.  
 hūrán\_xuānbù\_guānbì\_jīchǎng, yě\_xiàlìng\_jìnzhǐ\_suǒyǒu\_  
 jíhuì\_huódòng  
 suddenly\_\_announce\_\_close\_\_airport,  
 also\_\_order\_\_forbid\_\_all\_\_gathering\_\_activity  
*Suddenly the closure of the airport was announced, and all gatherings were banned too.*
- b. 暫停包括香港飛(V1)臺北, 以及臺北飛(V2)香港航班 ***listing***  
 zhàntíng\_bāokuò\_xiānggǎng\_fēi\_táiběi, yǐjǐ\_táiběi\_fēi\_  
 xiānggǎng\_hángbān  
 pause\_\_including\_\_Hong-Kong\_\_fly\_\_Taipei, \_\_and\_\_Taipei\_\_fly\_\_Hong-Kong\_\_flight  
*Paused flights include Hong Kong to Taipei and Taipei to Hong Kong.*

Belonging to the *synchronous* type, *and* is used to connect events that occur at the same time, while *listing* is simply used to link items being described that are not involved within the timeline. *And* is also easily confused with *apposition*, and *apposition* sometimes confused with *result*; (10) and (11) demonstrate the difference between these subtypes.

(10) *and* [-synonym] vs. *apposition* [+synonym]

- a. 一群人又跳(V1)又叫(V2) ***and*** vs.  
 yīqúnren\_yòu\_tào\_yòu\_jiào  
 a-group-of-people\_\_and\_\_dance\_\_and\_\_shout  
*A group of people dancing and shouting.*
- b. 把自己好好梳妝(V1)打扮(V2)一番 ***head event-apposition***  
 bǎ\_zìjǐ\_hǎohǎo\_shūzhuāng\_dǎbàn\_yīfān  
 ba\_oneself\_well\_decorate\_dress-up\_once  
*dress and decorate oneself properly.*

(11) *apposition* [+synonym] vs. *result* [+result state]

- a. 被騙(V1)上當(V2) ***head event-apposition*** vs.  
 bèipiàn\_shàngdàng  
 be-cheated\_\_be-fooled  
*be cheated and fooled*
- b. 哭(V1)不停(V2) ***head event-result***  
 kū\_bùtíng  
 cry\_\_not-stop  
*cries continuously*

*Apposition* is established only when V1 and V2 are synonymous; *result* is assigned when the second event denotes the result state of the first action. Along with these features, each subordinate type and subtype in Fig. 1 has been defined specifically; see Appendix 1; connective words that help reveal explicit relations are also attached to each correspondent subtype; see Appendix 2, Table 4.

To meet the completeness criterion, we have tried to identify as many semantic relations as possible that CPCs may have and we define the relation of *elaboration* and *addition* rather flexible and inclusive, which makes the completeness criterion easier to be achieved. The completeness criterion is verified by labeling over 50 paragraphs in HIT-CIR Chinese Discourse Relation Corpus (HIT-SCIR 哈工大社会计算与信息检索研究中心 2013) and 3000 sentences in Sinica Treebank (Chen and Huang 2004), to ensure sufficient coverage of the relations shown in Fig. 1 for Mandarin Chinese.

#### 4 Guideline for semantic relation identification

##### 4.1 Three factors that affect the deduction of relation recognition

Summarizing the factors that affect the deduction of relation recognition, other than senses of two events, three main aspects are primary considerations: markers, event ordering, and knowledge-based reasoning. At surface structures, conjunctions and adverbial markers are used to mark fixed explicit relations between subevents, as shown in (12). However, not all CPCs have explicit relation markers. In most cases, the logical relations between two events require common-sense knowledge to determine. Also, the ordering of the VPs may indicate the relationship between subevents, such as in (13): V1 always precedes V2 in the timeline to introduce an intention behind the action or a consequential result of the state. However, this is not an absolute constraint. In rhetoric, we may see sentences like 趕考進京 *gǎnkǎo jìn jīng* ‘to sit a civil service examination (he) goes to the capital’ as well, or as in the sentences given in (14), both orderings are commonly used.

- (12) a. 他吃(V1)完就走(V2) *TimeBefore-TimeAfter*  
 tā\_\_chī\_\_wán\_\_**jiù**\_\_zǒu  
 he\_\_eat\_\_finished\_\_**afterwards**\_\_left  
*He finished the meal and left.*
- b. 坐(V1)著看(V2)書 *manner-head event*  
 zuò\_\_**zhe**\_\_kànshū  
 sit\_\_**ZHE**\_\_read  
*sit and read.*
- c. 美(V1)得沒話說(V2) *head event-result*  
 měi\_\_**dé**\_\_méihuàshuō  
 beautiful\_\_**DE**\_\_hard-to-describe  
*[It is] too beautiful to describe.*
- d. 他雖然窮(V1)還是快樂(V2) *concession-disjunctive*  
 tā\_\_**suīrán**\_\_qióng\_\_**háishì**\_\_kuàilè  
 he\_\_**although**\_\_poor\_\_**still**\_\_happy  
*He is poor but still happy.*

- (13) a. 進京(V1)趕考(V2) **means-purpose**  
 jìnjīng\_\_gǎnkǎo  
 went-to-the-capital\_\_sitting-a-civil-service-examination  
*[He] went to the capital to sit a civil service examination.*
- b. 生病(V1)住院(V2)了 **cause-result**  
 shēngbìng\_\_zhùyuàn\_\_le  
 sick\_\_stay-in-the-hospital\_\_LE  
*get sick and stay in the hospital.*
- (14) a. 偷閒(V1)走(V2)到外面 **purpose-means**  
 tōuxián\_\_zǒudào\_\_wàimiàn  
 take-a-break\_\_go-to\_\_outside  
*In order to take a break [he] goes outside.*
- b. 走(V1)到外面偷閒(V2) **means-purpose**  
 zǒudào\_\_wàimiàn\_\_tōuxián  
 go-to\_\_outside\_\_take-a-break  
*go outside and take a break.*

Using common-sense knowledge, relations are often deduced from the knowledge of entailment, implication, or presupposition between CPCs, as shown in the following examples respectively.

- (15) 消失(V1)不見(V2)了 **head event-antiposition V1 entails V2**  
 xiāoshī\_\_bújiàn\_\_le  
 vanish\_\_disappear\_\_LE  
*vanish and disappear*
- (16) 喝酒(V1)醉倒(V2) **cause-result V2 implies V1**  
 hējiǔ\_\_zuìdǎo  
 drink-alcohol\_\_fall-down-drunkenly  
*drink wine and become drunk*
- (17) 水加熱(V1)到一百度沸騰(V2) **condition-result V2 presupposes V1**  
 shuǐ\_\_jiārè\_\_dào\_\_yībǎidù\_\_fèiténg  
 water\_\_heat-up\_\_to\_\_100-degree\_\_be-boiled  
*Heat water up to 100 degrees and it will boil.*

Clearly, because of the sentential (propositional) logic, we cannot freely reverse the V1-V2 sequence in the above sentences, unless a specific connective occurs to explain how the semantic focus has changed as in the example in (18). There are weak or unobvious entailment relations that exist between certain verbs, which also make for unreasonable reversed orderings as shown in (19). In other cases, the reversed ordering, although not ungrammatical, does cause a shifting of sense, at the same time changing the relation between sub-events as shown in (20), that is, the latter event is always considered a *purpose*.

- (18) a. 西班牙戰敗(V1)投降(V2) **cause-result**  
 xībānyá\_\_zhàn bài\_\_tóuxiáng

Spain\_\_be-defeated\_\_surrender  
*Spain was defeated and surrendered.*

- b. 西班牙投降(V1)是因為戰敗(V2) **result-cause**  
 xībānyá\_\_tóuxiáng\_\_shì\_\_yīnwèi\_\_zhàn bài  
 Spain\_\_surrender\_\_SHI\_\_because\_\_be-defeated  
*Spain surrendered because it was defeated.*

- (19) a. 桌子收拾(V1)乾淨(V2) **means-purpose**

zhuōzi\_\_shōushi\_\_gānjìng  
 table\_\_tidy-up\_\_clean  
*Table was tidied up and cleaned.*

- b. \*桌子乾淨(V1)收拾(V2)  
 zhuōzi\_\_gānjìng\_\_shōushi  
 table\_\_clean\_\_tidy-up

- (20) a. 開門(V1)出去(V2) **means-purpose**

kāimén\_\_chūqù  
 open-the-door\_\_go-out  
*open the door to go out*

- b. 出去(V1)開門(V2) **means-purpose**

chūqù\_\_kāimén  
 go-out\_\_open-the-door  
*go out to open the door*

In addition, combinations of specific verbs may be idiomatic and thus seldom reversed, as shown in (21).

- (21) a. 祝你旅行(V1)愉快(V2) **topic-comment**

zhù\_\_nǐ\_\_lǚxíng\_\_yúkuài  
 wish\_\_you\_\_travel\_\_happy  
*Wishing you happy travels.*

- b. \*祝你愉快(V1)旅行(V2)  
 zhù\_\_nǐ\_\_yúkuài\_\_lǚxíng  
 wish\_\_you\_\_happy\_\_travel

More examples are provided to illustrate that context and world knowledge are often necessary for a correct understanding of CPCs. As in (22), 想 *xiǎng* 'think' naturally precedes 回答 *huídá* 'reply' to reflect the process of human mental behavior, and in (23), the sequence of 救 *jiù* 'rescue' and 上岸 *shàngàn* 'ashore' demonstrate the factual process of rescue. In (24), we either infer from the context that one animal is sick so the speaker does not want it, or our common sense tells us that illness makes something undesirable; in either case, a *cause-result* relation between V1 and V2 is determined.

- (22) 他想(V1)了一會回答(V2)我 **TimeBefore-TimeAfter**

tā\_\_xiǎng\_\_le\_\_yíhuì\_\_huídá\_\_wǒ  
 he\_\_think\_\_a-while\_\_answer\_\_me  
*He thinks a while and answers me.*

- (23) 漁人把他救(V1)上岸(V2) *TimeBefore-TimeAfter*  
 yúrén\_bǎ\_tā\_jiù\_shàngàn  
 fisherman\_BA\_he\_rescue\_get-on-shore  
*The fisherman rescues him and gets him on shore.*
- (24) 這隻早就病(V1)了,換(V2)一隻別的 *cause-result*  
 zhè\_zhī\_zǎo\_jiù\_bìng\_le,\_huàn\_yī\_zhī\_bíe\_de  
 this\_CL\_early\_already\_sick\_LE,\_change\_one\_CL\_other\_DE  
*This one has long been sick; change to another one.*

Since our primary concern is about whether the classification system allows users to find a comfortable linking relation between CPCs, and whether different users recognize the same linking relation without difficulty, the immediate goal is to achieve a fairly consistent manual tagging result, which is also an important foundation for the future development of automatic semantic relation identification.

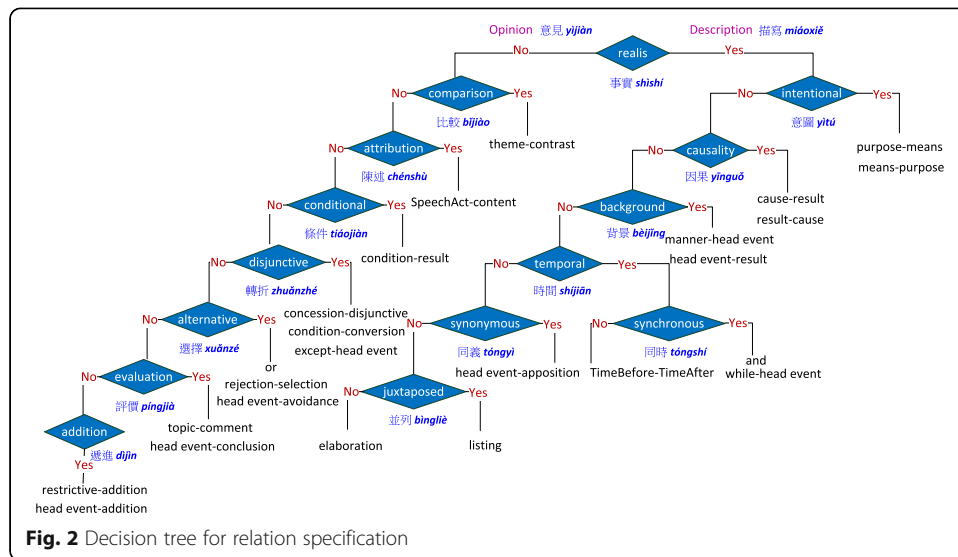
#### 4.2 How to determine a prior relation

Multiple relations may exist between CPCs; there is no ideal classification system that supports a unique interpretation based on world knowledge and the discourse context. That is, the relations shown in Fig. 1 are not mutually exclusive. The following sentence is an example.

- (25) 他回家(V1)看(V2)準決賽了 *TimeBefore-TimeAfter? means-purpose?*  
 tā\_hújiā\_kàn\_zhǔnjuésài\_le  
 he\_go-home\_watch\_semifinal\_LE  
*He has gone home to watch the semifinal.*

There are at least two possible interpretations in (25). One simply denotes the *temporal sequence* between V1 and V2, while the other denotes the *means* and *purpose* relation between V1 and V2 since it is highly likely that “watch the semifinal” is an aim. In order to achieve consistent and correct results for either manual or automatic annotations, we construct a decision tree to determine a prior relation among all possible relations, as given in Fig. 2.

The decision tree is generated by a complete semantic relation framework given in Fig. 1 and the features mentioned in Section 3.2 as discriminative decision node. In the tree structure, relation types also play roles as discriminative decision node. The most salient relation should be selected at first, and the closer to the bottom, the more inclusive and vague sense the relation linked. The decision tree demonstrates their priorities while determining the major relation. For example, in the sentence of 他在台灣出生(V1)成長(V2) *tā zài táiwān chūshēng chéngzhǎng* ‘he was born and raised in Taiwan’, we first use *realis* to determine it is a fact description; since there is no *intention* within V1 and V2, we look for *causality* in-between. Lacking *causality*, we then examine if V1 modifies V2 or if V2 is a result state of V1; disproving them both, we continue to look for a *temporal* relation between V1 and V2. With a positive answer, we then judge whether they are *synchronous*; since they are not, the *TimeBefore-TimeAfter* relation is determined.



Clearly, *opinion*-type relations are less confusing and most are introduced by connective words. To reveal their relations, Appendix 2 Table 4 shows the relations and their associated markers where only four relation markers associated with ambiguous relations as shown in (26).

(26) a. 除非 *chúfēi* ‘unless’

a1. **condition(-result)**

除非你同意(V1), 我才會去(V2)  
*chúfēi nǐ tóngyì, wǒ cái huì qù*  
 unless you agree, I then will go  
*Unless you agree, then I won't go.*

a2. **condition(-conversion)**

除非有(V1)課本, 不然我不去(V2)上學  
*chúfēi yǒu kèběn, bùrán wǒ bú qùshàngxué*  
 unless have textbook, otherwise I NEG go-to-school  
*Unless I have textbooks, otherwise I am not going to school.*

b. 除/除了 *chú/chúle* ‘In addition to; except for’

b1. **restrictive(-addition)**

除了送(V1)花, 他甚至還下跪(V2)  
*chúle sònghuā, tā shènzhì hái xiàguì*  
 in-addition-to give-flower, he even still kneel-down  
*In addition to flowers, he even knelt down.*

b2. **except(-head event)**

除了遇到(V1)颱風天, 我們全年無休(V2)  
*chúle yùdào táifēngtiān, wǒmen quánnián wúxiū*  
 except-for encounter typhoon-day, we all-year-round NEG rest  
*Except for the typhoon day, we open all year round.*

c. 不管/不論/無論 *bùguǎn/búlùn/wúlùn* ‘no matter; whether... or...’

c1. **condition(-result)**

不管誰出來選(V1)都會贏(V2)  
*bùguǎn shéi chūlái xuǎn dōu huì yíng*

no-matter\_\_who\_\_come-out\_\_run-the-election\_\_all\_\_will\_\_win  
*Whoever runs for election will win.*

c2. **or**

不管是走路(V1)、騎車(V2)或搭公車(V3)  
 bùguǎn\_\_shì\_\_zǒulù,\_\_qíchē\_\_huò\_\_dāgōngchē  
 whether\_\_walk,\_\_take-a-bike\_\_or\_\_take-bus  
*Whether on foot, by bike, or by bus*

## d. 也 yě 'and; or; not only...but also'

d1. **and**

他抽煙(V1)也喝酒(V2)  
 tā\_\_chōuyān\_\_yě\_\_hējiǔ  
 he\_\_smoke\_\_and\_\_drink-alcohol  
*He smokes and drinks.*

d2. **or**

你可以學(V1)中文,也可以學(V2)日文  
 nǐ\_\_kěyǐ\_\_xué\_\_zhōngwén,\_\_yě\_\_kěyǐ\_\_xué\_\_rìwén  
 you\_\_can\_\_learn\_\_Chinese,\_\_or\_\_can\_\_learn\_\_Japanese  
*You can learn Chinese or Japanese.*

d3. **(restrictive)-addition**

他不但唱歌(V1),也跳舞(V2)  
 tā\_\_búdàn\_\_chànggē,\_\_yě\_\_tiàowǔ  
 he\_\_not-only\_\_sing,\_\_but-also\_\_dance  
*He not only sings but also dances.*

We note that word-pair relation markers are more accurate than single-word markers, since their associated relations are usually definite and unique. For example, the three markers 除了 *chúle* 'in addition to', 似乎 *sihū* 'seem', 也 *yě* 'and' in (27) can establish five possible relations: *except-event*, *and*, *or*, *theme-contrast*, and *restrictive-addition*. However, 除了...也 *chúle...yě* 'not only... but also' which expresses the relation of *restrictive-addition* is the prior relation, since it is the most definite expression of the semantic relation in (27).

(27) 除了表彰(V1)他在中文文學創作的偉大成就之外,似乎也有意(V2)借此彰顯高行健遭到中共當局迫害 **restrictive-addition**

**chúle**\_\_biǎozhāng\_\_tā\_\_zài\_\_zhōngwén\_\_wénxué\_\_chuàngzuò\_\_de\_\_wěidà\_\_chéngjiù\_\_zhīwài,\_\_**sihū**\_\_**yě**\_\_yǒuyì\_\_jiècǐ\_\_zhāngxiǎn\_\_gāoxíngjiàn\_\_zāodào\_\_zhōnggòng\_\_dāngjú\_\_pòhài

**not-only\_\_to**\_\_honor\_\_he\_\_in\_\_Chinese\_\_literature\_\_creation\_\_DE\_\_great\_\_achievement\_\_besides\_\_**seem**\_\_also\_\_have-a-mind-to\_\_by-means-of\_\_highlight\_\_Gao-Xingjian\_\_suffer\_\_Chinese-communist\_\_authority\_\_persecute

*It not only honors his great achievements in Chinese literature, but also seems to be meant to highlight the Chinese authorities' persecution of Gao Xingjian.*

When no relation markers are available, we then take the meaning of two consecutive events into account. In addition to referring to the logical deduction in Section 3.1, here, we provide examples showing how we select the best relation. In (28), the preceding sentence



of (a) and (b) are the same; as the successive sentence of (a) raises an opposite expectation to the preceding event, a *concession-disjunctive* is determined. For (b), as the successive sentence implies a supposed result, *condition-result* is recognized.

- (28) a. 64歲福田康夫的政策手腕受到(V1)了好評, 如何在緊迫的政局當中得以發揮才是(V2)受到矚目的 **concession-disjunctive**  
 liùshísìsuì fútiánkāngfū de zhèngcè shǒuwàn shòudào le  
 hǎopíng rúhé zài jǐnpò de zhèngjú dāngzhōng déyǐ fāhuī  
 cáishì shòudào zhǔmù de  
 64-year-old Yasuo-Fukuda DE policy wrist receive LE favorable-comment how in urgent DE political-situation among to develop just SHI receive gaze-at DE  
*64-year-old Yasuo Fukuda's policy strategies have been well received, but what receives the greatest attention is how he handles this pressing political situation.*
- b. 64歲福田康夫的政策手腕受到(V1)了好評, 他可能被提名(V2) **condition-result**  
 liùshísìsuì fútiánkāngfū de zhèngcè shǒuwàn shòudào le hǎopíng  
 tā kěnéng bèi tímíng  
 64-year-old Yasuo-Fukuda DE policy wrist receive LE favorable-comment he may BEI nominate  
*64-year-old Yasuo Fukuda's policy strategies have been well received; he may be nominated.*

Finally, we note that in semantic relation identification for CPCs, we adopt a two-way linkage to avoid interference between head assignments. In the linking construction of Mandarin, Li and Thompson (1981: 631) identify essentially two kinds of sentence linking: forward linking and backward linking. As with linking elements then, connectives are also divided into two kinds. For example, in (29a), 假如 *jiǎrú* 'if' is a forward-linking element whose function is to signal the dependence of clause 1 on clause 2 to complete its message. However, constituents led by certain connectives always play the same role; thus as 下雨 *xiàyǔ* 'rain' must be a *condition* when introduced by 假如 *jiǎrú* 'if', it is unnecessary to decide which clause in the text is the main clause or the head verb. In fact, due to the influence of English syntax, we increasingly see sentences like (29b).

- (29) a. 假如下雨(clause 1), 我們就在屋裡吃飯(clause 2) **condition-result**  
 jiǎrú xiàyǔ, wǒmen jiù zài wūlǐ chīfàn  
 if rain, we then in house eat  
*If it rains (clause 1), we will eat in the house (clause 2).*
- b. 我們就在屋裡吃飯(clause 1), 假如下雨(clause 2) **result-condition**  
 wǒmen jiù zài wūlǐ chīfàn, jiǎrú xiàyǔ  
 we then in house eat, if rain  
*We will eat in the house (clause 1), if it rains (clause 2).*

We thus propose two-way linkage as opposed to one-way linkage, because it prevents interference between head assignments and focuses on the relation structure

of CPCs. For example, in (30a), we need not determine which verb is primary but instead clarify the verbs' relation and the roles they play.

- (30) a. 他做事(V1)快(V2) **topic-comment**  
 tā\_zuòshì\_kuài  
 he\_work\_fast  
*He works fast.*
- b. 他做事(V1)快(V2), 說話也快 **topic-comment (semantic focus on topic)**  
 tā\_zuòshì\_kuài\_shuōhuà\_yě\_kuài  
 he\_work\_fast\_talk\_also\_fast  
*He works fast and talks fast too.*
- c. 他做事(V1)快(V2), 說話慢 **topic-comment (semantic focus on the comment of topic)**  
 tā\_zuòshì\_kuài\_shuōhuà\_màn  
 he\_work\_fast\_talk\_slow  
*He works fast and talks slow.*
- (31) a. 他生病(V1)住院(V2)了 **cause-result**  
 tā\_shēngbìng\_zhùyùan\_le  
 he\_sick\_stay-in-the-hospital\_LE  
*He was sick and stayed in the hospital.*
- b. 他住院(V1)了, 因為生病(V2) **result-cause**  
 tā\_zhùyùan\_le\_yīnwèi\_shēngbìng  
 he\_stay-in-the-hospital\_LE\_because-of\_sick  
*He stayed in the hospital because of sickness.*

When a relevant sentence occurs, as it shown in (30b) and (30c), a switch of semantic focus does not change our understanding of the original CPCs. Even when the VP positions change, the relation of the construction does not change, as illustrated in (31), where an unspecified temporal relation holds between the events, allowing for the inversion of the constituents without significant changes in meaning.

## 5 Experiment and discussion

To evaluate the uniqueness and completeness criteria and to understand how well defined our classification system is, we conducted an annotation experiment involving two Chinese undergraduate students without a linguistic background and two second-year graduate students from the linguistic department. They had never participated in any semantic labeling task and were unfamiliar with our classification system. Before labeling, our classification system was explained using 100 examples with answers during a 1-h training course. Annotators were allowed to keep their 100 training examples (not part of the testing data) as references during the experiment. Each annotator was to label both middle-level types and fine-grained subclasses for 100 discourse relations extracted from HIT-CDTB and 100 serial verb relations extracted from Sinica Treebank, and at the same time reveal whether each tag of their selection was based on the decision tree or the connective markers. Since the annotators are

tested for the agreement of relation identification, they are told which verb-pair is the analyzed target. The analyzed verb-pair must be on the same parsing level, i.e., the nested structure is not taken into account since verbs occur in nested structure are not regarded as CPCs. At the meanwhile, a reference standard annotation has been set by two proficient annotators with full understanding of our classification and prior labeling procedure. Part of our experimental data is listed in the Appendix 3, Table 5.

Results show an average of 73% of the annotator labels were consistent with the reference standard annotation for middle-level labeling and an average of 69% were consistent with the reference standard annotation for fine-grained subclasses labeling, as shown in Table 1. Compare with the data claimed by current works as cited in Section 2.2, the result confirms that our classification system is promising and is easily understood. Because although the agreement score is 15–20% lower than Zhou and Xue (2012) and Zhou et al. (2014), they only deal with discourse relation and label coarse-grained sense relation. Furthermore, the uniqueness criterion of our classification system is met, since the decision tree leads to the best choice among the potentially ambiguous candidates. In addition, the completeness criterion is met for the decision tree end nodes, that is, *elaboration* and *addition* are sufficient to include a broader range of fine-grained minor semantic relations proposed by other systems. All annotators reported that they were able to find a satisfactory annotation for each test problem without difficulty, though they may still have different interpretations.

Cohen's kappa coefficients, a statistic which measures inter-rater agreement for categorical items, are also shown in Table 2.

According to the agreement evaluated by Cohen's kappa coefficient, all four annotators had scores of 0.61–0.80 with respect to the reference standard, which is interpreted as substantial agreement. As for the comparison between annotators, most of them attained scores of 0.41–0.60 or better, which indicates moderate agreement. This shows that the reference standard is indeed more knowledgeably created than the annotator labeling; this suggests more training for annotators to improve their performance. Nevertheless, our main concern is enhancing our classification system for future implementation in automatic semantic role labeling systems. To achieve this goal, we further analyzed the errors for each relation. The average labeling accuracies for all relations are shown in Fig. 3.

Clearly, *synchronous* is the most confused relation type for annotators; its error distribution is shown in Fig. 4. We observe that 38% of the replacement errors are caused by the first decision (*realis*), since the error labels *addition*, *comparison*, and *attribution* are on the other side of decision tree. It seems that we should provide more linguistic cues to discriminate *realis* and *irrealis* instead of purely relying on annotator intuition. For example, the markers 同時 *tóngshí* 'meanwhile' and 也 *yě* 'also' are good indicators for *realis* and *synchronous*. Also, annotators often used *elaboration* instead of *synchronous* because they were not aware of the temporal relation that exists between serial events such as 等船(V1)休憩(V2) *děng chuán xiūqì* 'wait for the boat (V1) coming and take a rest (V2)' or 歡呼(V1)雀躍(V2) *huānhū quèyuè* 'cheering (V1) and jumping (V2)'. However, as we have mentioned,

**Table 1** Annotator performance

Labeling grain	Annotator 1	Annotator 2	Annotator 3	Annotator 4	Average
Middle-level	0.715	0.680	0.760	0.780	0.734
Low-level	0.685	0.635	0.695	0.750	0.691

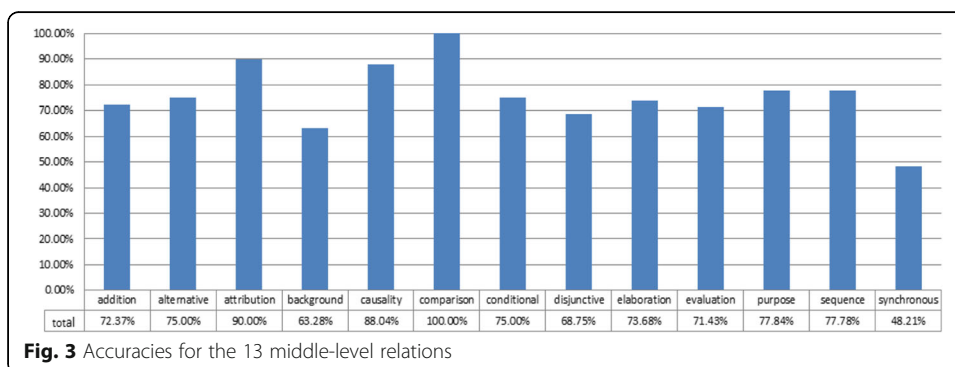
**Table 2** Cohen’s kappa coefficient for middle-level labeling

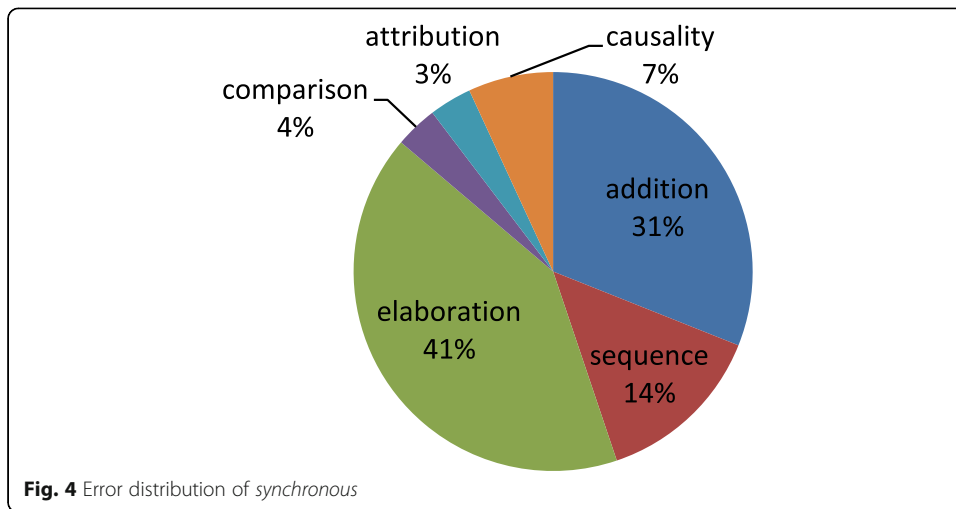
	Annotator 2	Annotator 3	Annotator 4	Annotator 5 (reference standard)
Annotator 1	0.59	0.60	0.64	0.67
Annotator 2		0.53	0.57	0.64
Annotator 3			0.63	0.73
Annotator 4				0.76

*elaboration* is allowed to have a broader interpretation and *elaboration* and *synchronous* are not complementary; thus, we may consider relaxing our standard to accommodate this, i.e., if annotators pick the near nodes of *addition* or *elaboration*, we should consider them agree to each other.

As another example, take *background*, the label with the second-worst accuracy. As shown in Fig. 5, the relation most confused with *background* is *evaluation*, because we classify the phrase pattern “V+result”—such as for 發展(V1)得很好(V2) *fāzhǎn de hěn hǎo* ‘well-developed’—as *background*. However, most annotators label this as *topic-comment* under *evaluation*, or as *elaboration* which denotes two *realis* events without a specific relation. This high incidence of mislabeling led us to consider disregarding “V +result” as a *background* relation and place *evaluation* nodes on both *realis* and *irrealis* sides of the decision tree since either *realis* or *irrealis* V1 could occur in sentences with evaluation constructions. As for the uncertainty between *background* and *purpose*, it is an uncertainty about intention. For example, in the sentence of 張大(V1)眼睛看(V2) *zhāng dà yǎnjīng kàn* ‘open eyes to look’, we use “to” to link V1 and V2 in English, implying an existing intention. However, in Chinese, there is no such marker indicating intention and we tend to regard V1 as a manner—either dynamic or static—to achieve V2. Actually, we adopt 著 *zhe* as a manner marker; thus, when the phrase pattern “V1 著 *zhe* V2” occurs, V1 is forced to be a *background* of V2. Similarly, if 張大著眼睛看 *zhāng dà zhe yǎnjīng kàn* ‘open ZHE eyes look’ is a legal sentence that means V1 is better as a *background* of V2. Therefore, again, this indicates that other than world knowledge, linguistic cues are important features to determine semantic relations for CPCs.

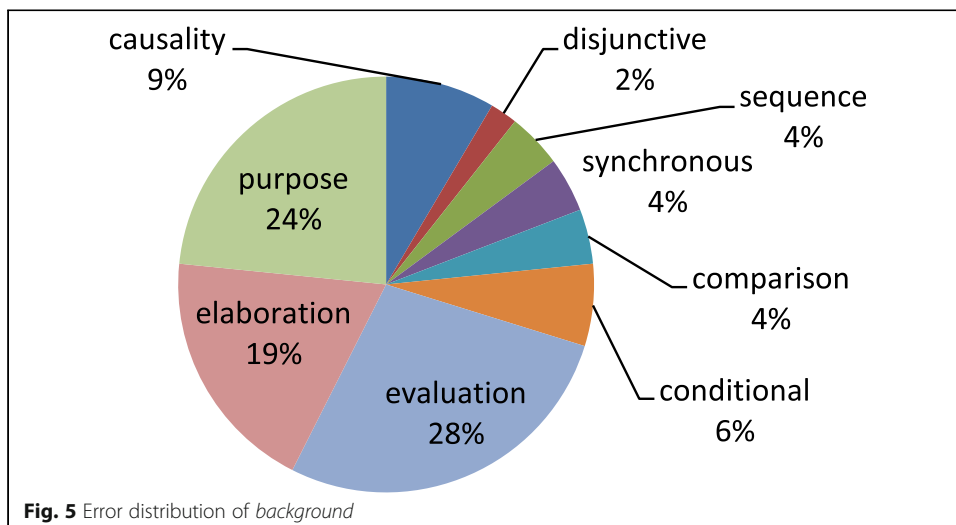
Connective markers are useful cues for annotators to decide relations. Table 3 shows the annotator labeling basis: 58% of the selections for discourses are based on the





connective markers provided in Appendix 2, Table 4. For SVCs, in contrast, because in Chinese we rarely use connective markers to link two serial verbs in a single sentence, only 14% of the selections are based on the provided markers. Hence, annotators reported that relation within a single sentence is more difficult to label than relation within a discourse. To resolve this problem, in the future, we may ask annotators to decide the semantic relation for CPCs without relation markers by adding appropriate conjunctive markers for help.

In summary, we propose six ways to improve our classification and labeling system. The first is that according to the kappa coefficient, the more training provided to our annotators, the more agreement we can expect. The second is to extract more connective markers and linguistic cues from real-world text and add these into the checklist for reference. The third is that since *addition* and



**Table 3** Labeling basis distribution

Labeling basis		Annotator 1	Annotator 2	Annotator 3	Annotator 4	Distribution of labeling basis
Discourse relation	Decision-tree	59	40	29	40	0.42
	Marker	41	60	71	60	0.58
SVCs relation	Decision-tree	87	91	79	87	0.86
	Marker	13	9	21	13	0.14

*elaboration* are broader relation types, we should consider relaxing our standard for their near node on the decision tree given more experimental evidence showing this need. The fourth is to consider the *evaluation* relation for both *realis* and *irrealis* subtrees. The fifth is to train annotators to test the relation type by fabricating connective markers. The sixth is to have annotators follow the decision tree step-by-step, that is, not allow annotators to neglect higher-level decisions and jump to latter choices.

### 6 Conclusion

Mandarin Chinese imposes weaker restrictions on the semantic properties of CPCs and thus makes no clear distinction between them. To determine a proper semantic relation between CPCs, we slightly modify our classification scheme by adding an





tree assistance in identifying a proper relation is based on event ordering and knowledge reasoning. In practice, however, labeling still depends heavily on human judgment. In order to clarify how well defined our classification system is, we conducted an experiment which shows an average of 73% accuracy and an approximate 70% agreement by Cohen's kappa coefficient in middle-level labeling which indicates substantial agreement. We analyzed the error type for each relation and summarized six ways to improve our classification and labeling system, which is predicted to enhance the agreement by Cohen's kappa up to 0.81–1.00, that is, almost perfect agreement in the future.

As a final remark, the proposed classification system is designed by following our proposed methodology. It results in a succinct semantic relation identification system for Chinese CPCs incorporated with a hierarchical decision tree to meet the uniqueness and completeness criteria of semantic relation recognition and which is in contrast to the conventional complex classification schemes discussed in Section 2.

## 7 Appendix 1

### 7.1 Definition of semantic relations for CPCs in Chinese

*Description[+realis]*: it is used principally to indicate that something is a statement of fact.

- *Sequence[+temporal]*: relation between events that are arranged in chronological order.
  - *TimeBefore-TimeAfter*: relation between a preceding event and its following event.
- *Synchronous[+temporal]*: relation between synchronous events.
  - *And*: relation between synchronous events.
  - *While-head event*: relation between synchronous events.
- *Causality[-intentional]*: relation between two events where the first event is understood to be the cause of the second event without intention involved.
  - *Cause-result & result-cause*: relation between a happened causal event and its resultative event. Contrast with conditional relation, causality relation often occurs in a happened situation.
- *Purpose[+intentional]*: relation between a desired result and the means to achieve it.
  - *Means-purpose & purpose-means*: relation between a preceding means and the intention behind it.
- *Background[-intentional]*: relation in which one event is a background description of the other.
  - *Manner-head event*: relation between a modifier (manner) and its head event.
  - *Head event-result*: relation between a head event and its result.
- *Elaboration[-temporal]*: relation in which one event is an elaboration or restatement of the other.
  - *Head event-apposition*: relation between two statements whose only connection is both are about the same entity.
  - *listing*: relation between events which are members of a list and enumerated in the discourse.



- *elaboration*: when two sentences juxtaposed without overt relation, we adopt elaboration relation to link them.

*Opinion[+irrealis]*: it is used to express the speaker's attitude towards something, and it does not focus on a situation or action is really happened.

- *Evaluation*: relation in which one event is an evaluation of the other.
  - *Topic-comment*: relation between a topic and the comment about it.
  - *Head event-conclusion*: relation between an event and the summary of it.
- *Attribution*: relation between speech act verbs and the narratives.
  - *SpeechAct-content*: relation between speech act verbs and its contents.
- *Conditional*: a conditional relation between two events indicates a logical deduction expressed by human which can refer to the real world, imagined world, or counterfactual situation.
  - *Condition-result*: a logical relation between a supposed condition and a supposed result or between a factual condition and its corresponding consequence.
- *Addition*: relation between two events where the latter emphasizes the former.
  - *Restrictive-addition*: relation between two equal-status statements serving a common theme. The former is a restricted statement while the latter is unlimited.
  - *Head event-addition*: relation between two equal-status statements serving a common theme. The latter is a further statement of the former.
- *Alternative*: relation between events which are options of someone or something.
  - *Or*: relation between alternatives.
  - *Rejection-selection*: relation between two counter events, in which one is being rejected and the other selected.
  - *Head event-avoidance*: relation between a statement and the event it tries to avoid.
- *Disjunctive*: relation between two events which do not stand for the same expectation or fact.
  - *Concession-disjunctive*: two events share a predicate or a property and the difference are related to expectations raised by one event which are then denied by the other.
  - *Condition-conversion*: relation between a request condition and its supposed result which arisen from the request being denied.
  - *Except-head event*: relation between two events when one evokes a situation which makes the other not fully be true.
- *Comparison*: relation between comparative events.
  - *Theme-contrast*: relation between one event and its resembling event.
- *[+realis] [+irrealis]*: the realis and irrealis moods denote a situation or action that has or has not actually occurred respectively.
- *[±temporal]*: the temporal feature denotes events that are involved within the timeline.
- *[±synonym]*: the synonym feature denotes the CPCs are synonymous.
- *[+result state]*: the result state feature denotes the second event is the result state of the first action.
- *[±intentional]*: the intentional feature denotes the events contain intention and motivation which lead the actor to pursue his act.



**Table 4** Connective words attached to each correspondent subtype (*Continued*)

	on the right', 如左 <i>rúzuǒ</i> 'as shown on the left', 如次 <i>rúci</i> 'as below', 包括 <i>bāokuò</i> 'including'.
topic-comment	有/無...V <i>yǒu/wú</i> ...V 'with/without', 於此 <i>yúci</i> 'here', 就 <i>jiù</i> 'on', 針對 <i>zhēnduì</i> 'for the topic of', 對於 <i>duiyú</i> 'for', 對於 <i>duiyú</i> 'for', 有關 <i>yǒuguān</i> 'concerning', 至於 <i>zhìyú</i> 'as for', 關於 <i>guānyú</i> 'on', 關於 <i>guānyú</i> 'on', 對此 <i>duìci</i> 'for the topic of'.
head event-conclusion	綜上所述 <i>zōngshàngsuǒshù</i> 'in summary', 總而言之 <i>zǒngéryánzhī</i> 'in summary', 換句話說/換言之 <i>huànjùhuàshuō/huànyánzhī</i> 'in other words', 或者說 <i>huòzhěshuō</i> 'or', 一般而言 <i>yībānyán</i> 'in general', 一般來說 <i>yībānláishuō</i> 'in general', 也就是說 <i>yějiùshìshuō</i> 'in other words', 如此一來 <i>rúcǐyīlái</i> 'so then', 那 <i>nà</i> 'so then', 那麼 <i>nàme</i> 'so then', 終歸一句 <i>zhōngguīyījù</i> 'in summary', 就是說 <i>jiùshìshuō</i> 'in other words', 照說 <i>zhàoshuō</i> 'accordingly', 歸根到底 <i>guīgēndàodǐ</i> 'in summary', 論說 <i>lúnshuō</i> , 則 <i>zé</i> 'as a result', 便 <i>biàn</i> 'as a result'.
SpeechAct-content	speech act verbs, e.g., 說 <i>shuō</i> 'say', 反應 <i>fǎnyīng</i> 'response', 指出 <i>zhīchū</i> 'point out', 回答 <i>huídá</i> 'answer', 控訴 <i>kòngsù</i> 'accuse'... etc.
condition-result	<b>condition</b> 只有 <i>zhǐyǒu</i> 'only if', 只要 <i>zhǐyào</i> 'as long as', 只消 <i>zhǐxiāo</i> 'as long as', 祇有 <i>zhǐyǒu</i> 'only if', 祇要 <i>zhǐyào</i> 'as long as', 除非 <i>chúfēi</i> 'unless', 惟有 <i>wéiyǒu</i> 'only if', 惟獨 <i>wéidú</i> 'only if', 光 <i>guāng</i> 'only', 光光 <i>guāngguāng</i> 'only', 惟 <i>wéi</i> 'only', 甯 <i>chí</i> 'only', 唯有 <i>wéiyǒu</i> 'only if', 如 <i>rú</i> 'if', 如果 <i>rúguǒ</i> 'if', 如果說 <i>rúguǒshuō</i> 'if', 如若 <i>rúruò</i> 'if', 果若 <i>guǒruò</i> 'if', 若 <i>ruò</i> 'if', 若使 <i>ruòshǐ</i> 'if', 若果 <i>ruòguǒ</i> 'if', 若是 <i>ruòshì</i> 'if', 要不是 <i>yàobúshì</i> 'if not', 要是 <i>yàoshì</i> 'if', 倘使 <i>tǎngshǐ</i> 'if', 倘若 <i>tǎngruò</i> 'if', 假令 <i>jiǎlǐng</i> 'if', 假如 <i>jiǎrú</i> 'if', 假使 <i>jiǎshǐ</i> 'if', 假若 <i>jiǎruò</i> 'if', 設使 <i>shèshǐ</i> 'if', 設若 <i>shèruò</i> 'if', 萬一 <i>wànyī</i> 'by chance', 果 <i>guǒ</i> 'if', 一旦 <i>yīdàn</i> 'once', 如若不然 <i>rúruòbùrán</i> 'if not', 若且唯若 <i>ruòqiěwéiruò</i> 'if and only if', 若非 <i>ruòfēi</i> 'if not', 若要 <i>ruòyào</i> 'if', 倘 <i>tǎng</i> 'if', 倘或 <i>tǎnghuò</i> 'if', 倘然 <i>tǎngrán</i> 'if', 設 <i>shè</i> 'if', 設或 <i>shèhuò</i> 'if', 儻 <i>tǎng</i> 'if', 苟能 <i>gǒunéng</i> 'if', 假設 <i>jiǎshè</i> 'if', 不管 <i>bùguǎn</i> 'no matter', 不論 <i>búlùn</i> 'no matter', 無論 <i>wúlùn</i> 'no matter', 無論如何 <i>wúlùnrúhé</i> 'no matter how', 也好 <i>yěhǎo</i> 'or', 哪怕 <i>nǎpà</i> 'even if', 的話 <i>dehuà</i> 'if' <b>result</b> 就 <i>jiù</i> 'then', 才 <i>cái</i> 'then', 則 <i>zé</i> 'then', 那 <i>nà</i> 'then', 那麼 <i>nàme</i> 'then', 即 <i>jí</i> 'then', 都 <i>dōu</i> 'not even', 將 <i>jiāng</i> 'will', 會 <i>huì</i> 'shall'.
restrictive-addition	<b>Restrictive</b> 但 <i>dàn</i> 'but', 不特 <i>bútè</i> 'not only', 不僅 <i>bùjīn</i> 'not only', 不獨 <i>búdú</i> 'not only', 非但 <i>fēidàn</i> 'not only', 非獨 <i>fēidú</i> 'not only', 不單單 <i>búdāndān</i> 'not only', 不只 <i>bùzhǐ</i> 'not only', 不光 <i>bùguāng</i> 'not only', 不光光 <i>bùguāngguāng</i> 'not only', 不單 <i>búdān</i> 'not only', 不僅僅 <i>bùjīnjīn</i> 'not only', 不但 <i>búdàn</i> 'not only', 除 <i>chú</i> 'apart from', 除了 <i>chúle</i> 'apart from' <b>addition</b> 還 <i>hái</i> 'and also', 也 <i>yě</i> 'and', 更 <i>gèng</i> 'more', 以及 <i>yǐjí</i> 'and also', 還有 <i>háyǒu</i> 'and also', 同時也 <i>tóngshíyě</i> 'and also', 而 <i>ér</i> 'and', 又 <i>yòu</i> 'and', 且 <i>qiě</i> 'also', 并且 <i>bìngqiě</i> 'and', 甚或 <i>shènhuò</i> 'even', 復 <i>fù</i> 'and', 乃至於 <i>nǎizhìyú</i> 'and even', 甚者 <i>shénzhě</i> 'even worse', 何況 <i>hékuàng</i> 'not to mention', 更何況 <i>gènghékuàng</i> 'not to mention', 況且 <i>kuàngqiě</i> 'moreover', 進而 <i>jìnré</i> 'and then', 反倒 <i>fǎndào</i> 'instead', 且 <i>qiě</i> 'and', 加上 <i>jiāshàng</i> 'plus', 再且 <i>zàiqiě</i> 'plus', 再就是 <i>zàijiùshì</i> 'then also', 并 <i>bìng</i> 'and', 而且 <i>érqiě</i> 'and', 而況 <i>érfuàng</i> 'not to mention', 並 <i>bìng</i> 'and', 並且 <i>bìngqiě</i> 'and', 尚且 <i>shàngqiě</i> 'even', 況乎 <i>kuànghū</i> 'even', 甚且 <i>shènqiě</i> 'even', 甚而 <i>shènér</i> 'even', 兼之 <i>jiānzhī</i> 'and', 跟著 <i>gēnzhe</i> 'and', 再說 <i>zàishuō</i> 'besides', 話又說回來 <i>huàyòushuōhuílái</i> 'anyway', 話說 <i>huàshuō</i> 'anyway', 話說回來 <i>huàshuōhuílái</i> 'anyway', 且說 <i>qiěshuō</i> 'anyway'.
head event-addition	而 <i>ér</i> 'and', 並且 <i>bìngqiě</i> 'and', 而且 <i>érqiě</i> 'and', 是...也是 <i>shì...yěshì</i> 'is... also is', 以及 <i>yǐjí</i> 'and'.
or	或(者/是) <i>huò (zhě/shì)</i> 'or', 抑或 <i>yìhuò</i> 'or', 抑是 <i>yìshì</i> 'or', 或 <i>huò</i> 'or', 或者 <i>huòzhě</i> 'or', 或則 <i>huòzé</i> 'or', 或是 <i>huòshì</i> 'or', 要麼 <i>yàome</i> 'or', 要不 <i>yàobù</i> 'or', (也)...也... (yě)... yě... 'or...or...', 是...還是... <i>shì... háishì</i> ... 'be...or...', 無論/不管/不論...還是/或是... <i>wúlùn/bùguǎn/búlùn ...háishi/huòshì</i> ... 'whether or not', 不是...就是... <i>búshì... jiùshì</i> ... 'either...or'.
rejection-selection	<b>rejection</b> 與其 <i>yǔqí</i> 'compare with', <b>selection</b> 不如 <i>bùrú</i> 'rather', 不然 <i>bùrán</i> 'otherwise', 毋寧 <i>wúning</i> 'rather', 若不然 <i>ruòbùrán</i> 'if not', 要不然 <i>yàobùrán</i> 'otherwise', 莫如 <i>mòrú</i> 'rather', 莫若 <i>mòruò</i> 'rather',

**Table 4** Connective words attached to each correspondent subtype (*Continued*)

	無如 <i>wú rú</i> 'rather', 還不如 <i>háibù rú</i> 'rather', 再不然 <i>zàibù rán</i> 'otherwise', 何如 <i>hé rú</i> 'rather', 寧 <i>ning</i> 'rather'.
head event-avoidance	以免 <i>yǐ miǎn</i> 'lest', 以防 <i>yǐ fáng</i> 'lest', 免得 <i>miǎnde</i> 'lest', 省得 <i>shěngde</i> 'lest'.
concession-disjunctive	是...不是... <i>shì... búshì...</i> 'be...not be...'; 是...而不是... <i>shì... ér búshì...</i> 'be...but not be...'; 不是...是... <i>búshì... shì...</i> 'be not... be...'; 不在...是在... <i>bú zài... shì zài...</i> 'be not at... be at...'; 將...而不是 <i>jiāng... ér búshì...</i> 'be going to... but not...'. <b>concession</b> 儘管 <i>jǐnguǎn</i> 'in spite of', 儘管 <i>jǐnguǎn</i> 'in spite of', 雖則 <i>suī zé</i> 'although', 雖然 <i>suī rán</i> 'although', 固 <i>gù</i> 'of course', 固然 <i>gù rán</i> 'of course', 雖 <i>suī</i> 'although', 雖說 <i>suī shuō</i> 'although', 好歹 <i>hǎo dǎi</i> 'anyhow', 姑且 <i>gū qiě</i> 'tentatively', 聊且 <i>liáo qiě</i> 'tentatively', 話雖如此 <i>huà suī rú cǐ</i> 'although', 不是 <i>búshì</i> 'be not', 即使 <i>jǐ shǐ</i> 'even if', 即或 <i>jì huò</i> 'even if', 即便 <i>jì biàn</i> 'even if', 就算 <i>jiù suàn</i> 'even if', 縱令 <i>zòng lìng</i> 'even if', 縱而 <i>zòng ér</i> 'even if', 縱使 <i>zòng shǐ</i> 'even if', 縱或 <i>zòng huò</i> 'even if', 縱然 <i>zòng rán</i> 'even if', 縱 <i>zòng</i> 'even if', 即令 <i>jì lìng</i> 'even if', 就是 <i>jiù shì</i> 'even if', 便是 <i>biàn shì</i> 'even if', 大不了 <i>dà bù liǎo</i> 'big deal' <b>disjunctive</b> 不過 <i>bú guò</i> 'but', 可是 <i>kě shì</i> 'but', 只是 <i>zhǐ shì</i> 'but', 而 <i>ér</i> 'but', 而是 <i>ér shì</i> 'but', 但 <i>dàn</i> 'but', 但是 <i>dàn shì</i> 'but', 祇是 <i>zhǐ shì</i> 'but', 然 <i>rán</i> 'however', 然而 <i>rán ér</i> 'however', 然則 <i>rán zé</i> 'however', 反而 <i>fǎn ér</i> 'instead', 只不過 <i>zhǐ bú guò</i> 'only', 乃是 <i>nǎi shì</i> 'but be', 並不是 <i>bìng bú shì</i> 'not be', 倒 <i>dǎo</i> 'instead', 偏 <i>piān</i> 'deliberately', 反之 <i>fǎn zhī</i> 'on the contrary', 卻 <i>què</i> 'yet', 可 <i>kě</i> 'but', 還是 <i>hái shì</i> 'still', 仍然 <i>réngrán</i> 'still', 也 <i>yě</i> 'still', 仍 <i>réng</i> 'still'.
condition-conversion	<b>condition</b> 除非 <i>chú fēi</i> 'unless' <b>conversion</b> 否則 <i>fǒu zé</i> 'otherwise', 不然 <i>bù rán</i> 'otherwise'.
except-head event	除此之外 <i>chú cǐ zhī wài</i> 'apart from this', 除此以外 <i>chú cǐ yǐ wài</i> 'apart from this', 除 <i>chú</i> 'except', 除了 <i>chú le</i> 'except', 除去 <i>chú qù</i> 'except', 除卻 <i>chú què</i> 'except', 除非 <i>chú fēi</i> 'except', 除...外 <i>chú... wài</i> 'except', 除了...都 <i>chú le... dōu</i> 'except'.
theme-contrast	如同 <i>rú tóng</i> 'as', 好像 <i>hǎo xiàng</i> 'like', 彷彿 <i>fǎng fú</i> 'as if', 似乎 <i>sì hū</i> 'seem'.

**9 Appendix 3**

**Table 5** Example of experimental data

Survey data	Middle-level relation	Low-level relation	Based on marker → Based on decision tree →2
Part I: Relation between discourse units			
1. 現年60歲的高行健在1987年逃離(V)了中國大陸,[1]流亡(V)到法國。	[1]	[1]	[1]
<i>xiànnián liùshísuì de gāoxíngjiàn zài yǐjiùbāqinián táolí le</i>	[2]	[2]	[2]
<i>zhōngguó dàlù liúwáng dào fǎguó</i>	[3]	[3]	[3]
<i>now the-60-year-old DE Gao-Xingjian in year-1987 flee</i>	[4]	[4]	[4]
<i>LE China mainland exile to France</i>	[5]	[5]	[5]
<i>Gao Xingjian, 60 years old, fled from Mainland China and lives in exile in France since 1987.</i>	[6]	[6]	[6]
他不僅是(V)一名小說家和劇作家,[2]同時也是(V)一名畫家。	[7]	[7]	[7]
<i>tā bùjǐn shì yī míng xiǎoshuōjiā hàn jùzuòjiā tóngshí yě</i>	[8]	[8]	[8]
<i>shì yī míng huàjiā</i>	[9]	[9]	[9]
<i>he not-only is a novelist and playwright in-the-meanwhile also is a painter</i>			
<i>He is not only a novelist and a playwright, but also a painter.</i>			
高行健在1987年流亡(V)到法國成為政治難民,[3]同時他在1989年天安門事件爆發之後,			
<i>gāoxíngjiàn zài yǐjiùbāqinián liúwáng dào fǎguó chéngwéi</i>			
<i>zhèngzhì nànmín tóngshí tā zài yǐjiùbāqinián tiānānmén</i>			
<i>shìjiàn bàofā zhīhòu</i>			
<i>Gao-Xingjian in year-1987 flee to France become politic</i>			
<i>refugee in-the-meanwhile he in year-1989 Tiananmen</i>			
<i>incident outbreak after</i>			
<i>Gao Xingjian went to France in exile, turned into a political refugee in 1987, and after the outbreak of the Tiananmen incident in 1989</i>			
因為目睹(V)中共軍隊殺害示威學生,[4]憤而宣佈(V)脫離了中國共產黨,[5]			

**Table 5** Example of experimental data (*Continued*)

<p>yīnwèi mùdǔ zhōnggòng jūnduì shāhài shìwèi xuésheng                  fèn'ér xuānbù tuōlì le zhōngguó gōngchǎndǎng                  because witness Chinese-Communist-Party army kill                  demonstrate student angry and declare divorce-from LE                  Chinese Communist-Party                  Because he witnessed the Chinese Communist Party killing the                  demonstrators, he was angry and declared to divorce from the Chinese                  Communist Party.                  於是中共宣佈(V)高行健為不受歡迎的人物,[6]也下令(V)                  禁止出版他的作品。[7]                  yúshì zhōnggòng xuānbù gāoxíngjiàn wéi bú shòu                  huānyíng de rénwù yě xiàlìng jìnzhǐ chūbǎn tā de                  zuòpīn                  so Chinese-Communist-Party declare Gao-Xingjian as not                  accept welcome DE figure also order prohibit                  publish he DE work.                  So the Chinese Communist Party declared Gao Xingjian as an                  unpopular figure, also ordered to prohibit the publication of his works.                  因此瑞典皇家科學院的評審挑選(V)高行健為2000                  年“諾貝爾文學獎”得主[8],                  yīncǐ ruìdiǎn huángjiā kēxuéyuàn de píngshěn tiāoxuǎn                  gāoxíngjiàn wéi èrlínglíngniǎn nuòbèi'ěr wénxuéjiǎng                  dézhǔ                  therefore Sweden royal academy-of-sciences DE judge                  choose Gao-Xingjian as year-2000 Nobel prize-in-                  literature winner                  Therefore the Royal Swedish Academy of Sciences chose Gao Xingjian                  for the 2000 "Nobel Prize in Literature" winner.                  除了表彰(V)他在中文文學創作的偉大成就之外,[9]似乎也有意(V)                  借此彰顯高行健遭到中共當局迫害。                  chúlè biǎozhāng tā zài zhōngwén wénxué chuàngzuò                  de wěidà chéngjiù zhīwài sìhū yě yǒuyì jiècǐ                  zhāngxǎn gāoxíngjiàn zàodào zhōnggòng dāngjú pòhài                  not-only to honor he in Chinese literature creation DE                  great achievement besides seem also                  have-a-mind-to by-means-of highlight Gao-Xingjian suffer                  Chinese-communist authority persecute                  It not only honors his great achievements in Chinese literature, but                  also seems to be meant to highlight the Chinese authorities'                  persecution of Gao Xingjian.</p>			
Part II: Relation between serial verbs			
<p>1. 你就少說幾句(V1)[101]如同大多數沉默群眾一樣(V2)                  ní jiù shǎo shuō jǐ jù rú tóng dà duō shù chénmò                  qúnzhòng yí yàng                  you shall less talk few sentence like most silent                  people the-same                  Please talk less, just like the most of silent people.</p>	[101]	[101]	[101]
<p>2. 學習(V1)[102]事半功倍(V2)、助我更易理解各科內容                  xuéxí shìbàngōngbèi zhù wǒ gèng yì liǐ jiè gè                  kē nèiróng                  learn get-twice-the-results-with-half-the-effort help me                  more easy understand each subject content                  To get twice the results with half the effort in learning, and help                  me in understanding each subject easily.</p>	[102]	[102]	[102]
<p>3. 希望吸收更多好學生前來(V1)[103]就讀(V2)                  xīwàng xīshōu gèngduō hǎoxuéshēng qiánlái jiùdú                  hope attract more good-student come to-study                  Hope to attract more good students to come to study.</p>	[103]	[103]	[103]
<p>4. 最後有十四所學校上訴(V1)[104]通過(V2)                  zuìhòu yǒu shísi suǒ xuéxiào shàngsù tōngguò                  at-last there-is fourteen school appeal passed                  Finally fourteen schools appealed (against it) and being successful.</p>	[104]	[104]	[104]
<p>5. 通過甄試學校的老師家長歡呼(V1)[105]雀躍(V2)                  tōngguò zhēnshì xuéxiào de lǎoshī jiāzhǎng huānhū                  quèyuè                  pass recommend-track-exams school DE teacher parents                  cheer jump-for-joy                  The teachers and parents of those schools that passed the                  recommend track exams are cheering and joyful.</p>	[105]	[105]	[105]
<p>6. 外國人不再替我們當家(V1)[106]作主(V2)後</p>	[106]	[106]	[106]

**Table 5** Example of experimental data (*Continued*)

wàiguórén__bú__zài__tì__wǒmen__dāngjiā__zuòzhǔ__hòu foreigner__not__anymore__for__us__manage-a- household__ decide__after <i>After the foreigners no longer master us</i>			
7. 這使得香港政府一再的引用(V1)數據[107]說明(V2) zhè__shǐde__xiānggǎng__zhèngfǔ__yìzài__de__yìnyòng__ shùjù__shuōmíng this__make__Hong-Kong__government__repeatedly__ DE__cite__data__explain <i>It makes the Hong Kong government citing the data to explain again and again.</i>	[107]	[107]	[107]
8. 教育署解釋(V1)[108]說(V2) jiàoyùshǔ__jiěshì__shuō Education-Department__explain__say <i>The Education Department explained</i>	[108]	[108]	[108]
9. 歷史張大眼睛(V1)[109]看(V2) lishi__zhāngdà__yǎnjīng__kān history__open__eyes__look <i>History open (her) eyes to look</i>	[109]	[109]	[109]

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