AN ERS MODEL FOR TENSE AND ASPECT INFROMATION IN CHINESE SENTENCES

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ABSTRACT: In this paper, we address a ERS model of time and aspect in Chinese sentences. We first discuss the possible tense forms in simple sentences when translating from Chinese into English. Next, we also address the possible combinations of the tense forms of complex sentences joined by linking elements and some complex sentences containing one subclause. Finally, we provide some conventional rules in English to modify the tense forms before generating the output English sentences.

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1. INTRODUCTION

Both tense and aspect in sentences play important roles in transmitting temporal and situational information between human beings. For a machine translation system, the analysis of tense and aspect has great influence on the quality of the output sentence. Lacking the analysis of tense and aspect may result in syntactic or semantic errors. Take the following Chinese sentence as an example.

(1) ta1 zuo2-tian1 mai3 le5 yi4 ben3 shu1

The corresponding sentence in English should be

(1a) He bought a book yesterday.

The translation such as

(1b) He buys a book yesterday.

would be illegal. Without the analysis of tense and aspect, a human being can hardly translate sentences correctly, neither can the machine.

The tense can be viewed as determined by the relationship between the time of the action or the state denoted by the verb and the time of speech. Thus, the tense information involves at least three components: the event time, the speech time and the degree of understanding of the subject between the hearer and the speaker. On the other hand, aspect does not refer to the time relation between the event time and speech time, but to how the situation itself being viewed from its internal structure[1]. All the information of tense and aspect reflecting in the *verb sequence* and *tense form* will be defined in the following section.

In order to transfer tense and aspect information of Chinese sentences into those of English sentences, we have to find the relationships between these two languages, which has been done in [2] and will be summarized in Section 2. In this paper, we will address the problem about the possible tense forms in a sentence. Still, the sentences we will analyze are confined to simple declarative sentences, which contain only one predicate. We will also analyze

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some more complex sentences joined by linking elements such as "de5 shi2–hou4"(when), "yi3–hou4"(after), "yi3–qian2"(before) and some sentences containing one subclause. We also provide some conventional rules to modify the tense forms before generating English sentences.

2. FORMALISM OF TIME AND ASPECT

In an English sentence, the verb sequence is one of the most important constituents, which are generally affected by the tense and aspect. Winograd [3] defined the verb sequence as a sequence of verbs and auxiliaries following a fixed order, as illustrated below:

(Modal) (Have) (Be1) (Be2) Main Verb

where *Modal* has either the tense meaning or modal meaning; *Have* represents the auxiliary has (or have or had); *Be1* represents the verb *be*; *Be2* denotes the clause being passive if present and *Main verb* is self-explained. Each combination of *Modal, Have, Be1, Be2* and *Main verb* is also called a tense form. For example, the sentence

(2) He   has   finished   his job.

       Model   *Have*   *Be1*   *Be2*   *Main verb*

has the option *Have*, but has no other options (*Modal, Be1, Be2*). Indeed, it has the tense form of "present–perfect".

Many linguists take only present and past as tense, future is considered as the modal. This kind of classification is not intuitive since human beings always partition the time axis into three parts: past time, present time and future time. Winograd [3] proposed that the first element of the tense sequence is the tense of the first element in the verb sequence unless it is a modal. The rest, correspond to the entire auxiliary sequence, excluding the main verb, are assigned *tense features* according to the following mapping:

<u>element in a verb sequence</u>   <u>tense feature</u>

Modal   Future   if the word is shall or will

	Modal	otherwise
Have		Past
Be1		Present

Consider the following sentence,

(3) By the time he comes home, I will have finished my job.

The tense sequence for the clause "I will have finished my job." is (Future, Past) since "will" gives the feature Future and "have" gives the feature Past. Now, we summarize the tense sequences (excluding the feature Modal) of possible verb sequences in Table 1.

Table 1

Tense sequences for the sequences

tense sequence	examples
Pres	(4) I *read* every day.
Pres Pres	(5) I *am* reading now.
Pres Past	(6) I *have* lived here for six years.
Pres Past Pres	(7) It *has been* raining on and off since this morning.
Past	(8) I *wrote* a letter yesterday.
Past Pres	(9) I *was* reading when he came in.
Past Past	(10) When he came in, I *had* finished my job.
Past Past Pres	(11) I *had been* reading a novel till he came to see me.
Past Fut	(12) She *was going to* give me her address.
Past Fut Past	(13) He once said he *was going to have* fixed all radios in town by the time he was forty.
Fut	(14) I *will* go to Taipei tomorrow.
Fut Pres	(15) I *will be* reading when you come back.
Fut Past	(16) When you come back, I *will have* finished my job.
Fut Past Pres	(17) I *will have been* learning English for five years by next month.

A problem in the above formalism appears when the sentence involves the progressive or perfective aspect. For example, it gives sentences (8) and (9) the tense features (Past) and (Past, Pres) respectively to capture their differences by time. However, both events in these two sentences occurred during the past time. What makes them different is not the time but the aspect. Thus we would like to give both sentences (8) and (9) the same time denotation and use other feature to capture their difference.

As mentioned above, the tense sequence is got by tracing the elements in the verb sequence in order. Unfortunately we can not apply it in Chinese sentences since there is no tense marker in Chinese. Thus, we have to use other information in a sentence. Here, the information we use is called *temporal information*. To represent this information, we partition the time axis into three parts which are *past time*, *present time* and *future time*. We can also divide each partition recursively. Therefore, the temporal information can be used to denote the relative relationship in the time axis. The representation for this relative time is called "*time marker*".

There are two aspects in English – *perfective* and *progressive*. Since these two aspects greatly influence on the tense form of English sentences, we choose aspect as the other attribute to represent the information for the tense form. Thus perfective or progressive are the two aspect marker.

Based on the time and aspect markers mentioned above, we distinguish the tense form of English by the values *present*, *past*, *future*, *perfective* and *progressive*. The tense forms of English sentences and their attribute values are listed in Table 2. Taken the tense form "past–perfect" in item 7 as an example, its time marker past–past denotes the event specified by the verb sequence occurred in the past, with respect to the past reference time. Consider the following sentence

(18) ta1 hui2-jia1 de5 shi2hou4, Zhang1san1 yi3jing1 zuo4-wan2 ta1 de5 gong1zuo4 le5

(When he came home, Zhangsan had finished his job.)

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The pair of time and aspect markers for the verbs "hui2–jia1" (go home) and "zuo4–wan2" (finish) should be {past – } and {past–past perfective } respectively. The method to determine these markers has been discussed in [2].

Table 2

Table of Tense Forms

tense form	time marker	aspect marker
1. present		present
2. present–progressive	present	progressive
3. present–perfect	past	perfective
4. present–perfect–progressive	past	perfective–progressive
5. past		past
6. past–progressive	past	progressive
7. past–perfect	past–past	perfective
8. past–perfect–progressive	past–past	perfective–progressive
9. past–future		past–future
10. past–future–perfect	past–future–past	perfective
11. future		future
12. future–progressive	future	progressive
13. future–perfect	future–past	perfective
14. future–perfect–progressive	future–past	perfective–progressive

3. POSSIBLE TENSE FORMS IN SENTENCES

We have provided a formalism of time and aspect to determine the tense form of the sentence. That is, if we can find the time and aspect markers of a verb, we can find the tense form through Table 2[2]. However, there is another approach to determine the tense form of an English sentence which will be translated from the Chinese sentence. This approach is based on the relations among speech time (S), reference time (R) and event time (E) proposed by Han Reichenbach in 1947 [4]. In this section, we will discuss the possible tense form in simple sentences and those in sentences containing two events.

3.1 Formalism of E, R, S and Aspect

To analyze the tense system of English, Han Reichenbach found that the analysis based on the absolute event time or the relative time relation between event and speech is not enough. Thus, he proposed the speech time, reference time and event time to account for the underlying structure of the English tense system. The speech time and event time are self-evident, while the reference time is the "temporal perspective" from which the described event is viewed[5]. There are six relations among E, R and S in simple sentences, which correspond to different tense forms, as Table 3 shows.

Table 3
The Mapping Between (E, R, S) and The Tense Form

relation of E,R,S	tense form
$E = R = S$	present
$E < R = S$	present-perfect
$E = R < S$	past
$E < R < S$	past-perfect
$S < E = R$	future
$S < E < R$	future-perfect

From this table, we find that the relationships among E, R, S are not enough to represent all various tense forms in English. Take the following sentences (19)–(20) as examples. The relations among E, R, S are all $E = R = S$.

(19) He usually plays the basketball.

(20) He is playing the basketball.

In fact, the role of the relations among E, R, S is the same to the time marker proposed in our time and aspect formalism. They all denote the time relation. The difference is that

former is explicit, while the latter is implicit in the denotation of the reference time of an event. Thus, to distinguish the various tense forms in English, we still need the aspect marker to denote the progressive attribute. We summarize this result in Table 4.

Table 4

The Mapping Between (E, R, S), Aspect Marker and The Tense Form

E, R, S relation	aspect marker	tense form
E = R = S	none	present
E = R = S	progressive	present–progressive
E < R = S	none	present–perfect
E < R = S	progressive	present–perfect–progressive
E = R < S	none	past
E = R < S	progressive	past–progressive
E < R < S	none	past–perfect
E < R < S	progressive	past–perfect–progressive
S < E = R	none	future
S < E = R	progressive	future–progressive
S < E < R	none	future–perfect
S < E < R	progressive	future–perfect–progressive

Now, we can make use of Table 4 to determine the tense form of an English sentence if we can find the E, R, S relation and the aspect marker from the Chinese sentence. As an example, see sentence (21). In sentence (21), since the relation among E, R, S is $E = R < S$ and the aspect marker is progressive, we have the "past–progressive" as the tense form of the translated English sentence.

(21) zuo2–tian1 ci3–shi3 ta1 zai4 kan4–shu1.

(He was reading this time yesterday.)

We have discussed the tense forms of English by E, R, S and aspect marker. However, not all tense form can be used in a simple sentence. In a sentence containing more than one event, the use of tense forms is further restricted. In the following sections, we will discuss the possible tense form in a simple sentence and those in a sentence containing two evens.

3.2 Possible Tense Forms in Simple Sentences

In Table 2, we have listed fourteen possible tense forms of English sentences. However, some of them can not be used in simple sentences. To discuss the possible tense forms in sentences, we first define some terms used below. The first one is the time category. Since time phrases contain the message of time, we partition the time phrases into four categories: Past, Present, Future, Nondeterministic[2], according to the time these phrases represented. The second term is the time precedence relations " $<$ ", " $=$ ", " $>$ ", where " $<$ " represents "happen before"; " $>$ " represents "happen after" and " $=$ " represents "happen simultaneously", respectively. In this section, we will discuss and give an example for each of them according to the E, R, S formalism mentioned in the last section.

The "present", "present–progressive" "present–perfect" and "present–perfect–progressive" tense forms are all current relevant (i.e, $R = S$), thus they do not need time phrases to specify their reference time. Sentences (22)–(25) show this case. The events in "past", "past–progressive", "past–perfect" and "past–perfect–progressive" tense forms are relevant to some past time, they need some phrases in Past time category to specify their reference time. Sentences (26)–(29) show such case. The word "qu4–nian2 ci3–shi2" (this time last year) in sentence (28) specifies the reference time for the event "zuo4–wan2 gong1–zuo4" (finish the work) and the words "zao3", "yi3" (already) specifies that the event happened before the reference time, thus the event "zuo4–wan2 gong1–zuo4" (finish the work) happened in the past–past time with respect to the speech time (i.e, $E < R < S$). The sentences of "future", "future–progressive", "future–perfect" and "future–perfect–progressive" tense forms usually have some phrases in Future time category to specify their reference time. The Sentences (30)–(33) denote this condition. The other two tense forms "past–future" and "past–future–perfect" are seldom used in a simple sentence. The reason is that these two tense forms are not current relevant and there does not exist any time phrase that can both specify the past meaning and the future meaning (relevant to the past time).

From above discussion, we show that we can use twelve tense forms in simple sentences, some of which need time phrases to modify the events in sentences. In the following section, we will discuss the tense forms in complex sentences.

(22) wo3 xi3-huan1 hua1 (I like flowers.)

(23) ta1 zai4 kan4 shu1 (He is reading now.)

(24) ta1 yi3-jian1 zuo4-wan2 gong1-zuo4 le5 (He has finished his job.)

(25) ta1 yi3-jing1 zai4 du2-shu1 le5 (He has been reading now.)

(26) *zuo2-tian1* ta1 qu4 le5 Tai2-bei3 (He went to Taipei yesterday.)

(27) *zuo2-tian1 ci3-shi2* ta1 zai4 kan4-shu1 (He was reading this time yesterday.)

(28) *qu4-nian2 ci3-shi2* wo3 zao3 yi3 zuo4-wan2 gong1-zuo4 le5 (This time last year, I had finished my job.)

(29) *qu4-nian2 ci3-shi2* wo3 zao3 yi3 zai4 kan4-shu1 (This time last year, I had been reading.)

(30) *ming2-tian1* ta1 jiang1 qu4 Tai2-bei3 (He will go to Taipei tomorrow.)

(31) *ming2-tian2 ci3 shi2* wo3 jiang1 zai4 kan4-shu1 (I will be reading this time tomorrow.)

(32) *ming2-nian2 ci3-shi3* ta1 jiang1 yi3 bi4-yeh4 (He will have graduated this time next year.)

(33) *ming2-nian2 ci3-shi2* ta1 jiang1 yi3-jing1 zai4 zhun3-bei4 kao3-shi4 le5 (He will have been preparing the examination this time next year.)

3.3 Possible Tense Forms in Sentences with Two Events

As we have analyzed in the last section, we can use one of the twelve tense forms to represent a simple sentence. When there are two events in a sentence, the tense forms of these events can not be any combination of the twelve tense forms, however. There may have some new tense forms such as "past-future" and "past-future-perfect" which can not be used in

the simple sentence. There may also have some illegal combinations such as {past, present–progressive} as in the sentence "When I came in, he is eating his lunch.". The requirement of correct combination for tense forms in a sentence is called *tense agreement*.

Some people define the tense agreement as that the tense forms in a sentence should be the same, as the sentence (34) shows. The sentence (34) is correct because the tense form of the verbs "knew" and "read" are the same while (35) is illegal because the tense forms of the verbs "knew" and "reads" are different. Some might think that the tense form of the subordinate clause should follows that of the main clause (such as the sentence (34) shows), or that the tense form of the main clause should follows that of the subordinate clause (such as the sentence (36) shows). However, these still have deficiencies[6]. They can not explain the correct sentence shown as sentence (37).

(34) I knew that he read a book.

(35) *I knew that he reads a book.

(36) The boy I talked to had blue eyes.

(37) The boy I grew up with is the president of America.

Lin & Chen[7] made some notes about the tense agreement in English. They claimed that in a complex sentence, if the main clause has the tense form of " present", "future", or "present–perfect", the tense form for the subordinate clause can be any of the twelve tense forms mentioned above. When the tense form of the main clause is "past", change the tense forms of the subordinate clause to the past form. Thus, the tense forms of the two clauses in a sentence may be any one in Table 5, ignoring the progressive aspect in the main clause.

Table 5

Possible Tense Forms for Sentences Containing Two Clauses

tense form of main clause	tense of subordinate clause

present, present–perfect future, or future–perfect	present, present–progressive present–perfect present–perfect–progressive past, past–progressive, past–perfect, past–perfect–progressive future, future–progressive future–perfect future–perfect–progressive
past, past–perfect	past, past–progressive, past–perfect, past–perfect–progressive past–future, past–future–perfect

Now, we consider the situations in Chinese. Taking sentence (38) as an example, the main clause has "past" as its tense form while its subordinate clause has the "past–future" tense form.

(38) ta1 zuo2–tian1 da1–ying4 wo3 lai2 zhe4–li3.

(He promised me yesterday that he would come here.)

(He allowed me to come yesterday.)

To find out the possible combinations of the tense forms for the two clauses in a sentence, we divide our domain into six parts, i.e., (a) nondeterministic, (b) $E2 > E1$, (c) $E2 < E1$ in serial verb construction sentences and (d) E1 "de5 shi2–hou4" (when) E2", (e) E1 "yi3–qian2" (before) E2, and E1 "yi3–hou4" (after) E2[2].

(a). nondeterministic for verbs in serial verb constructions

The possible tense forms of the events in sentences of serial verb constructions will be the same to those in Table 5. The reason is that the two events in the sentence have no predetermined relation. Thus, any possible relation is permitted to exist between them. For example, the combinations {present, present–perfect}, {future, present} are all legal as sentences (39)–(40) show.

(39) wo3 zhi1-dao4 ta1 yi3-ying1 qu4 ri4-ben3 le5.

(I know that he has gone to Japan.)

(40) ming3-tian1 ta1 jiang1 zhi1-dao4 Zhang1san1 xi3-huan1 A1-Hua1.

(Tomorrow he will know that Zhangsan likes A-Hua.)

(b). E2 > E1

The possible tense forms of the clauses in sentences of such kind are more restricted since the relation between the two events is specified. We list the possible combinations of tense forms for them in Table 6 and use the sentence (41) to illustrate it. In sentence (41), the tense forms for the verbs "da1-ying4" (promise) and "lai2" (come) are "past-perfect" and "past-future" respectively.

(41) ta1 zao3 yi3 da1-ying4 wo3 lai2 zhe4-li3.

(He had promised me that he would come here.)

(He had allowed me to come here.)

Table 6
Possible Tense Forms for E1 and E2 in E2 > E1

tense form of E1	tense form of E2
present	future
present-progressive	future
present-perfect	future
present-perfect-progressive	future
past	past-future
past-progressive	past-future
past-perfect	past-future
past-perfect-progressive	past-future
future	future
future-progressive	future
future-perfect	future
future-perfect-progressive	future

(c) E2 < E1

The possible tense forms of the events in sentences of such kind are also restricted as those of E2 > E1. We list the possible combinations of tense forms for them in Table 7 and illustrate it by the sentence (42). In sentence (42), the tense forms for the predicates "pi1-ping2" (criticize), "lan3-duo4" (lazy) are "past" and "past-perfect" respectively.

(42) ta1 pi1-ping2 wo3 tai4 lan3-duo4.

(He criticized that I had been too lazy.)

Table 7

Possible Tense Forms for E1 and E2 in E2 < E1

tense form of E1	tense form of E2
present	past
present-progressive	past
present-perfect	past
present--perfect-progressive	past
past	past-perfect
past-progressive	past-perfect
past-perfect	past-perfect
past-perfect-progressive	past-perfect
future	past
future-progressive	past
future-perfect	past
future-perfect-progressive	past

The roles of events E1 and E2 in serial verb construction sentences are different from those of E1' and E2' in sentences linked by linking element. In fact, the clause containing the event E1 is the main clause and the clause containing the event E2 is the subordinate clause, while the clause containing the event E1' is the main clause and the clause containing the event E2' is the subordinate clause. As we have mentioned in Sec. 3.2, there are twelve possible tense forms for the main clause of the sentence and the tense form of the subordinate clause may be determined by the time relation between E1 and E2. However, any time phrase in the subordinate clause may change the reference time for E2. Thus, we can hardly use the

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event time of E1 as the reference time of E2. For example, the reference time of verb "lai2" (come) in sentence (43) is not the event time of "da3–suan4" (propose) but some time in tomorrow.

(43) ta1 da3–suan4 ming2–tian1 lai2.

(He proposes to come tomorrow.)

On the contrary, in sentences linked by "de5 shi2–hou4" (when), "yi3–hou4" (after), "yi3–qian2" (before), the possible tense form of the event E2' can be usually determined by the relations of E, R, S. This is because in sentences of such cases, the event time of E1' can be used as the reference time for the event E2'. In the following paragraph, we denote the event times of E1' and E2' as E_1 and E_2, respectively. We also denote the speech time as S and the reference time for the event E2 as R_2. We analyze them as follows:

(d).E1 de5 shi2–hou4 E2

(i) If the tense form of the event E1' is "past" or "past–progressive", the event time of E1 (i.e., E_1 or say, R_2) is past. Thus, we have $R_2 <$ S. From Table 4, we have four pairs of { E, R, S relation, aspect} : { $E_2 = R_2 <$ S, none }, { $E_2 = R_2 <$ S, progressive }, { $E_2 < R_2 <$ S, none }, { $E_2 = R_2 <$ S, progressive } with the corresponding tense forms "past", "past–progressive", "past–perfect", and "past–perfect–progressive" for E2'.

(ii) If the tense form of the event E1' is "future" or "future–progressive", the event time of E1' is future. Thus, we have $S < R_2$. From Table 4, we have four pairs of {E, R, S relation, aspect marker} : { $S < E_2 = R_2$, none }, { $S < E_2 = R_2$, progressive }, { $S < E_2 < R_2$, none }, { $S < E_2 < R_2$, progressive }. From these pairs, we can get the possible tense forms : "future", "future–progressive", "future–perfect" and "future–perfect–progressive" for E2'.

(iii) If the tense form of the event E1' is "present" or "present-progressive", the event time is viewed as the same to S (i.e., $E_1 = S$). That is, $R_2 = S$. Thus, we have the pairs of {E, R, S relation, aspect}: { $E_2 = R_2 = S$, none }, { $E_1 = R_2 = S$, progressive} and E2' may possess the tense forms: "present", "present-progressive".

We summarize the results in Table 8 and give three sentences (44)–(46) with the tense forms as examples. One might find that some of the tense forms in the English sentences has been changed. For example, the tense form of the verb "lai2" (come) in sentence (45) is "present" while its original tense form is "future". This phenomena is due to the convention of English. We will discuss them in the next section.

(44) zuo2-tian1 ta1 lai2 de5 shi2-hou4, wo3 zai4 kan4-shu1.

   (When he came yesterday, I was reading.) {E1':past, E2':past-progressive}

(45) ta1 lai2 de5 shi2-hou4, wo3 jiang1 kai1 men2.

   (When he comes, I will open the door.) {E1':future, E2':future}

(46) mei3 ci4 wo3 zai4 kan4 shu1 de5 shi2-hou4, ta1 dou1 zai4 shui4-jiao4.

   (Every time when I'm reading, he is sleeping.){E1':present-progressive, E2':present-progressive}

Table 8

Possible Tense Forms for E1' and E2' in E1' de5 shi2-hou4, E2'

tense form of E1	tense form of E2
past	past, past-progressive, past-perfect, past-perfect-progressive
past-progressive	past, past-progressive, past-perfect, past-perfect-progressive
future	future, future progressive, future-perfect, future-perfect-progressive
future-progressive	future, future progressive, future-perfect, future-perfect-progressive
present	present, present-progressive

present–progressive   present, present–progressive

(e). E1' yi3–qian2 (before) E2'

 In this case, the relation between E1' and E2' is specified. This relation restricts the possible combinations of the tense forms for E1' and E2'.

 (i)If the event time of E1' is past (i.e. $E_1 = R_2 < S$), we have the relation $E_2 < R_2 < S$. Thus, the tense forms for E2' may be "past–perfect" or "past–perfect–progressive", as the sentence (47) shows.

 (47) wo3 qu4 Tai2–bei3 yi3–qian2 mai3 le5 yi4 ben3 shu1.

  (I had bought a book before I went to Taipei.)

 (ii) If the event time of E1' is future (i.e., $S < E_1 = R_2$), we have the relation $S < E_2 < R_2$. Thus, the tense forms for E2' may be "future–perfect" or "future–perfect–progressive". Sentence (48) illustrates such a example.

 (48) wo3 qu4 Tai2–bei3 yi3–qian2 jiang1 yi3 zuo4–wan2 gong1–zuo4 le5.

  (I will have finished my job before I come to Taipei.)

We also summarize the possible combinations of tense forms in Table 9.

Table 9

Possible Tense Forms for E1 and E2 in E1 yi3–qian2 E2

tense form of E1	tense form of E2
past	past–perfect
past	past–perfect–progressive
future	future–perfect
future	future–perfect–progressive

(f) E1 yi3–hou4 E2

In this condition the relation between E1' and E2' is $E_1 < E_2$. There are two cases:

(i) If the event time of E1' is past (i.e., $E_1 = R_2 < S$), we have the relation $R_2 < E_2 < S$. However, there is no such case in Table 4. Therefore, we have to make some changes. Intuitively, the event E2' happened before the speech time, thus we may give the tense form of E2' "past" or "past–progressive". The event E1' happened before E2', i.e., it happened in the past–past with respect to the speech time. It possesses the "past–perfect" as its tense form. The sentence (49) shows a good example.

(49) ta1 lai2 zhe4–li3 yi3–hou4 mai3 le5 yi4 ben3 shu1.

(He bought a book after he had come here.)

(ii) If the event time of E1' is future (i.e., S < $E_1 = R_2$), we have the relation: $S < R_2 < E_2$. Still, there is no such case in Table 4. The obvious solution to this case is to set the tense forms for E1' and E2' as {future–perfect, future} or {future–perfect, future–progressive}. See sentence (50) as an example.

(50) ta1 lai2 zhe4–li3 yi3–hou4 jiang1 mai3 yi4 ben3 shu1.

(He will buy a book after he comes here.)

The result is summarized in Table 10.

Table 10

Possible Tense Forms for E1 and E2 in E1 yi3–hou4 E2

tense form of E1	tense form of E2
past–perfect	past
past–perfect	past–progressive
future–perfect	future
future–perfect	future–progressive

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In this section, we have discussed the combinations of tense forms in sentences containing two events. However, there are some conventions in English that may change the tense forms of English sentences. We will discuss them in the next section.

4. Some Conventional Rules in English for Translation

When translating a Chinese sentence into English, the sentence pattern and the syntactic roles of corresponding words may be changed. In this paper, we assume a verb in Chinese sentence is translated into a verb in English. In most sentences, this assumption is correct.

Some tense forms in English need be modified according to other world knowledge. For example, the sentence

* (51a) Einstein has visited Princeton.

is incorrect because Einstein is dead, but sentence (51b) is correct.

(51b) Einstein visited Princeton.

In this paper, we propose a rule–checking method to solve this problem. After we generate the tense form, we test the tense forms to see whether they satisfy the following rules to avoid errors. We list some of them below[6,7].

(a). If the tense form we get is "present–perfect" and the person referred by the subject is dead, then change the tense form to "past". Sentence(51b) is an example.

(b). If the tense form is "present–perfect" and the time phrase is given specially, use "past" tense form instead. Take sentence(52) as an example.

  (52) ta1 zou2–tian1 yi3–jing1 qu4 le5 Tai2–bei3 le5.

    * (He has gone to Taipei yesterday.)

    (He went to Taipei yesterday.)

(c). If two clauses are linked by the conjunction "before" or "after", the tense form "past–past" can be changed to "past" and "past–future–past" to "past–future". It is because the con-

junction "after" or "before" is sufficient to indicate the relation between the two clauses it connects. As an example, see sentence (53).

(53) wo3 zuo4-wan2 gong1-zou4 yi3-hou4, cai2 chi1 wan3-fan4.

(I ate my dinner after I had finished my job.)

(I ate my dinner after I finished my job.)

(d). In subordinate clause, such as when-clause, if-clause, and so on, replace the "future" tense form by the "present" tense form. Sentence(54) shows such an example.

(54) dang1 chun1-tian1 lai2 de5 shi2-hou4, yan4-zi5 jiu4 hui4 hui2-lai2.

* (When the spring will come, the swallows will return.)

(When the spring comes, the swallows will return.)

(e). If the tense form of the main clause is "past" and the statement in the subordinate clause is a fact or a truth, the tense form of the subordinate clause is set to "present". The sentence (55) illustrates this convention. However, this rule is difficult to implement because the maintenance of the world knowledge is hard.

(55) wo3 gao4-su4 ta1 cheng2-shi3 wei2 shang4 ce4.

(I told him that honest was the best policy.)

(I told him that honest is the best policy.)

To further demonstrate the applicability of above rules, we analyze sentence (56) in detail.

(56) ta1 da1-ying4 wo3 zai4 wo3 li2-kai1 yi3-qin2, qian3 wo3 chi1 wan3-fan4.

The time markers for verbs "da1-ying4" (promise), "li2-kai1" (leave) and "chi1" (eat) in the sentence are past, past-future and past-future-past, corresponding to the tense forms "past," "past-future" and "past-future-perfect" respectively. By rule (c), the tense form of the verb "chi1 wan3-fan4" (eat dinner) is changed to "past-future" (that is, item 9 of Table

2) since there is a conjunction "before." By rule (d), the tense form "past–future" of "li2-kai1" (leave) is changed to "past." In summary, the tense forms of verbs "da1-ying4" (promise), "li2-kai1" (leave) and "chi1" (eat) are changes to "past," "past," "past–future" respectively. Because there are several ways to express the future tense of a verb, we still have to select the representation of its tense forms. Finally, the sentence generated would be "He promised, that he would give me a dinner before I left."

5. CONCLUSION

The paper has presented a preliminary analysis of possible tense forms in both simple sentences and complex sentences through the ERS model. We have found that different sentential structures may have different tense forms for the predicates in sentences. Thus, we may predict the possible tense forms from the structure or the linking element possessed by the sentence.

The problem in this paper is restricted by the domain anyway. The analysis and implementation of the tense forms for simple sentences have been done. However, we still have a long way to go for more complex sentences, discourse, and so on.

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