

A COGNITIVE TREATMENT OF ASPECT IN JAPANESE TO CHINESE MACHINE TRANSLATION

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ABSTRACT

Sentential aspect is the integrated function of lexical main verbs, aspect markers, adverbials, subjects and objects, and other syntactic constituents. The present approach represents sentential aspect by situation types and further distinction of aspectual meaning. Situation types are the basic categorization of situations that human make on the basis of their perceptual and cognitive faculties. Seven situation types are distinguished in this article, which include events (accomplishments, processes, achievements and activities), states, habituals and generics. Accomplishments and achievements express perfectivity, whereas others imperfectivity. Perfectivity and imperfectivity can be further distinguished into subdivisions such as 'telic' and 'perfective', and 'habitual', 'delimitative' and 'continuous' respectively. Based on the situation type and the further distinction of aspectual meaning of a source language, the generation of verbs, aspect markers and adverbials for a target language can be properly made. In this paper, the translation of aspect from Japanese to Chinese is described in detail. The problem that several aspect markers occur together in a sentence is also discussed.

I. INTRODUCTION

It has been observed that the aspectual properties of sentences are not determined simply by their lexical main verbs.¹ Rather, a large variety of syntactic constituents play a role in this determination, which include aspect markers, adverbials, subjects and objects, and other syntactic constituents such as prepositional phrases. According to different aspectual properties of a sentence, situation types, which are the basic categorization of situations that human make on the basis of their perceptual and cognitive faculties, can be distinguished. In this article, we follow Smith (1986) and distinguish seven types of situations as follows:[1]



Figure 1: Situation types and perfectivity

Except events and states, we also distinguish habituals and generics. Habitual situations are characterized by an extended period of time, whereas generic one refers to situations that denote facts, common sense, knowledge and so on. Events can be distinguished into happenings and actions. If the subject of a sentence is agentive, it denotes an action situation. Otherwise, a sentence denotes a happening situation. Both happenings and actions can be further distinguished into achievements and processes, and accomplishments and activities respectively. Achievements and accomplishments are perceived as a whole and thus are perfective, whereas processes and activities are regarded to continue for a period of time and are imperfective.

The perfective and imperfective oppositions can be mainly represented as follows: [2]²

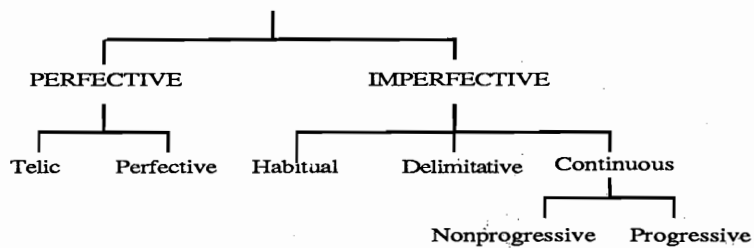


Figure 2: Aspectual oppositions

In the subdivisions of 'continuous', a distinction is made between 'progressive' and 'nonprogressive', the former being the combination of continuousness with nonstativity.

While many languages do have a single category to express perfectivity and another to express imperfectivity, there are other languages where perfectivity and imperfectivity are subdivided into a number of distinct categories, and yet others where there is some category that corresponds to part only of the meaning of perfectivity or imperfectivity.[2] The aspectual system of a particular language has to be investigated. Our approach is to represent sentential aspect by situation types and further distinctions of aspectual meaning and generate verbs, aspect markers and adverbials for a target language based on situation types and further distinctions of aspectual meaning of a source language. The present treatment of aspect in machine translation should be like the following figure:

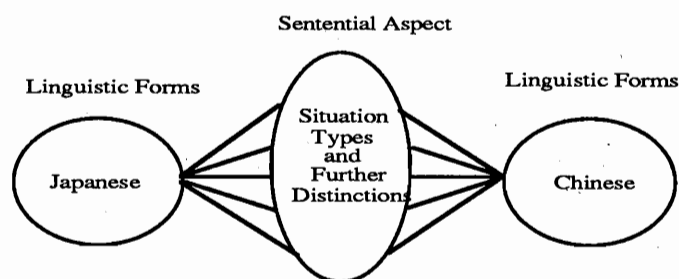


Figure 3: The treatment of aspect in machine translation

In the existing algorithms for processing Japanese, sentential aspect is identified to be such as 'start', 'continue', 'completion', and 'result.'[3][4] Our approach is different from those algorithms in that both the notion of situation types and further distinctions of aspectual meaning are suggested to be put into the treatment of aspect in machine translation mainly for distinguishing conceptual differences. For example:³

- (1) 私が入った時、彼は死んだ。(Achievement, perfective)
當我進門的時候,他死了
'When I came into the door, he died.'
- (2) 終戦の年には、もう祖父死んでいます。(State, perfective)
大戰結束那年,祖父已經死了
'At the year that the war ended, my grandfather was dead.'

The main clause of (1) is categorized into an achievement situation and (2) a state. Best

translation should depend on both of the situation type and the further distinction of aspect that are intended by the speaker. In (2), the English adjective 'dead' is more proper than the verb 'die' to describe a state. For Chinese, the state of 'deadness' is better expressed by the verb '死' 'die' plus the perfective marker '了' and the adverb '已經' 'already' since the Chinese lexicon does not distinguish the action from the state for deadness.

On the other hand, sentential aspect can be marked by aspect markers or not depending on the aspectual systems of particular languages. For example, for some Japanese accomplishment and achievement situations they are not marked by any aspect markers and simply occur in past tense (as in (3) and (4)). Besides, certain syntactic constructions (as in (5)) also contribute to the sentential aspect of the sentence. For example:

- (3) 私は食べました。(Accomplishment, perfective)
我吃了
'I have eaten.'
- (4) 彼は死んだ。(Achievement, perfective)
他死了
'He died.'
- (5) 私は日本へ行くことはありません。(State, experiential)
我沒去過日本
'I have not been to Japan before.'

The use of situation types and further distinctions are easy for the treatment of the sentential aspect of those sentences that are not marked by any aspect markers.

In section II and III we will first introduce the aspectual systems of Chinese and Japanese respectively. Section IV will show how such an approach can be implemented in a Japanese to Chinese machine translation, followed by section V that the combination of aspectual meaning will be discussed. Finally, the concluding remarks of this paper will be included in section VI.

II. ASPECTUAL SYSTEM OF CHINESE

In this section and the following one, we will first introduce the aspectual systems of Chinese and then Japanese.

The aspects of Chinese are perfective and continuous (or durative), typically indicated by the perfective marker '了', and the continuous markers '(正)在' and '著'. The former presents a situation from a perfective viewpoint and the latter an imperfective view. Besides, '過' is known as an experiential marker, and '起來' and '下去' are two continuous markers which derive their aspectual meaning from their lexical meaning 'up' and 'down' respectively.⁴ Other markers such as '完' 'finish' and '好' 'good' are complements that mark telic and perfective meaning respectively.

In determining the situation type of a sentence, verbs can be classified according to their inherent meaning or to aspect markers that they can co-occur with. In Chinese, verbs can be divided into action, process, telic, and state verbs. The classification of Chinese verbs are exemplified as follows:

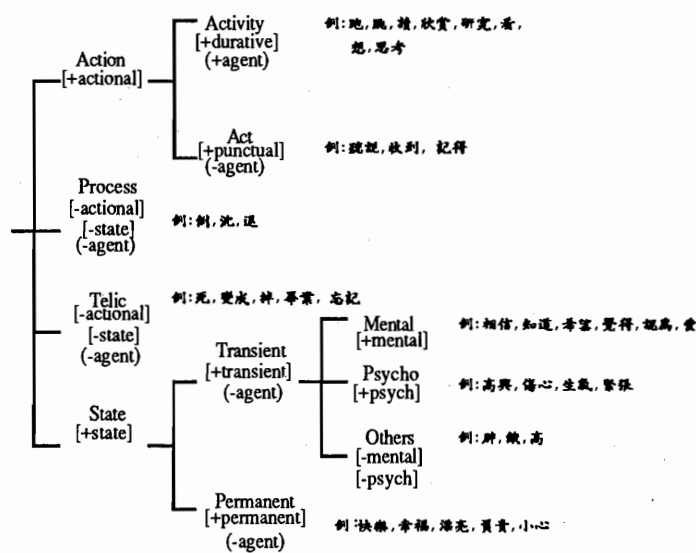


Figure 4: Verb classification of Chinese

Action verbs can be further distinguished into activity and act verbs. The former are durative and the latter are punctual. Two categories of states are distinguished: transient and permanent. The former are subdivided into mental state, psychological state and others. In the three types of state verbs, only psychological state verbs can occur with the continuous marker

(正)在.' This is very similar to English that lexically stative verbs can be used nonstatively and appear in the progressive.[2] On the other hand, only mental state verbs can be marked by the continuous marker '著.' Telic verbs cannot be marked by the continuous marker '(正)在' but adverbs such as '快要' 'almost,' or '渐渐' 'gradually' to refer to a process that necessarily comes to an end. Process verbs can be modified by '在' and means that a process is undergoing.

Action, process and state form a continuum. In Chinese, it is very often that action, process and state are polysemies. For example, the verb '開' 'open' and '停' 'stop' can be an action, a process or a state and occur in an accomplishment, an achievement and a state situation respectively as follows:

e.g.	Accomplishment	Achievement	State

	開了	開了	開著
	Accomplishment	Achievement	State

	停了	停了	停著

Action and process verbs are often marked by the perfective marker '了' to mean an accomplishment and an achievement respectively. In some other cases, the vocabulary might distinguish. For example:

Accomplishment	Achievement	State

走了	走了	不見了
	Achievement	State

	死了	已經死了

In the case of '死' 'deadness,' there is not any state verb for '死' 'deadness.' However, a state situation can be expressed by the verb '死' 'die,' the adverb '已經' 'already' and the perfective marker '了.' For the treatment of aspect, action, process and state verbs that form a continuum are suggested to be recorded in the dictionary as a unit.

In some languages, it is possible to derive verbs referring to specifically telic situations from verbs that do not necessarily refer to telic situations, usually as part of the derivational morphology.[2] Chinese is such a language that a resultative compound can be formed by an action verb plus a complement to express the resultant state of the action including such as '完' 'finish' and '好' 'good' and many other complements that the cooccurrence of which is mainly dependent on different verbs.

The situation types and the interpretations of Chinese aspect markers are listed as follows:

Table 1: The situation types and the interpretations of Chinese aspect markers

ST AM	Accomplishment	Activity	Achievement	Process	State	Habitual	Generic
了	'perfective' 'telic'	*	'perfective' 'telic'	'inceptive'	'perfective'	*	*
过	'experiential'	*	'experiential'	*	'experiential'	*	*
(正)在	*	'progressive'	*	'progressive' 'repetitive'	*	'habitual'	*
着	*	'progressive'	*	*	'nonprogressive'	*	*
起来	*	'inceptive'	*	'inceptive'	*	*	*
下去	*	'continuous'	*	'continuous'	*	'continuous'	*
V着 or V-V	*	'delimitative'	*	*	*	*	*

ST: Situation types, AM: Aspect markers

The perfective marker '了' can both occur in an accomplishment and an achievement situation. It can mean that the action is bounded or the terminal point of the action is achieved. The two continuous markers '(正)在' and '着' behave differently. Both '(正)在' and '着' can

occur in an activity situation and means 'progressive.' '在' but not '著' is used in a habitual situation to denote habituals.

Having analyzed the twelve textbooks of Mandarin Chinese for Elementary Schools, we concluded that two categories of verbs often occur with the continuous marker '著' in a subordinate clause, which function as a background for the figure indicated by its main clause.

Spacial postural verbs: 坐著 'sitting,' 躺著 'lying'

State verbs that are used causatively: 仰著臉 'facing up,' 彎著腰 'curve waist,'

低著頭 'facing down,' 壯著膽 'with guts,' 光著腳 'barefoot,' 紅著臉 'blushingly,'

歪著頭 'with oblique head,' 狠著心腸 'hardhearted'

Also, some verbs, though subcategorize for verb phrases or sentential complements, must contain aspect markers or the sentences will be unacceptable:

急著大喊 'cry anxiously,' 忙著除草 'busy in mowing,' 搶著提水 'rush for lifting

water,' 爭著長大 'fight for growing up,' 忘了告訴他 'forget to tell him,'

忘記了他會去 'forget that he will come'

However, in the following types of sentences, we found that aspect markers never occur.

1. Verbs that subcategorize for verbal phrases occur. For example:

(6)* 我希望了去他那裡。
I hoped to go to his place.

2. Verbs that subcategorize for sentential complements occur. For example:

(7)* 我知道了他要去。
I knew that he would come.

3. Verbs that subcategorize for pivotal sentences occur. For example:

(8)* 他批評了這部電影不好。
He criticized that this movie is not good.

4. Verbs that subcategorize for a goal or locative phrase occur. For example:

(9)* 我看見他躺著在床上看書。
I saw him lie on the bed and read.

5. Sentences that contain resultant or extent complements occur. For example:

- (10)* 這間房子佈置了得很漂亮。
This house was beautifully decorated.

6. Cleft sentences or causative sentences that occur. For example:

- (11)* 他使了大家很開心。
He made everybody happy.

Also, in Chinese the first event in a sequence of successive events are often marked by the perfective marker. For example:

- (12) 他買了票進去。
He bought a ticket and came in.

III. ASPECTUAL SYSTEM OF JAPANESE

The notion of aspect is related to seven auxiliary verbs in Japanese. They are 'teiru', 'teshimau', 'teoku', 'tekuru', 'teiku', 'temiru' and 'tearu'. [5] In general, 'teshimau' marks perfectivity whereas 'teiru', 'tekuru', 'teiku', 'temiru', and 'tearu' mark imperfectivity. While 'teoku' can mark perfectivity and imperfectivity. Verbs in Japanese can be divided into state, action, and change verbs. Change verbs can be further distinguished into three types: process, telic and resultant verbs. All verbs except state verbs can be marked by the aspect marker 'teiru.' The three types of verbs are exemplified as follows: [6]

- i. State verbs: ある、いる、できる
- ii. Action verbs: 読む、食べる、話す、歩く
- iii. Change verbs
 - a. Process verbs: 開く、沈む
 - b. Telic verbs: 知る、死ぬ
 - c. Resultant verbs: 愛する、似る、優る

The situation types and the interpretations of Japanese aspect markers are listed below:

Table 2: The situation types and the interpretations of Japanese aspect markers

ST \	Accomplishment	Activity	Achievement	Process	State	Habitual	Generic
Teiru	*	'progressive'	*	'progressive' 'repetitive'	'experiential' 'perfective' 'nonprogressive'	'habitual'	*
Teshimau	'telic'	*	'telic'	*	*	*	*
Teoku	*	*	*	*	'perfective' 'nonprogressive'	*	*
Tekuru	*	'continuous'	*	'inceptive' 'continuous'	*	*	*
Teiku	*	'continuous'	*	'continuous'	*	'continuous'	*
Temiru	*	'delimitative'	*	*	*	*	*
Tearu	*	*	*	*	'nonprogressive'	*	*

ST: Situation types

AM: Aspect markers

The interpretations of the seven aspect markers and the Chinese translation are discussed as follows:

1. Teiru

In general, a verb in the '-te' form plus 'iru' refers either (1) to an action that goes on over a period of time, or (2) to the state resulting from an action.

a. teiru--> (Activity, progressive)

When 'teiru' occurs with an action verb, it can mean 'progressive' of an activity. Adverbials that denote a period of time such as '今' 'now' often occur in an activity situation.

For example:

- (13) 今、英語の会話を習っています。
現在正在學英語會話

I am learning English conversation now.

- (14) みんなが外で遊んでいます。
大家正在外面玩
All are playing outside.

b. teiru--> (Process, progressive)

'Teiru' can mean 'progressive' of a process when it occurs with a process verb. In such a case, the translation '在' is better than '正在.' For example:

- (15) 雨が降って川の水がどんどん増えている。
因爲下雨所以河川的水不斷的在增加
The water in the river is continuously increased due to the rain.

c. teiru-->(Process, repetitive)

'Teiru' can mean 'repetitive' of a process when it occurs with a telic verb. The subject of a sentence that describes such a case is usually plural. For example:

- (16) 多くのガラスは破れている。
很多玻璃在破
A lot of glass is breaking.

d. teiru--> (State, experiential)

'Teiru' can also mean 'experiential' when it occurs with an action verb. Frequency adverbs such as '二三度' 'two or three times' often occur in the states that expresses experience. In Chinese, 'experiential' is often expressed by an action verb plus '過', which is recognized as an accomplishment situation.⁵

- (17) あ的那个人はたくさんの小説を書いている。
那個人寫過很多小説
That man has written many novels.

- (18) 私は若い時に二三度この小説を読んでいた。
我年輕時看過這本小説二三次
I had read this novel two or three times when I was young.

e. teiru-->(State, perfective)

When 'teiru' occurs with a telic, a resultant, or an action verb (as in (22) and (23)), it means the resultant state. To express a state, '了' should be used if a nonstative verb is chosen.

- (19) 隣は空地になっている。

隔壁變成了空地
The neighborhood has become an open area.

(20) ところどころに、大木がたおれている。
到處都有樹木倒了
Trees have fallen down everywhere.

(21) 昨日から桜の花が咲いている。
櫻花從昨天開了
Cherry blossoms have been in blossom since yesterday.

(22) 彼はすでにその本を読んでいる。
他已經讀了那本書
He has read that book.

(23) 彼はあの先生に三年教わっている。
他跟那位老師學了三年
He has learned from the teacher for three years.

In the case of action verbs, in order to distinguish the sentential aspect '(state, perfective)' from '(activity, progressive),' the definiteness of the subject and the object, and adverbials must be taken into consideration.

f. teiru-->(State, nonprogressive)

When 'teiru' occurs with a resultant verb (as in (24) and (25)) or an action verb (as in (26) and (27)), it can mean the 'nonprogressive' of a state. Most of Chinese state verbs are not marked for 'nonprogressive.' However, verbs such as '穿' 'wear' and '戴' 'wear,' which can denote both an action or a state, are marked by the continuous marker '著' in a state situation.

(24) 私はあなたを愛しています。
我愛你
I love you.

(25) この道は曲っている。
這條道路彎彎曲曲
The road curves.

(26) 陳さんは眼鏡を掛けている。
陳先生戴著眼鏡
Mr. Chen has glasses on.

(27) 王さんは背広を着ている。
王先生穿著西裝
Mr. Wang is in a suit.

In the case of (25) and (26), both interpretations, '(state, nonprogressive)' and '(activity,

progressive), ' are possible.

g. teiru-->(Habitual, habitual)

'Teiru' can also occur in a habitual situation, which means that the situation lasts for a period of time. Adverbs such as '毎朝' 'every morning' and '最近' 'recently' usually occur in habitual situations.

(28)彼は毎朝バイブルを読んでいる。
他每天早上讀聖經
He reads Bible every morning.

(29)この頃は栄養失調で人がどんどん死んでいる。
最近因爲營養失調人不斷的在死
Recently, people are dying due to malnutrition.

2. Teshimau

A verb in the '-te' form plus 'shimau' indicates either (1) that an action has been completed, or (2) that the speaker has regrets about the completion of the action.

a. teshimau-->(Accomplishment, telic)

When occurring with an action verb, 'teshimau' means that the action reaches the endpoint. Therefore, we categorize it as 'telic.' Its best Chinese translation is '完' 'finish.' For example:

(30)牛は昨日刈ってきた草をみんな食べてしまいました。
牛把昨天割來的草全部吃完了
The cow has eaten up all the grass that were mown yesterday.

(31)あの小説は面白いから一晩で読んでしまった。
那本小說很有趣所以一個晚上就看完了
That novel is very interesting so I have read it in a night.

b. teshimau-->(Achievement, telic)

'Teshimau' also means 'telic' when it occurs with a process verb and its Chinese translation should be '了'.⁶

(32)景気が悪いのでたくさんの会社が倒れてしまった。
因爲不景氣許多公司倒閉了
Due to the economic depression, many companies went bankrupt.

(33)あの娘は行ってしまいました。
那個女孩走了
That girl has gone.

3. Teoku

A verb in the '-te' form plus 'oku' refers to doing something for future use or something being left in a certain state.

a. teoku-->(Accomplishment, perfective)

When 'teoku' occurs with an action verb, it can mean that an action is done earlier than the time indicated or the speech act time. It is categorized into an accomplishment situation and can be translated by the complement '好' 'good.' Since Chinese does not have a single grammatical category to mark tense, the adverb '預先' 'in advance,' which indicates the time earlier, can be used. Thus the Chinese translation of this type of sentential aspect is '預先..好' 'in advance...down' if the verb is transitive. Otherwise, '先' 'first' will be given. For example:

(34)試験の準備をしておきます。

預先做好考試的準備

Have the preparation for the examination done in advance.

(35)友達が来るだろうと思ってビールを買っておきました。

我想朋友大概會來所以預先買好啤酒

I guessed my friends might probably come so I had bought beer in advance.

(36)報告の要点を記録しておくことが必要だ。

有必要把報告的要点預先記錄好

It is necessary to have recorded the main points of the report in advance.

Adverbials such as '前もって' 'in advance,' '先に' 'first,' 'ために' 'for the reason that' and 'に' 'for' often occur in such a situation.

b. teoku-->(State, nonprogressive)

When 'teoku' occurs with an action verb, it also means 'nonprogressive.' In such a situation, it emphasizes the state that is caused by the action remains. It is better translated into '著' if Chinese verbs such as '開' 'open' and '關' 'close,' which can both denote the action and the state, occur. For example:

(37)電灯は消さないで、朝まで付けておこう。

不要關燈一直開到早上吧

Do not turn off the light till the morning.

(38)窓を締めておきなさい。

讓窗戶關著吧
Let the door be closed.

(39) 相手を羨ましがらせて老いた。
讓對方羨慕
Let your opponent be jealous.

4. Tekuru

A verb in the '-te' form plus 'kuru' indicates either (1) that a change has been taking place up to certain time, or (2) that an action is done in the direction of the speaker.

a. tekuru-->(Activity, progressive)

When 'tekuru' occurs with an action verb, it can mean the action is 'progressive' if a period of time is indicated as is exemplified below:

(40) 私はこの工場で三十年間働いてきた。
我三十年間一直在這間工廠工作
I had been working for this factory during the thirty years.

Translation for 'progressive' should be '在' and the adverb '一直' 'always' can be used.

b. tekuru-->(Process, inceptive)

'Tekuru' can also mean inception when it occurs with a process verb or a resultant verb. In such a situation, '起來' or '了' can be translated. ⁷

(41) 私は体重が増えてきた。
我的體重增加起來了
I was putting on weight.

(42) 温度の上昇につれて砂糖がどんどん融けてきた。
隨著溫度的上昇砂糖不斷的溶化起來了
The sugar started to melt as the temperature went up.

(43) 一時間も作業をつづけていると、疲れてきた。
連續工作一小時就疲倦起來了
Having working for one hour without a stop, I started to be tired.

c. tekuru-->(Process, continuous)

When 'tekuru' occurs with a telic or a process verb, it means 'continuous.' It should be translated to '了' if a Chinese telic verb is used, or '一直在' 'always..been' if a process verb is chosen. For example:

(44)その本性がだんだん現われてきた。

它的本性渐渐暴露了
Its nature was revealed.

(45)ちょうどその場にいるような実感さえ湧いてくる。

甚至产生了彷彿在现场的身歷其境感
The feeling to be personally in the situation comes up.

(46)私は上車する前から下車するまで小便を堪えてきた。

我從上車前到下車一直在忍小便
I had been bearing urine from the time that I got up till I got off.

In the case of (46), the process verb is interpreted as 'continuous' since a period of time is used.

d. tekuru-->(Habitual, habitual)

'Tekuru' can mean 'continuous' of a habitual situation when adverbs such as '毎日' 'every day' occur. For example:

(47)毎日、一時間ずつ時間を決めて本を読んできた。

每天規定平均一小時的時間念書下去
Read averagely one hour a day everyday.

5. Teiku

A verb in the '-te' form plus 'iku' refers to a change taking place for a period of time.

a. teiku-->(Activity, continuous)

When 'teiku' occurs with an action verb, it means 'continuous' and can be translated as ...下去.' For example:

(48)本箱の本を片っ端から読んでいく。

把書架的書從這一邊依次讀下去
Read the books on the shelf from this side.

(49)新しい道ができて家がどんどん建てていく。

新路一做好房子就不斷的蓋下去
As soon as the road was done, new houses are built one after another.

b. teiku-->(Process, continuous)

When 'teiku' occurs with a process or a resultant verb, it means 'continuous' of a process. The continuousness of a process is marked by the aspect marker '了' with adverbs such as '快要' 'almost' and '渐渐' 'gradually, if a Chinese telic verb is used. The aspect marker '下去'

can be used, if a Chinese state verb is used. For example:

(50)だんだん英語を忘れていく。
渐渐忘了英文
I gradually forget English.

(51)新しい先生にも慣れていく。
渐渐熟悉了新的老師
I am getting used to the new teacher.

(52)体が毎日に弱っていく。
身體一天一天的弱下去
The body is getting weaker.

c. teiku-->(Habitual, continuous)

'Teiku' can occur within a habitual situation and means 'continuous.'

(53)毎日、一時間ずつ時間を決めて本を読んでいく。
每天規定平均一小時的時間念書下去
Read averagely one hour a day everyday.

6. Temiru-->(Activity, delimitative)

In general, a verb in the '-te' form plus 'muru' means 'to try and see.' 'Temiru' can only occur with an action verb to mean 'delimitative' since volition is involved in 'delimitative.' The Chinese 'delimitative' is expressed by reduplicating a verb as 'VV' or using the pattern 'VV-着.'

(54)日本の食物を食べてみます。
吃吃看日本的食物
Eat some Japanese food.

(55)物差で長さを測ってみて下さい。
請用尺量量看長度
Please use a ruler to measure the length.

7. Tearu-->(State, nonprogressive)

A transitive verb in the '-te' form plus 'aru' refers to a state that has resulted from an action. We represent it as 'nonprogressive.' In Chinese, a state can be expressed by adding the continuous marker '着' or it can be translated into passive sentences, if a verb that can both denote actions and states are chosen. For example:

(56)地図が黒板に貼ってある。
 地図被人貼在黑板上
 (黑板上貼著地圖)
 The map is pasted on the blackboard.

(57)字が紙に書いてある。
 字被人寫在紙上
 (紙上寫著字)
 Words are written on the paper.

In each first translation of the above examples, the continuous marker '著' is not used since a prepositional phrase indicating location is used.

In summary, the relation between verb classes and aspect markers is presented in the following table:

Table 3: Sentential aspect related to verb types and aspect markers

VC AM	Action verbs	Change Verbs			State Verbs
		Process	Telic	Resultant	
Teiru	(Activity, pg) (State, exp) (State, nonpg) (State, pf) (Habitual, hb)	(Process, pg)	(State, pf) (Process, rept)	(State, nonpg)	*
Teshimau	(Accmp, tlc)	(Achv, tlc)	*	*	*
Teoku	(Accmp, pf) (State, nonpg)	*	*	*	*
Tekuru	(Activity, pg) (Habitual, cnt) -	(Process, cnt) (Process, incpt)	(Process, cnt)	(Process, incpt)	*
Teiku	(Activity, cnt) (Habitual, cnt)	(Process, cnt)	*	(Process, cnt)	*
Temiru	(Activity, dlm)	*	*	*	*
Tearu	(State, nonpg)	*	*	*	*

VC: Verb classes, AM: Aspect markers
 Accmp: accomplishment, Achv: achievement, pg: progressive, cnt: continuous
 exp: experiential, tlc: telic, dlm: delimitative, incpt: inceptive, rept: repetitive
 hb: habitual

Except for the above combinations of situation type and further distinction, other combinations are possible. For example, the sentential aspect of those sentences that contain no aspect markers would be (Accomplishment, experiential) as follows:⁸

e.g. 私は二三度日本へ行きました。
我去過日本兩三次
I have gone to Japan two or three times.

IV. COMBINATIONS OF ASPECTUAL MEANING

For a sentence, it is either perfectivity or imperfectivity that is focused. However, there are situations that several aspect markers occur together. Logically, there are two possible combinations of perfectivity and imperfectivity. One is perfectivity in imperfectivity and the other is imperfectivity in perfectivity. In the first case, it is imperfective if the resultant state of a perfective situation is emphasized and it can be marked by an imperfective marker. For example,

(58) 私はもうあの本読んでしまっていた。
我已經讀完那本書了
I had already read that book.

In the above example, the first aspect marker 'teshimau' indicates that the situation is an accomplishment and can be interpreted as 'telic.' The second aspect marker 'teiru' indicates that the resultant state of the accomplishment situation is in the focus. Thus, it can be further marked by the imperfective marker 'teiru.' Thus we categorize the sentential aspect as '(State, telic).'

On the other hand, the other case that imperfectivity in perfectivity is impossible because it is only perfectivity or imperfectivity that can be focused in a sentence. Though an activity or a process can start and end before the reference time, yet it can not be marked by a perfective marker. Nevertheless, it can be expressed by simple past, past perfect or present perfect instead of perfective.

V. MECHANISM FOR THE PROCESSING OF SENTENTIAL ASPECT AND THE GENERATION OF ASPECT MARKERS

The treatment of aspect is shown in the following figure:

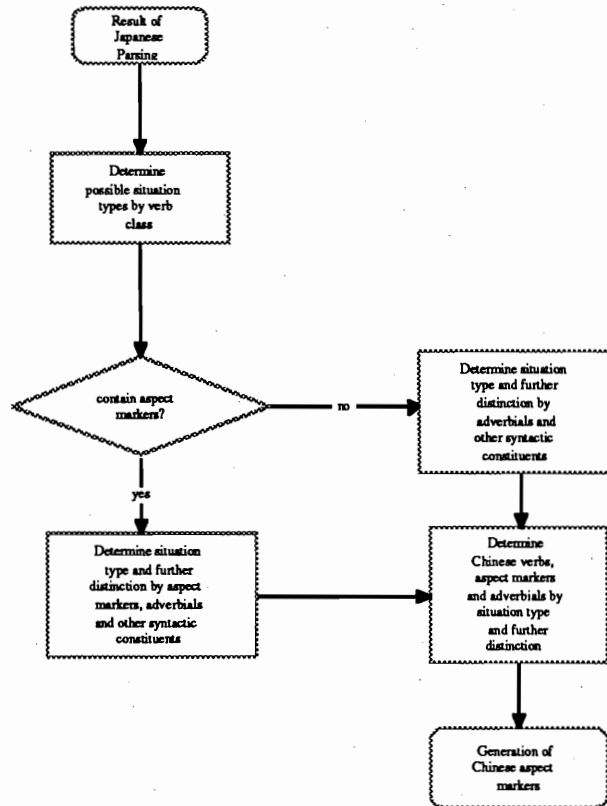


Figure 5: The flow of the treatment of aspect

Let us use sentence (22) as an example here. First, the class of a main verb is checked and possible situation types are determined:

Verb class=action
 Possible situation types=
 {(Accomplishment, x), (Activity, x), (State, x), (Habitual, x), (Generic, x)}

Following the check of verb class, aspect marker(s) are checked. When 'teiru' occurs with an action verb, the possible sentential aspects are as follows:

Aspect marker-->'teiru'

Possible sentential aspects:

{(Activity, progressive), (State, experiential), (state, nonprogressive), (state, perfective), (Habitual, habitual)}

Except aspect markers, the situation type can also be determined by the following factors:

i. Adverbials

Adverbials are important for determining situation types. For example, Japanese time adverbs such as '毎日' 'every day' denote habitual situations.

ii. Tense

Since accomplishments and achievements may only occur in simple past tense and may not be marked by any aspect markers, tense must be taken into consideration in the algorithm. Sentences in simple past tense may denote accomplishments and achievements. Also, a generic situation is described in present tense.

iii. Definite vs. indefinite subject and object

Definite subjects and objects are usually used in an accomplishment situation. Thus definiteness of subject and object is useful in distinguishing an accomplishment situation from an activity one.

iv. Number of the subject and the object

The number of the subject and object in a sentence is related to situation types. For example, generic sentences often occur with plural subjects and objects.

v. Quantified subject and object

An accomplishment situation accompanies with quantified objects, or quantified subjects that are more than one.

vi. Complements

Complements implies aspectual meaning, which must be considered in the overall algorithm.

In sentence (22), due to the adverb is 'すでに' 'already' and the object is definite, we can derive the sentential aspect as '(State, perfective).'

Adverbials: 'すでに' 'already'-->'perfective'
Object: definite-->'probably perfective'

In this case, the adverb 'already' is featured by 'perfective' and the definite object is characteristic of 'probably perfective.' Thus it can be interpreted as '(State, perfective),' which should be translated by adding the perfective marker '了' and it results in the translation '他已經讀了那本書' 'I have read that book already.' After all the constituents are checked, if there is still ambiguity in situation types or further distinctions, all of them will be included as the result of parsing. Nevertheless, only a default one will be translated into Chinese.

Finally, the Chinese translation is based on the situation type and the interpretation of the aspect marker. In this case, as long as the action verb '讀' 'read' is translated the perfective marker '了' can be given.

VI. CONCLUDING REMARKS

Chinese is different from Japanese and English in that it does not have a grammatical category to mark tense but has perfectivity and imperfectivity markers. In the machine translation systems that aim Chinese as a target language, the treatment of aspect must be carefully dealt with or the translation will be quite unacceptable. With this model, sentences that contain one aspect marker, several aspect markers or no aspect markers can be considered by the same approach. Moreover, it can also be applied to the translation of other languages with the only requirement that the aspectual systems are investigated language by language.

* NOTES

1. In this article, we do not distinguish predicative adjectives from verbs. When we refer to verbs, we mean predicative adjectives and verbs both in Japanese and Chinese.
2. We add 'telic' and 'delimitative' to Comrie's subdivision of perfectivity and imperfectivity

respectively.

3. In the examples and the followings, two values indicated in the parentheses mean situation type and further distinction of aspect respectively.

4. Aspect markers 'tekuru' and 'teiku', which are derived from 'come' and 'go', are very similar to the Chinese aspect markers '起來' and '下去', which are derived from 'up' and 'down.'

5. 'Experience' can be represented as an accomplishment or a state. In Japanese, an accomplishment that expresses experience is as follows:

e.g. 私は二三度日本へ行きました。
我去過日本兩三次
I have gone to Japan two or three times.

A state that expresses experience is as follows:

e.g. 私は二三度日本へ行っている。
我去過日本兩三次
I have been to Japan two or three times.

6. 'Telic' of achievement situations can be translated into Chinese by adding complements such as '掉' 'fall' and '下去' 'down,' which can be quite different depending on the meaning of verbs. The generation of these complements is possible if only if they are recorded in the dictionary.

7. In Chinese, there is a perfect marker '了', which occurs in the final position of sentence, indicates that the situation happens earlier than or at the reference time or the speech act time. In (41) to (43), the perfect marker '了' is used.

8. For the easy treatment of aspect, all the combinations of situation type and further distinction are stored in the computer.

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