Translating Emphatic/Contrastive Focus from English to Mandarin Chinese

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Abstract. This paper concerns the translation of spoken English into Mandarin Chinese, paying particular attention to the emphatic/contrastive focus in WH-questions which is realised by means of phonological stress in spoken English but by lexical and syntactic devices in Mandarin. A translation framework which is capable of treating emphatic/contrastive focus is outlined.

1 Introduction

The linguistic meanings of intonation are often ignored by spoken machine translation systems despite the fact that intonation plays an important role in spoken languages. The contrast between a translation pair like English and Mandarin is particularly interesting because the level of dependence on intonation is different: functions associated with intonation in English are often replaced by morphological, lexical or syntactic devices in tone languages such as Mandarin. This paper concentrates on the translation of emphatic/contrastive focus between the two languages.

Vermobil [1] and SLT [2] are the only two machine translation projects that have taken phonologically marked focus into account. Neither of these projects investigates the effect of emphatic/contrastive focus toward alternative translations in great depth. Nonetheless, there is a considerable amount of research into emphatic/contrastive focus in purely linguistic studies. The current work aims to incorporate this theoretical work into a working machine translation system.

In Section 2, a translation framework which is able to treat emphatic/contrastive focus translation is outlined. This framework includes mechanisms which parse English sentences with a focus marker, transfer English trees to Mandarin trees, applies focus rules and generates the final Mandarin sentences. Section 3 discusses emphatic/contrastive focus constructions in Mandarin and English based on previous linguistic studies. Section 4 outlines the focus rules that can be used in the translation framework proposed in Section 2. Finally, Section 5 is about testing and evaluation.

In this paper, only those sentences with one unambiguous emphatic/contrastive focus will be discussed. We also make a distinction between two kinds of phonological stress in English. When a phonological stress is on the WH-word in a WH-question, there might be two interpretations: emphatic/contrastive focus or an echo question. The first interpretation obtains when the speaker explicitly asks for a specific piece of information. Conversation (1) is an example. The second

interpretation obtains when the speaker forgets what has been answered or is surprised by what the addressee has answered. Conversation (2) is an example.

   (1) Q: When did you stop smoking?   (2) Q: How old are you?
          A: I don't smoke anymore.   A: I am two centuries old.
          Q: WHEN did you stop smoking?   Q: HOW old are you?

In the latter situation, the form of pitch contour on the word and on the rest of the utterance will be distinct from the pitch contours of the former situation. Only the translation of the former interpretation will be discussed in this paper.

2 The Framework of Translation

The translation system in this study consists of four: parsing the English sentence, transferring from English to Mandarin with a rule-based approach, applying focus rules, and generating the Mandarin sentence. Section 2.1 gives a very brief discussion of the speech recognition component. Section 2.2 discusses how English sentences are parsed, and particularly how emphatic/contrastive focus is treated. Section 2.3 describes the transfer stage, including the notations used in the transfer and focus rules. Section 2.4 discusses how a Mandarin sentence is generated.

2.1 Speech Recognition

We are interested in translating English sentences containing contrastive stress into Mandarin. For this to be a sensible activity, we have to start with spoken English, since that is where contrastive stress occurs. We use Nuance for recognising the words that were uttered, and we simultaneously examine the pitch and intensity contours to find stressed items. There are a number of interesting problems to be solved. In particular, because Nuance does not provide date stamps for individual words, we have to realign the speech signal with the Nuance transcription in order to determine which lexical items are stressed. The details of the algorithms we use for finding stressed phonemes and aligning these with the Nuance output are beyond the scope of this paper. The key point is that when we have found a stressed lexical item we mark it by inserting a following pseudo-word, written as *foc*, as shown in (3a). This pseudo-word is then treated as a post-modifier, which means that it is present in the parse tree for the English sentence and hence is available for inspection by the translation rules.

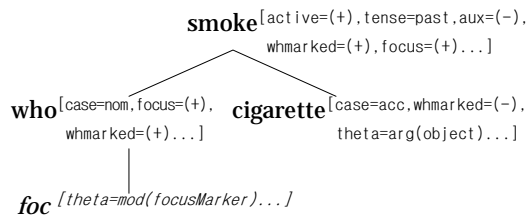### 2.2 Parsing English Sentences

The grammar used by the parser in this study is a version of HPSG [3]. The sentences are parsed into dependency trees. Several linguistic features are explicitly labelled in the trees for the purpose of matching the transfer rules and focus rules.

   A prosodic stress which is identified as an emphatic/contrastive focus is treated as a daughter of the word that bears the stress, as shown in (3b). The theta role of the node *foc* is a modifier. The emphatic/contrastive focus feature is treated as a non-local

feature, i.e. the value of emphatic/contrastive focus will be positive if the focus of its daughter is positive. Therefore, in (3b), both who and smoke have a positive focus.

(3) a. Who *foc* smoked cigarettes?

   b.

smoke [active=(+),tense=past,aux=(−),
whmarked=(+),focus=(+)...]

who [case=nom,focus=(+),
whmarked=(+)...]   **cigarette** [case=acc,whmarked=(−),
theta=arg(object)...]

foc [theta=mod(focusMarker)...]

2.3 Transfer Rules

A rule-based approach is adopted in the transfer stage. This is because when the domain is small, rule-based approaches have the advantage of better controls in the translation outputs. In any case, obtaining a parallel corpus of spoken English annotated for contrastive stress and Mandarin translations is beyond the resources of the current project, and as far as we are aware no such corpus is currently available.

A rule is defined with the source tree on the left and the target tree on the right separated by an arrow. On each side, structures are displayed along with the features of the nodes. These features are bracketed and separated from the structure by a slash. The skeleton of a typical rule is shown in (4).

(4) `(source tree)/[features]=>(target tree)/[features].`

Variables are allowed in the rules. In the tree structure, a variable has dollar sign ('`$`') as a prefix. In the features, the name of a node precedes an up-arrow ('`^`') followed by the feature and the value. If the name of the node is not specified, it defaults to the head of the tree. The features of the nodes on the RHS inherit the features on the LHS. In the case that the trees on the right and left have different structures, a colon ('`:`') will be used to specify which node on the right should be mapped to which node on the left. The focus rule shown in (5) will match a tree containing a verb that has a WH-marked modifier bearing a phonological stress. Such trees will be transferred to a tree on the RHS while the node *shi4* inherits the features of *foc*.

(5) `$v($wh(foc))`
    `/[cat=xbar(v(+),n(-)),wh^theta=mod(_),wh^whmarked=(+)]`
   `=> $v(shi4,$wh)/[shi4:foc].`

For the purpose of generation, some features related to the position will be adding to the RHS of the rules. There will be further discussions in Section 2.4.

Three types of rules are used in the transfer stage. The first type of rule handles fundamental syntactic differences between the two languages. Rule (6) is an example of transferring a yes-no question. Auxiliaries are the heads of yes-no questions in English while the particle *ma* (嗎) is used to mark a yes-no question in Mandarin.

(6) `$aux($v)/[cat=xbar(v(+),n(-)),aux=(+),mood=interrogative]`
   `=> $v(ma0).`

The second type of rule handles domain-specific translations. In a doctor-patient dialogue, expressions such as *be admitted to hospital* have rather complex tree

structures while the corresponding translation could be more simple. Rule (7) might be the most straightforward rule to produce an appropriate translation.

```
(7) be(admit($obj,to(hospital)))/[obj^theta=arg(object)]
    => ru4(yuan4,$obj)
        /[yuan4:hospital,ru4:admit,yuan4^pos=postverb].
```

The last type of rule deals with word for word transfer. If a word has several translation, features can be added as conditions. Rule (8) and (9) are examples where one word can be translated differently according to the additional features.

```
(8) cigarette/[number=(+)]=> yan1(zh1)/[zhi1^theta=mod(class)].
(9) cigarette => yan1.
```

At the transfer stage, the rules are applied until there are no variable nodes left in the tree. In each cycle, the first rule in the rule list that is found to match the part of tree will be applied. Therefore, specific rules must precede general rules. Tree (10) is the result of the transfer stage. This result is obtained by applying a general rule to add an aspect marker, and applying word for word rules to translate each word.

(10)

抽 (smoke)

了 (ASPECT)　誰 (who)　煙 (cigarette)

foc
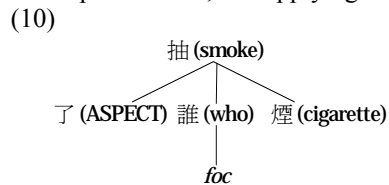
2.4 Mandarin Generation

The order of words in the final Mandarin sentence depends on the theta role and the case. In Mandarin, the subjects and modifiers precede verbs while other arguments follow the main verbs. Apart from this general rule, there are other function words or verbal complements which attach to verbs. In addition, certain function words need to be in a specific position of a sentence. In the transfer rules and the focus rule, *relpos(ition)* and *pos(ition)* are used as features to specify where the word should be in a sentence. For example, because the rule states that the aspect marker *le* (了) should immediately follow the verb, the generation of the tree (10), without considering the focus rule, will be (11).

(11) 誰　抽　　了　　煙
　　　shúi chōu　le　　yān
　　　who smoke ASPECT cigarette

Both Mandarin and English are SVO languages. Generating a Mandarin sentence by translating each word in English tree thus sometimes produces reasonable output. We take this approach as a fallback when transfer fails.

3 Focus Constructions in Mandarin

Shì (是) is often used to mark the constituent that conveys emphatic/contrastive focus. *Shì* can also be used as a copula. In the examples below, *shì* used to mark

emphatic/contrastive focus is referred to as 'emphatic *shì*'. It is often compared with the it-cleft construction in English, although there are some differences.

3.1 Focus Constructions

When the emphatic/contrastive focus is on a constituent preceding the predicate, emphatic *shì* can be inserted directly before the focused constituent to mark the focus. We will refer to this kind of construction as 'subject/adjunct focus'. If part or the whole of the predicate is focused, *shì* will still precede the predicate even if the main verb next to the emphatic *shì* is not focused. We will refer to this kind of construction as '*shi* + predicate' construction. In the first case, the syntactic construction clearly marks the focused item; consequently, the presence of phonological stress is optional. In the latter case, when the focused item is not adjacent to the emphatic *shì*, phonological stress will be important to specify which part of the predicate is in focus.

Constructions containing emphatic *shì* are often associated with the it-cleft construction in English. When the focus is on a subject or an adjunct, both Mandarin focus constructions and it-clefts have a clear syntactic indication of the focus item. However, the syntactic structures of the two focus constructions are distinct. The it-cleft has a dummy subject *it*, and the focused item is separated from the original clause. An analysis of an it-cleft sentence is shown in (12e). The Mandarin focus construction does not contain a dummy nor does it separate the focused item from the rest of the clause. It could be easily observed that the surface order of the original constituents are the same by comparing (12b) and (12d).
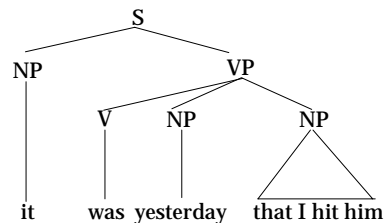
(12) a. I hit him yesterday.

    b. 我　昨天　打了　　他
       wǒ zuótīng dǎ le　　tā
       I yesterday hit ASPECT he

    c. It was yesterday that I hit him

    d. 我　是　昨天　打　了　　他
       wǒ shì zuótīng　dǎ le　　tā
       I SHI yesterday hit ASPECT he

e.

```
              S
           /     \
         NP        VP
         |       / | \
         |      V  NP  NP
         |      |  |    / \
        it    was yesterday  that I hit him
```
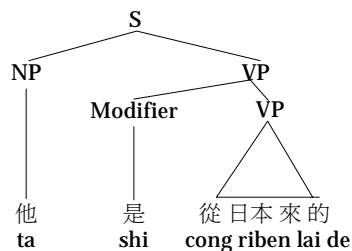
(13c) and (14c) show our proposed analyses of simple examples of emphatic *shì* .

(13) a. It is from Japan that he came.

    b. 他是從　日本　來　的
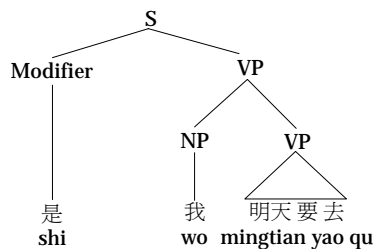   tā shì cóng Rìběn laí　de
      he SHI from Japan come DE

    c.

```
           S
         /    \
        NP      VP
        |      /   \
        |  Modifier  VP
        |     |       /\
       他    是   從 日本 來 的
       ta   shi  cong riben lai de
```

(14) a. It is I that want to go tomorrow

    b. 是　我　明天　　要　去
      shì wǒ míngtiān　yào qù
      SHI I tomorrow want go

    c.

```
            S
          /    \
     Modifier    VP
        |        /  \
        |       NP    VP
        |       |     /\
       是      我   明天 要去
       shi     wo  mingtian yao qu
```

Treating emphatic *shì* as a modifier provides a straightforward analysis, since the head of the VP does not alter in accordance with the presence of emphatic/contrastive focus. Such an analysis provides a clear explanation of why emphatic *shì* can be placed immediately before subject or adjunct without changing word order. We propose that emphatic *shì* is a modifier which precedes the smallest verbal projection containing the focused item. (13c) and (14c) are our analyses of (13b) and (14b).

Apart from the constructions containing emphatic *shì*, a pseudo-cleft like construction can be used to express emphatic/contrastive focus. (15b) is an example where the focus could be on the verb *chī (eat)*, the whole predicate *chī le pīngguǒ (ate apple)*, or the object *pīngguǒ (apple)*. When the focus is on the object, (15d) can be used as an alternative form where *pīngguǒ (apple)* is unambiguously in focus. Tree (15e) is an analysis of (15d). The function of *shì* in a pseudo-cleft like construction is different from emphatic *shì*. *Shì* in a pseudo-cleft like sentence acts like a copula.
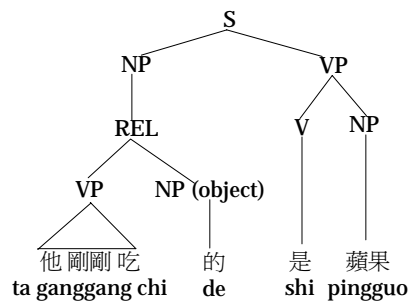
(15) a. She just ate an APPLE.

    b. 她 剛剛　　 是 吃 了　　 蘋果
      tā gānggāng shì chī le　　 pīngguǒ
      she just　　SHI eat ASPECT apple

    c. What she just ate was an apple.

    d. 她　剛剛　　 吃 的 是 蘋果
      tā gānggāng chī de shì píngguǒ
      she just　　eat DE SHI apple

e.

```
                    S
         _____
        NP                      VP
        |                    _____
       REL                   V      NP
     _____                |      |
    VP     NP (object)       是     蘋果
    |        |              shi   pingguo
他剛剛吃      的
ta ganggang chi   de
```

3.2 Presupposition and Focus

An it-cleft construction is presuppositional. Question (16a) presupposes *the addressee took some sort of medicine*, and therefore this presupposition holds even if the answer is negative. If such a presupposition is not true, it must be denied without answering the question, as shown in (16c). (16d) is an inappropriate response to (16a).

Phonological emphatic/contrastive focus could be used in contexts where the unfocused part of the sentence is presupposed. However, as Geurts and van der Sandt [6] pointed out, it is possible to suppress the presupposition that is conveyed phonologically. Consequently, even when the addressee did not take any medicine, it is still appropriate to answer question (17a), as shown in (17d).

(16) a. Q: Was it ibuprofen that you took?   (17) a. Q: Did you take ASPRIN?

    b. A: No, it was ibuprofen and aspirin   b. A: No, I took IBUPROFEN.

        that I took.   c. A: No, I didn't take aspirin.

    c. A: I didn't take any medicine.   d. A: No, I didn't take any

    d.*A: No, I didn't take any medicine.   medicine.

The focus in an it-cleft and the focus realised with intonation also differ in the status of exhaustive identification [5][6]. If the addressee of (16a) took not only ibuprofen but also aspirin, the answer should be negated, as shown in (16b). If question (17a) is asked in the same situation, a negation will not be necessary as long as aspirin was one of the things that the addressee took.

Among the focus constructions in Mandarin, subject/adjunct focus and the focus in a pseudo-cleft like construction obtain exhaustive identification readings [7]. On the other hand, such readings do not exist in the *shi* + predicate construction [7]. Moreover, the subject/adjunct focus and pseudo-cleft like constructions presuppose the unfocused part of the sentence, while the *shi* + predicate focus structure does not. Consequently, it is not always appropriate to translate phonologically marked emphatic/contrastive focus into a presuppositional focus construction. If an English sentence with a phonologically marked focus is not composed of presuppositional constructions, translation into subject/adjunct focus or pseudo-cleft like constructions will be inappropriate. Nevertheless, if the focus is on the verb or the object, translation into a *shi* + predicate focus construction in Mandarin will be acceptable.

4 Focus Rule Development

The notations used in the focus rules are identical to the notations used in the transfer rules described in Section 2.3. In the translation framework illustrated in Section 2, after an English labelled dependency tree is transferred to a Mandarin tree, the system searches a list of focus rules. If a matched rule is found, the Mandarin tree will be modified accordingly. If no rule is found, the original Mandarin tree will be used to generate the final Mandarin sentence.

The rules can be grouped into three categories: questions with WH-subject or WH-adjunct, cases where pseudo-cleft like constructions can be applied, and cases where a '*shi* + predicate' construction can be applied. The discussion below gives a feel for what these rules are like: space precludes a presentation of the full set of rules.

WH-subject or WH-adjunct. When the WH-subject (the WH-word or the head of the WH-element) is in focus, *shì* will be added as a daughter of the verb and appears as the verb's first daughter.

Rule 1: `$v($wh)/[cat=xbar(v(+),n(-)),wh^case=nom,wh^focus=(+),`
            `wh^whmarked=(+)]`
      `=> $v($wh,shi4)/[shi4^theta=mod(foc),shi4^relpos=first].`

After Rule 1 is applied, an emphatic *shì* is inserted, as shown in (18c). (18b) is the sentence generated before the focus rule is applied.

(18) a. WHICH factors trigger your asthma?

    b.   哪些個　因子　引發　你的　氣喘病

        nǎxiēge yānzǐ yǐnfā nǐde qìchuǎnbìng

   c. 是 哪些個　因子　引發　你的　氣喘病

    shì nǎxiēge yānzǐ yǐnfā nǐde qìchuǎnbìng

    SHI which　factor trigger your asthma

When the focus is on the WH-adjunct which precedes the predicate, emphatic *shì* is added to be a sister of the WH-adjunct. Since emphatic *shì* must precede the WH-adjunct, it has to precede the WH-adjunct in the rule.

Rule 2: `$v($wh)`
        `/[cat=xbar(v(+),n(-)),wh^whmarked=(+),wh^theta=mod(_)]`
      `=> $v(shi4,$wh)/[shi4^theta=mod(foc)].`

After Rule 2 is applied, (19b) is transferred to (19c).

(19) a. WHEN did you stop smoking?

b. 你　　什麼時候　　戒 煙
　　nǐ　　shémeshíhòu jiè yān

c. 你 是 什麼時候　　戒 煙
　　nǐ　shì shémeshíhòu jiè yān
　　you SHI when　　stop smoke

Pseudo-cleft like construction. When the focus is on a WH-element which follows the verb, a '*shi* + predicate' construction can always be used. This kind of transfer is not ideal since this construction still relies on intonation to mark the actual focused word, particularly when the predicate is composed of more than one constituent. In some cases, it is possible to translate the sentence with a pseudo-cleft like construction which unambiguously signals the focused constituent.

When a WH-object is in focus, Rule 3 will transfer the sentence to a pseudo-cleft like construction. However, this rule should not be used where the number of the object is asked since the object will not be the antecedent of a number.

Rule 3: `$v($wh)/[cat=xbar(v(+),n(-)),wh^theta=arg(object),`
`               wh^focus=(+),wh^whmarked=(+),not(wh^number=(+))`
`     => shi4($v(de0),$wh)/[cat=xbar(v(+),n(-)),aux=(-),`
`                           de0^theta=arg(object),v^pos=preverb].`

(20c) results from applying Rule 4 to (20b).

(20) a. Which SERVICE do you use?

b. 你 用　　哪些個　 服務
　　nǐ　yòng nǎxīege fúwù
　　you use　which　service

c. 你 用　　的是 哪些個　服務
　　nǐ　yòng de shì nǎxīege fúwù
　　you use　DE SHI which　service

If the focus is on *which*, a more specific rule can be applied. Rule 4 keeps the head of the object in the clause which is presupposed. (21b) is the result after Rule 4 is applied to (20b). In contrast with Rules 1 and 2 where there is no distinction between focus on the WH-word and focus on the head of the constituent, Rule 4 specifies that the focus is on *which*. Apart from applying Rule 4 to sentences with WH-objects, the same rule can be applied to (18b) when *nǎxīege (which)* is in focus and the head of the WH-element is a subject. However, such a rule cannot be applied to sentences with WH-adjuncts. There simply is no way of preserving the distinctions between focus on the WH-word and focus on the head in these cases. Rule 4 is more specific than Rule 1, therefore Rule 4 should precede Rule 1 in the list of focus rules.

Rule 4: `$v($n($wh(foc)))/[cat=xbar(v(+),n(-)),n^theta=X,n^case=C,`
`          wh^surface=which,wh^whmarked=(+),not(n^number=(+))]`
`     => shi4($n(null($v(de0))),$wh)`
`          /[cat=xbar(v(+),n(-)),aux=(-),null^theta=mod(_),`
`            null^relpos=first,de0^theta=X,de0^relpos=last,`
`            n^pos=preverb,wh^pos=postverb]:-`
`member([C,X],[[nom,_],[acc,arg(object)]]).`

(21) a. WHICH services do you use?

b. 你 用　的 服務　 是 哪些個
　　nǐ　yòng de fúwù　shì nǎxīege
　　you use　DE service SHI which

Some complements following the verb can queried in a WH-question. A '*shi* + predicate' construction can be applied in these cases. However, when the

complements or the object contain *how many* or *how much*, a rule schema with different instantiations for different lexical items used to transfer such question into a pseudo-cleft like construction. Rule 5 can be applied when *how many times* is asked and the speaker is interested in *many*. (22c) is the result of applying Rule 5 to (22b).

Rule 5: `$v($x0($y0(foc)))`
`/[cat=xbar(v(+),n(-)),x0^root=X0, y0^root=Y0]`
`=> shi4($x0(null($v(de0))),$y0)/[cat=xbar(v(+),n(-)),`
`aux=(-),x0^root=X,x0^pos=preverb,`
`null^theta=mod(headless),`
`v^pos=preverb,de0^theta=arg(de),`
`de0^relpos=last,y0^root=duo1shao3,`
`y0^pos=postverb]:-`
`member([X0,Y0,X],[[ci4,ji3,ci4shu4],`
`[qian2,duo1shao3,qian2],[li3,ji3,ying1li3shi4]]).`

(22) a. How MANY times have you been admitted to hospital?

 b. 你   入   院   幾   次
   nǐ   rù   yuàn   jǐ   cì
   you enter hospital how-many time

 c. 你   入   院   的 次數 是 多少
   nǐ   rù   yuàn   de cìshù shì dūoshǎo
   you enter hospital DE time SHI how-many

'*Shì* + predicate': Rule 6 applies to the situation where the verb or other postverbal element is in focus while other rules with higher priority cannot be applied. (23c) is an example. This rule also applies to declarative sentences.

Rule 6: `$v/[cat=xbar(v(+),n(-)),v^focus=(+)]`
`=>$v(shi4)/[shi4^theta=mod(foc)].`

(23) a. How MANY cigarettes did you smoke?

 b. 你   抽   幾   支   煙
   nǐ   chōu   jǐ   zhī   yān

 c. 你   是 抽   幾   支   煙
   nǐ   shì chōu   jǐ   zhī   yān
   you SHI smoke how-many CLASSIFIER cigarettes

The rules given above are a subset of the rules that we use. Space precludes a more complete discussion, but the rules described above provide a good illustration of what is going on. It is important to note that these rules deal with focused constructions in general, and are not limited to any specific domain. We therefore do not anticipate any major problems extending this aspect of our work to new domains.

5 Testing and Evaluation

As noted above there is no readily available corpus of English with contrastive stress markers and parallel Mandarin sentences. In order to develop the algorithm for detecting contrastive stress in spoken English referred to in Section 2.1, we had to record a collection of utterances spoken with stress on a variety of items. For this purpose we developed a collection of 207 sentences that reflected the tick boxes on a diagnostic checklist used by GPs for treating asthma. The sentences we developed had an average length of 8.6 words—shorter than is typical in unrestricted free speech, but

not unrealistic in situations where people are having difficulty communicating. For longer sentences the accuracy of the speech recogniser becomes a major issue, so there is little point in worrying about much longer sentences at this point anyway.

Because we have a default rule which simply translates the input word by word, preserving the surface order of the source text, we always get a 'translation', i.e. a string of Mandarin words with some connection to the source. The question is whether our 'translations' are actually well formed Mandarin sentences which convey the same message as the original English utterance.

Our informal tests show that on the testset we get reasonable translations in every case. This is perhaps not too surprising, since the testset was used in the development of the transfer rules. The key issue concerns the extent to which our transfer rules will cover examples other than those in the testset. We are fairly confident about the applicability of the general rules, since the source sentences cover a fairly wide range of syntactic structures. It may turn out that the set of phrase→phrase rules has to be extended for every domain, but that is an issue for any MT system.

In any case, the major innovation in the current paper is the translation of phonologically marked stress in one language into lexically and syntactically marked stress in another. In order to achieve this, we have proposed a novel analysis of Mandarin focus constructions. We treat emphatic *shì* as a modifier preceding the smallest verbal projection that contains the focus item. This treatment not only provides an improved explanation of the distribution of *shì* in Mandarin focus constructions, but also is computationally tractable. We have developed a set of focus rules that are aimed at handling this kind of focus, and we have shown that where we can get a reasonable translation of an English which does not contain a contrastive stress marker then we can also obtain a reasonable translation where the English does contain such a marker, even when this requires changes to the form of the Mandarin.

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