

# **A Modular and Statistical Approach to Machine Translation**

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## Abstract

In this paper, we report our experiment on a modular statistical approach to machine translation system. The experimental MT system consists of modules implemented by statistical methods to handle different level of linguistic analysis. The overall architecture of the system resembles that of a transfer-based MT system, but with less explicit expert knowledge involved. Five hundred simple bilingual sentences with main verbs restricted to 30 commonly used verbs are used as training data. These sentences are syntactically and semantically tagged to provide statistical data for case role analysis and transfer. A bilingual dictionary and collocation data from a corpus of Chinese news are used in target generation. The system is tested against the original 500 sentences and additional 100 sentences with promising results.

## 1. Introduction

Changes in the philosophy of language and mind heavily influence the MT researchers in using different approaches. In the 1970s and 1980s, rule-based systems are philosophically based on Norm Chomsky's *deterministic rationalism*, which means, the meaning of a sentence is inferred by a successively modification of internal model. As a result, the translation process amounts to the mechanical determination by fixed rules. However, Chomskyan paradigm is by now widely rejected [Sampson 83].

Another view being widely accepted is *fallible rationalism*, which means, the mind responds to experiential inputs not by a deterministic algorithm (rule), but by creatively formulating fallible hypothesis. On this view, it suggests MT researchers ought to exploit any techniques that offer the possibility of better approximation to acceptable translation.

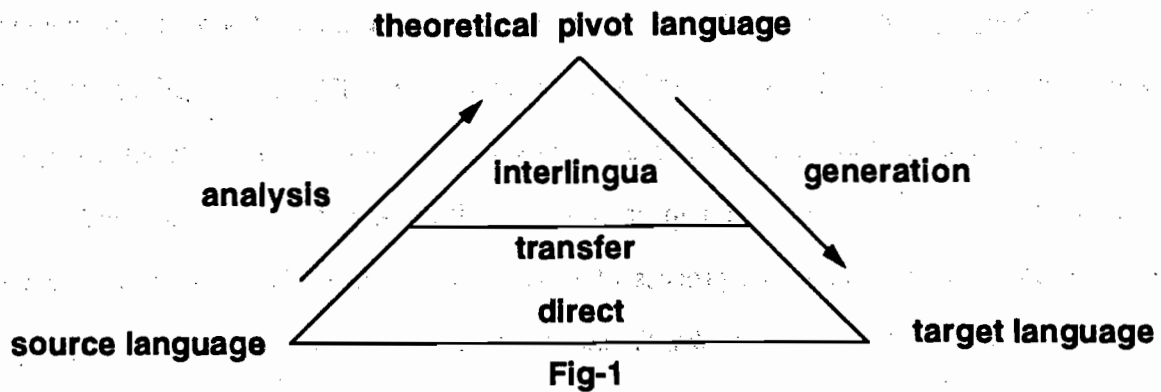
This changing trend was reflected by the growing popularity of statistical-oriented approaches in computational linguistics community. For MT, rule-based approaches need complete understanding of the characteristics of the source and target language; on the contrary, statistical-oriented approaches uses little linguistics analysis and treats translation problem purely as a process of optimization of possibility. Both approaches have its own benefits and drawbacks. Generally speaking, they can compensate for each other. Hence, to seek a balance point between these two different approaches seems a feasible way to go.

## **1.1 Machine Translation Model**

The models of MT range from rule-based to corpus-based. Others that lie between are example-based and hybrid systems. For simplicity, we only discuss the rule-based and corpus-based models here.

### **1.1.1 Rule-based Machine Translation**

Rule-based machine translation model may be roughly classified as *transfer* and *interlingua* approach. "The interlingua approach is now largely disfavored in most practical systems. The distinction among *direct translation*, *transfer-based* and *interlingua* system is fairly captured by the well-known pyramid diagram in Fig-1 that is probably first found in [Vauquois 73]. This diagram shows the deeper the analysis of the source language (SL), the less complex is the mapping from source language to target language (TL) [Somers 87]". But how deep should the analysis be remains an open issue. Undoubtedly, proper analysis greatly reduced the complexity of the problem.



In most transfer-based MT systems, SL text is syntactically analyzed, then transformed into some intermediate representation (e.g., case role in case grammar), and finally TL text is generated. In summary, the whole process can be realized in three phases: analysis, transfer, and synthesis.

### 1.1.2 Corpus-based Machine Translation

[Brown 90] first proposed a new MT model, consisting of *translation model* (TM) and *language model* (LM). The former describes the local correspondences between the two words in two different language while the latter shows the linear relations among the words within the same language. More precisely, given a sentence in SL, the translation problem reduces to: (1) find the word-by-word correspondences of the input in the TL and (2) among the corresponding words in (1), find the most likely translation of the input w.r.t the TM and the most plausible target sentence w.r.t the LM.

## 1.2 Recent Statistical Computational Linguistics Researches

The researchers on machine translation have paid much attentions to corpus-based approach for the past few years. This trend is due to the fact that machine translation involves in both complex and tremendous knowledge acquisitions. The rule-based

approach suffers from the disadvantages of time-consuming knowledge engineering and difficulty in maintaining data consistency.

Lately, much research effort in statistical approach has been devoted to fundamental works in computational linguistics. The following successful results encourages MT researchers to reconsider the MT problem from quite a different point of view.

- **Tagging part of speech**

Several studies attack the problem by optimizing the product of the probabilities of relative tag probability (RTP) and tag bi-gram, achieved a correctness of 95% [Derose 88, Church 89]. Also, a corpus-based segmentation of Chinese text reported a 90-95% accuracy [Chang 91].

- **Grouping non-recursive noun phrase**

Using the bi-gram probabilities of starting a noun phrase and ending a noun phrase, non-recursive noun phrases for unrestricted text can be grouped with a 95-99% accuracy [Church 88].

- **Finding clauses**

Similar technique also applies to finding clauses in unrestricted text with a mere 6.5% error rate [Ejerhed 88].

In addition, some researchers also use statistical models to disambiguate word sense [Brown 91] and [Dagan 91], and to tag sentences for thematic relation learning. Nevertheless, not all the statistics-oriented natural language processings are satisfactory. With the progress in these fundamental problems, the framework of a modular and statistical MT system apparently based on sound ground.

### 1.3 Our Model

Traditional rule-based systems deal with different linguistics problems in several modules because MT problem involves many huge and minute knowledge sources on different linguistic levels (morphology, lexicon, syntax, semantic, etc.). In a statistical MT system, in order to isolate the effects of irrelevant parameters, the work of analysis, transfer and synthesis should be accomplished within different modules.

Our major concern for this study is how to take advantage of the statistical power in dealing with uncertain or inconsistent data in corpus-based system, and the generalization power as well as economic property of linguistics knowledge. Hence, we propose a statistics-oriented method that incorporates the linguistics knowledge as the backbone of information retrievals.

Our assumption is that if statistical approaches to group all kinds of phrase and embedded sentences (instead of parsing) can be fully developed in the near future, it would be worth paying more attentions to do analysis, transfer and synthesis not in so rigid ways as before. We thus, by the use of case grammar, attempt to construct statistical models, with less effort involved, to deal with *case role analysis*, *case role translation* (some kind of transfer) and *lexical choice*. These three modules together can form the kernel of a MT system. We hope that some inspiration from our experiment might help to sketch out the skeleton of a modular and statistical machine translation system in Fig-2.

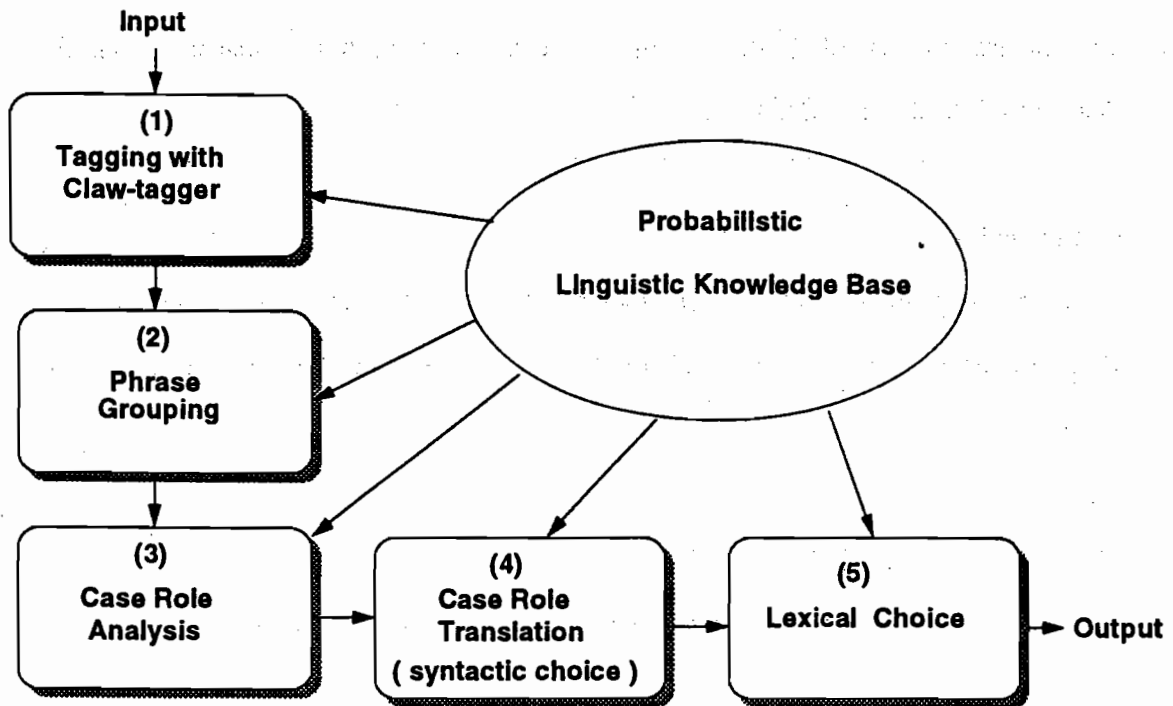


Fig-2

Our discussion includes (3), (4), and (5). (1) comes from the Claw tagging system. In (2), the statistical models for grouping non-recursive noun phrase comes from [K. D. Church 89]; the grouping of other kinds of phrase were implemented by some heuristics.

## 2. Case Role Analysis

Case grammar is widely adopted in MT researches because of its good property of capturing the deep structure of a proposition, and thus is suitable for analyzing source and generating the TL. For simplicity, in our experiment we only consider the easiest case, that is, simple sentence without any tense, aspect or mood.

### 2.1 Statistical Model for Case Role Analysis

A predicate may have many case frames; to tell one from the others may need a delicate mechanism to analyze the functional relationships among the constituents of a

structure. In order to avoiding such complex work, we attempt to construct a simpler statistical model to do the same things.

### **I. For inner roles:**

We use the tri-gram information of inner roles and prepositions (case makers) for a specific predicate to substitute the need for the case frame. Take the case of *provide* for an example:

2-1. [Ag I] [V provide] [Th a book] to [Be him].

The tri-grams are: ("", "", Ag), ("", Ag, V), (Ag, V, Th), (V, Th, to), and (Th, to, Be).

2-2. [Ag I] [V provide] [Be him] with [Th a book].

The tri-grams are: ("", "", Ag), ("", Ag, V), (Ag, V, Be), (V, Be, with), and (Be, with, Th).

In addition to the tri-gram *contextual probabilities* (CP), we also need *relative case probabilities* (RCP). We define RCP to be the "relative probabilities of the tags the of a phrase head to assume a certain case role", i.e.,  $\Pr(\text{role}|\text{tag}_{\text{head}})$ . For example, a singular common noun NN<sup>1</sup> may act as a Theme with the probability of 0.6, as an Agent with probability 0.1, as an Experiencer with 0.03 probability, and as a Beneficiary with 0.02 probability. Then, the RCP of NN would be:  $\Pr(\text{Th}|\text{NN})=0.6$ ,  $\Pr(\text{Ag}|\text{NN})=0.1$ ,  $\Pr(\text{Ex}|\text{NN})=0.03$ ,  $\Pr(\text{Be}|\text{NN})=0.04$ . Table-1 shows part of the RCP.

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<sup>1</sup> All the tags used in the paper come from LOB tagset.



| RCP | NN   | NP <sup>2</sup> | PP1A <sup>3</sup> | PP3OS <sup>4</sup> | JJ <sup>5</sup> |
|-----|------|-----------------|-------------------|--------------------|-----------------|
| Th  | 0.6  | 0.3             | 0.05              | 0.8                | 0.1             |
| Ag  | 0.1  | 0.2             | 0.8               | 0                  | 0.1             |
| Ex  | 0.03 | 0.1             | 0.07              | 0.06               | 0.05            |
| Be  | 0.04 | 0.1             | 0                 | 0.08               | 0.05            |
| Cp  | 0.02 | 0.01            | 0                 | 0.01               | 0.45            |

Table-1 Relative Context Probability

In table-1,  $\Pr(\text{Ag}|\text{PP1A})=0.8$  means that *I* tends to function as an Agent.  $\Pr(\text{Ag}|\text{PP3OS})=0$  means *them* never function as an Agent.  $\Pr(\text{Th}|\text{NN}) > \Pr(\text{Ag}|\text{NN})$  means a common noun has a greater tendency to function as a Theme than as an Agent. We choose the tag of a phrase head because of two reasons: (1) Head is the most informative word in a phrase and (2) The n-grams can capture more information with unimportant words skipped.

The analysis process is to maximize the product of case role tri-grams for the predicate and RCP.

## II. For outer roles:

Most outer roles can act as only one case role; this greatly reduces the ambiguity in analysis. Unfortunately, dealing with outer roles may be problematic in case role analysis because: (1) Outer roles occur with comparatively low frequency, simply training outer roles from corpus without special processing may suffer from the problem of undersampling. (2) The syntactic structures (surface structure) of outer roles are diverse,

<sup>2</sup> proper noun: *John, London*

<sup>3</sup> 1st singular nominative pronoun in subject position: *I*

<sup>4</sup> 3rd plural nominative pronoun in object position: *them*

<sup>5</sup> general adjective: *tall, good*

ranging from all kinds of phrase to subordinate clauses. Among them, some are analyzable; others are idiomatic.

Since there is no suitable statistical model at hand, we use mainly heuristics to deal with outer role analysis.

### **3. Case Role Translation**

Transfer operations improve the quality of translation. Instead of examining the syntactic structures and idiosyncrasies of specific lexical items, we choose to do *case role translation* to facilitate the transfer process.

#### **3.1 Why Transfer?**

Even though the deep (semantic) structures are identical, there are surface (syntactic) structure differences between source and target language. See the following examples:

3-1. [Ag I] [V washed] [Th the car] [Pl in the garage] [Ti yesterday].

The translation "[Ag 我] [Ti 昨天] [Pl 在車庫] [V 洗] [Th 車子]" shows the syntactic differences (case role order) between Chinese and English.

#### **3.2 Statistical Model for Case Role Translation**

As before, we rely on both translation and language model to cope with case role translation. The major tasks of case role translation are as follows:

- (1) Reorder the case roles.
- (2) Translate the preposition of outer role into proper target words.
- (3) Pick out some function words and put them in appropriate place.

For instance, the sentence "*I place the vase on the desk carefully*" has the case analysis:

3-1. [Ag I] [V place] [Th the vase] [Lo on the desk] [Ma carefully].

After the case translation, the result is "Ag Ma 地 把 Th V 在 Lo 上". These three tasks are realized separately as follows:

- (1) (Ag V Th Lo Ma) is reordered to (Ag Ma Th V Lo).
- (2) *on* is translated into 在...上.
- (3) 地 and 把 are inserted in the proper positions.

#### I. Translation model:

The translation model provides the probabilities of correspondences between source and targets case roles with/without a case markers. See table-2.

|                  |         |           |        |
|------------------|---------|-----------|--------|
| with a stick     | 用 棍子    | with Im   | 用 Im   |
| run              | 地 跑     | V         | 地 V    |
| fast             | 得 快     | Ma        | 得 Ma   |
| during last year | 在 去年 期間 | during Du | 在Du 期間 |
| to the school    | 到 學校    | to Lgo    | 到 Lgo  |
| with courage     | 勇敢 地    | with Ma   | Ma 地   |
| company          | 把 公司    | Th        | 把 Th   |

Table-2

## II. Language model:

It's not trivial to determine whether and where to insert the source-independent function words such as 得, 地, and 把 in the target sentences, because the inclusion of these words depends on the ordering of target case role. Consider the following examples:

3-2. [Ag John][V runs] [Ma fast].

[Ag 約翰][V 跑]得[Ma 快].

\*[Ag 約翰][V 跑][Ma 快].

3-3. [Ag John ][V runs][Lgo to the school ][Ma quickly].

[Ag 約翰][Ma 很快]地[V 跑][Lgo 到學校].

\*[Ag 約翰][V 跑][Lgo 到學校]得[Ma很快].

3-4. [Ag John ][V runs][Th the company ][Ma very successfully].

[Ag 約翰]把[Th 公司][V 經營]得[Ma 非常成功].

\*[Ag 約翰][Ma 非常成功]地[V 經營][Th 公司].

From the observations above, the language model should insure proper target role ordering and the insertion of function words consistent with the ordering of the target roles.

Our language model encodes the possibilities of the mutual ordering among case roles, which are possibly merged with function words, in the form of tri-gram. The tri-grams of the language model in example 3-2 above would be

("", "", Ag), ("", Ag, V), and (Ag, V, 得Ma).

Similarly, example 3-3 has tri-grams as

("", "", Ag), ("", Ag, Ma), (Ag, Ma, 地V), and (Ma, 地V, 到Lgo).

The process of case role translation is simply to optimize the product of these two models.

## 4. Lexical Choice

### 4.1 Statistical Model for Lexical Choice

Different senses of a word in a context result in different target words are significant. To choose proper lexical items, we employ *global scope* and *local scope* to differentiate word sense implicitly. "Global scope" means the sense of a word is determined by other words in different structures. On the contrary, "local scope" means the sense of a word is determined by its neighbors within the same structure (the words to the left and/or right). In the following, we will describe the proper translations of a verb and another informative word (*informant*) from global scope. Other words are translated with the local scope.

#### I. Global scope:

We assumed that, in a sentence, the meaning of a verb is related to one of its argument. More precisely, we presume the most probable informative argument to be the head word of an inner role. For examples, in

(run, machine), (river, run), (take, bus), (take, job), (break, bank), and (window, break),

the translation of run, take, and break is determined by its Theme. How to select the informant is not trivial, we thus make the decision by a heuristic. The inner role is selected by the precedence "Cp > Th > Lo > Ag".

## II. Local scope:

With the belief that words within a grammatical unit are strongly correlated, we deal with other words on the base of phrase, i.e., from a local scope. From observations, we know that heads and their modifiers have greater tendency to co-occur. Consequently, sampling the collocation information from corpora would be feasible.

To demonstrate how GSP and LSP work in lexical choice, consider following examples:

4-1. [Ag They] [V develop] [Th all the natural resources].

The proper translation can be "他們 開發 所有的天然資源"

The GSP is  $\Pr(\text{Verb}|\text{develop}) * \Pr(\text{Informant}|\text{resource}) * \Pr(\text{Verb}, \text{Informant})$ .

The LSP is  $\Pr(T_{31}|\text{all}) * \Pr(T_{32}|\text{the}) * \Pr(T_{33}|\text{natural}) * \Pr(T_{34}|\text{resource}) * X$  where

Collocation probability  $X = \Pr(T_{31}, T_{32}) * \Pr(T_{32}, T_{33}) * \Pr(T_{33}, T_{34})$ .

To get a feel of the difficulty involved in word selection, take a look at the possible translations of words listed in a dictionary:

develop: 引起 宏揚 沖洗 長 建設 振興 培養 產生 發育 發揮 開發 開闢 增進

natural: 天然 平常 天生

resource: 資源 安慰 消遣 機智

If we can extract sufficient collocation information from corpora, it is likely to encounter the co-occurrences of (開發,資源) in "開發台灣西部外海石油資源" and (天然,資源) in "天然資源並非取之不竭". Especially, to suit the need for a limited domain amounts to train the parameters from that domain rather than to build semantic hierarchy (network) by some domain-dependent features.

Technology of acquiring collocation information is beginning to mature and the burden of human knowledge acquisition will be alleviated at least partly [Smadja 90]. For this experiment, we use collocation probability to handle GSP. As for LSP, we use only the stand-alone probability of each word. The best translation of words is determined by the product of GSP and LSP.

## 5. Experimental Results

### 5.1 Training Data

To avoid additional work irrelevant to our discussion, our training data include only simple sentences with present aspect, active form, and non-recursive phrases. Five hundred bilingual (English-Chinese) sentences, with 30 commonly used verbs as the main verb, were adopted from two dictionaries<sup>6</sup>. The English sentences were syntactically tagged by Claw-tagger, and both English and Chinese sentences were semantically tagged (case role) by hand. After tagging, we grouped the phrases of the sentences then fed them to the system. These 30 verbs are averagely selected from 15 verb classes which are classified by Cook's *matrix model* in *Case Grammar Theory* [Cook 70], thus have a representative coverage in case role analysis. The tag set is from the LOB tag set, and case role set mainly borrows from [Tang 1975].

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<sup>6</sup> These two dictionaries are *Longman English-Chinese Dictionary of Contemporary English*, Longman Group (Far East) Ltd. 1988 and *英語常用動詞用法詞典* (A Dictionary of Commonly Used English Verb), 商務印書館, 上海譯文出版社, 1986.

In addition to these 500 sentences, about 8,000 subject-verb (SV) or verb-object (VO) type of Chinese phrase head bi-grams are extracted from two sources<sup>7</sup> to facilitate the lexical choice of verb and its informant.

The translation of single words comes from *BDC Chinese-English Dictionary* version 1.0 (致遠科技公司).

## 5.2 Evaluation Criteria

Due to the lack of programs for extracting collocation information and the shortage of bilingual corpus, our models severely suffer from the problem of undersampling. Therefore, to evaluate the performances of the models needs special consideration.

### I. For case role analysis:

Our criterion for judging case role analysis is rather simple. Namely, if the any case is assigned to a phrase incorrectly, we regard the whole sentence as a wrong analysis.

### II. For case role translation:

If the source case roles assigned to a sentence is reordered to target case role incorrectly, or any case markers is improperly inserted, omitted, or placed, we regard the case role translation as a failure.

### III. For lexical choice:

Since our simplified model for lexical choice in local scope model (LSM) hasn't incorporated the collocation probability yet, our evaluation criterion for lexical choice is restricted to the suitability of a verb-informant pair.

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<sup>7</sup> (a) 30,000 Chinese words from general domains. (b) 1,000,000 Chinese words of reportage from Union Press (聯合報).



### 5.3 Two Tests

We did two tests to evaluate the system performance according to the criteria defined above. In the first test, we test the system with the same training sentences to see its capability of learning. Secondly, we randomly selected 100 sentences from Brown Corpus of category A,B,C<sup>8</sup> under two constraints: (1) the usage of a verb cannot be a phrasal verb and (2) the inner and outer roles are within our recognition. The overall result shows a satisfactory capability of learning on the whole, as some of the testing sentences reveal<sup>9</sup>:

5-1. [ The /ATI delegation /NN ] ( arrives /VBZ ) in /IN [ Beijing /NP ] on /IN [ Wednesday /NR ]

AG V IN,LGO TI

代表團 訪問代表團 :2

出生 來臨 到 到了 到達 抵達 進站 開到 駕臨 :9

代表團 星期三 到達 北京

5-2. [ John /NP ] ( breaks /VBZ ) [ the /ATI windows /NNS ] with /IN [ a /AT stone /NN ]

AG V TH WITH,IM

中止 打破 折斷 沖破 刷新 消失 破 破裂 粉碎 停止 崩潰 透露 違反 違犯 違背 摧毀 暴跌  
潰決 壓破 斷 斷裂 鎮壓 離開 鑿開 :24

窗 窗子 窗戶 牖 :4

約翰 用石 把窗子 打破

5-3. ( Break /VB ) [ the /ATI news /NN ] to /IN [ him /PP3O ] { gently /RB }

V TH BE MA

消息 新聞 :2

中止 打破 折斷 沖破 刷新 消失 破 破裂 粉碎 停止 崩潰 透露 違反 違犯 違背 摧毀 暴跌  
潰決 壓破 斷 斷裂 鎮壓 離開 鑿開 :24

把消息 婉轉 地透露 給他

5-4. [ They /PP3AS ] ( count /VB ) [ him /PP3O ] among /IN [ their /PP\$ supporters /NNS ]

AG V TH CP

支數 伯爵 告發條項 依賴 計算 計數 當作 算 認為 數 數目 點 :12

支持者 :1

他們 當作 他 是他們的支持者

5-5. [ The /ATI train /NN ] ( moves /VBZ ) { slowly /RB } along /IN [ the /ATI river /NN side /NN ]

TH V MA ALON,PA

火車 系列 訓練 鍛練 :4

<sup>8</sup> Category A: 定期刊物 報導文學 (reportage), Category B: 定期刊物 社論 (editorial), Category C: 書評 (reviews).

<sup>9</sup> NP is grouped by "[ ]", VP by "()", ADVP by "{}", and ADJP by "<>". Line 1: input. Line 2: After analysis. Line 3,4: senses of informant and verb. Line 5: output.

心動 打動 有所感觸 改變 步 步驟 走 招數 建議 看法改變 挪動 動 動彈 移 移動 移線  
 進行 進展 感動 搬 搬走 搬移 搬遷 調動 撼動 轉 轉移 :27  
 火車 延著河水邊 慢慢 地移動

5-6. [ Last /AP year /NN ] [ we /PP1AS ] ( open /VB ) [ training /VBG classes /NNS ] for /IN [ the /ATI  
 school /NN teachers /NNS ]  
 TI AG V TH FOR,OBE  
 公開 打開 全天服務 伸開 拆封 空曠 展開 張開 爽朗 開 開始 開放 開啟 開著 開幕 開學  
 開闊 睜開 營業中 翻開 露封 :21  
 屆 班級 級別 期 等 階級 種類 :8  
 去年 我們 為學校老師 開 訓練班

The result of second test is slightly less satisfactory than that of first test since our examples suffer from undersampling in case role analysis and case role translation. Although many case frames are within our recognition, yet the case role orders of testing sentences are different from that of training sentence. As for the overall performances of these two tests, see table-3.

| Error Rate | Analysis   | Case Translation <sup>10</sup> | Choice      |
|------------|------------|--------------------------------|-------------|
| Test1      | 5/500=1%   | 15/495=3%                      | 1/495=0.2%  |
| Test2      | 17/100=17% | 6/83=7.2%                      | 20/83=24.0% |

Table-3

For more detailed examples, refer to appendix A.

## 6. Conclusions

### 6.1 Summary

We propose the MT model with statistical analysis, and modularity because of the following reasons: (1) encouraging results from recent statistical computational linguistics researches show the potentials in statistical MT, (2) the progress in automatic

<sup>10</sup> If the case analysis fails, then we did not do case translation.

## **6.2 Future Work**

### **6.2.1 Extend to More Complex Syntactic Structures**

Case roles can be assigned to not only phrases, but also to other structures (e.g., subordinate sentence and infinitive). Moreover, case relation can function at levels other than verb-phrase, such as *Characteristic/Composition* in "a book *of* poems" and *Partitive* in "the chairman *of* the board". That is, prepositions can also assign case roles to phrases.

To extend to complex syntactic structures, we might have to subdivide to case role set according to their different syntactic structures. For instance, although both an NP and an infinitive can function as a Th, we may assign them Th1 and Th2, respectively. However, this inevitably enlarges the size of n-gram matrix and consequently increases the cost of knowledge acquisition.

### **6.2.2 Substitute Semantic Tag for Case Role**

During the development of the system, the case role assignment and the coverage of case role set is unclear. This may be a bottleneck in the long run. A more specific pivot language (such as semantic tag) may be an alternative to tag a structure semantically and automatically. Yet, the study of semantic tag still has a long way to go.

## References

- [Hunag 88] 黃金仁, 王良志, 格框機器翻譯的應用, 第四屆中華民國計算語言學討論會論文集, 99-125 頁
- [Chang 91] 張俊盛, 陳志達, 陳舜德, 限制式滿足與機率最佳化的中文斷詞方法, 第四屆中華民國計算語言學討論會論文集, 墾丁, 147-166 頁, 1991.
- [Derose 88] Steven J. Derose. Grammatical Category Disambiguation by Statistical Optimization, *Computational Linguistics*, 14(1):31-39, Winter 1988.
- [Sampson 83] Geoffrey Sampson. Fallible Rationalism and Machine Translation. In Proceedings of First Conference of the European Chapter of the Association for Computational Linguistics, pages 86-89, Italy, 1983.
- [Church 88] Kenneth Ward Church. A statistical Parts Program and Noun Phrase Parser for Unrestricted Text. In *Proceedings of Second Conference on Applied Natural Language Processing*, pages 136-143, Austin, 1988.
- [Brown 91] Peter F. Brown, John Cocke, Stephen A. Della Pietra, Vincent J. Della Pietra, Fredrick Jelinek, John D. Lafferty, Robert L. Mercer, and Paul Roossin. A Statistical Approach to Machine Translation. *Computational Linguistics* pages 79-85 Volume 16, Number 2, June 1990.
- [Brown 91] Peter F. Brown, Stephen A. Della Pietra, Vincent J. Della Pietra, and Robert L. Mercer. Word-sense Disambiguation Using Statistical Methods, pages 246-270, In *Proceedings of the annual Meeting of the Association for Computational Linguistics*, 1991.
- [Brown,91] Peter F. Brown, Jennifer J. Lai, and Robert L. Mercer. Aligning Sentence in Parallel Corpora, In *Proceedings of the Annual Meeting of the Association for Computational Linguistics*, pages 169-176, 1991.
- [Dagan 91] Ido Dagan, Alon Itai, and Ulrike Schwall. Two Languages Are More Informative Than One. *29th ACL*.

[Somers 87], H.L. Somers 1987, *Valency and Case in Computational Linguistics*, Edinburgh University Press, pages 262-278.

[Tang 75] Ting-Chi Charles Tang, *A Case Grammar Classification of Chinese Verb*, Hai-Guo Book Company, Taipei, Taiwan, pages 26-43.

[Smadja 90] Frank A. Smadja and Kathleen R. MaKeown. Automatically Extraction and Representing Collocations for Language Generation, In *Proceedings of the Annual Meeting of The Association for Computational Linguistics*, pages 252-259, 1990.

[Su 91] Keh-Yih Su. An introduction to Corpus Based Statistical Oriented Techniques of Natural Languages Processing - A Tutorial, presented in *the 4-th ROC Computational Linguistics Conferenece (ROCLING IV)*, Kenting, 1991.

[Pieraccini 90] Roberto Pieraccini, Esther Levin, and Chin-Hui Lee. Stochastic Representation of Conceptual Structure in the ATIS work, In *Proceedings of the 3rd DARPA Speech and Natural Language Workshop*, 1990.

[Tsutsumi 91] Taijiro Tsutsumi, Word-Sense Disambiguation By Examples. ICCCL 1991, pages 440-446.

[Slocum 85] Jonathan Slocum, A Survey of Machine Translation: Its History, Current Status, and Future Prospects. *Computational Linguistics* pages 1-17, Volume 11, Number 1, January-March 1985.

[Isabelle 85] Pierre Isabelle and Laurent Bourbeau , TAUM-AVIATION: Its Technical Features and Some Experimental Results, *Computational Linguistics* pages 19-27, Volume 11, Number 1, January-March 1985.

[Garside 87] Roger Garside, Geoffrey Leech, and Geoffrey Sampson, *The Computaional Analysis of English*, Longman Group UK Limited 1987.

[Ejerhed 88] Eva I. Ejerhed, Finding Clauses in Unrestricted Text by Finitary and Stochastic Method, In *Proceedings of the Annual Meeting of the Association for Computational Linguistics*, pages 219-227, Austin, 1988.

[Cook 89] Walter A. Cook, *Case Grammar Theory*, Georgetown University Press, 1989.

# Appendix A

{ He /PP3A } { accepts /VBZ } { this /DT little /JJ gift /NM } under /IN { such /JJ condition /NNS }  
AQ V TH UNDER.COM  
問題 收受 受理 服 審納 接受 接納 :8  
禮物 禮品 :2  
接受 禮物  
在這樣的條件之下 他 接受 這少許禮物

{ Finally /RB } { they /PP3AS } { accept /VB } { our /PPS terms /NNS }  
TI AQ V TH  
問題 收受 受理 服 審納 接受 接納 :8  
專用術語 專門術語 條件 :3  
接受 條件  
最後 他們 接受 我們的條件

{ The /AT1 river /NM } { breaks /VBZ } { its /PPS banks /NNS }  
AQ V TH  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
崩潰 堤岸 銀行 :3  
沖破 堤岸  
河水 沖破 它的堤岸

{ They /PP3AS } { break /VB } { the /AT1 hard /JJ frozen /JJ earth /NM }  
with /IN { picks /NNS }  
AQ V TH WITH.IN  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
土地 球 :2  
墜隔 土  
他們 用去 把 這個堅硬的凍凍土 墜隔

{ We /PP3AS } { break /VB } { the /AT1 enemy's /NNS blockade /NM }  
AQ V TH  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
封鎖 :1  
粉碎 封鎖  
我們 粉碎 敵人的封鎖

{ He /PP3A } { breaks /VBZ } { two /CD national /JJ records /NNS } {  
that /DT evening /NM }  
AQ V TH TI  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
紀錄 唱片 唱碟 歌 錄下來 :6  
打破 紀錄  
他 那個晚上 打破 兩全國紀錄

{ The /AT1 warlord /NM government /NM } { breaks /VBZ } { the /AT1  
demonstration /NM }  
AQ V TH  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
示威 示威遊行 示威遊行 示威 :4  
崩裂 示威遊行  
軍閥政府 崩裂 示威遊行

{ The /AT1 mirror /NM } { breaks /VBZ } into /IN { pieces /NNS }  
TH V INTO.OO  
反映 反射 面 鏡子 :4  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
鏡子 破  
鏡子 破 成碎片

{ Brittle /JJ things /NNS } { break /VB } { easily /RB }  
TH V MA  
專 專物 專情 專事 東西 物件 :6  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
東西 破  
脆東西 破 得容易

{ I /PP1A } { never /RB } { break /VB } { that /DT vow /NM }  
AQ PR V TH  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
誓言 :1  
違背 誓言  
我 從不 違背 那個誓言

{ He /PP3A } { breaks /VBZ } under /IN { continuous /JJ questioning  
/VBQ }  
AQ V UNDER.COM  
他 破 :2  
中止 打破 折斷 沖破 劇斷 消失 破 破裂 粉碎 停止 崩潰 逃離 違反 違犯  
違背 搖脫 暴跌 潰決 壓破 斷 斷裂 崩裂 離間 墜隔 :24  
他 崩潰  
在不斷的盤問之下 他 崩潰

{ We /PP1A } { change /VB } { the /AT1 date /NM } to /IN { Feb /NP 28  
/CD }  
AQ V TH TO.OO  
兌換 扶換 扶換 改 改易 改變 更動 修改 掉 推移 換 替換 通換 變 變幻  
變更 變易 變換 變遷 :19  
日 日期 時日 菓子 號 :6  
改 日期  
我們 把日期 改 成二月二十八日

{ I /PP1A } { change /VB } { my /PPS address /NM } { next /JJ week /NM }  
AQ V TH TI  
兌換 扶換 扶換 改 改易 改變 更動 修改 掉 推移 換 替換 通換 變 變幻  
變更 變易 變換 變遷 :19  
地址 住址 致辭 發表聲明 :4  
改 地址  
我 下星期 改 我的地址

{ I /PP1A } { change /VB } { places /NNS } with /IN { you /PP2 }  
AQ V TH WITH.COM  
兌換 扶換 扶換 改 改易 改變 更動 修改 掉 推移 換 替換 通換 變 變幻  
變更 變易 變換 變遷 :19  
下地 地方 安 安放 安置 位置 所在 放 放置 座位 處 :12  
換 座位  
我 和你 換 座位

{ The /AT1 box /NM } { contains /VBZ } { some /DTI drugs /NNS }  
LO V TH  
內含 有 盒 含有 抑制 害 毒地 :7  
毒 毒品 挽救 毒藥 藥品 :4  
有 藥品  
盒 裡 有 一些藥品

{ His /PPS country /NM } { develops /VBZ } { its /PPS traditional /JJ  
friendship /NM } with /IN { China /NP }  
AQ V TH WITH.COM  
引起 宏揚 沖洗 長 長成 建設 振興 培養 產生 發丹 發展 發展起來 發展  
發揚 開發 開闢 增進 養成 辦 顯像 顯影 :21  
友誼 友誼 交情 情誼 情誼 :5  
發展 友誼  
他的國家 和 中國 發展 它的傳統友誼

{ He /PP3A } { develops /VBZ } { a /AT good /JJ habit /NM }  
AQ V TH  
引起 宏揚 沖洗 長 長成 建設 振興 培養 產生 發丹 發展 發展起來 發展  
發揚 開發 開闢 增進 養成 辦 顯像 顯影 :21  
習慣 習慣 性 癖 :4  
養成 習慣  
他 養成 一個好習慣

{ You /PP2 } { develop /VB } { this /DT film /NM } for /IN { us /PP1OS }  
AQ V TH FOR.OBS  
引起 宏揚 沖洗 長 長成 建設 振興 培養 產生 發丹 發展 發展起來 發展  
發揚 開發 開闢 增進 養成 辦 顯像 顯影 :21  
片子 底片 軟片 膠片 膠卷 :6  
沖洗 膠卷  
你 為我們 沖洗 這膠卷

{ A /AT large /JJ labouring /JJ class /NM } { develops /VBZ } {  
rapidly /RB } during /IN { past /JJ two /CD years /NNS }  
AQ V TH DURING.COM  
引起 宏揚 沖洗 長 長成 建設 振興 培養 產生 發丹 發展 發展起來 發展  
發揚 開發 開闢 增進 養成 辦 顯像 顯影 :21  
迅速 發展 發展起來 發展  
在過去 兩年 內 迅速 發展





他們開車到車站

{ He /PP3A } { drives /VBZ } { me /PP1O } to /IN( the /ATI station /NN )  
{ this-/DT morning /NN }  
AQ V TH TO,LOO T1  
行駛 起步 叮囑 盤踞 推動 推地 開車 開車送 轉動 趕 領 駕 駕車  
駕駛 驅動 :16  
我叫他 :3  
開車送 我  
他 今天早上 開車送 我 到車站

{ Drive /VB } { the /ATI nail /NN } through /IN( the /ATI wood /NN )  
V TH THRO,LOO  
揮 釘 釘子 :2  
行駛 起步 叮囑 盤踞 推動 推地 開車 開車送 轉動 趕 領 駕 駕車  
駕駛 驅動 :16  
釘子 釘  
把釘子 釘 入木頭

{ The /ATI workers /NNS } { drive /VB } { the /ATI tunnel /NN }  
through /IN( the /ATI mountain /NN )  
AQ V TH THRO,LOO  
行駛 起步 叮囑 盤踞 推動 推地 開車 開車送 轉動 趕 領 駕 駕車  
駕駛 驅動 :16  
地下道 地道 過洞 隧道 :4  
開 隧道  
工人 把 隧道 開 入山

{ He /PP3A } { enters /VBZ } { the /ATI hall /NN } with /IN( his /PPS  
sister /NN )  
AQ V LO R1TH,COAG  
人 上 吃 喝 吃 參加 進 進人 進來 :8  
大廳 門廳 堂 廳堂 廳堂 :6  
進人 大廳  
他 和他的 妹妹 進人 大廳

{ He /PP1AS } { fix /VB } { the /ATI pole /NN } in /IN( the /ATI  
ground /NN ) { properly /RB }  
AQ V TH IN,LO MA  
改正 固定 定下 修理 機 準備 搞 :7  
杆 杆子 波 個人 桿子 極 :6  
固定 杆子  
我們 適當 固定 杆子 在地上

{ Aunt /NN } { fixes /VBZ } { the /ATI breakfast /NN } for /IN( me  
/PP1O )  
AQ V TH FOR,OBG  
改正 固定 定下 修理 機 準備 搞 :7  
早餐 早膳 早餐 早點 晨間自助餐 :5  
準備 早餐  
伯母 為我 準備 早餐

{ I /PP1A } { fix /VB } { everything /PN } in /IN( advance /NN )  
AQ V TH T1  
改正 固定 定下 修理 機 準備 搞 :7  
每一件事 事事 物物 樣樣 :4  
準備 每一件事  
我 事先 準備 每一件事

{ I /PP1A } { fix /VB } { the /ATI radio /NN } for /IN( John /NP )  
AQ V TH FOR,OBG  
改正 固定 定下 修理 機 準備 搞 :7  
收音機 :1  
修理 收音機  
我 為約翰 修理 收音機

{ I /PP1A } { always /RB } { keep /VB } { my /PPS appointment /NN } on  
/IN( time /NN )  
AQ PR V TH MA  
放 保存 保持 保留 保留 維持 維持 留下 開 照顧 經營 長 遵守 顧 :15  
任命 決定 約定 約會 :4  
赴 約會  
我 總是 準時 赴 我的 約會

{ They /PP3AS } { keep /VB } { a /AT small /JJ shop /NN } in /IN( the  
/ATI city /NN )  
AQ V TH IN,PL  
放 保存 保持 保留 保留 維持 維持 留下 開 照顧 經營 長 遵守 顧 :15  
商店 商店 舖 舖子 購物 舖 舖子 :8

兩店  
兩店舖  
他們在都市 開 一個小店

{ His /PPS illness /NN } { keeps /VBZ } { him /PP3O } in /IN( the /ATI  
hospital /NN ) { 6 /CD weeks /NNS }  
AQ V TH IN,LO DU  
放 保存 保持 保留 保留 維持 維持 留下 開 照顧 經營 長 遵守 顧 :15  
他 :2  
得 他  
他的 毛病 把他 得 在醫院 6 星期

{ He /PP1AS } { keep /VB } { a /AT seat /NN } for /IN( him /PP3O )  
AQ V TH FOR,OBG  
放 保存 保持 保留 保留 維持 維持 留下 開 照顧 經營 長 遵守 顧 :15  
位子 坐位 容納 高位 座位 臥座 :6  
保留 座位  
我們 為他 保留 座位

{ I /PP1A } { always /RB } { keep /VB } { silent /JJ }  
AQ PR V CP  
放 保存 保持 保留 保留 維持 維持 留下 開 照顧 經營 長 遵守 顧 :15  
木納 沈默 沈默 寂靜 弱音無聲 靜默 :6  
保持 沈默  
我 總是 保持 沈默

{ He /PP3A } { lend /VB } { me /PP1O } { his /PPS bike /NN }  
AQ V BB TH  
予以 借 借給 貸出 增派 :6  
自行車 單車 腳踏車 :3  
借 腳踏車  
他 借 我的 腳踏車

{ Lend /VB } { me /PP1O } { your /PPS flashlight /NN }  
V BB TH  
予以 借 借給 貸出 增派 :6  
手電筒 電筒 :2  
借 手電筒  
借 我 你的 手電筒

{ They /PP3AS } { lend /VB } { us /PP1OS } { their /PPS cow /NNS } {  
generously /RB }  
AQ V BB TH MA  
予以 借 借給 貸出 增派 :6  
牛 :1  
借 牛  
他們 慨然 借 他們的 牛 給我們

{ They /PP3AS } { lend /VB } { all-out /JJ supports /NNS } to /IN( our  
/PPS school /NN )  
AQ V TH BB  
予以 借 借給 貸出 增派 :6  
支持 支援 支撐 助 換 快 扶持 受 助 擁護 援 護 :9  
予以 支持  
他們 予以 大力的 支持 給 我們的 學校

{ The /ATI prisoner /NN } { moves /VBZ } { his /PPS feet /NN } { slowly  
/RB }  
AQ V TH MA  
心動 打動 有所感觸 改變 步 步 響 走 招 致 遠 趨 看法 改變 挪動 動 動 彈  
移 移動 移 進 行 進 展 感 動 感 動 感 動 感 動 感 動 感 動 感 動 感 動 感 動 :27  
尺 呎 尺 英尺 英尺 呎 :6  
移動 腳  
囚徒 把他的 腳 移動 得 慢慢

line 177  
{ Move /VB } { your /PPS car /NN }  
V TH  
心動 打動 有所感觸 改變 步 步 響 走 招 致 遠 趨 看法 改變 挪動 動 動 彈  
移 移動 移 進 行 進 展 感 動 感 動 感 動 感 動 感 動 感 動 感 動 感 動 :27  
克拉 汽車 車 車子 益 益 益 益 益 :5  
移動 車子  
移動 你的 車子

line 178  
{ The /ATI tall /NN } { moves /VBZ } from /IN( London /NP ) to /IN( Paris /NP )  
TH V FROM,LSO TO,LOO  
文 換 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 寫 :10

心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
話 感 動  
談 判 轉 移  
話 從 倫 敦 感 動 到 巴 塞

line 179  
( The /AT1 government's /NNS opinions /NNS )( move /VB )  
TH V  
意見 意見 說 道 :4  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
意見 改變  
政府的意見 改變

line 180  
( They /PP3AS )( move /VB ) from /IN( the /AT1 present /JJ house /NN  
( yesterday /NR )  
AQ V FROM,LSO T1  
他們 她 們 我 們 搬 遷 :4  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
他們 移動  
他們 搬 走  
我們 搬  
他們 昨天 從 這 個 在 場 房 子 移 動

( The /AT1 work /NN )( moves /VBZ )( quickly /RB ) during /IN( these  
/DT3 two /CD weeks /NNS )  
TH V MA DUR1,DU  
工 工 作 工 程 事 業 事 從 事 處 理 部 論 著 :9  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
工作 進展  
部 署  
工作 在 這 些 兩 星 期 間 進 展 得 很 快

( The /AT1 train /NN )( moves /VBZ )( slowly /RB ) along /IN( the  
/AT1 river /NN side /NN )  
TH V MA ALON,FA  
火 車 乘 列 沿 鐵 軌 行 :4  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
火車 移動  
火車 延 著 河 水 邊 慢 慢 地 移 動

( The /AT1 assembly /NN line /NN )( moves /VBZ )( smoothly /RB )  
TH V MA  
台 詞 句 行 排 電 話 線 路 線 橫 列 運 送 :8  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
線 進 行  
配 件 線 進 行 得 順 利

( I /PP1A )( move /VB )( quickly /RB ) to /IN( the /AT1 table /NN )  
AQ V MA TO,LOO  
我 咱 家 其 實 這 個 人 :5  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
我 移 動  
我 很 快 地 移 動 到 桌 子 邊

( People /NNS )( move /VB ) through /IN( the /AT1 hall /NNS )  
TH V THRO,LOO  
人 人 人 人 們 :3  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
人 們 移 動  
人 們 移 動 過 大 廳

( The /AT1 earth /NN )( moves /VBZ ) round /IN( the /AT1 sun /NN )  
TH V BOUN,PA  
土 地 球 :2  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
地球 轉  
地球 繞 著 太 陽 轉

( Their /PP3 revolutionary /JJ drive /NN )( deeply /RB )( moves /VBZ  
( us /PP1OS )  
TH MA V BX  
行 駛 起 步 打 囉 囉 地 推 動 推 進 網 網 車 開 車 証 轉 動 理 網 訊 訊 實 實 車  
駕 駛 轉 動 :16  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
轉 動 感 動  
他 們 的 革 命 轉 動 深 深 地 感 動 我 們

( The /AT1 story /NN )( moves /VBZ )( them /PP3OS )( very /QL much  
/RB )  
TH V BX DO  
故 事 :1  
心動 打動 有所感觸 改變 步 步 走 招 徠 進 進 看 法 改 變 驚 動 動 動 彈  
移 移 動 移 移 進 行 進 展 感 動 驚 動 走 搬 移 搬 運 調 動 轉 動 轉 移 :27  
故 事 感 動  
故 事 使 他 們 非 常 很 多 感 動

( They /PP3AS )( open /VB )( the /AT1 dialogue /NN ) with /IN( us  
/PP1OS )  
AQ V TH WITH,COAO  
公 開 打 開 全 天 服 務 神 神 折 封 空 曠 展 開 預 開 與 明 開 開 始 開 放 開 啟  
開 窗 開 幕 開 學 開 關 開 關 益 其 中 結 開 寫 封 :21  
開 答 對 白 對 答 對 話 對 話 :5  
展 開 對 話  
展 開 對 話  
他 們 和 我 們 展 開 對 話

( They /PP3AS )( open /VB )( a /AT conversation /NN )( instantly /RB )  
AQ V TH MA  
公 開 打 開 全 天 服 務 神 神 折 封 空 曠 展 開 預 開 與 明 開 開 始 開 放 開 啟  
開 窗 開 幕 開 學 開 關 開 關 益 其 中 結 開 寫 封 :21  
會 話 對 話 :2  
展 開 對 話  
他 們 把 對 話 展 開 得 立 即

With /IN( their /PP3 help /NN )( we /PP1AS )( open /VB )( a /AT  
small /JJ bookshop /NN )  
WITH,IN AQ V TH  
公 開 打 開 全 天 服 務 神 神 折 封 空 曠 展 開 預 開 與 明 開 開 始 開 放 開 啟  
開 窗 開 幕 開 學 開 關 開 關 益 其 中 結 開 寫 封 :21  
書 店 :1  
開 書 店  
藉 著 他 們 的 幫 助 我 們 開 了 一 個 小 書 店

( Last /AP year /NN )( we /PP1AS )( open /VB )( training /VBO  
classes /NNS ) for /IN( the /AT1 school /NN teachers /NNS )  
T1 AQ V TH FOR,OB8  
開 開 打 開 全 天 服 務 神 神 折 封 空 曠 展 開 預 開 與 明 開 開 始 開 放 開 啟  
開 窗 開 幕 開 學 開 關 開 關 益 其 中 結 開 寫 封 :21  
屬 班 級 級 別 等 等 開 關 種 類 :8  
開 班  
去 年 我 們 為 學 校 老 師 開 辦 班 級

( They /PP3AS )( place /VB )( the /AT1 picture /NN )( too /QL high  
/RB ) on /IN( the /AT1 wall /NN )  
AQ V TH MA ON,LO  
下 地 地 方 安 安 放 安 置 位 置 所 在 放 放 置 座 位 處 :12  
情 況 插 插 繪 畫 圖 片 像 圖 片 圖 形 :8  
放 畫  
他 們 把 畫 在 牆 上 放 得 太 高

( I /PP1A )( place /VB )( the /AT1 book /NN ) under /IN( the /AT1  
desk /NN )  
AQ V TH UNDB,LO  
下 地 地 方 安 安 放 安 置 位 置 所 在 放 放 置 座 位 處 :12  
本 定 定 下 打 書 書 本 書 老 紀 人 帳 面 簿 :10  
放 書  
我 把 書 放 在 書 桌 底 下

( He /PP3A )( places /VBZ )( his /PP3 cap /NN ) on /IN( a /AT chair  
/NN )  
AQ V TH ON,LO  
下 地 地 方 安 安 放 安 置 位 置 所 在 放 放 置 座 位 處 :12  
汽 車 蓋 金 屬 帽 便 帽 高 帽 子 氣 通 便 帽 草 蓆 裝 噴 帽 裝 頭 蓋 :9  
放 帽 子  
他 放 他 的 帽 子 在 椅 子 上

( They /PP3AS )( provide /VB )( valuable /JJ data /NNS ) for /IN( soil /NN improvement /NN )  
AG V TH BB  
出供與 規定 提供 :4  
事實資料 資料 :2  
提供 資料  
他們 提供 有價值資料 給土壤改良

( The /AT1 state /NN )( grudgingly /RB )( provides /VBZ )( little /AP money /NN ) for /IN( water /NN conservation /NN projects /NNS )  
AG MA V TH BB  
出供與 規定 提供 :4  
金錢 肯 願 錢 錢財 :5  
提供 錢  
州 地地強強 地提供 少許錢 給水保護計劃

( I /PP1A )( always /RB )( regard /VB )( him /PP3O )( highly /RB )  
BX PR V TH MA  
n 他 :2  
有關 注視 看 重視 視為 當 認為 關心 :8  
他 看  
我 總是 把他 看得很高

( I /PP1A )( regard /VB )( him /PP3O ) as /IN ( my /PP1 brother /NN )  
BX V TH CP  
有關 注視 看 重視 視為 當 認為 關心 :8  
兄弟 弟弟 :2  
當 兄弟  
我 把他 當 成我的兄弟

For /IN ( a /AT moment /NN )( she /PP3A )( regards /VBZ )( me /PP1O ) with /IN ( wide /JJ eyes /NNS )  
FOR,DU BX V TH MA  
有關 注視 看 重視 視為 當 認為 關心 :8  
n 叫 照 我 :3  
注視 我  
有一會兒 她 眼睛睜得大大 地注視 我

( They /PP3AS )( regard /VB )( him /PP3O ) with /IN ( interest /NN )  
BX V TH MA  
有關 注視 看 重視 視為 當 認為 關心 :8  
n 他 :2  
注視 他  
看他  
他們 感興趣 地看他

( That /DT )( regards /VBZ )( me /PP1O )  
TH V COTH  
n 叫 照 我 :3  
有關 注視 看 重視 視為 當 認為 關心 :8  
我 有關  
那個 照 我有關

( Smoke /NN )( rises /VBZ ) from /IN ( the /AT1 factory /NN chimneys /NNS )  
TH V FROM,LSO  
吃煙 吸食 抽煙 炊煙 煙 煙燻 :6  
上升 上昇 上蒸 升 升起 找出 浮現 起 起立 起床 高漲 提高 聚會 發生  
增長 興起 矗立 :18  
煙 升起  
煙 從工廠煙囪 升起

( The /AT1 dog /NN )( rolls /VBZ ) on /IN ( the /AT1 floor /NN )  
TH V ON,PL  
狗 :1  
小圓麵包 區 打滾 她自己 毛滾 捲 捲捲 捲捲 捲捲 捲捲 滾滾 滾滾 滾滾  
滾滾 :16  
狗 打滾  
狗 在樓上 打滾

( The /AT1 train /NN )( calls /VBZ )( slowly /RB ) into /IN ( the /AT1 station /NN )  
TH V MA INTO,LOO  
火車 系列 到站 繼續 :4

小圓麵包 區 打滾 她自己 毛滾 捲 捲捲 捲捲 捲捲 捲捲 滾滾 滾滾 滾滾 滾滾  
滾滾 :16  
火車 開  
火車 慢慢 開 進車站

( He /PP3A )( rouses /VBZ up /RP ) from /IN ( sleep /NN )  
TH V FROM,LSO  
他 覺 :2  
引起 叫醒 弄醒 我 醒 覺醒 :6  
他 醒  
我 叫醒  
他 從睡夢 醒來

( The /AT1 cow /NN )( rouses /VBZ )( great /JJ indignation /NN )  
AG V TH  
引起 叫醒 弄醒 我 醒 覺醒 :6  
不平 憤慨 :2  
引起 憤慨  
消息 引起 大憤慨  
( The /AT1 bus /NN )( runs /VBZ ) from /IN ( Yansu /NP ) to /IN ( Xian /NP )  
TH V FROM,LSO TO,LOO  
公共汽車 公車 巴士 :3  
車 走私 延伸 治理 持續 流 執行 帶動 揀 跑 跑步 跑來 進行 開 趕盡  
運轉 管理 繼續 臥 躺 換 兒 換 變 變得 :23  
公共汽車 開  
公共汽車 從延安 開 到西安

( The /AT1 trolley-bus /NN )( runs /VBZ )( every /JJ three /CD minutes /NNS )  
TH V FR  
電車 :1  
車 走私 延伸 治理 持續 流 執行 帶動 揀 跑 跑步 跑來 進行 開 趕盡  
運轉 管理 繼續 臥 躺 換 兒 換 變 變得 :23  
電車 開  
電車 每三分鐘 開

( The /AT1 road /NN )( runs /VBZ ) for /IN ( many /AP miles /NNS )  
by /IN ( the /AT1 sea /NN )  
TH V FOR,LS BY,FA  
公路 馬路 路 路徑 道路 :6  
車 走私 延伸 治理 持續 流 執行 帶動 揀 跑 跑步 跑來 進行 開 趕盡  
運轉 管理 繼續 臥 躺 換 兒 換 變 變得 :23  
公路 延伸  
路 延伸  
路 沿著海 延伸 許多英里

( The /AT1 forest /NN )( runs /VBZ )( intermittently /RB ) for /IN ( 200 /CD kms /NNS )  
TH V MA FOR,LS  
森林 樹林 :2  
車 走私 延伸 治理 持續 流 執行 帶動 揀 跑 跑步 跑來 進行 開 趕盡  
運轉 管理 繼續 臥 躺 換 兒 換 變 變得 :23  
森林 延伸  
森林 交插著 延伸 200公里

( Their /PP3 food /NN supply /NN )( runs /VBZ )( low /RB )  
TH V CP  
車 走私 延伸 治理 持續 流 執行 帶動 揀 跑 跑步 跑來 進行 開 趕盡  
運轉 管理 繼續 臥 躺 換 兒 換 變 變得 :23  
不夠 低 低下 低微 低微 低微 變 變得 :6  
變得 不夠  
他們的糧食供應 變得 不夠了

( The /AT1 train /NN )( runs /VBZ ) on /RP ( Sunday /NR )  
TH V T1  
火車 系列 到站 繼續 :4  
車 走私 延伸 治理 持續 流 執行 帶動 揀 跑 跑步 跑來 進行 開 趕盡  
運轉 管理 繼續 臥 躺 換 兒 換 變 變得 :23  
火車 開  
火車 星期日 開

( The /AT1 tear /NNS )( run /VBZ ) down /RP ( his /PP3 face /NN )  
TH V DOWN,LO  
淚 眼淚 淚 淚 淚 :4  
車 走私 延伸 治理 持續 流 執行 帶動 揀 跑 跑步 跑來 進行 開 趕盡  
運轉 管理 繼續 臥 躺 換 兒 換 變 變得 :23  
眼淚 流  
眼淚 流下 他的臉