Symmetric Rules for Translation of English and Chinese

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SYMMETRIC RULES FOR TRANSLATION
OF ENGLISH AND CHINESE

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ABSTRACT
A system of grammars using symmetric phrase structure and translation rules in a Lisp version of Prolog is shown to provide symmetric bidirectional translation between English and Chinese for a fragment of the two languages. It is argued that symmetric grammars and translation rules significantly reduce the total grammar writing requirement for translation systems, and that research on symmetric translation systems deserves further study.

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INTRODUCTION

The intriguing notion that a single procedural logic grammar could be written so as to accomplish both parsing from English to logical form and generation of English from the logical form was investigated in Simmons and Chester [1982]. That paper showed a successful treatment in a rule-base of about eighty grammar rules. Later unpublished work by Usui [1982] showed a similar finding for both English and Japanese grammars, and in Simmons [1984] techniques were shown for using such symmetric grammars to control the automatic computation of English summaries from the logical representation. Usui’s thesis, an experiment in English-Japanese translation, raised the interesting question as to whether the paraphrase rules that were used to transform from the logical structure of one language to that of another could be written in a symmetric form so that one set of translation rules could be used to translate in both directions.

This paper studies that hypothesis by investigating the form and application of completely symmetric rules for translation between a few English and Chinese sentences. Although the sample of language is too small to warrant conclusions that immediately apply to large translation systems, the experiment was successful in showing that symmetric ruleforms can be designed, written, and used successfully to achieve symmetric translation at least for fragments of the two languages. The significance of the finding is discussed in the concluding section of the paper.

1. Theory of Symmetric Grammars

A predicate logic statement in Prolog begins with a predicate name followed by a set of variables and/or constants. For example (R _X _Y _Z) where R is a predicate name with its variables _X, _Y and _Z. A Prolog relation, (R _X _Y _Z) may be called with some or all of the variables uninstantiated. If it succeeds, usually the uninstantiated variables will be bound as a consequence. A rule has its premises placed in the right hand side of the rule form and its conclusion placed in the left hand side. An example function BETWEEN can be written as follows:

\[ \text{BETWEEN} _X _Y _Z \leftarrow \text{LEFTOF} _X _Y (\text{RIGHTOF} _Z _Y) \]

It states that, if X is to the left of Y and Z is to the right of Y, then Y is between X and Z. This procedure can be called with various bindings, e.g.

\[ \text{BETWEEN RED-BLOCK } X \text{ BLUEBLOCK} \]
which states that X stands between red block and blue block, to identify the middle one.

\[ \text{BETWEEN} _X \text{ GREEN-BLOCK BLUEBLOCK} \]
which states that green block stands between X and blue block, to find the left one.

\[ \text{BETWEEN RED-BLOCK GREEN-BLOCK } X \]
which states that green block stands

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between red block and X, to find the right-hand one.

It is equally possible to write a rule for parsing a noun phrase, NP such as,

\[ (NP \_STRING \_STRUCTURE \_REMAINDER) \leftarrow (\ldots) \]

where predicate NP has an input sentence string _STRING, noun phrase case structure _STRUCTURE and sentence remainder _REMAINDER, and call it with the string instantiated and the other variables unbound, or the structure instantiated and the other variables unbound. The result of successful parsing returns a binding for the unbound variables. From a linguistic point of view this is most reasonable in that for any string that it can accept, a grammar will return at least one structure, and that structure will generate, among others, that string. In other words, constituent string-i \( \leftrightarrow \) constituent structure-i; it is a bi-implication. The fact that there is a many-many mapping, that is structure-i will generate not only string-i, but also perhaps string-j, string-k, etc. and that string-i may also generate structure-h, structure-g, etc. does not prevent the symmetry. The reason is that the grammar has a particular ordering of rules and each rule has a particular ordering of constraints. Thus whether string-i or structure-i is the bound variable, the rules are consulted in the same order and each rule's constraints are applied in the same order to result in the bi-implication.

The same principle applies to paraphrase rules where if structure-i, is a paraphrase of structure-j, then structure-j is necessarily a paraphrase of structure-i. Providing that the antecedents of the paraphrase or translation rule are written to avoid the use of any functions that have no inverse [e.g. (IS _Y (RANDOM-NBR))] or relations that try to match unbound variables, the rules will be symmetric.

In other words there is a triangular relation among constituent, structure, and grammar; given any two elements the third can be deduced.\(^5\) In order to use this principle to obtain symmetric grammars the grammar writer must follow the discipline of writing only symmetric rules. Our experience in the several previously cited studies shows that this is not an arduous task.

2. The Translation System

This investigation of automated translation between Chinese and English uses procedural logic rules interpreted by a Lisp version of Prolog. The grammar rules are context-free phrase-structure rules, each augmented with a semantic testing and transformation component that translates each phrase-structure constituent into a Semantic Relation (SR) which is a form of deep-case analysis explained in full detail in Simmons[1984]. As each larger constituent is encountered, the analysis of its component constituents is embedded until finally when the sentence rule is completed, the full case analysis has been accomplished. The grammar rules are written directly in procedural logic and are directly interpretable by the Lisp-Prolog interpreter.

The problem of the study is to define English and Chinese grammars, and translation rules in such a form that the well-known symmetric properties of logical relations\(^8\) will enable symmetric translation between the two languages. Our requirement for symmetric translation implies that there will be one Chinese grammar that both parses and generates Chinese sentences, one English grammar with the same constraint, and one set of rules for translating from the semantic relational structure of one to the other, in either direction. The common paradigm for translation usually requires two grammars for each language, one each for generation and for parsing, and two sets of translation (paraphrase or substitution) rules, one for use in either direction of translation -- from Chinese to English or English to Chinese. If it is possible to scale upward the findings of this study to a larger and more representative

\(^5\)This principle has also been applied successfully to inducting a grammar from sentences and their parsings by Howard Smith [1984].

\(^8\)see Kowalski[1979]
sample of translations between the two languages, the consequence will be to halve the rule-writing requirements for achieving translation.

The study was conducted on a small number of sentences requiring only a small set of grammar and translating rules. The source language is parsed into semantic relational form SRe or SRC, then translation is accomplished between Chinese semantic relations SRC and English semantic relations SRe. Finally, the target language is generated from SRe or SRC. The entire procedure is described as follows:

English sentence $\iff$ SRe $\iff$ SRC $\iff$ Chinese sentence

Taking advantage of symmetric relations in Prolog, the translation can be done in both directions under the same grammar rules. Because Chinese is quite different from English, it is usually impossible to get a good quality translation in the surface language level by word-for-word translation. However, both languages can be analyzed into deep case structures which have largely overlapping case names. Such cases as Agent, Instrument, Affected-Entity, Source, Goal, etc. are common to both. But some constructions in each language do not occur in the other, so each language provides some unique cases. For examples, the NP cases (i.e. slots) Determiner and Number occur in English, but not in Chinese, while the particles "la" (completed) and "zhengzai" (ongoing) are examples of a Chinese marker we can call "Tense-Particle" that is unique to Chinese. Thus there is a need for a system of translation rules that paraphrase case structures from one language to those of the other. If symmetry is maintained in the translation rules, then symmetric translation using only one set of translation rules is possible.

Three sets of rules and appropriate lexical structures were designed:
Chinese grammar rules MY-SRC --- a set of Sc rules,
English grammar rules MY-SRe --- a set of Se rules, and
translating rules MY-TRANS --- a set of TRANS0 rules,
a vocabulary entity MY-WORDS and,
a set of semantic event forms MY-SEF.

The basic rule-forms are outlined below:
Sc --- parse Chinese sentence into Chinese semantic relation SRC and vice versa.
    ( Sc <Chinese sentence> <SRC> )

Se --- parse English sentence into English semantic relation SRe and vice versa.
    ( Se <English sentence> <SRe> )

TRANS0 --- translate SRe into SRC and vice versa.
    ( TRANS0 <SRe> <SRC> )

Both English and Chinese grammar rules share the same vocabulary entity, which is a set of tuples with 4 or 5 items:

( <constituent> <English> <word-feature> <Chinese> )
( <constituent> <English> <word-feature> <Chinese> <constraint> )

Since in Chinese nouns are not distinguished by singular and plural, and verbs are not marked for tense, the constituents NBR and TNS were omitted in this study. A set of semantic event forms constrains the translation to semantically well-formed constituents.
3. Differences between English sentences and Chinese sentences:

3.1. Word order:

Word order in Chinese sentences is quite different from that in English. Compare the two sentences:7

"Since 1980 the Chinese puppet troupes have made several visits to Europe and the United States."

*(Since-pre 1980 year since-post Chinese puppet troupes have to Europe and the United States made several visits.)

"Zhongguo muou jutuan yijing dao Ouzhou he Meiguo jinxingde duoci fangwen."

S1 = PP NP AUX VERB NP1 PP --- English grammar
S2 = PP NP1 AUX PP VERB NP1 --- Chinese grammar

In this example the Chinese PP is embedded between AUX and VERB, while in English it follows the verb and its object.

3.2. The constituents and order of PPs:

The Chinese PP has several different constituents:

PP := PREP NP PREP | PREP NP | NP PREP

In the example above preposition "since" is split into two parts: "zicong" and "yilai". 1980 nian (year) is put in between.

since 1980 ----> *(since-pre 1980 year since-post)

zicong 1990 nian yilai

The following example shows the order difference between English PPe and Chinese PPC:

"The visit of Chinese puppet troupe"

NPe PPe = PREP NPe

*(Chinese puppet troupe of visit)

"Zhongguo muou jutuan de fangwen"

PPc = NPC1 PREP NPC

The attributive modifier (Zhongguo muou jutuan de) is put in the front of NPC (fangwen) and the preposition (de)8 follows NPC1 (Zhongguo muou jutuan).

3.3. Determiners:

In Chinese sentences, the determiner "the" is not used. In translating any English sentence into a Chinese sentence, a rule simply deletes the determiner "the". But in translating Chinese into English the question arises:

In which instance should articles be placed in front of NPe? This question offers difficulties that have not yet been generally resolved in thirty years of linguistic research.

---

7 In order to make the Chinese sentences readable, each word for word Chinese identification is placed inside the parentheses marked by a * and followed by its translation equivalent.

8 Actually it is a post-position or adposition, but called PREP in our grammar.
3.4. English Idiomatic expression interpretation:
"They brought this Chinese ancient art form to the attention of more foreigners."

The English idiomatic expression "to bring something to somebody's attention" first must be interpreted as "let somebody notice something" or "let something to be noticed by somebody", then be translated into Chinese. The Chinese sentence will look like:

*(they let this Chinese ancient art form cause more foreigners of attention.)

"Tamen shide zhezhong Zhongguo gudaide yishu xingshi yingqihe hengduo waiwuren de zhuyi."

The translation rules accomplish this paraphrase.

3.5. Date representation:
In Chinese, "day", "month" or "year" must follow the date and indicate the year first, month next and day last.
in October 1984 --- *(in 1984 year 10 month) 
zai 1984 nian 10 yue

3.6. Multiple interpretation:
One English word corresponding to several Chinese words happens frequently. For example, in this program the preposition "to" has several interpretations in different cases, for example
to the attention --- *TO to Europe --- LOC

Four sentences are chosen to illustrate the problems mentioned above.

"Since 1980 Chinese puppet troupes have made several visits to Europe and the United States."

"They brought this Chinese ancient art form to the attention of more foreigners."

"The 1981 American debut of the Fujian puppet troupe was an unparalleled success."

"In October 1984 the visit of the Shanghai puppet troupe delighted San-Francisco audiences."

4. Mechanism of translation:
Based on the differences between the ordering conventions for the two languages, paraphrase rules between SRe and SRC map the ordering of one into the ordering of the other, substituting elements from the target lexicon for the source lexical elements. The grammars for English and Chinese are designed to provide for each a canonical ordering of the case analysis. For Chinese and English the case ordering is very similar and thus the ordering tasks of the translation rules are minimized. The writer of translation rules must be aware of the standard ordering that results from a parse so as to provide an appropriate input to the symmetric grammars for target language generation.

Grammar rules MY-SRe parse English sentences according to the order of constituents.

Sε ::= NPε VPe | PPε NPε VPe
NPε ::= ART NPε1 PPε | ART NPε1 | NPε1
NPε1 ::= ADJ NPε1 | NOUN | PRON
VPe ::= AUX VERB VCOMPe | VERB VCOMPe
PPε ::= PREP NOUN NOUN | PREP NPε *AND NPε
For Chinese sentences, grammar rules MY-SRc reflect the ordering of Chinese constituents. These rules result in a somewhat different ordering of cases in the resulting parse.

\[
\begin{align*}
\text{Sc} & := \text{NPC} \text{ VPc} | \text{PPc} \text{ NPC} \text{ VPc} \\
\text{NPC} & := \text{ART} \text{ NPC}1 | \text{PPc} \text{ NPC} | \text{NPC}1 \\
\text{NPC}1 & := \text{ADJ} \text{ NPC}1 | \text{NOUN} | \text{PRON} \\
\text{VPc} & := \text{VERB} \text{ VCOMPC} | \text{AUX} \text{ NPC} \text{ VERB NPC} \\
& \quad | \text{AUX} \text{ PPc} \text{ VPc} | \text{PPc} \text{ VPc} \\
\text{PPc} & := \text{PREP} \text{ NOUN} | \text{PREP} \text{ NOUN NOUN} \\
& \quad | \text{PREP} \text{ NPC} \text{ NPC} | \text{NPC} \text{ PREP} \\
\text{VCOMPC} & := \text{PPc} \text{ NPC} | \text{NPC} | \text{NIL}
\end{align*}
\]

Context-sensitive translation rules are used to map between the word orderings in the two languages. Compare two grammar rules below:

\[
\begin{align*}
\text{NP}e & := \text{ART} \text{ NP}e1 \text{ PP}e \\
\text{NP}c & := \text{PPc} \text{ NPC}
\end{align*}
\]

These rules contrast the English noun phrase NP\(e\),

"the visit of Chinese puppet troupe"

with the Chinese noun phrase NPC,

"Zhongguo muou jutuan de fangwen"

\[
\begin{align*}
\text{VP}e & := \text{AUX} \text{ VERB} \text{ VCOMPe} \Rightarrow \text{AUX} \text{ VERB NP}e \text{ PP}e \\
\text{VPc} & := \text{AUX} \text{ PPc} \text{ VPc} \Rightarrow \text{AUX} \text{ PPc} \text{ VERB NPC}
\end{align*}
\]

These two rules contrast the English verb phrase VPe,

"have made several visits to Europe and the United States"

with the Chinese verb phrase VPc,

"(have to Europe and the United States made several visits)" "yijing dao Ou zhou he Meiguo jinxingle douci fangwen"

Translation rules could be written to map syntactic constituents of one language into those of the other, but a finer control of translation quality is obtained by mapping between the case relations, SRe and SRC. The following examples show the form of the translation rules.

Rule

\[
\text{((TRANS (W (X DET the . S) .R) (W (X1 .S1) .R1)) < (NOUN X NF X1 the) \quad (TRANS S S1) \quad (TRANS R R1))}
\]

will delete the semantic relation pair (DET the) when translating English into Chinese and will add it to the right place when translating Chinese into English. In the same way, rule

\[
\text{((TRANS (TIME (X .S) .R) (TIME (X1 MSR X2 .S1) .R1)) < (NOUN X TIME X1 X2) \quad (TRANS S S1) \quad (TRANS R R1))}
\]

handles the date representation when the noun has feature "TIME" and constraint "nian".

Rule
((TRANS (PREP X .R) (PREP X1 PREP X2 .R1)) <
 (PREP X PF X1 X2)
 (TRANS R R1))

will substitute X1, X2 for X when translating the English preposition "since" into the Chinese preposition "zicong" "yiilai" and vice versa.

Multiple interpretation is controlled in the parsing grammars by a set of semantic event forms MY-SEF. (ACT LOC LOC) will constrain "to" to be interpreted as a LOCative thus causing the Trans rule to translate to "dao" because the preposition feature "LOC" matched. In contrast (ACT ACTION "TO") will constrain "to" to be interpreted as "to" (in the example of "to the attention") and it will later be deleted by the translation rule. Some vocabulary tuples include <constraint> which indicates that some extra word needs to be added when this word is matched.

The rule-set MY-SRe, MY-SRc, MY-TRANS, MY-WORDS and MY-SEF complete translation mechanism.

5. Translation Results:

This program has been tested on a limited set of sentences. The problems mentioned above have been solved fairly well by the rule forms described. Translating the four Chinese sentences to English and the four English to Chinese gives the results shown in Table 1.

<table>
<thead>
<tr>
<th>sentence</th>
<th>E1 E2 E3 E4 C1 C2 C3 C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of</td>
<td>..........................................................</td>
</tr>
<tr>
<td>interpretations</td>
<td>2 2 2 2 4 2 4 4</td>
</tr>
</tbody>
</table>

Table 1. Sentence Interpretations

The grammar gave multiple interpretations for each sentence, ranging originally from 2 - 8 analyses each. The grammar was then rewritten to result in fewer interpretations as shown above, but in general multiple interpretations are a fact of life in linguistic analysis. Translations for all of these analyses were examined and of the total 22 analyses all were judged good. Then, the grammar rules were augmented to translate a piece of text abstracted from 'China reconstruction' magazine (see appendix B. Text 2). Although the syntactic and semantic phenomena became more complicated, the system continued to accomplish good quality translation but at increased cost in translating speed. As the size of the grammar and sample increase, some poor interpretations are to be expected if there are inconsistencies existing in the grammars and dictionaries.

6. Discussion:

6.1. Balance between efficiency and generality:

The more abstract the grammar rules the briefer the grammar. But the more abstract grammar rules apply more frequently to give many more interpretations. Associating the general syntactic rules with semantic event forms which define well-formed semantic combinations for each type of syntactic constituent reduces the number of possible interpretations by rejecting those syntactic interpretations which are not covered by semantic forms. For some special situations writing long grammar rules that require sharp semantic constraints increases the translation accuracy. For example, writing rule PP = PREP NOUN NOUN specially for date representation as "in October 1984" and constraining the interpretation with a semantic event form to the classes (IN/AT TIME TIME) will be more efficient than the rule:
PP = PREP NP NP | PREP NP NCOMP.

This study keeps the balance between generality and efficiency by means of writing general translation rules associated with SEFs and purposely writing special rules for some special phrases. In the limit, it will also be necessary to include idiomatic expressions in the lexicon for verbatim translation, although such a technique was not studied here.

6.2. Rule order affects the efficiency and correctness of translation:

For English grammar:

\[
\begin{align*}
S_e & ::= NPe \ VPe | PPe \ NPe \ VPe \\
PPP & ::= PREP \ NOUN \ NOUN | PREP \ NPe \ \text{AND} \ NPe \\
& | PREP \ NPe
\end{align*}
\]

since all PPs start with preposition, a sentence beginning with PP will fail at the first word parsing for the rule \(S_e = NPe \ VPe\). A sentence beginning with NPe also will fail at the first word parsing for the rule \(S_e ::= PPe \ NPe \ VPe\). In this instance, the rule order makes no big difference. On the contrary, the rule order in Chinese grammar affects the efficiency.

\[
\begin{align*}
S_c & ::= PPC \ NPC \ VPC | NPC \ VPC \\
PPC & ::= PREP \ NOUN \ NOUN | PREP \ NOUN \\
& | PREP \ NPC \ NPC | NPC \ PREP
\end{align*}
\]

In the example of \(PPC = NPC \ PREP\), it is difficult to tell which grammar rule will match the sentence until reaching the preposition. If PPC turns out to be a failure, the NPC will be recomputed once again which is very inefficient. A good idea is to assert the NPC when parsing NPC succeeds. This desire introduces the principle of the well-formed substring table that eliminates the need for recomputing phrases when back-up is necessary.

The rule order also affects the correctness of the translation. For example,

\[
\begin{align*}
VCOMPc & ::= NPC \ PPC | NPC
\end{align*}
\]

writing \(VCOMPc = NPC \ first\) will cause incorrect translation. When parsing NPC succeeds, sometimes the PPC part following NPC will be missing. Writing rules recursively

\[
\begin{align*}
VCOMPc & ::= NPC \ VCOMPc | PPC \ VCOMPc | NIL
\end{align*}
\]

can solve this problem. But, again, it will affect the translating speed.

The strategy we used for ordering rules is:

- If special rules are a subset of general rules, write the special rules first.
- If special rules are not a subset of general rules write the frequently used rules first.

6.3. The role of Semantic Event Forms --- SEF:

Semantic event forms are n-tuples composed of class terms of which the words in a constituent are instances. For example in English the constituent "angry pitcher" is an instance of \(\text{EMOTION PERSON EMOTION}\) where EMOTION is a case or slot that relates the two terms into the SR, \(\text{PITCHER-1 EMOTION ANGRY}\). At once, the SEFs provide a semantic test of well-formedness and a case relation name to relate the elements of a constituent. Notice that "empty pitcher" is an instance of \(\text{STATE PHYSOBJ STATE}\) leading to the SR, \(\text{PITCHER-2 STATE EMPTY}\), where PITCHER-1 has the type PERSON and PITCHER-2 has type PHYSOBJ. The SEFs are a convenient method for selecting sense meanings and appropriate case relations for nominal phrases and as a result
provide semantic constraints which to some extent improve the interpretations.

During the implementation of Chinese-English translation the SEFs accomplished the following roles:

- Controlling word order — During the procedure of parsing surface language into semantic relations, SEFs select case relation names that provide signals to the translation rules to rearrange the word order to result in better quality translation.

- Avoiding ambiguity:
  
  \[
  \begin{align*}
  Sc & = Ppc Npc VPC \\
  Ppc & \text{ modifies } VPC, \text{ as selected by SEF.} \\
  Sc & = Npc VPC \Rightarrow Ppc Npc VPC \\
  Ppc & \text{ modifies } NPC, \text{ as selected by its SEF.}
  \end{align*}
  \]

  Given two sentences:

  *(In 1980 Chinese puppet troupe visited the U.S.)
  *"Zai 1980 nian Zhongguo puju enyeahun fangwenle Meiyou"

  *(Chinese puppet troupe of visit delighted San Francisco audiences)
  *"Zhongguo puju enyeahun de fangwen doulele San-Francisco guangzhong"

  Based on SEF (ACT TIME TIME) the first sentence matches the first grammar rule, and the second sentence matches the second rule, relying on SEF (EVT HUMAN "OF"). As a result the ambiguity is avoided.

- Controlling multiple interpretations: Preposition "to" has four different interpretations in these two short texts:

  - Indicate location:
    
    "to Europe and the U.S."
    "to China"
    "to a number of countries"
    "to Tibet"

  - Indicate event:
    
    "to the attention of more foreigners"

  - Indicate object:
    
    "to Westerners"
    "to ordinary Chinese viewers"

  - Indicate range:
    
    "from intrigued puzzlement to angry rejection"

  In each example the preposition to corresponds to different Chinese prepositions or is omitted. By assigning different features to each preposition sense to, e.g. LOC, TO, OBJ, "TO, associated with Semantic Event Form : (ACT LOC LOC), (ACT ACTION TO), (ST OBJ OBJ) and (ACT "TO "TO) respectively, the system is able to select appropriate sense meanings and to use an appropriate Chinese form resulting in a good translation.

A more complete discussion of the use of SEFs is provided in Simmons[1984]. The reader should be warned, however, that the SEF system needs to be augmented by the use of a grammar with rules that contain syntactic features and tests of these for use in any large application; otherwise the size of the SEF set will grow too rapidly for practical control of the system. In large grammars the SEFs find a primary use in resolving noun-noun and conjunctive phrases, where often, only semantic patterns can reduce the inherent ambiguity.
7. Conclusions

We conclude that it is definitely possible to write grammars to translate between two subsets of natural languages using symmetric rule forms.

Even from the study of this tiny corpus of language, it is also possible to conclude, tentatively, that the human factors task of maintaining symmetry in the three grammars places no excessive burden on the grammar writer.

We propose that a translation grammar can be characterized by the following diagram:
Lang1 <<Grammar1>> SR1 <<Transrules>> SR2 <<Grammar2>> Lang2

Essentially for any two languages L1 and L2, the syntactic grammars for translating between strings and logical structures can be symmetric, and a single set of symmetric translation rules can be used to map the SR interpretations from one to the other. This finding is supported by previous work already cited as well as by earlier unpublished experiments using parsers and generators written in Lisp. We know of no other work so far that has investigated symmetry of translation, but we recently re-examined Usui's English/Japanese system and determined that it too can use symmetric translation rules of the type presented here.

These appear to be fairly strong conclusions for a study of translation in a limited sentence corpus. But the conclusions concern ruleforms and computational procedures rather than effective and useful translation systems. We must be concerned, not only as to whether the technique will scale up to large applied translation grammars, but also whether the constraints on writing rules so as to maintain symmetry will prove practicable on a large scale from a human factors viewpoint. Much more experience with these rule forms is needed before such pragmatic issues can be firmly settled.

In the present state of the translation art, (see Slocum [1985]) the several existing European and American systems and the dozen or so Japanese ones do not typically use Prolog grammars, rarely use semantic constraints, have evolved over several years based on one or another syntactic theory, and are much more concerned with developing large vocabularies and grammars than with improving the translation model. Indeed, the concerns with coverage and accuracy of grammars and lexicon, and the search for effective linguistic acquisition tools currently outweigh theoretical questions of how many grammars need be used to accomplish translations.

But despite current heavy emphasis on developmental engineering, it must be remembered that the science of automated translation still requires much research. Our conclusion that symmetric translation is a potentially viable option is a research finding that deserves further attention.

Appendix A

Examples of the translating procedure:9

*****************************************************************************
THE DETAILED PROCEDURE OF TRANSLATING ENGLISH TO CHINESE.
*****************************************************************************

1. Translate English into SR2.

((SE (since 1980 Chinese puppet troupes have made several visits to Europe and
the US)

---
9The technical report with detailed program and demonstration is available in the AI lab of Dept of Computer Science in UT under the same title, AI-TR86-36.
2. Translate SRE to SRC.

((TRANS0 (made AGT (troupes NAME Chinese TYPE puppet))
  TIME (1980 PREP since)
  AUX have
  AE (visits MODEL several)
  LOC (Europe PREP to *AND (US DET the))))

3. Generate Chinese from SRC.

((SC (zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Maiguo
  jinxingle duoci fangwen)
  (jinxingle AGT (jutuan NAME Zhongguo TYPE muou)
   TIME (1980 MSR nian PREP zicong PREP yilai)
   AUX yijin
   AE (fangwen MODEL duoci)
   LOC (Ouzhou PREP dao *HE (Maiguo))))

THE DETAILED PROCEDURE OF TRANSLATING CHINESE TO ENGLISH.

1. Translate Chinese into SRC.

((SC (Fujian muou jutuan de 1981 nian maiguode souciyianchu shi yige kongqian
dechengong)
  (shi AE (souciyianchu *OF (jutuan PREP de NAME Fujian TYPE muou)
    TIME (1981 MSR nian)
    LOC maiguode)
  AE (chengong DET yige MODEL kongqianand))))

2. Translate SRC into SRE.

((TRANS0 (was AE (debut DET the
  *OF (troupe DET the PREP of NAME Fujian TYPE puppet)
  TIME 1981
  LOC American)
  AE (success DET an MODEL unparalleled))
  (shi AE (souciyianchu *OF (jutuan PREP de NAME Fujian TYPE muou)
    TIME (1981 MSR nian)
    LOC maiguode)
  AE (chengong DET yige MODEL kongqianand))))

3. Generate English from SRE.

((SE (the 1981 American debut of the Fujian puppet troupe was an unparalleled
  success)
  (was AE (debut DET the
    *OF (troupe PREP of DET the NAME Fujian TYPE puppet)
    TIME 1981
    LOC American)
AE (success DET an MODEL unparalleled)
Appendix B

DEMONSTRATION OF TRANSLATING ENGLISH TO CHINESE

TEXT 1.

*(TRY E1)*

((TRANSEC (since 1980 Chinese puppet troupes have made several visits to Europe and the US)
(zicong 1980 nian yilai Zhongguode muou jutuan yijin dao Ouzhou he Meiguo jinxingle duoci fangwen)))

*RTIME
(15.827 SECS)

*(TRY E2)*

((TRANSEC (they brought this ancient art form to the attention of more foreigners)
(taman shide zhezhong gudaide yishu xingshi yingqi le hanguo waiyuan de zhiyi)))

*RTIME
(3.375 SECS)

*(TRY E3)*

((TRANSEC (the 1981 American debut of the Fujian puppet troupe was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguo souciyianchu shi yige kongqiande chengong)))

*RTIME
(1.186 SECS)

*(TRY E4)*

((TRANSEC (in October 1984 the visit of the Shanghai puppet troupe delighted SanFrancisco audiences)
(zai 1984 nian 10 yue Shanghai muou jutuan de yianchu doulele SanFrancisco guanzhong)))

*RTIME
(2.957 SECS)

TEXT 2.

*(TRY E5)*

((TRANSEC (over the past five years Rauschenberg has traveled to a number of countries to take photographs and videotapes)
(zai guoguo wu nian Rauschenberg yijing luyouguo xudu guojia bin paihele zhaopian he dianshipian)))

*RTIME
(2.754 SECS)

*(TRY E6)*

((TRANSEC (these become the raw materials of his art)
(zhexie changwui tada yishu de yuanshi cailliao)))

*RTIME
(1.732 SECS)

*(TRY E7)*

((TRANSEC (a few years ago he got around to China)
(jinji nian qian ta dao Zhongguo quguo))

*(TIME 5.108 SECS)*

*(TRY E8)*

((TRANSEC (last fall and winter Rauschenberg returned to China with a huge art
roadshow)

(qunian qiutian he dongtian Rauschenberg daizhe yige daxingde yishu
xunhui-zhanlan hui dao Zhongguo))

*RTIME

(5.567 SECS)*

*(TRY E9)*

((TRANSEC (this big exhibition took up a number of rooms in Beijing’s China Art
Gallery than traveled on to Tibet)

(zhezhong daxin zhanlanhui zhanjule zai Beijingde Zhongguo Yishu Guan
lide xudo fanjian ranhou dao Xizhan jixuluyou))

*RTIME

(3.968 SECS)*

*(TRY E10)*

((TRANSEC (since fifties Rauschenberg’s particular modern brand has become
familiar to Westerners)

(zicong wushi niandai yilai Rauschenbergde techu de xian dai huade
biaozhi duiyu xifaxian yiping chengwui henshuxile))

*RTIME

(7.358 SECS)*

*(TRY E11)*

((TRANSEC (to ordinary Chinese viewers all of these was quite new)

(duiyu yibande Zhongguode pinglunzhe suoyou de zhexie shi shifen
xinxiande))

*RTIME

(14.092 SECS)*

*(TRY E12)*

((TRANSEC (the reactions ranged from intrigued puzzlement to angry rejection)

(fanying cong youxinge mihuo dao fanggnude fandui gebuxiantong)))

*RTIME

(6.47 SECS)
References


file <TRANS.HCP> includes a set of axioms:
translation rules <MY-TRANSLATION>
English grammar rules <MY-SRE>
Chinese grammar rules <MY-SRC>
vocabulary entry <MY-WOEDS>
semantic event forms <MY-SEF>
and a set of testing sentences.

(VARIABLES E C C X X0 X1 X2 Y Y0 Y1 Y2 Z Z1 Z2 R R1 S S1 W W1 W2 V V1 U U1 NF NF1 NF2 AF VF PF AFU)

; ---------------------------------------------------------------------

MY-TRANSLATION is the top level of translation.

TRANSEC translates English into Chinese.
   (TRANSEC <English sentence> <Chinese sentence> )

TRANSCE translates Chinese into English.
   (TRANSCE <Chinese sentence> <English sentence> )

; ---------------------------------------------------------------------

(SETQ MY-TRANSLATION '(
   ((TRANSEC E C) < (SE E Y) (TRANS0 Y Z) (SC C Z))
   ((TRANSEC E C) < (SC C Z) (TRANS0 Y Z) (SE E Y)) ))

(AXIOMS MY-TRANSLATION)

; ---------------------------------------------------------------------

MY-TRANS translates English semantic Relation (SRE) into Chinese
  Semantic Relation (SRC) and verse via.
   (TRANS0 <SRE> <SRC> )

; ---------------------------------------------------------------------

(SETQ MY-TRANS '(
   ((TRANS0 (X .R) (X1 .R1)) < (VERB X VF X1) (TRANS R R1))
   ((TRANS0 (X .R) (X1 .R1)) < (VERB X VF X1 X2) (TRANS R R1))
   ((TRANS (*AND (X DET the .S) .R) (*HE (X1 .S1) .R1)) < (NOUN X NF X1 the)
     (TRANS S S1 )
     (TRANS R R1))
   ((TRANS (W (X DET the .S) .R) (W (X1 .S1) .R1))
     < (NOUN X NF X1 the)
     (TRANS S S1 )
     (TRANS R R1))
   ((TRANS (*TO (X PREP to DET the .S) .R) (*TO (X1 .S1) .R1))
     < (NOUN X NF X1 X2)
     (TRANS S S1 )
     (TRANS R R1))
)
((TRANS (W X Y Z DET the .S) .R) (W (X1 Y Z1 .S1) .R1))
   < (NOUN X NF X1 the )
       (PREP Z PF Z1)
       (TRANS S S1)
       (TRANS R R1))

((TRANS (W X .S) .R) (W (X1 .S1) .R1)) < (NOUN X NF X1)
   (TRANS S S1)
   (TRANS R R1))

((TRANS (AGT X .R) (AGT X1 .R1)) < (NOUN X NF X1)
   (TRANS R R1))

((TRANS (AGT X) .R) (AGT (X1) .R1)) < (PRON X NF X1)
   (TRANS R R1))

((TRANS W X .R) (W X1 .R1)) < (ADJ X W X1) (TRANS R R1))

((TRANS (TIME X .S) .R) (TIME (X1 MSR X2 .S1) .R1)) < (NOUN X TIME X1 X2)
   (TRANS S S1)
   (TRANS R R1))

((TRANS (TIME X .R) (TIME (X1 MSR X2) .R1)) < (ADJ X TIME X1 X2) (TRANS R R1))

((TRANS (TIME X .R) (TIME (X1 MSR X2) .R1)) < (NOUN X TIME X1 X2) (TRANS R R1))

((TRANS (AUX X .R) (AUX X1 .R1)) < (AUX X AUF X1) (TRANS R R1))

((TRANS (DET X .R) (DET X1 .R1)) < (ART X X1) (TRANS R R1))

((TRANS (PREP X .R) (PREP X1 .R1)) < (PREP X PF X1) (TRANS R R1))

((TRANS (PREP X .R) (PREP X1 PREP X2 .R1)) < (PREP X PF X1 X2) (TRANS R R1))

((TRANS NIL NIL)))

(AXIOMS MY-TRANS)

{
 --------------------------
 MY-SRE translates English into SRE and verse via.
 (SE <English sentence> <SRE> )
 --------------------------

(SETQ MY-SRE '(

((SE X (W U X0 .W1)) < (NPE X NF Y X0)
   (VPE Y VF NIL (W .W1))
   (NF VF U))

((SE X (W U Y0 S X0 .W1)) < (PPE X PF Y X0)
   (NPE Y NF Z Y0)
   (VPE Z VF NIL (W .W1))
   (VF PF S)
   (NE VF U))

((NPE (X .Y) NF R (V DET X U (W .W1) .V1)) < (ART X X1)
   (NPE1 Y NF Z (V .V1))
   (PPE Z PF R (W .W1))
   (NF PF U))

((NPE (X .Y) NF R (V DET X .V1)) < (ART X X1) (NPE1 Y NF R (V .V1))

((NPE X NF R X0) < (NPE1 X NF R X0))

((NPE1 (X .Y) NF R (V S X .V1)) < (ADJ X AF X1)
   (NPE1 Y NF R (V .V1))
   (NF AF S))

((NPE1 (X .X) NF R (V S X .V1)) < (ADJ X AF X1 X2)
   (NPE1 Y NF R (V .V1))
   (NF AF S))

((NPE1 (X .Y) NF Y (X)) < (NOUN X NF X1))

((NPE1 (X .Y) NF Y (X)) < (NOUN X NF X1 X2))

((NPE1 (X .Y) NF Y (X)) < (PRON X NF X1))

((VPE (X Y Z) VF R (Y S X .W)) < (AUX X AUF X0)
   (VERB Y VF Y0)
   (AUF VF S)
(((VPE (X .Z) VF R (X .W)) < (VERB X VF X0) 
(VCOMPE Z VF R W))
((VPE (X .Z) VF R (X AUX X2 .W)) < (VERB X VF X0 X2) 
(VCOMPE Z VF R W))
((VCOMPE NIL VF NIL NIL NIL))
((VCOMPE X VF NIL (U X0 S Y0)) < (NPE X NF Y X0) 
(VF NF U) 
(PPE Y PF NIL Y0) 
(VF PF S))
((VCOMPE X VF NIL (U X0)) < (NPE X NF NIL X0) 
(VF NF U))

((PPE (X Y Z .R) PF R (Y TIME Z1 PREP X)) 
< (PREP X PF X1) 
(NOUN Y TIME Y1 Y2 ) 
(NOUN Z TIME Z1 Z2 )))
((PPE (X .X) PF R (V PREP X *AND Z1 .V1)) < (PREP X PF X1) 
(NPE Y NF (and .Z) (V .V1)) 
(NPE Z NF R Z1))
((PPE (X .X) PF R (V PREP X .V1)) < (PREP X PF X1 X2) 
(NPE Y NF R (V .V1)))
((PPE (X .X) NF R (V PREP X .V1)) < (PREP X PF X1) 
(NPE Y NF R (V .V1))))

(AXIOMS MY-SRE)

{; .................................................................
 MY-SRC translates Chinese into SRC and verse via.
 (SC <Chinese sentence> <SRC> )
 .................................................................

(SETQ MY-SRC '(
((SC (X W U Y1 S X1 .W1)) < (PPC X PF Y X1) 
 (NPC Y NF Z Y1) 
 (VPC Z VF NIL (W .W1)) 
 (VF PF S) 
 (NF PF U))
((SC (X W U X1 .W1)) < (NPC X NF Y X1) (VPC Y VF NIL (W .W1)) (NF VF U))
((NPC (X1 .Y) NF R (V DET X1 .V1)) < (ART X X1) (NPC1 Y NF R (V .V1)))
((NPC X NF R (V U X1 .V1)) < (PPC X PF Y X1) 
 (NPC Y NF R (V .V1)) 
 (NF PF U))
((NPC X NF R X1) < (NPC1 X NF R X1))
((NPC1 (X1 .Y) NF R (V S X1 .V1)) < (ADJ X AF X1) 
 (NPC1 Y NF R (V .V1)) 
 (NF AF S))
((NPC1 (X1 X2 .Y) NF R (V S (X1 MSR X2) .V1)) < (ADJ X TIME X1 X2) 
 (NPC1 Y NF R (V .V1)) 
 (NF TIME S))
((NPC1 (X1 .Y) NF Y (X1)) < (NOUN X NF X1))
((NPC1 (X1 .Y) NF Y (X1 MSR X2)) < (NOUN X TIME X1 X2))
((NPC1 (X1 .Y) NF Y (X1)) < (NOUN X NF X1 X2))
((NPC1 (X1 .Y) NF Y (X1)) < (PRON X NF X1))
((VPC (X1 .Y) VF NIL (X1 S Y1)) < (VERB X VF X1))
((NPC Y NE NIL Y1) (VF NE S))
((VPC (X1 Y) VF NIL (W AUX X1 U Y1 S Z1)) < (AUX X AUX X1)
  (NPC Y NF1 (W.Z) Y1)
  (VERB W1 VF W W2)
  (NPC Z NF2 NIL Z1)
  (VF NF1 U)
  (VF NF2 S))
((VPC (X1 Y) VF NIL (W AUX X1 .W1)) < (AUX X AUX X1)
  (VPC Y VF NIL (W .W1)))
((VPC X VF NIL (W W1 W2 U X1)) < (PPC X PF Y X1)
  (VPC Y VF NIL (W W1 W2))
  (VF PF U))
((PPC (X1 Z1 Z2 X2 .R) TIME R (Z1 MSR Z2 PREP X1 PREP X2))
  < (PREP X TIME X1 X2)
  (NOUN Z TIME Z1 Z2))
((PPC (X1 Z1 Z2 Y1 Y2 .R) TIME R (Y1 MSR Y2 TIME (Z1 MSR Z2) PREP X1))
  < (PREP X PF X1)
  (NOUN Y TIME Y1 Y2)
  (NOUN Z TIME Z1 Z2))
((PPC (X1 Y) PF R (V PREP X1 *HE Z1 .V1))
  < (PREP X PF X1)
  (NPC Y NF (he .Z) (V .V1))
  (NPC Z NF R Z1))
((PPC X PF R (V PREP Y1 .V1)) < (NPC1 X NF (Y1 .R) (V .V1))
  (PREP Y PF Y1))))

(AXIOMS MY-SRC)

{:

vocabulary entry.

( <constituent> <English> <feature> <Chinese> <constraint> )

-----------------------------------------------------------------

(SETQ MY-WORDS '(
  ((NOUN troupe HUMAN jutuan ))
  ((NOUN visits EVT fangwen ))
  ((NOUN Europe LOC Ouzhou ))
  ((NOUN US LOC Meiguo the ))
  ((NOUN 1980 TIME 1980 nian ))
  ((VERB made ACT jinxingle))
  ((AUX have AUX yijin ))
  ((ADJ Chinese NAME Zhongguo))
  ((ADJ puppet TYPE muou ))
  ((ADJ several MODEL duoci ))
  ((ART the the ))
  ((CONJ *AND *HE ))
  ((PREP to *TO to ))
  ((PREP to LOC dao ))
  ((PREP since TIME zicong yilai ))
  ((NOUN form EVT xingshi ))
  ((NOUN attention ACTION zhuyil the ))
  ((NOUN foreigners HUMAN waiguoren ))
  ((PRON they HUMAN tamen ))
  ((VERB brought ACT yingqile let ))
  ((AUX let AUX shide ))
  ((ADJ ancient TYPE gudaide ))

-----------------------------------------------------------------
(ADJ art TYPE yishu ))
(ADJ more MODEL hendoza ))
(ART this MODEL zhezhong ))
(PREP of *OF de ))

(NOUN debut ACTION souciyianchu the ))
(NOUN troupe HUMAN jutuan the ))
(NOUN success EVT chengong ))
(NOUN visit ACTION yianchu the ))
(NOUN 1984 TIME 1984 nian))
(NOUN audiences HUMAN guanzhong ))
(NOUN October TIME 10 yue ))
(ADJ SanFrancisco LOC SanFrancisco ))
(VERB was ST shi ))
(VERB delighted ACT doulele ))

(ADJ 1981 TIME 1981 nian ))
(ADJ American LOC meiguode ))
(ADJ Fujian NAME Fujian ))
(ADJ unparalleled MODEL kongqiande ))
(ADJ Shanghai NAME Shanghai ))
(ADJ Rod NAME Rod ))
(ART an TIME yige ))
(PREP in TIME zai )) )))

(AXIOMS MY-WORDS)

; -------------------------------

MY-SEF is a set of semantic event forms.
(<NF> <VF> U ) semantic relation between subject NP and VP
(<NF> <PF> U ) semantic relation between NP and PP
(<NF> <AF> U ) semantic relation between NP and ADJ
(<VF> <NF> U ) semantic relation between VP and object NP
(<VF> <PF> U ) semantic relation between VP and PP
(<AUF> <VF> U ) semantic relation between AUX and VP

-------------------------------

(SETQ MY-SEF '(
(HUMAN ACT ACT ))
(ACTION ACT AE ))
(ACT HUMAN AE ))
(ACT EVT AE ))
(ACT TIME TIME ))
(ACT ACTION *TO ))

(ACT LOC LOC ))
(ACT AUX AUX ))
(AUX ACT AUX ))
(AUX EVT AE ))
(HUMAN NAME NAME ))
(HUMAN TYPE TYPE ))
(HUMAN LOG LOC ))
(HUMAN MODEL MODEL ))
(EVT MODEL MODEL ))
(EVT LOC LOG ))
(EVT TIME TIME ))
(EVT TYPE TYPE ))
(ACTION HUMAN *OF ))
(ACTION TIME TIME ))
{{

((ACTION LOC  LOC ))

((ACTION ST  AE ))

((ACTION *OF  *OF ))

((ST   EVT  AE ))

(AXIOMS MY-SEF)

{:  

a set of test sentences

{:  

C1 --- translate Chinese into English
E1 --- translate English into Chinese

(SETQ C1 ' (TRANSCE X ( zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguo jinxingle duoci fangwen)))
(SETQ C2 ' (TRANSCE X (tamen shide zhezhong qudaide yishu xingshi yingqile henduo waiguoren de zhuyi)))
(SETQ C3 ' (TRANSCE X (Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiande chengong)))
(SETQ C4 ' (TRANSCE X (zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong)))
(SETQ E1 ' (TRANSEC (since 1980 Chinese puppet troupes have made several visits to Europe and the US ) X))
(SETQ E2 ' (TRANSEC (they brought this ancient art form to the attention of more foreigners) X ))
(SETQ E3 ' (TRANSEC (the 1981 American debut of the Fujian puppet troupe was an unparalleled success) X ))
(SETQ E4 ' (TRANSEC (in October 1984 the visit of the Shanghai Rod puppet troupe delighted SanFrancisco audiences) X))

{:  

ENGLISH1 --- translate SRE into SRC.

{:  

(SETQ ENGLISH1 ' (TRANS0 (made AGT (troupes NAME Chinese TYPE puppet) TIME (1980 PREP since) AUX have AE (visits MODEL several) LOC (Europe PREP to *AND (US DET the)))) X ))

(SETQ ENGLISH2 ' (TRANS0 (brought AGT (they) AE (form DET this TYPE ancient TYPE art) *TO (attention PREP to DET the *OF (foreigners PREP of MODEL more)) X ))

(SETQ ENGLISH3 ' (TRANS0 (was AE (debut DET the *OF (troupe PREP of DET the NAME Fujian TYPE puppet) TIME 1981 LOC American) AE (success DET an MODEL unparalleled)) X ))

}}
(SETQ ENGLISH4 ' (TRANS0 (delighted AE (visit DET the
 *OF (troupe PREP of
 DET the
 NAME Shanghai
 NAME Rod
 TYPE puppet))
 TIME (October TIME 1984 PREP in)
 AE (audiences LOC SanFrancisco))) X ))

{: ; -------------------------------------------------------------
| ENGl  --- generate English sentence from SRE

(SETQ ENGI ' (SE X (made AGT (troupes NAME Chinese TYPE puppet)
 TIME (1980 PREP since)
 AUX have
 AE (visits MODEL several)
 LOC (Europe PREP to *AND (US DET the)) ) ))

{: in ENG2 extra constituent (AUX let) is for matching SRC

(SETQ ENGI2 ' (SE X (brought AGT (they)
 AUX let
 AE (form DET this TYPE ancient TYPE art)
 *TO (attention PREP to DET the
 *OF (foreigners PREP of
 MODEL more)) ) ))

(SETQ ENGI3 ' (SE X
 (was AE (debut DET the
 *OF (troupe PREP of DET the
 NAME Fujian TYPE puppet)
 TIME 1981
 LOC American)
 AE (success DET an MODEL unparalleled)))

(SETQ ENGI4 ' (SE X (delighted AE (visit DET the
 *OF (troupe PREP of
 DET the
 NAME Shanghai
 NAME Rod
 TYPE puppet))
 TIME (October TIME 1984 PREP in)
 AE (audiences LOC SanFrancisco)))

{: ; -------------------------------------------------------------
| CHINEISE1  --- translate SRC into SRE.

(SETQ CHINEISE1 ' (TRANS0 X
 (jinxingle AGT (jutuan NAME Zhongguo TYPE muou)
 TIME (1980 MSR nian PREP zicong PREP yilai)
 AUX yijing
 AE (fangwen MODEL duoci)
 LOC (Ouzhou PREP dao *HE (Meiguo))))

(SETQ CHINEISE2 ' (TRANS0 X
 (yingqile AGT (tamen)
 AUX shide
 AE (xingshi DET zhezhong TYPE gudaide
 TYPE yishu))
*TO (zhuyi *OF (waiguoren PREP de
MODEL hendo)) ) )

(SETQ CHINESE3 ' (TRANS0 X
  (shi AE (souciyianchu *OF
               (jutuan PREP de NAME Fujian TYPE muou)
               TIME (1981 MSR nian)
               LOC meiguode)
          AE (chengong DET yige MODEL kongqiande)) )

(SETQ CHINESE4 ' (TRANS0 X (doulele AE (yanchu *OF (jutuan PREP de
               NAME Shanghai
               NAME Rod
               TYPE muou))
               TIME (1984 MSR nian TIME (10 MSR yue)
               PREP zai)
          AE (guanzhong LOC SanFrancisco)) )

{; --------------------------------------------------------------
CH1 -- generate Chinese sentence from SRC
---------------------------------------------------------------}

(SETQ CH1 ' (SC X
  (jinxingle AGT (jutuan NAME Zhongguo TYPE muou)
          TIME (1980 MSR nian PREP zicong PREP yilai)
          AUX yijin
          AE (fangwen MODEL duoci)
          LOC (Ououhg PREP dao *HE (Meiguo)) ) )

(SETQ CH2 ' (SC X
  (yingqile AGT (tamen)
          AUX shide
          AE (xingshi DET zhezhong TYPE gudaide
              TYPE yishu )
          *TO (zhuyi *OF (waiguoren PREP de
                         MODEL hendo)) ) )

(SETQ CH3 ' (SC X
  (shi AE (souciyianchu
          *OF (jutuan PREP de NAME Fujian
                 TYPE muou)
          TIME (1981 MSR nian)
          LOC meiguode)
          AE (chengong DET yige MODEL kongqiande)) )

(SETQ CH4 ' (SC X (doulele AE (yanchu *OF (jutuan PREP de
               NAME Shanghai
               NAME Rod
               TYPE muou))
               TIME (1984 MSR nian TIME (10 MSR yue)
               PREP zai)
          AE (guanzhong LOC SanFrancisco)) )

{; --------------------------------------------------------------
SENE1 -- translate English sentence into SRF.
---------------------------------------------------------------}

(SETQ SENE1 ' (SE (since 1980 Chinese puppet troupes have made several visits
to Europe and the US ) X )

(SETQ SENE2 ' (SE (they brought this ancient art form to the attention of
more foreigners) X ))

(SETQ SENE3 ' (SE (the 1981 American debut of the Fujian puppet troupe was an unparalleled success) X ))

(SETQ SENE4 ' (SE (in October 1984 the visit of the Shanghai Rod puppet troupe delighted San Francisco audiences) X ))

{| - translate Chinese sentence into SRC. |
(SETQ SENC1 ' (SC (zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguou jinxingle duoci fangwen) X ))

(SETQ SENC2 ' (SC (tamen shide zhezhong gudaide yishu xingshi yingqile henduo waiguoren de zhuyi) X ))

(SETQ SENC3 ' (SC (Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiangde chengong) X ))

(SETQ SENC4 ' (SC (zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele San Francisco guanzhong) X ))

(SETQ LIMIT 5000)
(SETQ DEPTH 20)
(SETQ LENGTH 20)

2@elisp
[Keeping Elisp]
Elisp, 10 14 85

The variable MSG shows how to begin and MSG1 shows how to save your files.

"HCPVR.ELAP.1"

*(load "trans.hcp")
Files-Loaded

*{: generate Demonstration of translating English to Chinese .
   }

NIL

*(TRY E1)
((TRANSEC (since 1980 Chinese puppet troupes have made several visits to Europe and the US)
 (zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguou jinxingle duoci fangwen)))

ANOTHER? *N
NIL

*RTIME
(3.258 SECS)

*(TRY E2)
(TRANSEC (they brought this ancient art form to the attention of more foreigners)
(tamen shide zhezhong gudaide yishu xingshi yingqile hengduo waiguoren de zhuyi))

ANOTHER? *N NIL

*RTIME (1.82 SECS)

* (TRY E3)
(TRANSEC (the 1981 American debut of the Fujian puppet troupe was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiande chengong))

ANOTHER? *N NIL

*RTIME (1.032 SECS)

* (TRY E4)
(TRANSEC (in October 1984 the visit of the Shanghai Rod puppet troupe delighted SanFrancisco audiences)
(zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong))

ANOTHER? *N NIL

*RTIME (1.587 SECS)

*

*{: Demonstration of translating Chinese to English. }

NIL

*

*(TRY C1)
(TRANSEC (since 1980 the Chinese puppet troupe have made several visits to Europe and the US)
(zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguo jinxingle duoci fangwen))

ANOTHER? *N NIL

*RTIME (2.183 SECS)

*(TRY C2)
(TRANSEC (they brought this ancient art form to the attention of more foreigners)
(tamen shide zhezhong gudaide yishu xingshi yingqile hengduo waiguoren de zhuyi))
ANOTHER? *N
NIL

*RTIME
(1.78 SECS)

*(TRY C3)
((TRANSEC (the 1981 American debut of the Fujian puppet troupe was an
unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige
kongqiande chengong)))

ANOTHER? *N
NIL

*RTIME
(3.256 SECS)

*(TRY C4)
((TRANSEC (in October 1984 the visit of the Shanghai Rod puppet troupe
delighted SanFrancisco audiences)
(zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele
SanFrancisco guanzhong)))

ANOTHER? *N
NIL

*RTIME
(2.735 SECS)

*

{;
----------------------------------------
Statistics of translations.
----------------------------------------}
NIL

*(TRY E1)
((TRANSEC (since 1980 Chinese puppet troupes have made several visits to Europe
and the US)
(zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he
Meiguo jinxingle duoci fangwen)))

ANOTHER? *Y
((TRANSEC (since 1980 Chinese puppet troupes have made several visits to Europe
and the US)
(zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he
Meiguo jinxingle duoci fangwen)))

ANOTHER? *Y
NIL

----------------------------------------
*(TRY E2)
((TRANSEC (they brought this ancient art form to the attention of more
foreigners)
(tamen shide zehzhong gudaide yishu xingshi yingqile henduo waiguoren
de zhuyi)))

ANOTHER? *Y
(TRANSEC (they brought this ancient art form to the attention of more foreigners)
(tamen shide zhezhong gudaide yishu xingshi yingqile henduo waiguoren de zhuyi))

ANOTHER? *Y
NIL

---

*(TRY E3)
((TRANSEC (the 1981 American debut of the Fujian puppet troupe was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiande chengong)))

ANOTHER? *Y
((TRANSEC (the 1981 American debut of the Fujian puppet troupe was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiande chengong)))

ANOTHER? *Y
NIL

---

*(TRY E4)
((TRANSEC (in October 1984 the visit of the Shanghai Rod puppet troupe delighted SanFrancisco audiences)
(zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong)))

ANOTHER? *Y
((TRANSEC (in October 1984 the visit of the Shanghai Rod puppet troupe delighted SanFrancisco audiences)
(zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong)))

ANOTHER? *Y
NIL

---

*(TRY C1)
((TRANSEC (since 1980 the Chinese puppet troupe have made several visits to Europe and the US)
(zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguo jinxingle duoci fangwen)))

ANOTHER? *Y
((TRANSEC (since 1980 Chinese puppet troupe have made several visits to Europe and the US)
(zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguo jinxingle duoci fangwen)))

ANOTHER? *Y
((TRANSEC (since 1980 the Chinese puppet troupe have made several visits to Europe and the US)
(zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguo jinxingle duoci fangwen)))

ANOTHER? *Y
since 1980 Chinese puppet troupes have made several visits to Europe and the US
(zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguo jinxingle duoci fangwen))

another? *y

NIL

* (try c2)
(they brought this ancient art form to the attention of more foreigners)
(tamen shide zhezhong gudaide yishu xingshi yingqile henduo waiguoren de zhuyi))

another? *y
(they brought this ancient art form to the attention of more foreigners)
(tamen shide zhezhong gudaide yishu xingshi yingqile henduo waiguoren de zhuyi))

another? *y
NIL

* (try c3)
(the 1981 American debut of the Fujian puppet troupe was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiangde chengong))

another? *y
(the 1981 American debut of Fujian puppet troupes was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiangde chengong))

another? *y
(the 1981 American debut of the Fujian puppet troupe was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiangde chengong))

another? *y
(the 1981 American debut of Fujian puppet troupes was an unparalleled success)
(Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiangde chengong))

another? *y
NIL

* (try c4)
(in October 1984 the visit of the Shanghai Rod puppet troupe delighted SanFrancisco audiences)
(zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong))

another? *y
((TRANSCE (in October 1984 the visit of Shanghai Rod puppet troupes delighted SanFrancisco audiences)
            (zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong)))

ANOTHER? *Y
((TRANSCE (in October 1984 the visit of the Shanghai Rod puppet troupe delighted SanFrancisco audiences)
            (zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong)))

ANOTHER? *Y
((TRANSCE (in October 1984 the visit of Shanghai Rod puppet troupes delighted SanFrancisco audiences)
            (zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong)))

ANOTHER? *Y
NIL

*{:; ; The detailed procedure of translating English to Chinese.
 * ;===============================================}
NIL

*{: 1. Translate English into SRE.
   ;--------------------------
   }

*(TRY SENE1)
((SE (since 1980 Chinese puppet troupes have made several visits to Europe and the US)
   (made AGT
       (troupes NAME Chinese TYPE puppet)
       TIME
       (1980 PREP since)
       AUX
       have
       AE
       (visits MODEL several)
       LOC
       (Europe PREP to *AND (US DET the))))

ANOTHER? *
*{: 2. Translate SRE to SRC.
 * ;--------------------------
   }

NIL

ANOTHER? *
*(TRY ENGLISH1)
((TRANSO (made AGT
            ((TRANSO (made AGT
                (troupes NAME Chinese TYPE puppet)
                TIME
                (1980 PREP since)
                AUX
                have
                AE
                (visits MODEL several)
                LOC

                (zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong))))
            (zai 1984 nian 10 yue Shanghai Rod muou jutuan de yianchu doulele SanFrancisco guanzhong))))

}(a)
(Europe PREP to *AND (US DET the)))

(jinxingle AGT
  (jutuan NAME Zhongguo TYPE muou)
  TIME
  (1980 MSR nian PREP zicong PREP yilai)
  AUX
  yijin
  AE
  (fangwen MODEL duoci)
  LOC
  (Ouzhou PREP to *HE (Meiguo))))

ANOTHER? *

*{; 3. Generate Chinese from SRC.

-----------------------------------------------------------------------------------

NIL
ANOTHER? *

*(TRY CH1)

((SC (zicong 1980 nian yilai Zhongguo muou jutuan yijin dao Ouzhou he Meiguo
      jinxingle duoci fangwen)
    (jinxingle AGT
      (jutuan NAME Zhongguo TYPE muou)
      TIME
      (1980 MSR nian PREP zicong PREP yilai)
      AUX
      yijin
      AE
      (fangwen MODEL duoci)
      LOC
      (Ouzhou PREP dao *HE (Meiguo))))

ANOTHER? *

*{;

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NIL
ANOTHER? *

*{; The detailed procedure of translating Chinese to English.

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NIL
ANOTHER? *

*{; 1. Translate Chinese into SRC.

-----------------------------------------------------------------------------------

NIL
ANOTHER? *

*(TRY SENC3)

((SC (Fujian muou jutuan de 1981 nian meiguode souciyianchu shi yige kongqiande
      chengong)
    (shi AE
      (souciyianchu *OF
        (jutuan PREP de NAME Fujian TYPE muou)
        TIME
        (1981 MSR nian)
        LOC
        meiguode)
      AE
      (chengong DET yige MODEL kongqiande))))
ANOTHER? *

*{: 2. Translate SRC into SRE.
  * ____________________________
NIL

*(TRY CHINESE3)
((TRANS0 (was AE
  (debut DET the
   *OF
   (troupe DET the PREP of NAME Fujian TYPE puppet)
   TIME
   1981
   LOC
   American)
  AE
   (success DET an MODEL unparalleled))
  (shi AE
   (souciyianchu *OF
     (jutuan PREP de NAME Fujian TYPE muou)
     TIME
     (1981 MSR nian)
     LOC
     meiguode)
  AE
   (chengong DET yige MODEL kongqianle))))

ANOTHER? *

*{: 3. Generate English from SRE.
  * ____________________________
NIL
ANOTHER? *

*(TRY ENG3)
((SE (the 1981 American debut of the Fujian puppet troupe was an unparalleled success)
  (was AE
   (debut DET the
    *OF
    (troupe PREP of DET the NAME Fujian TYPE puppet)
    TIME
    1981
    LOC
    American)
  AE
   (success DET an MODEL unparalleled)))))

ANOIHER? *

*℃
2@POP

[PHOTO: Recording terminated Wed 19-Mar-86 12:51PM]