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Japanese generation within ASURA framework

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Abstract

In this report the Japanese generation grammar for the ASURA system is described. Firstly, remarks are made about input from transfer and generation rules as well as the generation engine.

Secondarily, the main linguistic as well as technical aspects of the grammar are described. Finally, the reversibility of Japanese analysis to Japanese generation grammar is examined. Also, there is some discussion about the adaptation of linguistic theory to the generation of MT. In the appendix all generated sentences of the conference registration corpus A, B are listed.

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Keywords and abbreviations

case grammar, feature structure, generation, machine translation (MT), pronoun *ellipsis*, rewriting system (RWS), *slash* schema, *subcategorization*, *topicalization*, *trace* theory, *x-bar* theory

Research period of time

Generation system was developed by G. Kikui as an Japanese-English generation system in September of 1989 in ATR. Our research on English-Japanese generation and experiments started in October of 1992 and has stopped at the end of seven years project, in March of 1993.

Contents

1 Introduction

MT of spoken language is performed in 3 successive phases: speech recognition, MT and speech synthesis. MT occurs in 3 stages, analysis, transfer and generation. The whole system, called ASURA, uses 3 different engines for analysis, transfer and generation. Analysis uses a chart-parser interpreting unification grammar, transfer uses a f-structure rewriting system engine, and generation uses unification based engine. The linguistic basis of our work is *HPSG* grammar, which provides for adequate semantic[1]representation of spoken language. Throughout MT process, the representation of utterances contains a trichotomy of syntax, semantics and pragmatics, encoded in unique feature structure.

This report aims to describe our English-Japanese (E-J) generation grammar. There are given general explanations about the component that provides the input for the grammar and about the generation mechanism and grammar description. Also there is small discussion about differences between analysis grammar, written for Japanese-English translation and E-J generation grammar.
Our task domain is telephone conversation of which topic is limited to inquiries about international conference. Speakers on telephone are a caller and receptionist of the conference office.

[1]This use of the word 'semantic' should not be confused with the more common usage denoting portion of a grammar concerned with the meaning of a sentences.

2 Transfer to generation

2.0.1 Transfer output

Generation is final phase of MT. It takes as input feature structures which are the output of the transfer component per sentence.The following is the transfer output which is effected through rules which is called RWS rule[2].
This contains two kinds of features at the top arcs: sem and prag

```
[[SEM [[RELN PHATIC]                              .....1.
       [AGEN !X1[[LABEL *SPEAKER*]]]              .....2.
       [RECP !X2[[LABEL *HEARER*]]]               .....3.
       [OBJE [[RELN Mosimosi-INTERJ-1]            .....4.
              [AGEN !X1]
              [RECP !X2]]]]]
 [PRAG [[BENEFIT HEARER-SIDE]                     .....5.
        [HEARER !X2]
        [INTENTION GREET]
        [PRSP-TERMS [[PRSP-MOD NULL]]]
        [SPEAKER !X1]
        [politeness [[degree 1]]]
        [TOPIC [[TOPIC-MOD NULL]]]]]]
```

(1) is *Semantic* features [reln PHATIC] is a kind of label which is called IFT, and is provided at transfer phase for each sentence. IFT represents grammatical aspects of or speaker's intentions in a sentence. All sentence are labeled with one of phatic, questionif, questionref, inform, response and promis at the top level of semantic portion feature structure.
(2) and (3) agen and recp, are provided for setting up of the conversation environment, according to topics in the conversation. There are two conversationistes who are *speaker* and *hearer*.
(4) is the concrete contents of what the IFT represents.
(5) is *Pragmatic* features.
Such pragmatic issues as *presupposition*, *honorifics*, *topicalization*...etc. are discribed here.

[2]English analysis isn't performed yet. So, for instance, we are using Japanese-English transfer results as output with minimum changes

2.0.2 Generation mechanism and rules

A generation rule is represented as a set of trees, annotated with feature structures. Each tree represents syntactical structure which is set as a pair with a semantic feature structure. A tree is substituted for another tree and is formed into a larger structure, according to rule activation. In the rule, the sem information from transfer is subsumed in the annotation of the rule and unified to [sem....] portion. [prag...] information is subsumed in rule definition portion.

Each rule which is called PD (phrase description), begins with g_pd and has several identifiers which are obligatory. The value of :name(1), the name of the rule, can be chosen freely. The first item in the list of :internal_structure(2) is a pointer to the left-hand side of the phrase structure rule. The other arguments are pointers to the elements of the right-hand side of the phrase structure. The names of these pointers must be unique within the same rule.

:environment(3) is a condition for whether the rule in question is applied or not. The value of :environment is politeness degree or topic-mod.

:annotation(4) is the body of the rule. It consists of the left-hand side and the right-hand side which are identified by the pointers of :internal_structure. The order of these elements in the body of the rule is irrelevant.

Two types of the rule are shown:

```
(g_pd
 :name S2PHATIC-S1_SIGN                          ......1.
 :internal_structure (S2 S1 SIGN)                ......2.
 :environment [[poliness [[degree 1]]]]          ......3.
 :annotation                                     ......4.
 ((S2   [[syn [[cat s2]]]
         [sem [[reln phatic]
       [agen [[label *speaker*]]]
       [recp [[label *hearer*]]]
       [obje ?obje]]]])
  (S1   [[syn [[cat s1]]]
              [sem ?obje]])
  (SIGN [[syn [[cat sign] [lex "."]]]])))
```

```
[PD-1 syntactical rule]
```

(1) is rule name.
(2) is tree structure of a phrase structure.
(3) is the condition for applying of pd.
(4) is feature structure of the phrase.

There is the difference between syntactical and lexical rule, according to the difference of the category. Lexical rule has no left and right hand side, but only one category.

```
(g_pd
 :name V-WAKARU_ASPL
 :internal_structure V
 :annotation
 ((V [[syn [[cat v][lexid wakaru-1][lex "wakari"][ctype cons-uv]
            [cform aspl]]]
      [sem [[reln wakaru-v-1]
            [expr ?expr]
            [obje []]
            [tense ?tense]
            [sem-aspe ?sem-aspe]]]
            [subcat [[first [[syn [[cat np][agr [[case Ninformation]]]]]
                            [sem []]]]
                     [rest [[first [[syn [[cat np][agr [[case dative]]]]]
                                    [sem ?expr]]]
                            [rest end]]]]]]))))

            [PD-2 lexical rule]
```

3 Grammar

3.1 Linguistic Grammar

The E-J generation grammar is designed with *head-driven phrase-structure* (HPSG) grammar. HPSG is one of phrase structure grammar and takes advantage of the power of *unification*. For HPSG, lexical rules are the most important and are described with such thoughts or method as:

- describing a phrase as a constituting set of different thinking paradigm of a lexie in the linguistic point of view: for example, part of speech, grammatical role, morphological form, subcategorized elements, movable elements...etc.
- encoding a phrase as a set of categories in the grammar rule, a description method of feature/value system is made.

Current grammar rules have following features at different levels of phrase structure.

- semantic feature

  e.g. [[sem ?sem]]

- subcat features

  e.g.

```
[subcat [[first [[syn [[cat np]]]
                 [sem ?sem]]]
         [rest end]]]
```

- slash feature

  e.g.

```
[slash [[np [[syn ?slash-syn]
             [sem ?slash-sem]
             [defsem ?defsem]]]]]
```

- agreement features

  e.g. [agr ?agr], [[agr [[case nominative]]]

- case features

  e.g. [[case nominative]]

- syntactical features

  e.g. [[syn [[cat s2]]]

- morphological features

  e.g. [[cform aspl]]

- pragmatic features

  e.g. [[politeness [[degree 2]]]]

- mood features

  e.g. [[mood imperatif]]

Simple explanations are made about some features and values among them next section.

3.2 Features and its value

3.2.1 *Subcat* feature

Subcat feature for *subcategorization* is used to specify necessary categories with which a category will become *saturated category.* For example, a verb which has two *complement objects* gramatically as obligatory arguments, subcategorizes these *complement objects* in lexical rules. S or NP is considered to be the *saturated* category and V or N is *unsaturated* category, because V or N, in general does not function alone in a phrase structure. So, V or NP has no subcat features/values. The subcat feature in lexicon, especially in verbs' lexicon is the most helpful information to assemble a sentence, because the subcat feature contains information about necessary *argument* number of a verb and its' positional order in a sentence.

The feature of the *subcategorization* has two features *first, rest* and one end marker value *end.*

```
[subcat [[ first [[syn [[cat np]
                                [agr [[case dative]
                           [sem ?obje]]]
 [ rest [[first [[syn [[cat np]
```

```
                                    [agr [[case nominative]]]]]
                              [sem ?agen]]]
                        [rest  end]]]]]
```

Within pd above given, a Japanese verb is assumed to have two arguments as the *spec* for the *VP*. So firstly *NP* for ?obje is subcategorized and secondarily *NP* for ?agen is subcategorized. This is the same idea as *maximal projection* of *GB* theory, though *maximal projection* of *V* is *VP* and one of *S* is *INFL* in *GB* thoery.

However, there is no inflectional ending concord with the subject or objects in Japanese. So, *S* belongs to the same category as *VP* in our grammar. All arguments of subcat feature try recursively to attach to the *VP* and *S* in order to be *saturated category.* (see also relative clause)

3.2.2 *Slash* feature

The slash feature is used to determine movable position of a sentence element in the grammar. The value of the *slash* feature depends on slashified category. Typical case using *slash* feature is relative clause structure.(see relative clause) Initial position for moved argument is shown by a symbol *t(trace).* This is one of *binding* feature, and shows from where to where and why the movement of the argument happens.

Also slash feature is used for pronoun *ellipsis.* In Japanese, almost of subject pronoun for the first and second person is omitted. In our corpus, labeled *hearer* and *speaker* are not omitted in an utterance, because *agent* of an action is identified by *honorifics* or *condescending* suffix. However, the use of *slash* features for pronoun *ellipsis* is opportunism.

3.2.3 *Agreement* features

In general, *agreement* features are used to match the gender/number of *NP* with the morphology of verbs. However, in Japanese verb form doesn't depend on the subject or the object of a sentence, but depends on postpositioning grammatical elements. Within the grammar, *agreement* features are used

- to choose an adequate postpositional particle for *NP*
- to choose a word form of the verb.

For instance, all conjugation forms of a verb are entries as each different lexie and it needs to choose a form among 4 forms[3], depending on meanings of a sentence: for example a negative sentence occurs with different conjugation form from affirmative sentence one.

3.2.4 *Case* feature

Case feature is used at the same time with *agreement* feature to choose an adequate postposional particle for *NP*: newinformation, nominative, objective, dative,...for ga, wa, wo, ni...etc. It's possible to indicate directly postpositional particles which the verb in question grammatically demands. In the grammar, case names are labeled, in view of the convenience to take the agreement between category levels.

```
[[syn [[cat np]
       [agr [[case nominative]]]]]]
```

3.2.5 Syntactical features

Syntactical features mean features which belong to syntactical portion in a rule. There are two types of category: terminal categories and non-terminal categories. All categories in the rules are shown as well as their levels and their path:

N-com —nouns

N-name —proper nouns

WH-N —wh-pronouns

adv —adverb

auxvformal —formal auxiliary

auxvaspl —aspectual auxiliary

auxv-evid —politeness auxiliary

sfp —sentence final particles

comp —complementizers

idiom —idioms

v —verbs

[3]The Japanese verb has 4 conjugation forms

p1-7 —postpositional particles

pronp —pronouns

conj —conjunction

dmarker —discourse marker

The path of these categories is [[syn [[cat X]]]].

Non-terminal categories are as follows:

NP —noun phrase

N1 —noun bar 1

VP —verb phrase

VP-NEGT —verb phrase

VP1 —verb phrase bar 1

P —postpositional particle bar 1

Advp —adverbial phrase

S —sentence

S1 —sentence bar 1

S2 —sentence bar 2

The path of these categiries is [[syn [[cat X]]].

Other syntactical categories as follows:

tense —tense

sem-aspe —aspect

cform —verb conjugation form

ctype —verb conjugation type

aform —auxiliary conjugation form

mood —imperative, affirmative, negative, passive

case —grammatical case

agr —agreement

dummy —dummy

The path of these categories is [[syn [[X ?X]]]].

3.2.6 Semantic categories

Semantic category means categories which belong to semantic portion in the rules.

reln —relation name for IFT

agen —interlocutor

recp —interlocutor

obje-reln —object of IFT

obje —objective case

expr —experiencer case

agen —agentive case

recp —receipient case

loct —locative case

tloc —time case

tdept —time case

parm —parameter x

restr —restriction of parameter x

entity —entity of parameter

manner-reln —manner case

attd —attitude of interlocutor

cond-reln —conditionel

The path of these categories is [[sem [[X ?X]]]] or [[sem [[X ?X[]]]]].

3.3 Linguistic phenomena

This section aims to show pd rules, while selecting main syntactical or semantic differences between two languages.

1. *Head* in the phrase structure

   The *head* of the *VP* (verb phrase), *NP* (noun phrase) is located at the end of the phrase in Japanese, contrastively with at the beginning of one in English.

In *X-bar* theory the *head* of phrase structure is located at most left/right site of *x-bar projection*, respectively. This can be interpreted as the word order principle for Japanese is that the modifier precedes what is modified.

In the grammar described, a rule expresses two aspects at the same time as mentioned above: the immediate dominance between *mother* and *daughter* nodes and the linear precedence between *sister* nodes. *GPSG* grammar handles these aspects separately. In our grammar, the dominance and the word order of sentential elements are handled at the same time. In following rule[4], the *VP* dominates *NP* and *VP1*, and at the same time *NP* is followed by *VP* as word order in a sentence. This is described with vertical order in a rule.

```
(g_pd
 :name VP-NP_VP1
 :internal_structure (VP NP VP1)
 :annotation
 ((VP  [[syn [[cat vp][agr ?agr]]]
        [sem ?sem-vp]
        [subcat ?subcat-rest]])
  (NP  [[syn [[cat np][agr ?agr]]]
        [sem ?sem-np]])
  (VP1 [[syn [[cat vp][agr ?agr]]]
        [sem ?sem-vp]
        [subcat [[first [[syn [[cat np][agr ?agr]]]
 [sem ?sem-np]]]
 [rest ?subcat-rest]]]]])))
```

Also pd rule, N_V_N1 shows the word order of *N* modified with *relative clause*. The modifier is V and the modified is N1, and corresponds to, for example such a Japanese expression as 'wakaranai ten'. So, the *head*, ten in the phrase structure is represented at the last position as word order in the pd rule.

2. *WH*-movement

   Interrogative pronoun in English occurs obligatorily at the beginning of a sentence. In Japanese, almost of *WH*-elements can

[4]This rule corresponds to such a sentence to generate as 'Tarou wa Hanako wo Naguru'.

occur anywhere as well as other elements of a sentence, though there is such a few exception as adverbial *WH*-element.
e.g.

What did Hanako buy?

Hanakowa naniwo kattano?
Naniwo Hanamkowa kattano?

Therefore, *WH*-elements of *NP* are handled by the same method as usual *NP*: when a *WH*-element is grammatically the subject/object of a verb, it's subcategorized as the subject/object of the verb. In case of *WH*-elements which is an adverb and free arguments of sentential verb, it's described in the syntactical portion of *VP*. This treatment is the same as the case of general adverbs. Provided that there is *agreement* with the mood value.

e.g. From when will you stay?

Itsukara otomarininarimasuka

```
(g_pd
 :name VP-ADVP_VP1
 :internal_structure (VP ADVP VP1)
 :annotation
 ((VP   [[syn [[cat vp][tdep ?tdep]
               [agr [[mod interrogative]]]]]
        [sem ?sem]
        [subcat ?subcat]])
  (ADVP [[syn [[cat advp]]]
        [sem ?tdep]])
  (VP1  [[syn [[cat vp]]]
        [sem ?sem]
        [subbcat [[first [[syn [[cat advp]]]
                         [sem ?tdep]]]
                  [rest ?subcat]]]])))
```

Japanese *WH*-elements is expressed by nani (what), doko (where), dare (who), itsu (when)...etc. When these *WH* are combined with

desuka (interrogative-copula), the postpositional particle doesn't appear.

e.g.

> By the way, what's the official language at the conference.
> tokorode, kaigideno koushikigengowa nan desuka

In order to handle interrogative pronoun accompanied with desuka by the same way as *WH*-elements with postpositional particles, N-WH is built as terminal and non-terminal category.

```
(g_pd
 :name NP-N-WH_P7
 :internal_structure (NP N-WH P7)
 :annotation
 ((NP   [[syn [[cat np]]]
         [sem ?sem]])
  (N-WH [[syn [[cat n-wh]]]
 [sem ?sem-n]])
  (P7   [[syn [[cat p7]]]
         [sem ?sem-p]])))
```

A pd rule of the case where *VP*-node is constituted with *N-WH* and *copula* is showm below.

```
(g_pd
 :name VP-N-WH_AUXV-COPL
 :internal_structure (VP N-WH AUXV-COPL)
 :annotation
 ((VP         [[syn [[cat vp][agr ?agr][wh yes]
                     [tense ?tense][sem-aspe ?sem-aspe]]]
               [sem ?sem]
               [subcat ?subcat]])
  (N-WH       [[syn [[cat n-wh][agr ?agr]]]
               [sem ?sem-n]])
  (AUXV-COPL [[syn [[cat auxv-copl][agr ?agr][wh yes][agr ?agr]]]
               [sem ?sem]
               [subcat [[first [[syn [[cat n-wh]]]
                                [sem ?sem-n]]]
                        [rest ?subcat]]]])))
```

3. Yes-No question

For Yes-no question, ajuncted auxiliary (do, have will etc.) to a affirmative form occurs at the begining of a sentence in English, contrastively with sentence final particle, ka in Japanese.
e.g.

Do you already have a regidstration form?
Sudeni tourokuyoushiwa omochidesuka

Transfer result for this utterance is as follows:

```
[[SEM [[RELN QUESTIONIF]
       [AGEN !X4[[LABEL *SPEAKER*]]]
       [RECP !X1[[LABEL *HEARER*]]]
       [OBJE [[RELN motsu-V-1]
              [TENSE PRESENT]
              [AGEN !X1]
              [OBJE [[PARM !X2[]]
                     [RESTR [[RELN tourokuyoushi-IDIOM-1]
                             [ENTITY !X2]]]]]
              [TLOC [[PARM !X3[]]
                     [RESTR [[RELN sudeni-ADV-1]
                             [ENTITY !X3]]]]]
              [SEM-ASPE STATIVE]]]]]]
```

[RELN QUESTIONIF] is generated always into a sentence with a sentence final particle ka. So, *yes-no*-question expression is dominated directly by S2.

```
(g_pd
 :name S2QUESTION-S1_SFP_SIGN
 :internal_structure (S2 S1 SFP SIGN)
 :annotation
 ((S2   [[syn [[cat s2]]]
         [sem [[reln questionif]
               [agen [[label *speaker*]]]
               [recp [[label *hearer*]]]
               [obje ?proposition]]]])
```

```
(S1   [[syn [[cat s1]]]
       [sem ?proposition]])
(SFP  [[syn [[cat sfp]]]
       [sem [[reln ka]]]])
(SIGN [[syn [[cat sign][lex "."]]]]))
```

4. The order of sentence elements

   In Japanese, the word order of sentence elements is relatively free except for the topicalized noun which normally occurs at initial position as well as English topicalization.

   Additionally, Japanese free order phenomenon will be possible to be taken as results of *subcat slash scrambling* which was applied to basic word order[5]. In Japanese analysis grammar, the *subcat slash scrambling* is described as follows:

```
(DEFFSTEMP SC-SL-2-1 (%COMP1 %COMP2)
  (<!M !SYNSC !FIRST> == %COMP1)
  (:OR
    ((<!M !SYNSC !REST> == (:LIST %COMP2))
     (<!M !SYNSL>       == !EMPTY-DLIST))
    ((<!M !SYNSC !REST> == !EMPTY-LIST)
     (<!M !SYNSL>       == (:DLIST %COMP2)))) )
```

   This template corresponds for 2 arguments of which the order might change in a sentence. However, in the generation, it is unnecessary to generate varieties of output as results.

   In our grammar, topicalized *NP* in English is generated as topicalized Japanese, by using topic particle, wa, but the other word-order possibilities of sentence elements aren't generated.
   e.g.

   > At Kitaooji station, you can take a taxi.
   > Kitaoojiekidewa takusiga riyoudekimasu

   The transfer result for this example, is as follows:

```
[[SEM [[RELN INFORM]
       [AGEN !X4[[LABEL *SPEAKER*]]]
```

[5]The basic order is assumed as S,O2,1,V.

```
        [RECP !X1[[LABEL *HEARER*]]]
        [OBJE [[RELN POSSIBILITY]
               [TENSE FUTURE]
               [EXPR !X1]
               [OBJE [[RELN Riyoudekiru-V-1]
                      [AGEN !X1]
                      [OBJE [[PARM !X2[]]
                             [RESTR [[RELN takusiN-1]
                                     [ENTITY !X2]]]]]
                      [LOCT [[PARM !X3[]]
                             [RESTR [[RELN NAMED]
                                     [IDEN Kitaoojieki-PROPN-1]
                                     [ENTITY !X3]]]]]]
               [SEM-ASPE UNREAL]]]]]
  [PRAG [[TOPIC-MOD     ]
         [OBJECT ?LOCT]]]]
```

Corresponding pd rule to this transfer result is as follows:

```
(g_pd
 :name V-RIYOUDEKIRU
 :environment [[topic-mod dewa][object ?loct]]
 :internal_structure V
 :annotation
 ((V [[syn [[cat v][cform aspl][ctype suru][lexid riyoudekiru-1]
    [lex "riyoudeki"][agr ?agr]]]
      [sem [[reln RIYOUDEKIRU-v-1]
            [agen ?agen]
            [obje ?obje]
            [loct ?loct]]]
      [subcat [[first [[syn [[cat np][agr [[case Ninformation]]]]]
                      [sem ?obje]]]
       [rest [[first [[syn [[cat np][agr [[case nominative]]]]]
                           [sem ?agen]
                     [rest [[first [[syn [[cat np]
                                          [agr [[case locative]]]]]
                                   [sem ?loct]]]
```

```
                                        [rest end]]]]]]]]))
```

NP of this PD rule is topicalized NP as is shown by PRAG in transfer result. In lexicon of V-RIYOUDEKIRU, elements of verbs is described as three subcategory elements. The subcategoried order of them is the reverse word order to be generated. Also, this *NP* is generated at the begining of the sentence with topic partile dewa in Japanese.

5. Expletives

   There is no expleitive structure in Japanese, contrastively with English expletives *e.g.* there, it.
   e.g.

   > There is something I understand.
   > Wakaranai tenga gozaimasu

   This *there* is called introductory-there. The transfer results is as follows:

```
[SEM [[RELN REQUEST]
      [AGEN !X2[[LABEL *SPEAKER*]]]
      [RECP !X1[[LABEL *HEARER*]]]
      [OBJE !X10[[RELN GOZARU-V-1]
 [TENSE FUTURE]
 [OBJE [[PARM !X16[[PARM !X4[]]
                                      [RESTR [[RELN TEN-N]
                                              [ENTITY !X4]]]]]
                          [restr [[RELN NEGATE]
                                  [OBJE [[reln WAKARU-V-1]
                                         [tense future]
                                         [sem-aspe unreal]
                                         [expr !X1]
                                         [obje !X16]]]]]]]

                    [SEM-ASPE UNREAL]]]]]
```

English expletive is neutralized in transfer result and the normal generation procedure is taken without any problem.

6. Multiple subjects in a sentence

   In Japanese, multiple subjects with postpositional particle ga is possible in a sentence, contrastively with only one subject as grammatical category in English.

   e.g. Kitaoojiga kaijyouga chikai[6]

   This linguistic phenomenon is not special in spoken Japanese, but we don't handle it.

7. *Pro-forms*

   Pronouns aren't modified by such modifiers as adjectives in English. But, in Japanese, all of pronouns is possible to be modified by noun phases, adjective and adverbs.
   e.g.

   konkaino sore (*this time's it)
   sensyuuno kare (*last week's he)

   This seems problematic in J-E generation, but In E-J generation there is no problem, because modifiers of *pro-forms* don't occur in English. It's generated in general case, as *pro-forms* and advrbial clause.

3.3.1 Free arguments

There are two types arguments in a sentence, according to *case grammar*: obligatory arguments and such a free argument as location, manner, time. Obligatory arguments of verbs are specified in the subcat features in lexicon of the verb. Free arguments of verbs don't belong to subcat features, but are handled, *en gros mod*, in syntactical portion. Free arguments are adverbial phrases by ADV or NP in Japanese and they can occur any where in a sentence, except topicalized free argument.

Topicalization of free arguments is the free argument of a verb, but isn't free argumrnt of the sentence. Also syntactically it occurs, in general at the begining position of a sentence.

[6]Kuno '73 has an example for this kind sentence: Bunmeikokuga, dansega, heikinjyumyouga mijikai (It is civilized countries that man, their lifespan is short in.)

In following example, adverb phrase Kitaoojiekidewa (at Kitaooji station)' is the topicalized free argument of the verb 'take', which means *location.*
e.g.

Kitaoojiekidewa takusiga riyoudekimasu

(At Kitaooji station, you can take a taxi.)

Within the grammar, topicalized free argument of *NP* is treated in subcat feature as well as obligatory arguments.

3.3.2 Relative clasue

The generation of *relative clause* is handled by using the slash feature. This specifies initial position and movable position of the phrase structure as is mentioned above. Output from transfer component for a sentence including *relative clause* is as follows:

```
[OBJE !X16[[PARM !X4[]]
           [RESTR [[RELN TEN-N-1]
                   [restr [[RELN NEGATE]
                           [OBJE [[reln WAKARU-V-1]
  [tense future]
  [sem-aspe unreal]
                                  [expr !X1]
                                  [obje !X16]]]]]
                   [ENTITY !X4]]]]]
```

pd rule for the *relative clause*as follows:

```
(g_pd
 :name N-S-NEGT-N1
 :internal_structure (N S-NEGT N1)
 :annotation
 ((N      [[syn [[cat n][agr ?agr]]]
           [sem [[parm ?X :SPECIFIED]
                 [restr ?restr]]]])
  (S-NEGT [[syn [[cat s-negt][cform vong][agr ?agr]]]
           [sem ?restr]
           [slash ?slash [[np [[syn [[cat np][agr [[case Ninformation]]]]]
                               [sem ?X]
```

```
                                    [defsem ?defsem]]]]]
          [defsem ?defsem]])
  (N1     [[syn [[cat n]]]
          [sem ?X]])))
```

Two feature values, !X16 in tranfer result indicate the same things. They correspond to *slash* values, ?X of S-NEGT in the pd rule.

Following tree stuctures are shown to give generation process in detail.

```
S2 [#1058 EXPANDED  (S2REQUEST-S1_SIGN)]
|--S1 [#1059 EXPANDED  (S1-S_AUXV-OPTT S-NP_V V-GOZARU)]
|  |--S [#1060 EXPANDED  NIL]
|  |  |--NP [#1061 EXPANDED  (NP-N_P1 N-S-NEGT_N1)]
|  |  |  |--N [#1062 EXPANDED  NIL]
|  |  |  |  |--S-NEGT [#1063 EXPANDED  (S-NEGT-VP_AUXV-NEGT)]
|  |  |  |  |  |--VP [#1064 EXPANDED(VP-NP_VP1 VP-NP_VP1 VP-V V-WAKARU_VONG)]
|  |  |  |  |  |  |--NP [#1065 EXPANDED  (NP-N_P4 N-HEARER)]
|  |  |  |  |  |  |  |--N [#1066 LEXIFIED "*hearer*"  NIL]
|  |  |  |  |  |  |  |--P4 [#1067 LEXIFIED "ni"  (NI)]
|  |  |  |  |  |  |--VP [#1068 EXPANDED  NIL]
|  |  |  |  |  |  |     |--NP [#1069 TRACE "<trace>"  NIL]
|  |  |  |  |  |  |     |--VP [#1070 EXPANDED  NIL]
|  |  |  |  |  |  |        |--V [#1071 LEXIFIED "wakara"  NIL]
|  |  |  |  |  |--AUXV-NEGT [#1072 LEXIFIED "nai"  (AUXV-NEGT)]
|  |  |  |  |--N [#1073 LEXIFIED "ten"  (N-TEN)]
|  |  |  |--P1 [#1074 LEXIFIED "ga"  (GA)]
|  |  |--V [#1075 LEXIFIED "gozai"  NIL]
|  |--AUXV-OPTT [#1076 LEXIFIED "masu"  (MASU)]
|--SIGN [#1077 LEXIFIED "."  NIL]
```

Generation result is as follows:

speaker ni ⟨ trace ⟩ wakara nai ten ga gozai masu .

3.3.3 *Passive voice*

Passive voice with *patient* case is not handled and transformational rules are explicitely not used for *passive voice*. This means Japanese passive is handled by such a thought that a sentence is embeded in suffix reru or rareru with postpositional particles, [ga..ni] or [ga... niyotte]. And particles are introduced by *agreement* feature.

```
S2 [#1656 EXPANDED  (S2-S1_AUXV-VOICE_AUXV-EVID_SIGN1)]
|--S1 [#1657 EXPANDED  (S1-S_AUXV-VOICE S-VP VP-P_VP1 VP1-P_V V-FUKUMU)]
|  |--S [#1661 EXPANDED  NIL]
|  |  |--VP [#1662 EXPANDED  NIL]
|  |     |--P [#1663 EXPANDED  (P-N_POSTP-OBLG5 N-N-COM N-KANGEIKAIHI)]
|  |     |  |--N [#1671 EXPANDED  NIL]
|  |     |  |  |--N-COM [#1672 LEXIFIED "kangeikaihi"  NIL]
|  |     |  |--POSTP-OBLG [#1673 LEXIFIED "niwa"  (NIWA-PASS)]
|  |     |--VP1 [#1664 EXPANDED  NIL]
|  |        |--P [#1665 EXPANDED  (P-N_POSTP-OBLG1 N-N-COM N-SANKARYOU)]
|  |        |  |--N [#1668 EXPANDED  NIL]
|  |        |  |  |--N-COM [#1669 LEXIFIED "sankaryou"  NIL]
|  |        |  |--POSTP-OBLG [#1670 LEXIFIED "ga"  (GA-PASS)]
|  |        |--V [#1666 LEXIFIED "fukuma"  NIL]
|  |--AUXV-VOICE [#1667 LEXIFIED "re"  (AUXV-VOICE-RERU)]
|--AUXV-ASPC [#1658 LEXIFIED "tei"  (TEIRU)]
|--AUXV-EVID [#1659 LEXIFIED "masu"  (MASU)]
|--SIGN [#1660 LEXIFIED "."  NIL]
```

3.3.4 *Negative*

Scope of *Negative* in Japanese is the most small clause including negative lexie, nai. S-NEGT is built as a category and is dominated by S2[7] Indication of *Negative* at the transfer output is as follows:

```
[[reln NEGATE]
 [obje ?obje]]
```

A part of pd rule is as follow:

```
(S-NEGT [[syn [[cat s-negt]]]
```

[7]In current version, S-NEGT. is domionate by s1. However it's more convenient that it's dominated directly by S2. So, It has been changed above.

```
[sem [[reln NEGATE]
      [obje ?obje]]]])
```

There seems to be problematic in the Japanese analysis or the transfer than J-generation, if the *scope* of negation will be treated. In following example, a) is transfered as *affirmative* and b) as *negative* sentence, respectively.
e.g.

a)Kareshika konai

Only he will come.

b)karedake konai

Only he will not come.

3.3.5 Treatment of excetional *NP*

In *NP* rules, there exists exceptional pd for personal name or address expressions. These rules are not binary branch tree structure.

```
(g_pd
 :name N-N1_N2_N3_N4
 :internal_structure (N N1 N2 N3 N4)
 :annotation
 ((N [[syn [[cat n]]]
      [sem [[parm ?X[]]
            [restr [[reln ADDRESS-1]
                    [entity ?X]
                    [CHOUME [[parm ?Y[]]
                             [restr [[reln ?choume]
                                     [entity ?Y]]]]]
                    [CITY [[parm ?Z[]]
                           [restr [[reln named]
                                   [iden ?city]
                                   [entity ?Z]]]]]
                    [TOWN [[parm ?A[]]
                           [restr [[reln named]
                                   [iden ?town]
                                   [entity ?A]]]]]
                    [WARD [[parm ?B[]]
                           [restr [[reln named]
```

```
                                        [iden ?ward]
                                        [entity ?B]]]]]]]]]])
 (N1 [[syn [[cat n]]]
      [sem [[iden ?city]]]])
 (N2 [[syn [[cat n]]]
      [sem [[iden ?ward]]]])
 (N3 [[syn [[cat n]]]
      [sem [[iden ?town]]]])
 (N4 [[syn [[cat n]]]
      [sem [[reln ?choume]]]])
 ))
```

3.3.6 Honorifics

Honorifics is handled by checking the environment value in the rule. English honirifics is expressed by various manners: intonation of sentencial elemnts, lexies, the interrogative...etc, according to the degree of formarilty or politeness, contrastively with Japanese honirifics which is expressed by polite or condescending lexies, the interrogative or the negative.

In current version of the grammar, the politeness is represented by polite or condescending lexies for politeness degree 2. Concretely says, a *VP* category which has [[politeness [[degree 2]]]] as environment value is generated with gozai masu form as narraive style.

3.3.7 *Subordinate clause*

Subordinatec clause is S1 and is dominated by S2, like *coordinate clause.*

```
((S2   [[syn [[cat s2]]]
        [sem [[reln request]
              [agen [[label *speaker*]]]
              [recp [[label *hearer*]]]
              [obje ?proposition]
              [manner ?manner]
              [cond ?cond]
              [attd ?attd]]]])
 (S1-1  [[syn [[cat s1]]]
         [sem ?cond]])
 (CONJ  [[syn [[cat conj]]]
```

```
          [sem [[parm ?X[]]
                [restr [[reln tara-conj-1]
                        [iden ?iden]
                        [entity ?X]]]]])
  (SIGN1 [[syn [[cat sign][lex ","]]]])
  (S1-2  [[syn [[cat s1]]]
          [sem ?proposition]])
  (FP    [[syn [[cat fp]]]
          [sem tekudasai]])
  (SIGN2 [[syn [[cat sign][lex "."]]]]))
```

S1-1 is combined with S1-2 by a conjunction, tara. Between two clauses, there are no different treatments for the *subordinate* or the *coordinate*. In generation phase, the semantic structure is fixed and no need to identify the two.

3.3.8 Idioms

Idiomatic expressions as sentences,like
e.g.

Good bye.

Sitsureishimasu

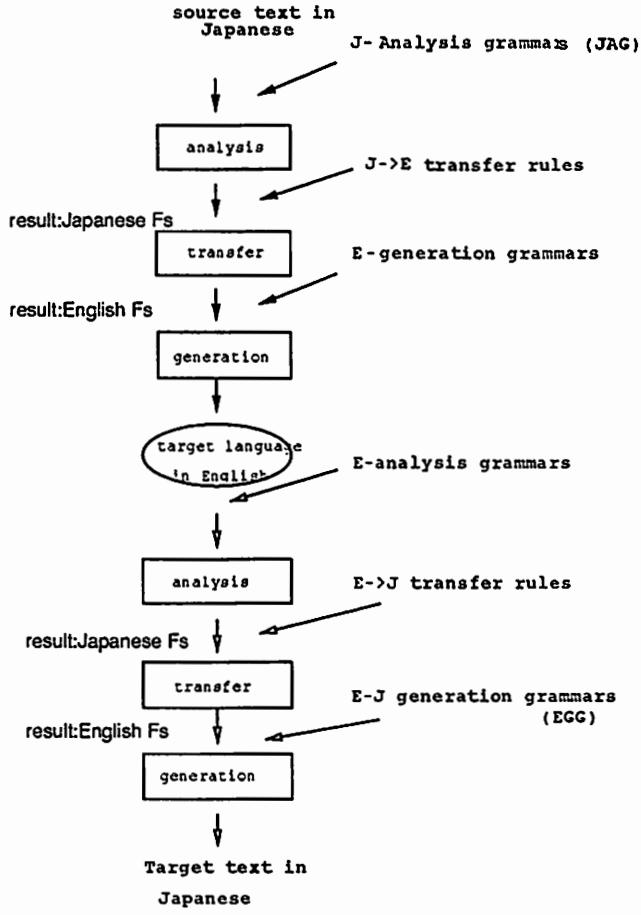
is handled by the method in which is presumed to be dominated by S2. Therefore, the rule for idiomatic sentence is as follows:

```
(g_pd
 :name S2PHATIC-IDIOM_SIGN
 :internal_structure (S2 IDIOM SIGN)
 :annotation
 ((S2    [[syn [[cat s2]]]
          [sem [[reln phatic]
        [agen [[label *speaker*]]]
        [recp [[label *hearer*]]]
        [obje ?obje]]]])
  (IDIOM [[syn [[cat idiom]]]
          [sem ?obje]])
  (SIGN  [[syn [[cat sign] [lex "."]]]])
  ))
```

3.4 Reversibility of JAG to JGG

The experiments comparing Japanese-analysis grammar (JAG) with Japanese generation one (JGG) was tried to examine reversibility of (JAG).

It's, *en gros mod* possible to use JAG for E-J generation within Japanese-English generation framework by making minimun changes. In generation phase, semantic structure per sentence is already determined as transfer output and all generation rules should function necesarily in this semantic representation frame.



JAG are described with *HPSG* grammar, in the sense of using the *head feature convention* or the *foot feature principle*. In fact, through *slash* feature principle, phenomena such as *relative clause* formation or *topicalization* are handled. JAG is non-chomskian grammar at the

same time in the sense in which there are no *transformational* idea, *X-bar* consept, trace theory or *movement* theory. It's the reason Japanese language isn't such a language as the *movement* of sentence elements occurs syntactically and systematically for interrogative sentence or relative cluase as mentioned above. Also, Japanese *passive voice* or *causative sentence* are expressed by atacking a kind of suffix to the verb. Since each suffix has explicitely proper case frame, the *transformation* for the passive or the causative isn't necessary. Therefore, the passive or causative in JAG is described such a thinking way as embeding a sentence in the suffix[8].

Tree structure of a sentence including *passive voice* by JAG is shown for an example:

```
|--START
   |--SENT
      |--V
         |--V-MOOD2
            |--AUXV-EVID ->masu
            |--V-ASPECT
               |--AUXV-ASPECT ->tei
               |--V-VOICE
                  |--V-VOICE
                     |--V-VOICE
                        |--AUXV-VOICE
                           |--AUXV-DEAC ->re
                        |--V-KERNEL
                           |--VINFL ->ma
                           |--V-STEM ->fukuma
                     |--P
                        |--POSTP-OBLG ->ga
                        |--N
                           |--N-COM ->kangeikaihi
               |--P
                  |--POSTP-OBLG
                     |--POSTP-TOPIC ->ha
                     |--POSTP-OBLG ->ni
                  |--N
```

[8]This *passive voice* derivation was proposed by mainly Inoue, 1964.

```
                    |--N-COM ->sankaryou
```

After making JGG, according to JAG description, a generation experiment was tried. Following tree structures are output[9]:

```
S2 [#96 EXPANDED  (S2-S1_SIGN1)]
|--S1 [#97 EXPANDED
 (S1-S S-V V-V-MOOD2 V-MOOD2-V-ASPECT_AUXV-EVID V-ASPECT-V-VOICE_AUXV-ASPC
 V-VOICE-P_V-VOICE1 V-VOICE-P_V-VOICE1 V-VOICE-V-KERNEL_AUXV-VOICE V-FUKUMU)]
|  |--S [#98 EXPANDED  NIL]
|     |--V [#99 EXPANDED  NIL]
|        |--V-MOOD2 [#100 EXPANDED  NIL]
|           |--V-ASPECT [#101 EXPANDED  NIL]
|           |  |--V-VOICE [#102 EXPANDED  NIL]
|           |  |  |--P [#103 EXPANDED
                          (P-N_POSTP-OBLG5 N-N-COM N-KANGEIKAIHI)]
|           |  |  |  |--N [#104 EXPANDED  NIL]
|           |  |  |  |  |--N-COM [#105 LEXIFIED "kangeikaihi"  NIL]
|           |  |  |  |--POSTP-OBLG [#106 LEXIFIED "niwa"  (NIWA-PASS)]
|           |  |  |--V-VOICE [#107 EXPANDED  NIL]
|           |  |     |--P [#108 EXPANDED(P-N_POSTP-OBLG1 N-N-COM N-SANKARYOU)
|           |  |     |  |--N [#109 EXPANDED  NIL]
|           |  |     |  |  |--N-COM [#110 LEXIFIED "sankaryou"  NIL]
|           |  |     |  |--POSTP-OBLG [#111 LEXIFIED "ga"  (GA-PASS)]
|           |  |     |--V-VOICE [#112 EXPANDED  NIL]
|           |  |        |--V-KERNEL [#113 LEXIFIED "fukuma"  NIL]
|           |  |        |--AUXV-VOICE [#114 LEXIFIED "re"  (AUXV-VOICE-RERU)]
|           |  |--AUXV-ASPC [#115 LEXIFIED "tei"  (TEIRU)]
|           |--AUXV-EVID [#116 LEXIFIED "masu"  (MASU)]
|--SIGN [#117 LEXIFIED "."  NIL]
```

```
    --kangeikaihi niwa sankaryou ga fukuma re tei masu .
```

Some problems laies on the output.

- Subcategirization features

  This is one of generated tree structure and generated Japanese among three different outputs. Other two sentences which are not correct are output at the same time:

[9] In JGG, verbs are not divided into Stem and VINFL as category. And the postpositional particle niwa is handled as a lexical entry, contrastively in JAG it's two different entires: ni and wa

-sankaryou ga fukuma re tei masu .

-fukuma re tei masu .

The reason for second and third outputs is there are two obligatory arguments as case frame of the verb.

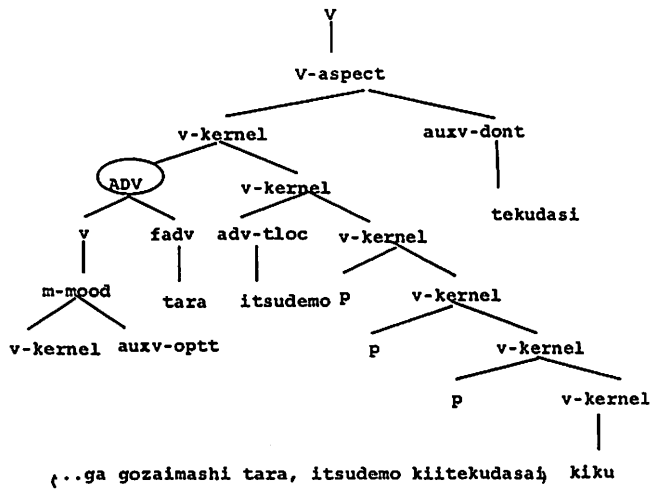
In JAG, matches of subcat features of verbs are made with a set of posibilities such a projection as either or...either or... This is due to be taken account of the omission of Japanese *NP* of a sentence. Supposing a verb which occurs with an obligatory object and subject, there is a PD with three different items: for the cases of 1) subcat without ellipted *NP*, 2) subcat with ellipted subject and 3) subcat with ellipted object. In JAG, these three PDs are applied with or system, as mentioned above. Such an or description in JAG subcat is necessary, because only one *case frame* among a set of possibilities appears in source text to be analyzed.

However, in JGG it should be determined previously how many *NP* a verb has as obligatory arguments. If there are several possibilies of the case frame for a verb, rule should be described as different rule, because of *subcat* numbers. It's applied separately as different rules to avoid generating multiple outputs.

- Redundancy of grammars

  When the semantic representation has already determined, it is redundant to apply grammar rules which are oriented to determining semantic representation.

  For example, subordinate clause is analyzed as an adverbial phrase in JAG which is dominated by v-kernel.



This analysis result is rewritten at the transfer phase as follows:

```
[SEM [[RELN REQUEST]
      [AGEN !X4[[LABEL *SPEAKER*]]]
      [RECP !X3[[LABEL *HEARER*]]]
      [OBJE [[RELN ASK-V-1]
             [TENSE FUTURE]
             [AGEN !X3]
             [RECP !X4]
             [OBJE []]
             [TLOC [[PARM !X1[]]
                    [RESTR [[RELN ANY_TIME-ADV-1]
                            [ENTITY !X1]]]]]
             [SEM-ASPE UNREAL]]]
      [MANNER DIRECT]
      [COND [[RELN IF-CONJ-1]
             [OBJE [[RELN HAVE-V-1]
                    [ASPT UNRL]
                    [TENSE FUTURE]
                    [AGEN !X3]
                    [OBJE [[PARM !X2[]]
                           [RESTR [[RELN QUESTION-N-1]
                                   [ENTITY !X2]]]]]
                    [SEM-ASPE UNREAL]]]]]
      [ATTD DECLARATIVE]]]
```

For this rewritten results, following rule is sufficient to generate

a *subordinate* clause.

```
S2REQUEST-S1-1_CONJ_SIGN1_S1-2_SFP_SIGN2
```

- Decisive differences between the two

  - JAG is not reversible because of *or*-description in *subcat* as mentioned above. In JAG, case frame description by (:OR ...) permits to get chosen one among (:OR ...) for the analysis, but for generation it gives ambiguities. Following JAG is given as an example:

```
(deflex-named OSHIERU-stem-1 OSHIE vstem
  !(lex-phon-orth "oshie" "OSHIE")
  !(others-VERB-STEM-syn OSHIE !chng- vow)
  (<!m syn head vcat> == [[vol +][move -]])
  (<!m prag aspe > == !empty-dlist )
  (:or
     (!(GA/SUBJ-WO/OBJ-NI/OBJ2-VDT OSHIERU-1 agen obje recp)
      (<!m syn head grfs subj semf> == [[anim +]])
      (<!m syn head grfs obj2 semf> == [[anim +]]))
     (!(GA/SUBJ-KA/OBJ-VT OSHIERU-1 agen obje)
      (<!m syn head grfs subj semf> == [[anim +]])))
  !(nonpolite-verb-prag ?speaker ?hearer) )
```

  - JAG is not helpful for generating ellipted pronoun as mentioned above. Obligatory arguments of an English verb is not frequently obligatory frequently in Japanese. Especially pronoun ellipsis is taken account into. Following example shows that , if the objective pronoun is not omitted in Japanese, nuances of utterance will occur.

    e.g.

    Well then, I'll send you a registration form.
    Soredewa tourokuyoushiwo okurimasu
    Soredewa anatani tourokuyousiwo okurimasu

    Needless to say, transfer output provides all obligatory arguments. In current generation grammar, *dative* or *nominative* case and labeled *NP* which in general *hearer* or *speaker* can be omitted by *slash* indication. This is an example of generation for the ellipsis of only dative case:

soredeha , *speaker* wa) trace (tourokuyoushi wo okuri masu .

- postpositional partiles

  In JAG, compound postpositional particles, *e.g.* SAEMO, DENO, DEHA, MADEMO..ETC are combined by the phrasal structure rule. However, it's convenient to describe them a lexie in lexicon. For example, SAEMO can be devided into SAE (postp-contr) and MO (postp-contr) and in JAG there is a rule like this:.

  postp-contr → (postp-contr postp-contr)

  SAE and MO are pragmatic categories and are handled by ckecking the environment value in JGG. To avoid augmentation of rules quantity and checking frequency, it's better to make unification of postpositional particles and to build new categories for compound postpositional particles.

Conclusion

There is a number of linguistic theories or grammars in the world. Among these grammars, *case* grammar for determining the meaning of the sentence elements, *x-bar* theory for determining the level of phrase structure and *trace* thoery for pronoun ellipsis and relative clause are used for JGG.

In *principle-based parsing*, *x-bar*, *WH-movement*, theta thoery, *case* thory are applied at the cascarde method, keeping step according to parsing process. If *x-bar* rule and *+-N+-V* feature concept of *x-bar* theory are used for underspecification of ambiguities, it must be useful. Also the underspecification will be helpful to analyse ungrammatical sentences.

The reversibility of JAG-JGG was verified *en gros mod* with JAG's minimum changes. The analysis system is slightly different from the generation system, although the two are using the unification grammar. Also, in JAG, a number of templates is used, contrastively zero template in JGG. In stead of these differences, if JAG can be rewritten quasi-automatically as generation grammar, it looks like interresting.

Annex

Generation results for conversation A,B are shown[10][11].

Hello.
–mosimosi .
Is this conference the office?
–sochira wa kaigijimukyoku desu ka .
Yes.
–hai .
That's right.
–sodesu .
I'd like to aplly for te Conference.
–kaigi ni sankasi tai nodesuga .
Do you already have a registration form?
–sudeni tourokuyoushiwo mot teimasu ka .
No.
–iie .
Not yet.
–madadesu .
I see.
–wakarimashita .
Well then, I'll send you a registration form.
–soredeha *speaker* wa ¡trace¿ tourokuyoushi wo okuri masu .
May I have your name and your address, please?
–jyuusho to namae wo onegaishimasu .
My address is 23 Cyayamachi, Kitaku, Osaka.
–jyuusho wa osakashi kitaku chayamachi 23 desu .
My name is Mayumi Suzuki.
–namae wa Suzuki Mayumi desu .
I see.
– wakarimashita .
I'll send you a registration form immediately.
–soredeha , *speaker* wa ¡trace¿ tourokuyoushi wo okuri masu .

[10]Output is not only one, but all outputs for a sentence are same.

[11]The rules has two versions of JAG and JGG. Between the two, few differences of category name are thre.

If there's something you don't understand, please ask me aun time.
-wakara nai ten ga gozaimasu .
-itsudemo kii tekudasai .
(This sentence was devided into two, because of 'out of memory'.)
Thank you very much.
-arigatougozaimasu .
Well then, good-bye.
-shitsureishimasu .
Good-bye.
—-shitsureishimasu .
Hello.
-mosimosi .
This is the Conference office.
-kochira wa kaigijimukyoku desu .
I'd like to attend the conference.
-*speaker* wa kaigi ni sankasi tai nodesuga .
What should I do?
-dou sure ba yorosii desu ka .
First, you have to use a registration form.
-mazu *hearer* wa tourokuyoushi de tetsuzuki wo si teitadaka nakutewanarimasen .
Do you already have a registration form?
-sudeni tourokuyoushiwo mot teimasu ka .
Not yet.
-madadesu .
Please send me the foorm.
-*speaker* ni youshi wo okut tekudasai .
Welle then, may I have your name and your address, please?
-dewa jyuusho to namae wo onegaishimasu .
My address is 1-2 Tokui-machi, Higashi-ku, Osaka.
-jyuusho wa osakashi higashiku tokuimachi 2 no 1 desu .
My name is Taro Shimizu.
-namae wa shimizu Tarou desu .
I see.
-wakarimashita .

Do you need an attendance fee?
–sankaryou wa iru nodeshou ka .
Yes.
–hai .
As the registration fee, thirty-five thousand yen per person is necessary.
–ohitori 35000 yen ga sankahi toshite hitsuyoudesu . Isee.
–wakarimashita .
Thank you very much.
–arigatougozaimashita .
Good-bye.
–shitsureishimasu .

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