Extraction of Pragmatic Information in a CALL System

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NLP-m Project Report

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1 Introduction

1.1 The Problem

Diagnosing pragmatic ill-formedness in a computer-assisted instruction system is not a straightforward task. Since pragmatic information can be expressed at dififerent linguistic levels, such as in the lexicon or in syntactic structure, a simple matching of parsed output does not lead to a good error-detecting strategy. For example, uncertainty of the speaker can be expressed with a sentential adverb such as *maybe* or *perhaps,* or a modal auxiliary such as *may* or *might,* by embedding the proposition inside / *think that...* or / *assume that...,* or by attaching a tag question at the end of the proposition. A system which relies only on the f-structure, which is the output from the syntactic parser, would have no way of knowing that those structures actually convey very similar information, and that sentences with dififerent syntactic structures conveyed the same prepositional and pragmatic content.

If pragmatic information can be extracted from the output of a syntactic parser, and and if it can represented in a systematic way, a computer assisted instruction system benefits in two ways. One is that the system will be able to give students flexibility to express propositions in different ways, since the system can recognize the similar pragmatic information expressed in dififerent structures and accept them. The second advantage is that the system will be able to detect errors and give finer feedback on pragmatic usage of the language based on the information systematically represented and stored.

1.2 A Solution: P-STRUCTURE

As a solution to the problem described above, constructing a *p-structure,* which represents pragmatic content as feature-value sets scoping over the prepositional content of a sentence, is proposed. This requires a mapping program which converts f-structures into p-structures.

The motivation for constructing this program is based on the hypothesis that syntactic structures are able to convey meanings outside the basic semantic predicate-argument structures [Fillmore et al., 1988] [Levin and Nirenburg, 1992]. The program thus needs to be able to recognize and extract pragmatic information which is embedded not only at the lexical level but also at the constructional level in f-structure. This p-structure mapping program enables us to obtain a detailed pragmatic representation, and to compare propositional content of more than one sentence independently from its syntactic structures or pragmatic content.

In this project such a mapping program was implemented and integrated with the existing Japanese tutorial system ALICE-chan. In the ALICE-chan system, a teacher is able to construct an exercise by simply typing in a correct sentence and defining a blank around it The system automatically sends the sentence to the natural language processing component for analysis. The students' input sentence is also analyzed in exactly the same way as the teacher's input. The result is then sent to the matching program, which compares the teacher's and the student's predicate-argument structures and returns appropriate feedback.

The new p-structure mapping program involves the neutralization of syntactic structures. This raise the question of when and which syntactic information to throw away in processing of the input. For example, different constructions which express the same pragmatic content contain different subcategorization frames that are crucial for building a predicate-argument structure. Such construction-specific information should be retained until a predicate-argument structure is built, but then be dropped in the syntactically neutralized p-structure. For this reason, the new p-structure mapping program is placed between the grammatical-function assignment program and the matcher. The integration of the mapping program into system thus involves the modification of the matcher as well as the design of appropriate feedback for the pragmatic usages of the language. This project focuses on two phenomena in Japanese: constructions to express evidentiality (or speaker's uncertainty), and expressions of request.

2 The Original ALICE-chan System

2.1 Overview

ALICE-chan is a computer assisted language learning environment for Japanese language instruction, developed in the Laboratory for Computational Linguistics and at the Center for Machine Translation at Carnegie Mellon University. The system uses natural language processing (NLP) methods both for authoring exercises and for evaluating students' responses.

The analysis of the author's model answer is stored as part of the exercise and is later compared to the analysis of the student's answer during error detection, where mismatches are pointed out to the student. The system can thus assist the author in getting better result with less work, since the author does not have to specify possible wrong answers and feedback for each exercise. Furthermore, by optionally allowing the author to edit the analysis to increase or restrict the range of student answers that should be accepted, the system gives the author some control over the NLP-based error detection mechanism without having to understand the internals of the NLP components.

Unlike in some other CALL systems which only rely on string matching for error detection [REFERENCE???], in the ALICE-chan system the NLP-based analysis makes it possible to recognize a wide range of responses as right or wrong without requiring an exhaustive list. (This includes sentences that differ in word order.) Using the rich information from the analysis, the system can not only find the location of errors but also explain the error in terms of linguistic relations.

2.2 Lexical and Morphological Analyzer

The NLP lexicon contains information for the system to recognize words in all of their morphological variants and to identify syntactic and semantic features of the word. Each lexical entry consists of two main parts:

- A list of three different orthographic representations of the word.
- A list of syntactic and semantic features and possible continuation of the morpheme.

The morphological processor takes the form of a finite state machine whose transitions are morphemes. The processor finds a sequence of morphemes that can travel from an initial state (possible beginning of a word) to a final state (possible ending of a word), while accumulating feature-value pairs from each morpheme entry. The output of the morphological analysis is a feature structure which identifies the morphemes that comprise the input word and their inflectional and semantic features.

2.3 Syntactic Analyzer

The ALICE-chan system uses the same syntactic analyzer during both exercise authoring and student exercises. In exercise authoring, the correct answers from the author are analyzed so that

3 Background

3.1 Linguistic Analysis of Pragmatic Information Encoding

3.1.1 Speech Act Theory and Linguistic Politeness

The concept of speech act was introduced by [Austin, 1962] to be actions that are performed by saying certain utterances in the right context. Austin also proposed the concept of felicity conditions, which need to be satisfied in order for an utterance to function as a particular speech act. While Austin's speech act was limited to explicit performatives, [Searle, 1975] extends the idea and develops the theory of indirect speech acts, which can be expressed in various linguistic structures. Searle classifies speech acts into five general categories (listed below) and defines the felicity conditions for each act:

1. **Representatives.** Statements about the world that can be judged as true or false, such as assertions and conclusions.

2. **Directives.** Attempts of the speaker to change the hearer's intentions or behavior, such as request, beg, suggest, and command.

3. **Commissives.** Commitments of the speaker to some intention or behavior, such as promise and threat.

4. Expressives. Expressions of the speaker's psychological state, such as apologize and thank.

5. **Declaratives.** Executions of some act by the use of language, such as quit, fire, marry, and resign.

Grice's theory of communication [Grice, 1971, Grice, 1975] has been basis for many studies of indirect speech acts and linguistic politeness. Grice argues that only when the speaker's intention to communicate is recognized by the addressee, that the communication is considered to be achieved. He proposes maxims to calculate the intended meaning of an utterance from the expressed proposition based on the cooperative principle observed among interlocutors.

Brown and Levinson develop a theory of politeness [Brown and Levinson, 1978] and [Brown and Levinson, 1987] in order to provide an explanation for discrepancies between Grice's maxims and observed conversations. They postulate the idea of "face", which has two aspects, "negative face" and "positive face". Negative face is defined as "the want of every 'competent adult member' that his action be unimpended by others", and positive face is defined as "the want of every member that his wants be desirable to at least some others" [Brown and Levinson, 1978] p. 68. Based on this concept of 'face,' five major politeness strategies are formulated and claimed to be universals:

1. Without redressive action, baldly.

2. Positive politeness.

3. **Negative politeness.**

4. **Off record.**

5. **Avoid the Face Threatening Act.**

While Brown and Levinson's work and Grice's are based solely on the propositional content of an utterance, [Matsumoto, 1989] and [Ide, 1989] observe another type of politeness which is encoded in linguistic structures but falls outside of propositional content. Ide calls it the *discernment* aspect which is

> **... oriented mainly toward the wants to acknowledge thb ascribed positions or roles of the participants as well as to accommodate to the prescribed norms of the formality of particular settings. [Matsumoto, 1989], p. 231.**

While some languages allow the expression of discernment to be optionally encoded in a neutral utterance, a language like Japanese does not have a neutral form and thus requires the encoding of discernment information in every utterance. Matsumoto points out that a speaker of Japanese has to be constantly choosing the appropriate speech level according to the formality of the setting and the relationship among the interlocutors. The speaker's use of an unexpected encoding may trigger what Matsumoto calls "interactional implicatures" which then invoke inferences even when other aspects of the utterance such as relevance and quality of information are perfectly appropriate.

These studies suggest that the representation of linguistic politeness will require at least two separate scales: discernment and volition (employment of verbal strategies, etc.) Both aspects are points on a continuum, and a single utterance thus usually contains the both aspects interacting each other in expressing politeness. [Matsumoto, 1989] p. 218 presents an interesting example of the interaction of the two aspects in the following two utterances:

```
(a) kore-o morattemo ii?        (Matsumoto's (11))
    this-ACC receive even though O.K.
    'Is it O.K. to have(get) this from you?'

(b) kore-o kudasai.             (Matsumoto's (12))
    this-ACC give-me-Imperative-polite
     'Please give this to me.'
```

Although (a) is less imposing (less "face-threatening" in Brown and Levinson's term) than (b), (a) is generally perceived less polite because of its informal speech level, unless uttered to a close friend of the speaker's.

The interaction of the two aspects becomes more distinct when we take a close look at a laige number of expressions with the same propositional content. The following are lists of expressions collected in the quantitative study conducted by [Hill et al., 1986]. 30 Japanese and 30 American

students were asked to list all expressions they use in borrowing a pen in their native language. The students were then asked to rate the politeness of each expression on a 5-point scale..

Ranking of politeness of request forms in Japanese:

(4-5) okarisitemo yorosiidesyoo ka
kasiteitadakitaindesu keredo
kasiteitadakemasuka
okaridekimasuka
kasiteitadakemasenka
kasitekudasaimasenka
(3-4) kasitekuremasenka
iidesuka
kasitekudasai
(2-3) kasitehosiindakedo
kariteii
kasitekureru
(1-2) tukatteii
kasiteyo
kariruyo
ii
kasite
pen
aru

Ranking of politeness of request forms in American English:

(4-5) May I borrow
Would you mind if I borrowed
Would it be all right if I borrowed
I was wondering if I could borrow
(3-4) Do you think I might borrow
Do you mind if I borrow
I wonder if I could borrow
Is it all right if I borrow
Do you have a pen I can use
Can I bother you for a pen
Would you lend me
Could I borrow
Could you lend me
Can you lend me

(2-3) Can I borrow
Can I use
let me borrow
(1-2) Got a pen I can use
Lend me
Can I steal
Gimme
A pen

Although some expressions in these lists require large amount of inference in order to function as a request and thus are out of scope of this project, the lists and ranking provide us some insight about the encoding of linguistic politeness in requests. It is striking that all the Japanese expressions over scale 3 contain predicate with the formal ending, whereas the ones under 3 do not In addition, we can recognize that the distinction between honorific and non-honorific verbs is also contributing the difference in the degree of politeness. For example, *kasite itadakemasen ka* is ranked higher than *kasite moraemasen ka,* and *kasite kudasaimasen ka* is ranked higher than *kasite kuremasen ka,* where the only difference between the pairs is in the auxiliary verbs *(itadaku* versus *morau, kudasaru* versus *kureru).* It implies that the discernment aspect has a consistent effect on the perceived degree of politeness.

The authors of this quantitative study claim that the imposition factor is kept constant since the study deals only with the requests in borrowing a pen. I believe, however, that the rankings are clearly affected by the degree of imposition expressed in each utterance. The uses of negative forms, interrogative forms, the past-tense form of auxiliary verbs *(could* or *would),* and hedging *(Do you think...* or *would you mind if...* in English,... *temo iidesuka* or... *kedo* in Japanese) can all be considered verbal strategies to reduce the degree of imposition, and they do contribute to the higher degree of perceived politeness in the ranking. It is thus very important to decompose the different aspects of politeness expressed through various linguistic forms and represent them in a systematic way, in order to capture pragmatic information accurately.

The study by Hill et al. also found that Japanese forms are distributed more evenly and within a longer span of the scale than American English forms. Furthermore, the study also investigated the relative frequency with which specific request forms are used toward specific categories of addressees in typical situations. It found that the Japanese subjects show a stronger correlation between particular person/situation features and the form of a request than American subjects. The result of this study implies that different languages assign different weight to the various factors subsumed under the discernment aspect and the volition aspect, although they follow the same overall model of polite use of language.

3.1.2 Expression of Evidentially in Japanese

Evidentiality is another kind of pragmatic information which is not fully grammaticized but encoded by various word of morpheme classes in the Japanese language. [Kamio, 1975] analyzes

Japanese evidentials in terms of "territory of information". He claims that certain sentence-final forms (the bare verbal form, sentence-particle *yo* and the extended predicate) can be used only when the given proposition is held exclusively by the speaker, that is when the information belongs to the speaker's 'territory of information.' Following is some examples of such forms.

(a) Taroo wa byooki da. (Kamio's (2))
(Taroo is ill.)

(b) Usuzan ga mata hunkasita-yo. (Kamio's (4))
(Mt. Usu erupted once again.)

(c) Soori-wa moosugu intaisuru-n-da. (Kamio's (5))
(It is that the Prime Minister will soon retire.)

On the other hand, when the information does not belong to the speaker's territory of information, sentences such as (a), (b) and (c) arc not appropriate. Instead, different forms such as (d), (e) and (f) are generally used:

(d) Taroo wa byooki da tte. (Kamio's (3))
(It's said Taro is ill.)

(e) Usuzan-ga mata hunkasita yoo da-na. (Kamio's (8))
(It appears that Mt. Usu erupted once again, doesn't it?)

(f) Usuzan-ga mata hunkasita soo da-ne. (Kamio's (8))
(It is said that Mt. Usu erupted once again, isn't it?)

While Taro's father is likely to use (a) to utter to one of his son's friend, if the friend in turn wants to convey the same information, (d) is more natural.

Although Kamio's idea of "territory of information" playing an important role in Japanese evidentials is very insightful, to categorize the evidentials into only two (inside and outside of the speaker's territory) seems too simple-minded. For example, sentence (d) can take sentential particles such as 'ne' and 'yo' to express different connotations:

(d') Taroo wa byooki da tte ne.

(d'') Taroo wa byooki da tte yo.

Since the sentences above still contain the hearsay marker *tte*, the information does not belong to the speaker's territory according to Aoki's analysis. However, (d") is used only when the speaker believes the addressee has not heard the news yet, whereas (d') is used when the speaker assumes that the addressee has already heard the news. Therefore, there are at least two separate aspects in evidentiality expressed in Japanese. One is the speaker's belief or assumption about the addressee's

knowledge on the particular piece of information. The other is the source of information, i.e. how the speaker has obtained it.

The speaker's belief about the addressee's knowledge. When the speaker believes the addressee does not know the proposition, s/he uses the forms such as (&), (b) and (c) above (the bare-verbal form, sentential particle *yo' and the extended predicate). On the other hand, if the speaker believes the addressee has also had an access to the information, s/he uses sentential particle *ne' or the tentative form of the predicate with rising intonation. In fact, as Kamio points out, a statement about the weather can be extremely strange without such a marker since both of the interlocuters have an access to the information:

(g) Ii tenki desu-ne. (Kamio's (29))
(It's very fine,..isn't it?)

(g') *Ii tenki desu_. (Kamio's (30))

The source of information. The direct form (the bare predicate) is used when the speaker has a direct access to the information. The speaker's perceptual content or the speaker's interpretation based on his/her perception is a typical instance of such kind of information. Especially in the Japanese language the speaker's own perception and a third person's are clearly distinguished because one is not considered able to access any perception or inner feelings of anyone else other than his/her own. Therefore an expression of perception or feelings with the bare form such as (h) below is always considered the speaker's own, whereas some evidential marker is required to express someone else's perception or feelings as in (i) and (j):

(h) Sabisii.
lonely
(I'm lonely.)

(h') *Kare wa sabisii.
he T.M. lonely
(He is lonely.)

(i) Kare wa sabisii no da.
he T.M. lonely COP
(He is lonely.)

(j) Kare wa sabisi -gatteiru.
he T.M. lonely
(He is showing signs of being lonely.)

The extended predicate used in (i) turns the proposition into a statement of fact, whereas *-gatteiru* in (j) is a verb meaning 'showing signs of...' implying the speaker's inference based on his/her

perception of the signs.

When the speaker expresses the information which has been obtained by hearing from someone, one of the hearsay markers which may be translated as *they say*, *I hear* or *it is said*. The typical hearsay markers in Japanese are *soo* plus a copula and the more colloquial *–tte* as in examples (d) and (f). In this way, the speaker is able to express that the source of the information is someone else but without having to specify the source.

There are also other evidentials to imply an indirect source of information. The detailed analysis of such markers is presented by [Aoki, 1986]. The evidentials such as the one used in (e) are inferential forms translated as *seem*, *look like*, and *appear*. According to Aoki, *–yoo da* is used "when the speaker has some visible, tangible, or audible evidence collected through his own senses to make an inference" [Aoki, 1986] p. 231. He gives the following example to illustrate this point:

(k) Soreni omae no yoosu o mi -reba doomo sima
further you P.M. behavior O.M. see -when at all island

e iku no o kunisi -te-i -nai -yoo da.
to go NOM. O.M. be troubled -PROG -NEG
(Besides, as I watch you I get the feeling that you are not at all bothered by the prospect of exile.)

(Aoki's (41))

The second inferential marker *–rasi –i* is used "when the evidence is circumstantial or gathered through sources other than one's own senses" [Aoki, 1986] p. 231. This observation is based on the fact that one can utter (l), a sentence with *rasii*, not when looking at the clear sky, but when unable to see the sky and merely making a guess based on the factors such as the brightness of the room.

(l) Hare te-i-ru rasi -i. (Aoki's (42))
clear result
(It seems to be clear.)

Aoki also points out that *Soo da* as an inference marker (attached to the pre-masu form rather than the plain form of a verb) expresses the speaker's belief of the proposition being true. Therefore (m) is ungrammatical.

(m) *Ame ga huri soo da ga hur -ru to wa omowa -na -i.
rain S.M. fall but fall -NP Q.M. T.M. think -NEG -NP
(It seems that it is going to rain but I don't think it will.)
(Aoki's (48))

Other evidentials in Japanese. There is a subclass of adverbs which deals with the speaker's attitude toward the truth value of a proposition. They express evidentiality either alone or in

combination with other evidential elements in the predicate. Those adverbs can be classified into three major classes:

1. **Adverbs that express the speaker's conviction or certainty.**
2. **Adverbs that express the speaker's doubt.**
3. **Adverbs that express the speaker's negative conviction.**

The first class of adverbs includes *matigainaku* (unmistakably), *utagainaku* (undoubtedly), *tasikani* (certainly), *kanarazu* (infallibly), *kitto* and *sazo* (surely). Adverbs in this class do not necessarily require other evidential markers in the predicate. The second class of adverbs includes *tabun, osoraku, dooyara,* which can all be translated as *probably.* Adverbs which express a greater degree of doubt such as *mosikasitara* or *hyottosite* (possibly) often require the predicate indicate a corresponding degree of certainty, as Aoki points out in the following examples:

(n) Dooyara kare wa hon o yon-de-iru rasi -i. (Aoki's (60))
likely he T.M. book O.M. read-PROG
(He seems to be reading the book.)

(n') *Dooyara kare wa hon o yon-de-iru. (Aoki's (61))
likely he T.M book O.M. read-PROG
(He is likely to be reading a book.)

The third class of adverbs such as *masaka* (surely not) usually requires both inferential and negative element present in the same sentence:

(o) Masaka kare wa sono hon o yon-de-i -nai daroo.
surely he T.M. the book O.M. read-PROG -NEG TENTATIVE
(I doubt that he is reading the book.) (Aoki's (64))

(o') *Masaka kare wa sono hon o yon-de-iru. (Aoki's (62))
(He could not possible be reading the book.)

(o'') *Masaka kare wa sono hon o yon-de-iru rasi-i. (Aoki's (63))
(He could not possibly be reading the book.)

We should also note that those evidentials are used not only as a marker of the speaker's attitude toward the addressee's knowledge or toward the proposition, but also as a verbal strategy to express politeness. For example, the speaker may use sentential particle *ne* as one of "positive politeness strategies" in Brown and Levinson's sense by expressing the sense of shared knowledge. The evidentials to express the speaker's doubt or uncertainty can often be used to soften the effect of asserting a proposition, even when the speaker is certain about its truth value. This use of evidential can be considered one of the "negative politeness strategies" which reduce the Face Threatening effect of some speech act.

3.2 Representation of Pragmatic Information in Computational Systems

In the PENMAN text generation project based on the *Nigel* grammar developed at the University of Southern California [Bateman et al., 1990], textual meaning is represented in the "upper model", a hierarchical property-inheritance network of concepts. The upper model consists of four subhierarchy: the process hierarchy, the object subhierarchy, the quality subhierarchy and the interpersonal attitude subhierarchy. Pragmatic information is represented under the interpersonal subhierarchy in the model. The interpersonal subhierarchy, however, includes only polarity and speech acts. Furthermore, the speech acts that this model handles are limited to the ones which can be directly translated from certain syntactic structures. That is, there are only four kinds of speech acts — question, command, assertion and answer, which result in a surface form interrogative clause, imperative clause and indicative clause and an elliptical form functioning as an answer, respectively.

[Nirenburg and Defrise, 1992] have developed a model of text-meaning representation which consists of the following:

1. T: textual meaning.
2. G: an agent's active set of goals and plans.
3. S: the setting of the communication situation.

In their model, the speaker's attitudes (epistemic, evaluative, deontic, volition, etc.) are represented in T (textual meaning) on a 0, 1 scale scoping over part of the text. On the other hand, pragmatic factors such as formality, directness and respect are represented in S (the setting of the communication situation). This way of representation makes it possible to capture and represent the meaning of multi-clause sentences, where the scope of the speaker's attitude is limited to one proposition, namely one clause, whereas other pragmatic factors scope over the whole sentence or the whole discourse.

ATR's speech translation system [Kogure et al., 1988, Kurematsu, 1993] uses the intention translation method in which two different representations, prepositional content and the speaker's intention, are translated separately. Whereas prepositional contents are represented by recursively defined relationships which are language-dependent, intentional contents such as request, promise, greetings, etc. are passed through the transfer process.

3.3 Extraction of Pragmatic Information in Computational Systems

In interpreting speakers' intentions and attitudes in natural language processing systems, the most well-known *approach* is based on plan recognition [Perrault and Allen, 1980, Sidner and D. J, 1981, Allen, 1983], where a speech act is recognized as part of the speaker's plan. The system uses beliefs of each individual agent and shared knowledge which are explicitly stored in the database and other beliefs derived from them to recognizes plans.

The plan-based system is able to recognize the intended meaning of sentences by searching through the interlocutors' beliefs and also preconditions and effects of each action appeared in a

plan. In order to perform this recognition process successfully, the system need not only to have beliefs of each individual agent and knowledge shared by the interlocutors stored systematically, but also to be able to derive other relevant beliefs based on the information in the database. Thus, this process can be computationally very expensive. Furthermore, it fails to use language specific information, such as the fact that some semantically equivalent structures may not be pragmatically equivalent; for example, *Can you pass the salt?* is often used as a request whereas *Are you able to pass the salt?* is not.

In more recent systems [Allen and Hinkelman, 1989], therefore, the plan-based approach is combined with structural processing. The linguistic component of the system uses a set of language-specific rules to identify words or structures which might indicate certain speech-act in some context. The mapping between those linguistic features and corresponding speech acts are, however, highly ambiguous. Unlike true idioms, their literal and non-literal readings do interact with each other at the surface level. In their system, therefore, the linguistic component produces the range of possible interpretations rather than a unique speech act type. The plan recognition component is then used to resolve the ambiguities in context and return a single interpretation.

This combined approach has been used in other areas of natural language systems. For example, in ATR's Japanese to English speech translation system [Kogure et al., 1990b, Kogure et al., 1988], a typed feature rewriting system is used to derive a set of candidate speech act types, which are then filtered using a dialogue plan recognition system. On the other hand, in a limited, goal-oriented dialogue domain such as the NADINE system's [Kogure et al., 1990a] it has been found that a plan recognition component is not crucial for correct translation. Analyzing pragmatic felicity conditions in addition to syntactic and semantic information of the input sentence makes it possible to resolve ambiguities and ellipses [Yoshimoto, 1988],

Another notable computational system that deals with pragmatic information is the work by [Bateman, 1988] who extended the NIGEL grammar. The grammar has a system called "inquiry semantics" which formulates questions to the database and obtains information necessary to construct appropriate grammatical structures in the process of text generation. Bateman has extended the interpersonal subhierarchy of the NIGEL grammar to handle politeness features in Japanese. The system asks all the questions related to the aspect of the social relationships of the interlocutors and the speech situations, and makes appropriate selection of grammatical features based on the information. One of the problem Bateman faced is that pragmatic information and its linguistic encoding do not have one-to-one correspondence. By making the choosers in the system to be able to make any number of selections of grammatical features in the network, he has succeeded in handling a minimal alternation of politeness which can result in radically different grammatical structures that differ by many syntactic features.

3.4 State of the Art of NLP in CALL systems

An intelligent computer assisted language instruction (ICALI) system requires a sophisticated natural language processing component which understands the student input and generates system

responses. Most of the existing ICALI systems use a syntactic parser first to obtain structural information of the input and then pass the information to semantic routines for validation.

In open-ended text processing systems and grammar exercise programs, using such natural language processing techniques, can handle significant syntactic problems foreign language learners face, such as subject-verb agreement and inflection of verbs, although the levels of sophistication in tems of number and type of errors they can detect vary across the systems [Catt, 1988].

When it comes to error-detection beyond syntactic level, it is only possible in more restricted domain such as microworld systems. Microworld systems implement a conversation with students on some very constrained world. Since it is easy to represent knowledge in such a restricted world, those systems are capable of understanding and reacting to student input and detecting semantically incoherent input as well as syntactic errors. Examples of experimental microworld implementations include the LINGO system developed in MIT as part of the Athena Language Learning Project [Morgenstern, 1986] whose microworld consists of a dormitory room. The student is to tell the character (a poltergeist) to move things one place to another to mess up the room. The system can understand the student input and display the outcome of each action in pre-stored graphic image as well as produce responses dictated by conversational strategies. Another microworld implementation is the Foreign Language Adventure Game for Latin and French developed in University of Delaware [Mulford, 1989], where the student is an adventurer who explores the objects around him/her and discovers the plot of the drama s/he is involved. This system does not use graphics but produces utterances to inform the student the outcome of the action, and it can handle more types of actions than the LINGO system.

In both of the two microworld systems, due to their highly controlled text, the vocabulary and structures to be encountered are highly predictable and leave little room for pragmatic exercise. For example, since both programs expect the student to give commands to the system, plain imperative forms are highly expected whereas more subtle ways of expressing requests are unlikely to appear. The student's command then has to be mapped onto one of the operators defined in the program to perform the action, the additional information that the student's lexical choice might have contained will be discarded. (For example, *hurry, sneak* and *creep* are all reduced to the operator go in the Adventure Game) The systems thus cannot give feedback on the appropriateness of the manner of the action (or choice of lexical items) in the given context.

A notable effort to detect more than syntactic errors in less restricted domain can be found in STASEL, a style analyzer developed in University of Toronto [Payette, 1990]. The system is capable of giving feedback on stylistic features such as vagueness, wordiness or unbalanced coordinations by passing the parser output to the "syntactic style analyzer" and then to the "goal-directed style analyzer." However, a rhetoric and pragmatics module that assesses the input sentence according to the writer's intention or purpose is yet to be implemented.

4 Data and Linguistic Analysis

4.1 Speaker's Uncertainty

The major linguistic features which can express the speaker's uncertainty and should be handled in this projects are as follows:

1. **tentative,** susi-o taberu darou.
2. **think,** susi-o taberu to omou.
3. **double-negative,** susi-o tabenai n zya nai.
4. **adverb,** mosikasitara susi-o taberu.
5. **evidential-na.** susi-o taberu mitai da.
6. **evidential-adj.** susi-o taberu kamosirenai.
7. **evidential-stem,** susi-o tabe-soo da.
8. **hearsay,** susi-o taberu soo da.
9. **sentential-particle,** susi-o taberu ne.
10. **extended-predicate,** susi-o taberu to omou n da.
11. **negative,** susi-o tabenai ka to omou.
12. **negative-extended-predicate,** susi-o taberu n zyanai ka.
13. **interrogative,** susi-o taberu ka to omou.
14. **conjunction,** susi-o taberu to omou ga.
15. **interrogative-spart.** susi-o taberu kasira to omou.

When those sentences above are uttered as a mere statement of a fact, the features to express the speaker's uncertainty can be viewed as devices to reduce the speaker's conviction about the truth of the proposition. This view is based on the assumption that one of the felicity conditions [Searle, 1975] for speech act "providing information" to be successfully carried out is:

```
belief:        speaker S believes that proposition P
               is true
```

An affirmative sentence can be used to cany out speech acts other than "providing information". For example, if a person utters one of the sentences above in reply to a question *Would you like to go to an Italian restaurant with me?,* the intended speech act might be "rejection". In that case, the features to express the speaker's uncertainty is functioning as a device to weaken one of the

felicity conditions for speech act "rejection" (i.e. the person's unavailability), and as a result the face-threatening effect of "rejection" is reduced.

In this project, therefore, those above mentioned features are treated as "reducing-factors" for felicity conditions of any speech act.

4.2 Requestives

Since only one sentence at a time can be sent to the analyzer, structures that require inferences beyond sentence level in order to carry out an indirect speech act are not considered within the scope of this project. This restriction is reasonable in this stage, because the interpretation of a given sentence can be constrained by the context/speech situation which the author can specify within the exercise when s/he authors it.

The list of linguistic structures that should be processed as request by the system is as follows:

1. **imperative,** tegami-o kake. *(Write a letter.)*
2. **give-favor-inward-imperative,** tegami-o kaite kure *(Give me a favor of writing a letter.)*
3. **potential-interrogative,** tegami-o kakemasu ka. *(Can you write a letter?)*
4. **give-favor-inward-interrogative,** tegami-o kaite kuremasu ka. *(Will you give me a favor of writing a letter?)*
5. **want,** tegami-o kaite hosii. (/ *want you to write a letter.)*
6. **receive-favor-desiderative.** tegami-o kaite moraitai. (/ *want to receive a favor of writing a letter.)*
7. **receive-favor-potential-interrogative.** tegami-o kaite moraemasu ka. *(Can I receive a favor of writing a letter?)*

Here felicity conditions for speech acts "requesting action" are assumed as:

```
propositional content:   future act A of hearer H
belief:                  speaker S believes that H can do A
desire:                  S wants H to do A
expectation:             S expects H to do A
```

When each requestive form in the data is closely examined, it is found that a particular one of these felicity conditions is usually evoked in a sentence; either the condition is stated or questioned. For example, in sentence 3 *tegami-o kakemasu ka.* the belief condition (S believes that H can do A) is questioned, and in sentence 5 *tegami-o kaite hosii.* the desire condition (S wants H to do A) is expressed straightforwardly.

If the linguistic features to express speaker's uncertainty is used with a requestive, they are interpreted as "reducing factor" for the felicity condition each sentence evokes. For example in

tegami-o kaite hosii to omou n desu ga features such as *omou* (think), the extended predicate and negative conjunction *ga* can be viewed as devices to weaken the speaker's desire for the addressee to perform the action of writing a letter.

While similar grammatical structures seem to carry out the same speech act across languages, some linguistic features to express certain speech act are language-specific. For example, *Can you do X* cannot function as a requestive [Searle, 1975] whereas *You want to do X* is a common form of request in Hebrew [Allen and Hinkelman, 1989]. The constructions with giving-receiving auxiliary verbs for requestives are certainly specific to Japanese. The Japanese language has seven verbs in common usage which correspond to the English *give* and *receive*. These verbs differ according to the relative social positions of the participants in the giving event and the direction of the giving action. When they function as auxiliary verbs attached to another verb, they will add meaning of "give (receive) a favor of doing X". In this project, whenever an appropriate giving-receiving auxiliary verb is used in a requestive, it is interpreted that the expectation condition (the speaker expects the addressee to do the action) is evoked.

4.3 The Design of P-structure

Based on the approach described above, a p-structure is designed so that pragmatic features are represented in terms of felicity conditions and their reducing factors.

There are, however, other pragmatic features that do not affect the felicity conditions of the intended speech act. One is speaker's perception of the speech situation. In Japanese, it is obligatory to express the formality of the speech form in every predicate. The choice of formal/informal form of the predicate expresses mere the speaker's perception of the speech situation in some cases, and can imply the speaker's respect/disrespect or distance/closeness toward the addressee in other cases. Another pragmatic feature encoded in a sentence is speaker's perception of the position of the addressee. By using or not using the honorific form of a verb, the speaker expresses that s/he perceives the addressee socially lower, higher or equal to herself/himself. In the p-structure designed here, therefore, has slots "speech situation" and "placement of addressee" at the top level scoping over the propositional content.
Below is the basic structure of a p-structure designed and used in this project.

```
<p-structure> ::= <requesting-action>
                  <requesting-information>
                  <providing-information>

<requesting-action> ::= ((speech-act requesting-action)
                         (syntactic-feature SYNTACTIC-FEATURE)
                         (action <clause>)
                         (belief <felicity-condition>)
                         (desire <felicity-condition>)
                         (expectation <felicity-condition>)
```

```
                              (placement-of-addressee  PLACE)
                              (speech-situation  SPEECH-SITUATION))

<requesting-information>  : := ((speech-act requesting-information)
                                (proposition <clause>)
                                (reducing-factor  REDUCING-FACTOR)
                                (speech-situation SPEECH-SITUATION) )

<providing-information>  ::= ((speech-act providing information)
                                (proposition <clause>)
                                (reducing-factor  REDUCING-FACTOR)
                                (placement-of-addressee  PLACE)
                                (speech-situation  SPEECH-SITUATION))

<clause> : := {predicate-argument-structure}

<felicity-condition>  :::= ((feature SYNTACTIC-FEATURE)
                             (reducing-factor  REDUCING-FACTOR))

SYNTACTIC-FEATURE  ::= elliptical
                       give-favor-imperat ive
                       give-favor-inward
                       imperative
                       potential
                       receive-favor-desiderative
                       receive-favor-potential

REDUCING-FACTOR : : = extended-predicate
                      conjunction
                      favor
                      adverb
                      double-negative
                      evidential-na
                      evident ial-adj
                      evidential-stem
                      hearsay
                      interrogat ive
                      negative
                      negative-extended-predicate
                      sentence-particle
                      tentative
                      think
```

```
PLACE  ::= higher/lower

SPEECH-SITUATION  ::=  formal/informal
```

5 Implementation

5.1 Extension and Revision of the Syntactic and Semantic Analyzer

In order to process all the structures in the data described in the previous section, the grammar coverage for both the syntactic analyzer and the semantic mapper has been extended. The newly covered constructions include:

causative

passive

desiderative

potential

giving-receiving auxiliary verbs

combination of above

As a next step, the mapping process has been integrated into the parser so that the grammatical function/semantic role assignment of input sentences with complex predicates can be done more effectively. The process is now split into subprocesses and called from the parser at different stages of parsing.

Subprocess 1: Subcategorization the frame. Since the morphological analyzer has a very simple data structure and cannot change the value of the features during the process, the subcategorization information of each lexical entry is limited to minimum feature-value pairs. The presence or absence of each feature-value pair indicates specific subcategorization frame that the predicate requires. For example, the lexical entry of "taberu" (to eat) contain only one pair "wo-patient +" concerning its subcategorization frame.

An complete subcategorization frame for the base form of the predicate is build when the predicate, processed by the morphological analyzer, enters the parser. The frame also specifies semantic restriction of each role based on the information from the feature-value pair in the predicate. For the above mentioned verb "taberu", the function constructs the following frame:

```
((subcat  ((ga  ((actor animate)))
           (wa  ((actor animate))
                ((actee any)))
           (mo  ((actor animate))
                ((actee any)))
           (wo  ((actee any)))
           (ni  ( (time-at time-ni)))
           (to  ((accompaniment animate)))
           (de  ( (location place)))
           (kara  ( (time-from time)))
           (made  ( (time-to time))))))
```

For each particle/case marker, all the possible semantic roles are listed with their semantic restriction. Since any argument NP can be dropped in Japanese, both argument and adjunct roles are treated in exactly the same way.

Subprocess 2: Revising the subcategorization frame. **In** the next step, the parser checks if there is any additional syntactic feature which can affect the subcategorization frame such as passive or causative. If any of those features are recognized, the frame is sent to another mapping function for a further revision. For example, if the feature "passive" exists, the frame above is revised into the one below:

```
( (subcat ( (ga ( (actee any))
                ((affected animate)))
            (wa ((actor animate))
                ((actee any)))
            (mo ((actor animate))
                ((actee any)))
            (wo ((actee any)))
            (ni ((actor animate))
                ((goal any))
                ((time-at time-ni)))
            (to ((accompaniment animate)))
            (de ((location place)))
            (kara ((time-from time)))
            (made ( (time-to time))))))
```

Note that the mapping program reverses the roles "actor" and "actee" between "ga" and "ni", while keeping the semantic restrictions of each role as defined. It is also clear from the frame that the semantic roles and case-markers do not have one-to-one correspondence: more than one particle can marie the same semantic role, and the same particle can marie more than one semantic roles. This is the reason why some semantic roles can not be deterministically assigned as soon as a noun phrase is recognized during parsing, since it depends on the assignments of other noun phrases/semantic roles in the sentence.

Subprocess 3: Make a list of all possible roles for each noun phrase. When a noun phrase is recognized in the input sentence by the parser, its particle and semantic features are compared with the subcategorization frame, and a list of possible roles it can fill is inserted into the feature structure of the noun phrase. For example, a noun phrase *tanakasan-wa* (Mr.Tanaka) will have the following feature structure when combined with the verb *taberu:*

```
((s "Tanaka—family name") (cat noun) (title +) (proper +) (part wa)
 (roles (*MULTIPLE* affected actor actee)))
```

The "roles" feature above indicates that this noun phrase can fill one of the three semantic roles: affected, actor, or actee.

Subprocess **4: Assigning semantic roles to each noun** phrase. After a whole clause is processed by the parser, it is finally sent to the mapping program for the assignment. The mapping, program tries all possible combinations in which all the noun phrases in the input sentence are mapped onto some roles and each role filled by no more than one noun phrase. In order to map all the noun phrases efficiently, noun phrases with restrictive particles (i.e. ones do not mark more than one role) are mapped first, and then noun phrases with less restrictive particles are mapped onto the slots which are still empty. There are some special restrictions that need to be considered during mapping.

1. **Noun phrases with** *mo.* More than one noun phrases marked by particle *mo* can be mapped on to the same role as long as they are adjacent to one another.

2. **Precedence.** If role "affected" and "actee" are both present in the parse, "affected" has to precede "actee".

3. **Role conflict.** Two roles cannot be filled by two *ga* marked noun phrases in one clause.

5,2 Use of Information from the Author's Parse

The second major revision in the system is to separate the processing of author's input and the processing of student's input. By doing so, the efficiency of both of the processings are improved:

1. The parser does not have to consider the possibility of the input being ill-formed when parsing author's input.

2. The processing of student's input can be guided by information from the author's parse, which can reduce the ambiguities in the analysis.

After the author's input is analyzed, some information is extracted from the template and inserted into student's feature structure to guide the parsing/mapping. While case-marking of each noun phrase is crucial in determining its grammatical functions and/or semantic roles in Japanese since noun phrases can be almost freely scrambled, case-marking is one of the most frequent error sources made by students of the language. The mapper, therefore, if the meaning of a noun phrase in the student's input and the meaning of one of the noun phrases in author's parse match, automatically assigns them the same semantic role regardless of the particle the student used or not used with the noun phrase. Using this mapping strategy, the feedback to the student can be improved significantly. For example, when a student types *susi-ni watasi-ga tabemasita* intending / *ate sushi, susi-ni* would be assigned "extra" using the original mapping strategy, since the subcategorization of the frame does not allow a ni-marked noun phrase to be mapped onto "actee":

```
TEACHER:  watasi ga  susi  wo tabemasita.
          I          sushi    eat-PAST
          <actor>    <actee>
```

```
STUDENT: susi ni  watasi ga tabemasita.
         sushi    I         eat-PAST
         <extra>   <actor>
```

Therefore, the feedback used to be:

```
I cannot identify the function of ''susi-ni'' in your sentence.
You left out an actee phrase with the following feature:
meaning sushi.
```

Using the new mapping strategies, the system can correctly recognize that the student used "susi ni" as a actee phrase and made a particle error. The new feed back should be:

You seem to have used the wrong particle on the actee phrase ''susi-ni''.

5.3 The P-structure Mapping Program for Authoring

The new p-structure mapping program is implemented between the syntactic/semantic analyzer and the disambiguaton As in the new syntactic/semantic analyzer, the p-structure mapping program also processes author's input and student's input in different ways.
This program, taking the output from the parser, performs two major tasks:

1. **Strip off those syntactic features that function as reducing factors and identify the propositional content of the given input.**
2. **Identify the indirect speech act of the given sentence and build a "p-structure" accordingly.**

During both of these tasks, the analyzer will encounter many ambiguities. For example, one particular syntactic construction such as / *think that...* can be either a reducing factor for the embedded proposition or an actual part of the proposition. Therefore it is important for the system to preserve these ambiguities and leave it to the author to select an appropriate interpretation.

The first step in the pragmatic mapper is to identify some special forms of the predicate such as the imperatives (*... kake.)* and the elliptical requestives (*... kaite.),* which are recognized as a form of "requesting action" speech act. If the input sentence has none of those special form of predicate, then the pragmatic mapper tries to strip off all the reducing factors until it reaches the propositional content. At the same time it identifies possible speech act types and build p-structures for each one. For example, if the input sentence is *tegami-wo kaite itadakenai darou ka to omou n desu ga.,* it goes through the following processes in the pragmatic mapping program:

```
Input (output from the parser):

COMPLEMENT
```

```
          FAVOR          ACTEE    手紙を (tegami-wo)
                                  SENSE    ''letter''
                         書いて (kaite)
                         SENSE    ''write''
          頂けない (itadakenai)
          SENSE          ''receive''
          POTENTIAL      +
          NEGATIVE       +
          TENTATIVE      だろう (darou)
          QPART          か (ka)
          COMPLEMENTIZER   と (to)
思う (omou)
EXTENDED-PREDICATE
          んです (n desu)
CONJUNCTION
          が (ga)
```

1. <teacher-p-mapping>

   Is it an imperative or an elliptical requestive?

    No. (==> nonimperative-mapping)

2. <nonimperative-mapping>
    Is it an interrogative?

    No. (==> declarative-mapping)

3. <declarative-mapping>
   Identify reducing factors for declaratives and put them
   under REDUCING-FACTOR.

Result:

```
COMPLEMENT
          FAVOR          ACTEE    手紙を (tegami-wo)
                         SENSE    ''letter''
                         書いて (kaite)
                         SENSE    ''write''
          頂けない (itadakenai)
          SENSE          ''receive''
```

```
          POTENTIAL     +
          NEGATIVE      +
          TENTATIVE     t£h 5 (darou)
          QPART    tf*    (ka)
          COMPLEMENTIZER   £ (to)
55 (omou)
REDUCING-FACTOR
          EXTENDED-PREDICATE      A/t:-f (n desu)
          CONJUNCTION             7^ (ga)

Does ' ' S5 ' ' present in the input?

Yes.  (==> (1) the whole sentence goes into nonimperative2-mapping)
      (==> (2) only the complement goes into nonimperative2-mapping
               and " JS5 "  goes under REDUCING-FACTOR)

Interpretation (1):

COMPLEMENT
          FAVOR          ACTEE     £P*ft£ (tegami-wo)
                         SENSE     ''letter''
                         Itwc (kaite)
                         SENSE     ''write''
          BCfrt&v* (itadakenai)
          SENSE          ''receive''
          POTENTIAL      +
          NEGATIVE       +
          TENTATIVE      /£*> 5 (darou)
          QPART     fa     (ka)
          COMPLEMENTIZER   t (to)
65 (omou)
REDUCING-FACTOR
          EXTENDED-PREDICATE      AsX"t (n desu)
          CONJUNCTION              # (ga)

Interpretation (2):

FAVOR          ACTEE    3^K£ (tegami-wo)
               SENSE    ''letter''
               it^T (kaite)
               SENSE    ''write''
```

頂けない (itadakenai)
SENSE ''receive''
POTENTIAL +
NEGATIVE +
TENTATIVE *fih*)* (darou)
QPART *fa* (ka)
REDUCING-FACTOR
EXTENDED-PREDICATE *AsX~t* (n desu)
CONJUNCTION # (ga)
THINK &5 (omou)
COMPLEMENTIZER
t (to)

5. <nonimperative2-mapping>
Is it an interrogative?

(1) No. (==> decIarative2-mapping)
(2) Yes. (==> interrogativel-mapping)

6. <declarative2-mapping>
Identify reducing factors for declaratives and put them under REDUCING-FACTOR.

Does any RECEIVE feature present?
No. (==> affirmative-mapping)

7. <affirmative-mapping>
Identify evidential markers and put them under REDUCING-FACTOR.
Build a p-structure for speech act of ''providing-information. ''

Interpretation (1):

SPEECH-ACT providing-information
PROPOSITION
COMPLEMENT
FAVOR ACTEE ^ft£ (tegami-wo)
SENSE ''letter''
ff\^-C(kaite)
SENSE ' 'write''
IRtf&v^ (itadakenai)
SENSE ''receive''

```
                    POTENTIAL     +
                    NEGATIVE       +
                    TENTATIVE    fih*> (darou)
                    QPART     fa     (ka)
                    COMPLEMENTIZER   & (to)
          思う (omou)
REDUCING-FACTOR
          EXTENDED-PREDICATE    k~X:1r (n desu)
          CONJUNCTION       fa       (ga)
SPEECH-SITUATION   formal
```

8. <interrogativel-mapping>
   Identify reducing factors for interrogatives and put them under REDUCING-FACTOR.

Interpretation (2):

```
FAVOR        ACTEE    ^&fc* (tegami-wo)
              SENSE     "letter"
              Hr^T (kaite)
              SENSE     ''write''
B|l't&^ (itadakenai)
SENSE         ''receive''
POTENTIAL     +
REDUCING-FACTOR
          EXTENDED-PREDICATE   k~Qir (n desu)
          CONJUNCTION      fa      (ga)
          THINK                 S5 (omou)
                                COMPLEMENTIZER
                                             t (to)
          NEGATIVE              +
          TENTATIVE             #3 5 (darou)
          INTERROGATIVE     fa     (ka)
```

Are any of the features for requestives present?
Yes. (==> (2.1) interrogative2-mapping)
(==> (2.2) receive-potential-mapping)

9. <interrogative2-mapping>
   Identify evidential markers and put them under REDUCING-FACTOR.
   Build a p-structure for speech act of ''requesting-information.''

Interpretation (2.1):

```
SPEECH-ACT        requesting-information
PROPOSITION
          FAVOR         ACTEE    ?&$,* (tegami-wo)
                         SENSE     ''letter''
                         it^T (kaite)
                         SENSE     "write"
          Mtf*:^ (itadakenai)
          SENSE          "receive"
          POTENTIAL      +
REDUCING-FACTOR
          EXTENDED-PREDICATE  AsX"t (n desu)
          CONJUNCTION          # (ga)
          THINK                ,®5 (omou)
                               COMPLEMENTIZER
                                          t (to)
          NEGATIVE             +
          TENTATIVE          t£*>.*> (darou)
          INTERROGATIVE    fa    (ka)
SPEECH-SITUATION   formal
```

10. <receive-potential-mapping>
    Build a p-structure for speech act of ''requesting-action.''

Interpretation (2.2):

```
SPEECH-ACT        requesting-action
FEATURE           receive-favor-potential
ACTION           ACTEE    f?£ft£ (tegami-wo)
                         SENSE    "letter''
                 S^T (kaite)
                 SENSE    "write"
BELIEF
DESIRE
EXPECTATION
          FEATURE    receive-favor-potential
          REDUCING-FACTOR
                    EXTENDED-PREDICATE   hr^T (n desu)
                    CONJUNCTION           ^ (ga)
                    THINK                ,B5 (omou)
```

		COMPLEMENTIZER
		t (to)
	NEGATIVE	+
	TENTATIVE	*fcb* *> (darou)
	INTERROGATIVE	* (ka)
	FAVOR	IMtffc^ (itadakenai)
PLACEMENT-OF-ADDRESEE	higher	
SPEECH-SITUATION	formal	

As shown in the above example, the pragmatic mapper is always aware of the possibility of certain syntactic features being a part of propositional content as well as being a part of reducing factor or speech act. Thus, it preserves necessary ambiguities and often produces more than one output. In the example above, there are three p-structures (1), (2.1) and (2.2) produced by the pragmatic mapper.

5.4 The Disambiguator

The disambiguator searches the output of the pragmatic mapper for certain types of ambiguities and engages the user in disambiguation dialogs to resolve the ambiguities. The first thing the disambiguator looks for is SPEECH-ACT feature. In a case like the example above, the three output p-structures can be disambiguated by asking the user which speech act was intended.

```
What type of speech act did you intend?  Double-click on the
appropriate answer, of defer:

        REQUESTING-ACTION
        PROVIDING-INFORMATION
        REQUESTING-INFORMATION

        defer this question until later
```

Sometimes the disambiguator asks the range of the propositional content of the given sentence.

```
What is the appropriate bracketing for the requested or provided
information (if any)?  Double-click on the appropriate answer, or
defer:
```

主人は *ms* [jiaoc ff<] *t* 思います
主人は *[WB MMK* ff<] *t* 思います
[主人は 明日 東京に ff<] i 思います
[主人は 明日 東京に 行く

defer this question until later

5.5 The Author's Template

After disambiguation, the result of the natural language processing is displayed in the author's template, which the teacher is able to edit in order to control the range of students' answers to be accepted by the system. The template for output(2.2) will look like this:

```
speech-act          REQUESTING-ACTION
syntactic-feature   RECEIVE-FAVOR-POTENTIAL     REQ
                    ELLIPTICAL             -     ILL
                    GIVE-FAVOR-IMPERATIVE        ILL
                    GIVE-FAVOR-INWARD            ILL
                    IMPERATIVE                   ILL
                    POTENTIAL                    ILL
                    RECEIVE-FAVOR-DESIDERATIVE   ILL
action tfv>"C (kaite)                           REQ
    meaning  WRITE
    thing_acted_on  ^|ft(tegami)                 REQ
        particle  £ (wo)                         REQ
        meaning  LETTER
    dictionary-form  ISK (kaku)
expectation                                      REQ
    feature  RECEIVE-FAVOR-POTENTIAL             REQ
    reducing-factor
        INTERROGATIVE fa (ka)                    REQ
        FAVOR  H< (itadaku)                      REQ
            meaning  RECEIVE-FAVOR
        EXTENDED-PREDICATE  A/trf (n desu)       REQ
        NEGATIVE                                 REQ
        CONJUNCTION          # (ga)               REQ
        INTERROGATIVE-SPART  ^ (ka)              REQ
        TENTATIVE           fch 5 (darou)        REQ
        THINK                B5 (omou)
                            COMPLEMENTIZER
                                      t (to)     REQ
        ADVERB                                   ILL
        DOUBLE-NEGATIVE                          ILL
        EVIDENTIAL-NA                            ILL
        EVIDENTIAL-ADJ                           ILL
        EVIDENTIAL-STEM                          ILL
```

```
        HEARSAY                                 ILL
        NEGATIVE-EXTENDED-PREDICATE             ILL
        SENTENTIAL-PARTICLE                     ILL
PLACEMENT-OF-ADDRESSEE   HIGHER                 REQ
speech-situation   FORMAL                       REQ
```

Each feature present in the teacher's output is displayed with REQ (required) feature, which means the feature is expected to be found in the student's output. The author can click on REQ button and change it into either OPT (optional) or ILL (illegal). The author can also type in additional word, morpheme or feature to be accepted by the system. This template is stored to be used by the matcher.

5.6 The P-structure Mapping Program for Student Exercise

When processing student's input, the pragmatic mapper uses the information extracted from the author's template as a guide. In this way, the analyzer is able to accept ill-formed input while avoiding an enormous number of ambiguities. The available information from the author's parse includes:

speech act type

main predicate of the proposition

meaning of each argument noun phrase

required and allowed reducing factors

Whereas the author p-mapping program tries to identify all possible speech act types the input sentence can carry out, the student p-mapping program starts with the given speech act type from the author to limit the search. By doing so, even when student fails to use certain linguistic feature to mark particular speech act, the system can recognize the student's attempt and give an appropriate feedback.

For example, in an exercise where the example sentence above is authored, if a student types in a sentence "tegami-wo kaite sashiagerarenai darou ka to omou n desu ga" using the giving-receiving verb with the wrong direction, it will go through the following processes:

```
Input (output from the parser):

COMPLEMENT
        FAVOR           ACTEE   tegami-wo
                                SENSE   ''letter''
                        kaite
                        SENSE   ''write''
        sasiagenai
```

```
        SENSE           ''give''
        POTENTIAL        +
        NEGATIVE         +
        TENTATIVE        +
        QPART            ka
        COMPLEMENTIZER   to
omou
EXTENDED-PREDICATE
        n desu
CONJUNCTION
        ga
```

1. <student-p-mapping>

   Is the author's speech act type ''providing-information''?
   No.

   Is the author's speech act type ''requesting-information''?
   No.

   Is the author's speech act type ''requesting-action''?
   Yes. (=> student-request-mapping)

2. <student-request-mapping>

   Is it an imperative or an elliptical requestive?
   No. (=> nonimperative-request-mapping)

3. <nonimperative-request-mapping>

   Is the top-level predicate identical to the author's predicate?
   No. (=> nonimperative-requestl-mapping)

4. <nonimperative-requestl-mapping>

   Is there a lower-level clause embedded in the ''omou'' construction?
   Yes. (=> embedded-nonimperative-request-mapping)

5. <embedded-nonimperative-request-mapping>

   Strip off the top level construction and put all the reducing factor
   at that level under REDUCING-FACTOR

```
Result:

FAVOR           ACTEE    tegami-wo
                         SENSE    ''letter''
                kaite
                SENSE    ''write''
sasiagenai
SENSE           ''give''
POTENTIAL       +
NEGATIVE        +
TENTATIVE       +
QPART           ka
REDUCING-FACTOR
        THINK           omou
                        COMPLEMENTIZER   to
        EXTENDED-PREDICATE      n desu
        CONJUNCTION     ga

   Is the new top-level predicate identical to the author's predicate?
   No.  (=> nonimperative-request2-mapping)

6. <nonimperative-request2-mapping>

   Is the feature FAVOR present at the top-level?
   Yes .  (=> student-favor-request-mapping)

7. <student-favor-request-mapping>

   Is the predicate ''give'' or ''receive''?
   ''give''. (=> student-give-request-mapping)

8. <student-give-request-mapping>

   Build a p-structure for speech-act of ''requesting-action''.

Result:
SPEECH-ACT      requesting-action
FEATURE         give-favor-potential
ACTION          ACTEE    tegami-wo
                         SENSE    ''letter''
                kaite
                SENSE    ''write''
```

```
BELIEF
DESIRE
EXPECTATION
        FEATURE give-favor-potential
        REDUCING-FACTOR
                THINK           omou
                                COMPLEMENTIZER  to
                EXTENDED-PREDICATE      n desu
                CONJUNCTION     ga
                FAVOR           sasiagenai'
                NEGATIVE        +
                TENTATIVE       darou
                QPART           ka
PLACEMENT-OF-ADDRESSEE  higher
SPEECH-SITUATION        formal
```

```
Is the direction of the giving verb inward or outward?
outward ==> add error-feature ''give-direction-error-out''
```

5.7 The Mateher

As in the original ALICE-chan system, the matcher compares the analysis of the student input sentence with the author's template and report any features that are missing or different from each other. It also finds error features that are inserted during the analysis and formulate appropriate feedback sentences from them. For example, the in the student's input described above contains error feature "give-direction-error-out". So the system will say You seem to have used the giving verb with the wrong direction. You should have used the verb with inward direction.

The system can detect the following types of errors in addition to syntactic/semantic errors:

1. Wrong degree of imposition.
2. Wrong degree of uncertainty.
3. Wrong direction of auxiliary giving-neceiving verbs.
4. Unmatched honorifics.
5. Inappropriate formality.

In addition to the student's errors, the outline of the system's analysis of the input sentence is also presented, in order to help students to understand the error messages. The information that the system can present includes:

- **The speech act type the system used for the interpretation.**
- **The main feature that marks the particular speech act.**
- **The main predicate of the sentence.**

See the Appendix for example exercises, list of acceptable answers and feedback.

6 Conclusion

In this project, I have succeeded in separating the pragmatic information that is encoded in a sentence from the prepositional content of the sentence. The extracted pragmatic information is classified and represented in a "p-structure". The program, implemented in a Computer Assisted Language Learning system, can help students to learn and practice different way of expressing certain indirect speech act, and use the target language appropriately in the given situation.

The system with the new pragmatic mapping program is able to recognize various sentences with the same prepositional content, even if their syntactic structures are not identical. It is thus able to allow students to express a certain proposition more freely without burdening the author with the task of typing in all possible correct answers and incorrect answers with appropriate feedback.

In the p-structure, the pragmatic information is represented in terms of the speech-situation, the speaker's attitude toward the addressee, and the felicity conditions for the intended speech act. Linguistic features that express the speaker's uncertainty are interpreted as reducing factors that weaken felicity conditions of the intended speech act of the sentence.

While this mapping program has succeeded in extracting and representing pragmatic informations, it has not been able to come up with a reliable way of measuring the effect of the individual and combined pragmatic features. For instance, a certain reducing factor seems to weaken the speaker's conviction more than another, but it is difficult to measure reducing forces of each feature with respect to every other feature. It becomes even more difficult when two or more reducing factors are combined. This problem causes some difficulties in authoring and matching in the system: when the author wants to allow certain range of indirectness, the system provides no easier way than going through every possible feature and specify the status whether it is required, optional or illegal. More detailed and broad linguistic analysis is necessary in order to build a system that can provide a simpler way of recognize the range of pragmatic forces.

The other possible direction of improvement is to extend the analysis ability beyond the sentence level. This will require an implementation of an inference system that can recognize the speaker's intention based on the contextual information and world knowledge. The system then will be able to recognize a broader range of pragmatic forces and help student to understand and use the language appropriately in realistic speech situations.

A Examples of Declarative F-Stmctures and P-Structures

1. "Susi-o tabemasu"

f-structure

```
ACTEE   PRED "susi"
        SENSE sushi
        PART  wo
PRED    "taberu"
SENSE   eat
STYLE   formal
TENSE   present
```

p-structure

```
SPEECH-ACT      providing-information
PROPOSITION     ACTEE   PRED "susi"
                        SENSE sushi
                PRED    "taberu"
                SENSE   eat
                TENSE   present
REDUCING-FACTOR
CERTAINTY-FACTOR
SITUATION       formal
```

2. "Mosikasitara susi-o taberu kamosirenai n zyanai darou ka to omou n desu ga"

f-structure

```
COMPLEMENT
        ADJP-MODIFIER
                ACTEE   PRED    "susi"
                        SENSE   sushi
                PRED    -taberu"
                SENSE   eat
        PRED    "kamosirenai"
        SENSE   maybe
        TENSE   present
        NEGATIVE-EXTENDED-PREDICATE +
        TENATIVE +
        INTERROGATIVE +
        QPART   PRED    "ka"
COMPLEMENTIZER
        PRED    "to"
CERTAINTY-ADVERBIAL
        PRED    "mosikasitara"
        SENSE   by any chance
PRED    "omou"
SENSE   think
```

```
TENSE   present
STYLE   formal
EXTENDED-PREDICATE +
CONJUNCTION     PRED    "ga"
```

p-structure

```
SPEECH-ACT      providing-infonmation
PROPOSITION
                ACTEE   PRED    "susi"
                        SENSE   sushi
                PRED    "taberu"
                SENSE   eat
                TENSE   present
REDICING-FACTOR
                CONJUNCTION             "ga"
                EXTENDED-PREDICATE      +
                THINK                   PRED    "omou"
                                        SENSE   think
                INTERROGATIVE           +
                TENTATIVE               +
                NEGATIVE-EXTENDED-PREDICATE     +
                ADJ-EVIDENTIAL          PRED    "kamosirenai"
                                        SENSE   maybe
                ADVERB                  PRED    "mosikasitara"
                                        SENSE   by any chance
SPEECH-SITUATION        formal
```

B Examples of Request F-Structures and P-Structures

1. "Tegami-o kake"

f-structure

```
ACTEE    PRED     "tegami"
         SENSE    letter
         PART     wo
PRED     "kaku"
SENSE    write
IMPERATIVE +
```

p-structure

```
SPEECH-ACT          requesting-action
FEATURE             imperative
ACTION   PRED       "kaku"
         SENSE      write
         ACTEE      PRED     "tegami"
                    SENSE    letter
DESIRE   FEATURE
         REDUCING-FACTOR
BELIEF   FEATURE
         REDUCING-FACTOR
EXPECTATION
         FEATURE
         REDUCING-FACTOR
PLACEMENT-OF-ADDRESEE    lower
SPEECH-SITUATION
```

2. "Tegami-o kaite itadake nai darou ka to omou n desu ga"

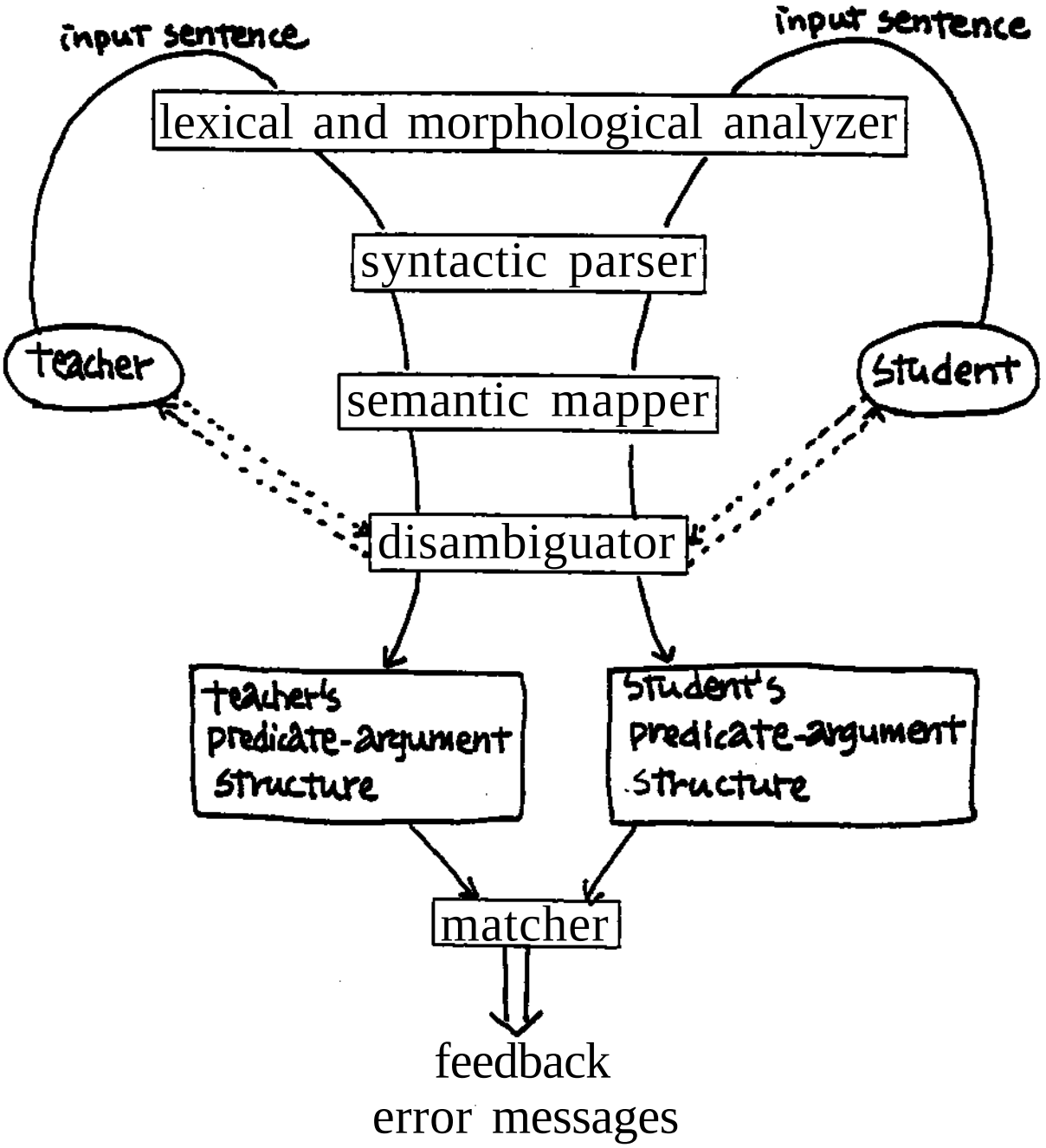
f-structure

```
COMPLEMENT
         COMPLEMENTIZER
                  PRED     "to"
         PRED     "itadaku"
         SENSE    receive-favor
         FAVOR    PRED     "kaku"
                  SENSE    write
                  ACTEE    PRED     "tegami"
                           SENSE    letter
                           PART     wo
         POTENTIAL +
         TENTATIVE +
         NEGATIVE  +
         INTERROGATIVE +
PRED     "omou"
SENSE    think
STYLE    formal
EXTENDED-PREDICATE +
CONJUNCTION      PRED     "ga"
```

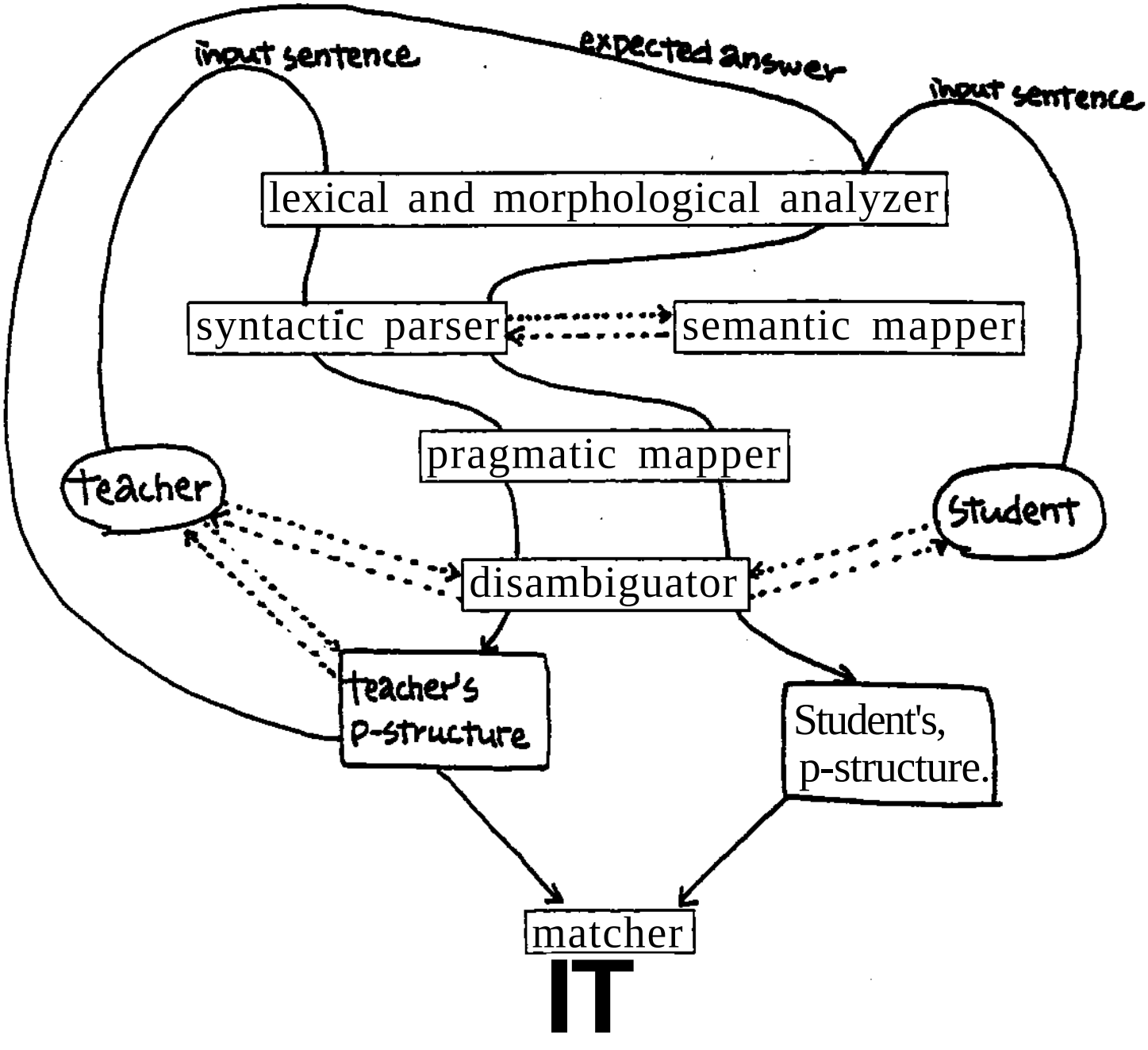
p-structure

SPEECH-ACT	request		
FEATURE	receive-favor-potential		
ACTION	PRED	"kaku"	
	SENSE	write	
	ACTEE	PRED	"tegami^{M}
		SENSE	letter
DESIRE	FEATURE		
	REDUCING-FACTOR		
BELIEF	FEATURE		
	REDUCING-FACTOR		
EXPECTATION	FEATURE	receive-favor-potential	
	REDUCING-FACTOR		
		CONJUNCTION	"ga^{M}
		EXTENDED-PREDICATE	+
		THINK	"omou"
		INTERROGATIVE	+
		TENTATIVE	+
		NEGATIVE	+
		FAVOR	+
PLACEMENT-OF-ADDRESEE	higher		
SITUATION	formal		

C Original AucE-chan System.

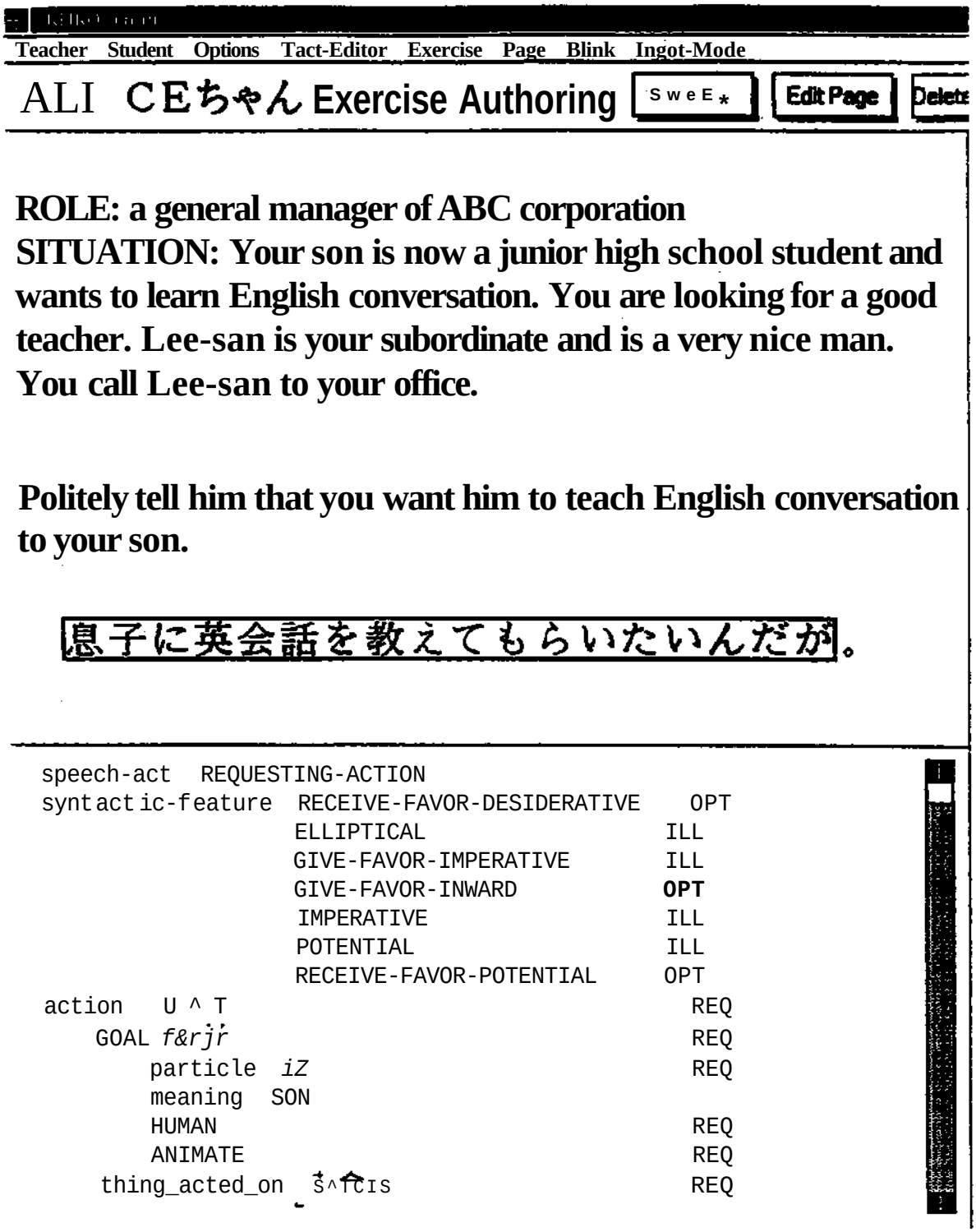


D New AucE-chan System

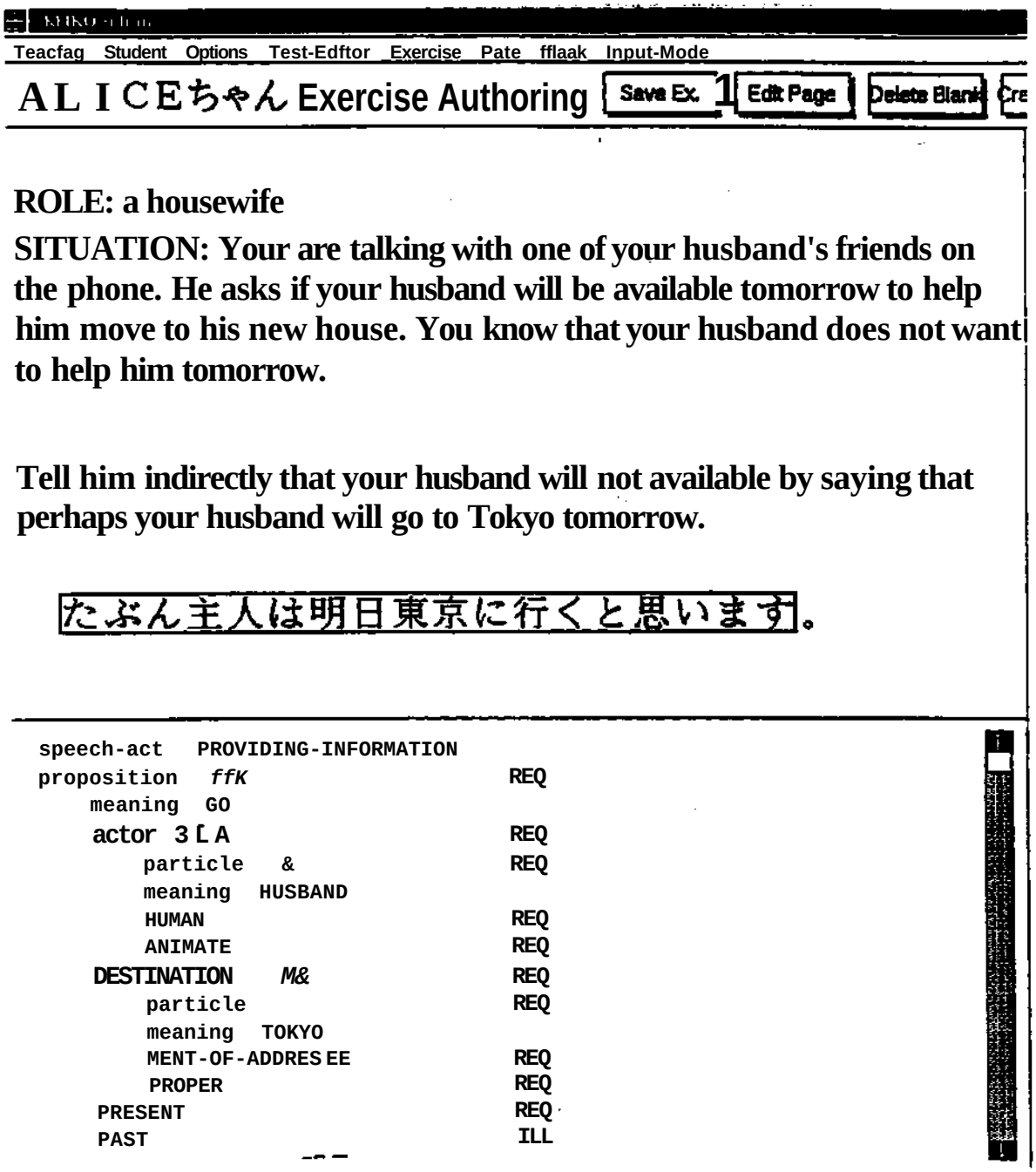


feedback
error messages

E Example Exercise 1



F Example Exercise 2



G Acceptable Answers and Feedback for Exercise 1

```
<text>

   role:      a general manager of ABC corporation
   situation: Your son is now a junior high school student and wants
              to learn English conversation.  You are looking for a
              good teacher.  Lee-san is your subordinate and is a very
              nice man.  You call Lee-san to your office.

   Politely tell him that you want him to teach English
   conversation to your son.

<author's sentence>

   "musuko-ni eikaiwa-wo osiete yatte moraitai n da ga"

<author's template>

syntactic-feature  RECEIVE-FAVOR-DESIDERATIVE    OPT
                   ELLIPTICAL                    ILL
                   GIVE-FAVOR-IMPERATIVE         ILL
                   GIVE-FAVOR-INWARD             OPT
                   IMPERATIVE                    ILL
                   POTENTIAL                     ILL
                   RECEIVE-FAVOR-POTENTIAL       OPT
action  |ff_"C                                  REQ
    meaning  TEACH/TELL
    GOAL  M=f~                                  REQ
        particle  K                              REQ
        meaning  SON
        HUMAN                                    REQ
        ANIMATE                                  REQ
    thing-acted-on  3£^i&                       REQ
        particle  £                              REQ
        meaning  ENGLISH CONVERSATION
    dictionary-form  !ff_£
desire
    reducing-factor
        EXTENDED-PREDICATE  hfi                  OPT
        CONJUNCTION  i£                          OPT
            meaning  ALTHOUGH
        FAVOR  *hV*ftW                          REQ
            meaning  GIVE-FAVOR
            TAI-FORM                             OPT
        ADVERB                        ILL
```

```
        DOUBLE-NEGATIVE              ILL
        EVIDENTIAL-NA                ILL
        EVIDENTIAL-ADJ               ILL
        EVIDENTIAL-STEM              ILL
        HEARSAY                      ILL
        INTERROGATIVE                OPT
        INTERROGATIVE-SPART          ILL
        NEGATIVE                     OPT
        NEGATIVE-EXTENDED-PREDICATE  ILL
        SENTENTIAL-PARTICLE          ILL
        TENTATIVE                    ILL
        THINK                        ILL
    feature  RECEIVE-FAVOR-DESIERATIVE          OPT
placement-of-addressee  LOWER                   REQ
speech-situation  INFORMAL                      OPT

<acceptable answers>

        "musuko-ni eikaiwa-wo osiete yatte moraitai n da ga"
            (exact match)

        "musuko-ni eikaiwa-wo osiete yatte moraitai n desu ga"
            (speech-situation formal)

        "musuko-ni eikaiwa-wo osiete yatte moraeru ka"
            (syntactic-feature receive-favor-potential)
            (reducing-factor interrogative)

        "musuko-ni eikaiwa-wo osiete yatte moraenai ka"
            (syntactic-feature receive-favor-potential)
            (reducing-factor negative, interrogative)

        "musuko-ni eikaiwa-wo osiete yatte moraemasu ka"
            (speech-situation formal)
            (syntactic-feature receive-favor-potential)
            (reducing-factor interrogative)

        "musuko-ni eikaiwa-wo osiete yatte moraemasen ka"
        "musuko-ni eikaiwa-wo osiete yatte moraenai desu ka"
            (speech-situation formal)
            (syntactic-feature receive-favor-potential)
            (reducing-factor negative interrogative)

        "musuko-ni eikaiwa-wo osiete yatte kurenai ka"
            (syntactic-feature give-favor-inward)
```

(reducing-factor negative, interrogative)

"musuko-ni eikaiwa-wo osiete yatte kuremasen ka"
"musuko-ni eikaiwa-wo osiete yatte kurenai desu ka"
(speech-situation formal)
(reducing-factor negative interrogative)
(syntactic-feature give-favor-inward)

<errors and feedback>

"musuko-san-ni eikaiwa-wo osiete yatte itadakitai n da ga"
"musuko-san-ni eikaiwa-wo osiete yatte itadakitai n desu ga"
"musuko-san-ni eikaiwa-wo osiete yatte itadakeru ka"
"musuko-san-ni eikaiwa-wo osiete yatte itadakemasu ka"
"musuko-san-ni eikaiwa-wo osiete yatte itadakenai ka"
"musuko-san-ni eikaiwa-wo osiete yatte itadakemasen ka"
"musuko-san-ni eikaiwa-wo osiete yatte itadakenai desu ka"
(placement-of-addressee HIGHER)
feedback: You used honorific verb to place the addressee higher, which is not appropriate in this speech situation.

"musuko-ni eikaiwa-wo osiete yatte kuretai n da ga"
"musuko-ni eikaiwa-wo osiete yatte kuretai n desu ga"
(wrong direction of giving-receiving verb)
feedback: You used "kureru," a inward-giving verb in desiderative form.
You can either use a receiving verb in desiderative form or use a inward-giving verb in question form in order to make a request.

"musuko-ni eikaiwa-wo osiete yatte agetai n da ga"
"musuko-ni eikaiwa-wo osiete yatte agetai n desu ga"
(wrong direction of giving-receiving verb)
feedback: You used "ageru, " a outward-giving verb in desiderative form.
You can either use a receiving verb in desiderative form or use a inward-giving verb in question form in order to make a request.

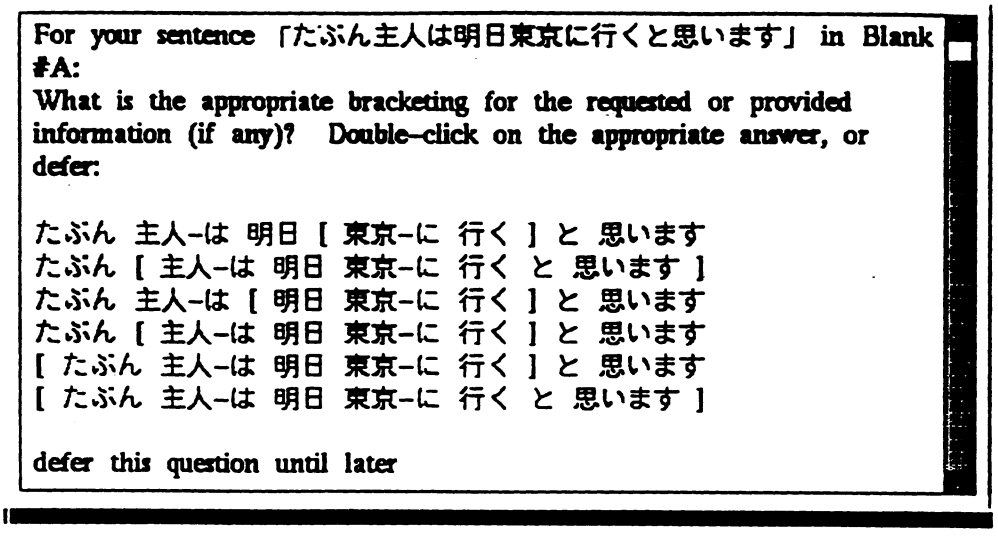
"musuko-ni eikaiwa-wo osiete yatte agerareru ka"
"musuko-ni eikaiwa-wo osiete yatte agerarenai ka"
"musuko-ni eikaiwa-wo osiete yatte ageraremasu ka"
"musuko-ni eikaiwa-wo osiete yatte ageraremasen ka"
(wrong direction of giving-receiving verb)
feedback: You used "ageru," a outward-giving verb in the

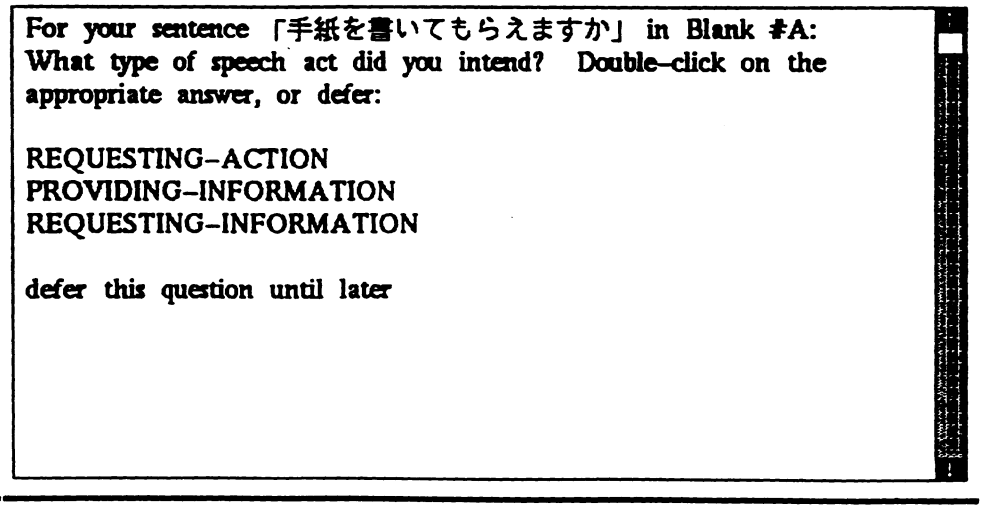
potential interrogative form.
You should have used a receiving verb in the potential form to make a request.

[M]musuko-ni eikaiwa-wo osiete yatte agenai ka"
[M]musuko-ni eikaiwa-wo osiete yatte agemasen ka[M]
"itfti^uko-ni -eikaiwa-wo osiete yatte 'agenai desu ka[M]
(wrong direction of giving-receiveing verb)
feedback: You used "ageru, " a outward-giving verb in the interrogative form.
You should have used a receiving verb in the interrogative form to make á request.

"musuko-ni eikaiwa-wo osiete yatte kure[M]
"musuko-ni eikaiwa-wo osiete yatte kudasai[M]
[M]musuko-ni eikaiwa-wo osiete yatte[N]
[H]musuko-ni eikaiwa-wo osiete yare"
(lack of reducing factors)
feedback: Your sentence seems to be too indirect for this context. Try to be a littel more indirect.

H Example Disambiguator





I Example Feedback

主人は明日東京へいきます

A.

In blink # A: Error Your sentence seems to be too direct for this context. Try to be a little more indirect. Your sentence is interpreted u expressing t speech tct of PROVIDING-INFORMATION. The predicate of the proposition is interpreted as いきます meaning "GO".

息子に英会話を教えてもらいたい

A.

In blank # A: Error Your sentence seems to be too direct for this context Try to be a little more indirect Your sentence is interpreted as expressing a speech act of REQUESTING-ACTION. You used a RECBVE-FAVOR-DESIDERATIVE to make a request The requested action is interpreted as 3&3.T meaning TEACH/TELL-.

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