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Research Activities
of the
Natural Language Understanding Department
and the
Data Processing Department
for **Nov. 1989~Mar. 1991**

ATR Interpreting Telephony Research Laboratories

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ATR Interpreting Telephony Research Laboratories

Abstract

This report summarizes the research activities of the language-related departments in the ATR Interpreting Telephony Research Laboratories: the *Natural Language Understanding Department* and the *Data Processing Department.* Also contained are reprints of the related technical publications during Nov. 1989.~ Mar. 1991.

The research areas of the Data Processing Department are

(1) Integration of Speech and Language Processing
- HMM-LR Speech Recognition
- Speech Recognition Using Stochastic Language Models
- Sentential Speech Recognition Using Two-Level LR Parsing
- Unknown Word Processing in Speech Recognition
- Construction of Sentential Grammar for Speech Recognition
- Evaluation of Stochastic Language Model for Speech Recognition
- Linguistic Knowledge for Spoken Dialogue Processing

(2) Language Processing for Spoken Dialogue Translation
- Analysis of Japanese
- Transfer from Japanese into English
- Generation of English

(3) Development of a Prototype System for Spoken Dialogue Translation
- General Overview
- The the current status and the future plan

(4) Linguistic Database
- Construction of Linguistic Database and its Management
- Statistics on Collected Linguisticbase

(5) Knowledge Extraction and Lexical Investigation based on Corpora
- Extraction of transfer and thesaurus knowledge from LDB
- Investigation of Some Linguistic Phenomena Specific to Japanese Dialogue

The current research areas of the Natural Language Understanding Department include:

(6) Dialogue Modeling and Context-Based Inferences
- Plan Recognition Model for Dialogue Understanding
- Interpreting and Generating Elliptical Sentences in Machine Translation
- Identifying and Understanding Noun Phrases in Dialogue

- Translating Feature Structures to a Kind of Logical Form

(7) Distributed Natural Language Processing and Machine Translation
- Transfer-Driven Machine Translation(TDMT)
- Generation of English Dialogue
- Example-Based Machine Translation (EBMT)
- Local Cohesive Knowledge for Dialogue Translation
- Parallel Parsing Algorithms

(8) Memory-Based Massively-Parallel Spoken Language Processing
- MT Architecture Based upon Massively-Parallel Graph-Based Constraint Propagation

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1. Research Organizations:

ATR Interpreting Telephony Research Laboratories

An Automatic Telephone Interpretation system is a facility which enables a person speaking in one language to communicate readily by telephone with someone speaking another language. At least three constituent technologies are necessary for such a system: *speech recognition*, *machine translation*, and *speech synthesis*. Integrated research into these technologies is also very important. A feasibility study, published by the Japanese Ministry of Posts and Telecommunications, says that realizing such a system will require at least fifteen years.

Basic research on each of the above technologies has already started at the ATR Interpreting Telephony Research Laboratories of which Dr. Akira Kurematsu is the president. These laboratories were founded in April, 1986 with the support of the Japan Key Technology Center, ATR International, NTT, KDD, NHK and other Japanese enterprises.

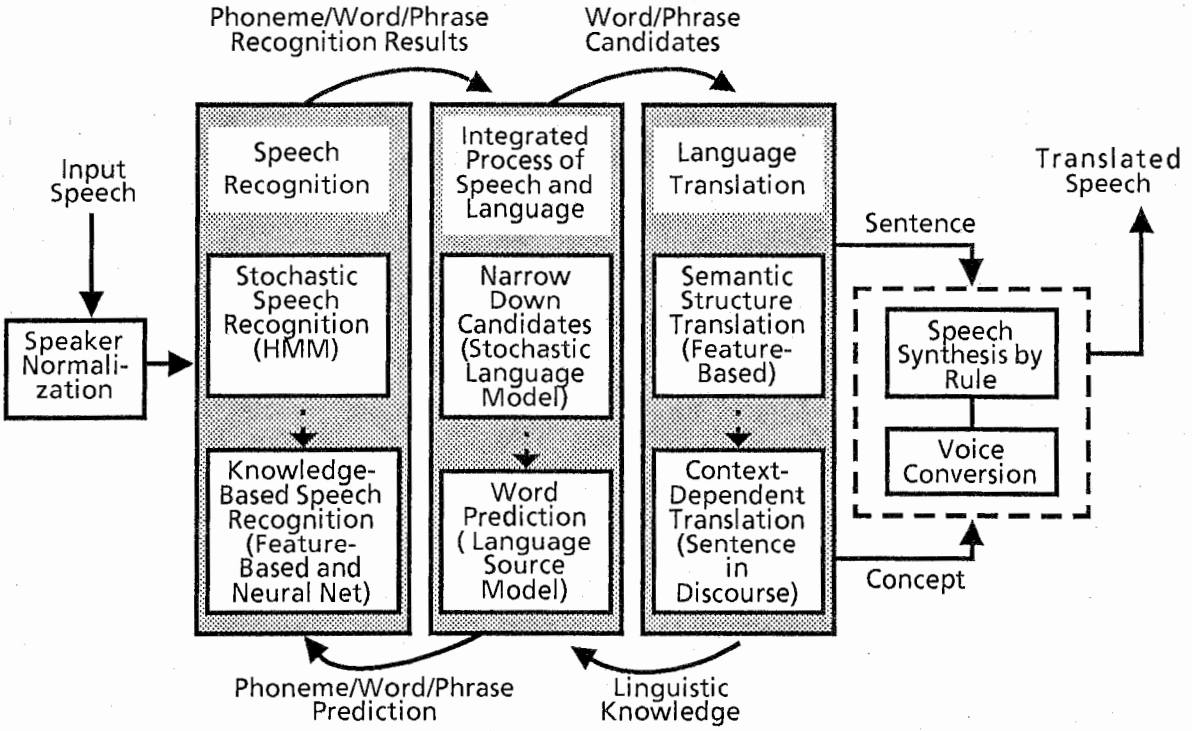

Figure 1. Proposed Automatic Telephone Interpretation System.

The ATR Interpreting Telephony Research Laboratories have three departments: the Speech Processing Department, the Natural Language Understanding Department and the Data Processing Department. These three departments cover the respective research areas to demonstrate the feasibility of an automatic telephone interpretation system shown in **Figure 1.** In this figure,

the speech processing department is concerned with speech recognition, speech synthesis, speaker normalization, and voice conversion. The main research area of the natural language understanding department is language translation, and that of the Data processing department is integrated process of speech and language.

Technical Publications: [Kurematsu 90-04][Kurematsu 90-05][Kurematsu 90-10-1][Kurematsu 90-10-2][Kurematsu 91-01][Kurematsu 91-03]

2. Research Activities

Research activities and the related technical publications for 1989 are summarized in Sections 2.1 through 2.5 for the Data Processing Department, and in Sections 2.6 through 2.8 for the Natural Language Understanding Department.

2.1. Integration of Speech and Language Processing

2.1.1 HMM-LR Speech Recognition

One of the major problems in speech recognition is coping with large search spaces. As search space size increases, recognition performance decreases. Syntactic constraints are effective in reducing the search space and hence increase processing speed and recognition accuracy. HMM-LR is an efficient speech recognition algorithm using Hidden Markov Models (HMMs) and predictive LR parsing. Predictive LR parsing is an extension of generalized LR parsing, and makes it possible to predict next phonemes in speech according to a context-free grammar. Predicted phonemes are then verified by using corresponding HMMs. The beam-search technique is also used to reduce the search space.

We implemented a Japanese phrase recognition system using the HMM-LR algorithm. For accurate phoneme recognition, multiple codebooks (separate vector quantization), fuzzy vector quantization, and HMM state duration control were used. A speaker adaptation algorithm based on codebook was also incorporated. The system attained an average phrase recognition rate of 98.5% and 99.2% for the top five choices in the speaker-dependent condition. In the speaker-adapted condition, rates were 81.6% and 98.0%, respectively.

We also showed the feasibility of the HMM-LR system in very large vocabulary speech recognition, a vocabulary of several thousand words or more. The system attained over 95% for the top five choices in 8,000-word phrase recognition.

Technical Publications : [Hanazawa 89-12] [Hanazawa 90-03] [Kita 90-03-1] [Hanazawa 90-04] [Hanazawa 90-10] [Kita 91-03-2]

2.1.2 Speech Recognition Using Stochastic Language Models

To take into account the stochastic characteristics of a language, we incorporated stochastic language models into the HMM-LR speech recognition system. Three stochastic language models were investigated.

1. Trigram model of Japanese syllables.
   Word bigram/trigram models are extensively used to correct speech recognition errors and improve recognition accuracy. The general idea of a trigram model was applied to Japanese syllables.

2. Stochastic LR parsing.
   The HMM-LR system uses the LR parser to deal with syntactic constraints supplied by a context-free grammar. In a traditional LR parser, each shift/reduce action is treated equally. However, some actions occur frequently, others rarely. Stochastic LR parsing was introduced to take their frequency of occurrence into account when calculating the recognition likelihood.

3. Trigram model of rewriting rules.
   Using the co-occurrence of rewriting rules, it is possible to avoid CFG rewriting rules generating incorrect word/phoneme sequences. This mechanism was implemented as a trigram model of CFG rewriting rules.

By utilizing these stochastic language models, the phrase recognition rate of the HMM-LR was improved from 88.2% to 93.2%.

Technical Publications : [Kita 90-01] [Kita 90-03-2] [Kita 90-04] [Kita 90-09-2]

2.1.3 Sentential Speech Recognition Using Two-Level LR Parsing

The grammatical structure of Japanese has two levels: intra-phrase level and inter-phrase level. Thus, using two kinds of grammars, namely an intra-phrase grammar and an inter-phrase grammar, is sufficient for recognizing Japanese sentences. Two-level LR parsing provides a mechanism to use these two grammars stepwise during speech recognition. First, the inter-phrase LR parser predicts the next phrase categories, and then the HMM-LR system recognizes phrase candidates belonging to the predicted categories. The system attained a word accuracy of 95.9% and a sentence accuracy of 84.7%.

Technical Publications : [Kita 90-09-1] [Kita 90-11]

2.1.4 Unknown Word Processing in Speech Recognition

Current speech recognition systems essentially ignore unknown words. Systems are designed to recognize words in the lexicon. However, for using speech recognition systems in a real application, it is very important to process unknown words. Preliminary research for unknown word processing has been initiated.

In our approach, two kinds of grammars are used. The first grammar is a normal grammar which describes our task. The lexicon for the task is embedded in this grammar as phoneme sequences. The second grammar describes the Japanese phonetic structure, in which constraints between phonemes are written. These two grammars are merged and used in the HMM-LR system. The HMM-LR system outputs words in the lexicon if no unknown word is included in the speech. If an unknown word is included, the system outputs a phonetic transcription that corresponds to the unknown word. Experiment results showed that this approach is very promising.

Technical Publications : [Kita 91-03-1]

2.1.5 Construction of Sentential Grammar for Speech Recognition

In the area of speech recognition applying syntactic rules is drawing a great deal of attention because of its potential for raising recognition accuracy. At the same time, this application reveals the lack of detailed study of syntactic phenomena, especially regards as spoken Japanese. We are therefore investigating building syntactic constraints which are effective for speech recognition and can handle spoken Japanese properly.

In contrast to traditional intuitive syntactic classification, we examine the behavior of syntactic categories quantitatively, using the dialogue data collected at ATR. Based on the retrieval results together with the speech recognition results, we are trying to find the best trade-off. In this way we have particularly studied sentence final conjunctive postpositions. The implementation of the study has very high filtering effect. By applying the constraints the acceptance rate goes down from 70% to 40%. Further we are studying sentence internal conjunctions and postposition deletion in nominal phrases, which are also features of spoken Japanese.

Technical Publications : [Hosaka 90-03] [Hosaka 90-08] [Hosaka 90-09] [Takezawa 90-12] [Hosaka 91-03-1] [Hosaka 91-03-2]

2.1.6 Evaluation of Stochastic Language Model for Speech Recognition

It is generally understood that introducing stochastic characteristics of language is useful in speech recognition. However, quantitative evaluation of ability of each stochastic model itself has not been performed so far. As for this problem, first an ability of the grammar which is used in our speech recognition system was investigated by applying it to a large amount of texts extracted from

ATR dialogue database. By this investigation, it turned out that only less than 1% of all the grammar rules were actually used. This indicates that introducing a more tight grammar or an equivalent stochastic grammar can improve the speech recognition accuracy. Next issue to be made clear is to evaluate quantitatively the relationship between target texts and learning texts. It might be obvious that, for instance, a language model which is made from newspaper articles is not adequate to apply to spoken sentences, but how would the speech recognition accuracy be when a language model made from some domain is applied to a slightly different domain?. To evaluate this issue, we introduced a method which maps every texts into an n-dimensional Euclidean space, in which every texts are located at the points as they reflect the distances between them. The distance between two texts can be calculated from either the occurrent frequency of same words, or the usage frequency of same grammar rules. From this analysis, it was observed that the speech recognition accuracy has strong correlation with the degree of how many neighboring texts are used as learning texts.

Technical Publications : [Sakano-89-12] [Sakano 90-06] [Sakano 90-09] [Sakano 90-11]

2.1.7 Linguistic Knowledge for Spoken Dialogue Processing

Our previous speech recognition system was using only intra-phrase syntactical constrains, and output several hypotheses for each phrase. Then most of the sentences simply constructed by combining each phrase hypotheses are ill-formed. For improving of this kind of erroneous recognition, analysis on the points what kind of linguistic information is necessary to suppress/ detect such incorrect hypotheses. and how well they can work are investigated. From the analysis, the following points are made clear:

(a)Most of the incorrect hypotheses could be eliminated by introducing inter-phrase syntax.
(b)To suppress/detect the rest of them, semantics, pragmatics or contextual knowledge should be used. In particular, contextual knowledge, such as environment, cooperativeness or structure of dialogue, play an important role, because Japanese short post-positional particles or adverbial particles are likely to be mis-recognized, even though they control the total meaning of the sentence.

Currently, we are carrying researches along with this line.

Technical Publications : [Morimoto 90-11]

2.2 Language Processing for Spoken Dialogue Translation

2.2.1 Analysis of Japanese

The principal task in this period was to examine feasibility of the Unification based Active Chart Parser for the current target corpus, the 12 files of model

dialogues on conference registration task. It means to expand the treatable linguistic phenomena without loss of efficiency as possible. However, we observed the increase of processing time according to the combinatorial explosion of unification in analysis. It derived from the complexity of the grammar, which includes a number of disjunctions. Though the introduction of disjunctions into the grammar was thought to give powerful and efficient mechanism for writing grammar rules, it turned out to force heavy computational cost with enormous copies in unification processing. For the purpose of this resolution, several measures were taken as follows :

1. Speed -up of unification with late evaluation technique
2. Rewriting the programs of unification from Lisp into C
3. Dividing of grammar rules into medium-grained CFGs with relatively few disjunctions
4. Morphological analysis using pre-analysis phase
5. Memory management technique

Due to these techniques the parsing system is achieving a certain extent of time reduction, though those efforts should be continued for improvement.

In parallel with this computational enhancement, the coverage of the grammar has been enlarged. According to the basic theory of the situation semantics, its semantic representation still remains within a narrow range of linguistic phenomena. Thus, the grammar originally designed by Yoshimoto based on the theory was elaborated in order to be able to treat more complex expressions in Japanese dialogue. This work should also be continued.

Technical Publications : [Nagata 90-3-1] [Nagata 90-3-2] [Kume 90-3] [Kogure 90-6] [Nagata 90-7] [Kume 90-7] [Nagata 90-8] [Kogure 90-8] [Nagata 90-9] [Nagata 91-03]

2.2.2 Transfer from Japanese into English

The feature structure rewriting system (RWS), implemented by Hasegawa, was refined and is used as the core transfer engine of the prototype system. One of the advantages of this RWS is the flexible application control of rewriting (transfer) rules, using Rewriting Environment (RE) and Application Constraints (AC). Each rewriting rule has its own AC composed of a parameter - attribute list. When the AC of a rule meets the RE which is assigned by the processing of the RWS, the rule will fire. Though the RE is globally designated in the main rewriting rule, it can be locally set with individual rewriting rules. This provides efficiency with avoiding rule application in failure. The new refinement on RWS is concerned with the following major items :

1. Introduction of preference for selecting an appropriate result

2. Realization of the type system for representing thesaurus knowledge

Apart from this refinement on the RWS, the core transfer engine, a new paradigm of translation based on lexical function was investigated. It is based on the concept of lexical functions and the Meaning Text Theory proposed by Mel'čuk. In this work a semantic network is supposed to reflect the context where an utterance is spoken. This network is divided and managed through the use of partitions such as theme vs. rheme or new vs. old information. For producing a proper dialogue sentence in the target language, a repartitioning of the network could be performed. This basic idea still needs a concrete framework for realization.

Technical Publications : [Hasegawa 90-3] [Hasegawa 90-7] [Hasegawa 90-8] [Stanwood 90-7] [Suzuki 91-3]

2.2.3 Generation of English

The current generation component in the prototype system was designed for limited tasks for demonstrations. The algorithm is relatively rigid with mixture of programs and rules. Thus, a new generation algorithm is being examined for the forthcoming prototype system. Though it is still under experiment, the new generation module based on unification is expected to be feasible and scalable. The basic idea is as follows :

Some kinds of expressions frequently used in goal-oriented dialogues such as conference registration task are idiomatized as fixed phrases. These cannot be generated from ordinary lexicon and general grammar rules. Instead, using pre-arranged phrasal descriptions with constraints, a flexible production of surface expressions suited for performative expressions, etc. The processing is divided into three phases : generation of the basic syntactic structure, refinement of the structure and morphological generation. During the top-down traverse of a input feature structure in the first phase, the constraints are checked with unification. In some phrasal descriptions context sensitive constraints are considered for dynamical production of an expression affected by the previous utterance.

Technical Publications : [Kikui 91-1]

2.3 Development of a Prototype System for Spoken Dialogue Translation

2.3.1 General Overview

The demonstration of the prototype system, SL-TRANS, gave certain impact as a first step of the spoken dialogue translation. After the ASTI symposium, however, the problems and the necessary tasks were pointed on the direction of enhancement of the system. Along this line, the final goal of this projects term

was discussed. The target performance is that the prototype system runs near in semi real time and has the certain wide coverage of spoken dialogue within the domain of conference registration task. Toward this goal, the reconstruction of the system was examined mainly on the integration of speech and linguistic processing and the improvement of linguistic analysis of Japanese. The respective detail is described in the corresponding sections.

2.3.2 The the current status and the future plan

In this period the skeleton of our prototype system, SL-TRANS, was recognized as an architecture with collecting elementary techniques of speech and language processing. And the scale of the system is small in the coverage of treatable dialogue expressions. For the near future at the end of the current project, the feasibility of the spoken language translation in the target domain, conference registration task should be evaluated. We need a higher level of integration between speech recognition and linguistic analysis and an improvement of dialogue translation both in quality and quantity. The respective approaches are described in the corresponding sections. Thus the target performance of the prototype system is expected as follows :

1. From the viewpoint of allowable processing time, the whole run time should be within a minute in maximum.

2. The recognition rate of the input speech should be more than 85 % in sentence level with speaker adaptation.

3. The target words are expected to be 1,500, which was estimated with the statistics of frequent words in the collected corpus.

4. The analysis grammar should cover the basic polite expressions used for goal-oriented conversations. As the processing difficulties depend the expressions, their priority was decided through the survey of Japanese basic grammar.

5. During the course of translation, the selection of suitable expressions should be performed as possible, when there are alternations. Context sensitive decisions will also be needed.

Technical Publications : [Morimoto 89-11] [Kogure 90-10] [Morimoto 90-10] [Kurematsu 90-11][Morimoto 90-11-2][Kurematsu 91-02]

2.4 Linguistic Database

2.4.1 Construction of Linguistic Database and its Management

The ATR Dialogue Database (ADD) has continuously grown to a large amount of dialogue corpora on several domains. Concerning the conference registration task (current target for the prototype system) and the inquiry to a travel agency, 200,000 words of dialogue texts were collected for each media, telephone and keyboard conversation. As a supplementary content of the ADD, English

morphological information is being added. Furthermore, the management system of the ADD was improved for various requirements of retrieval.

Technical Publications : [Hashimoto 89-12] [Ogura 90-03] [Hashimoto 90-3] [Ehara 90-03] [Ogura 90-07] [Kurematsu 90-11] [Ehara 90-11] [Ehara 91-3-1]

2.4.2 Statistics on Collected Linguistic Database

The collected linguistic data are utilized for various purposes of investigation shown in the next section. As a general interest of viewing the characteristics of the corpora, some statistical investigation was carried out.

Technical Publications : [Inoue 90-3] [Ehara 90-9] [Ehara 91-3-2]

2.5 Knowledge Extraction and Lexical Investigation based on Corpora

Using the above mentioned linguistic database, various kinds of attempts were performed for extracting knowledge and investigating specific linguistic phenomena.

2.5.1 Extraction of transfer and thesaurus knowledge from LDB

For extracting the characteristics of corpora on certain domains, classification of dialogue texts in a semantic space was attempted.
Some experiments were performed on trying to extract transfer rules from the co-occurrences between a verbs and its subordinate nouns. As the result, it turned out that simple co-occurrence relationships cannot predict the suitable word selection in the target language. The problem is not so simple because the lexical choice is affected by various factors including contextual situation. Currently there would be two kinds of approaches. The first one is to refine the cooccuurence information within a sentence. For this purpose, hierarchical classification of nouns can be meaningful in a certain domain, taking ordinary lexicons into consideration. From this viewpoint, an automatic noun clustering technique was proposed as a procedure to create a knowledge base for MT system. The second one is to find the strategy of context sensitive lexical choice in a certain corpus. As the preliminary study for that, the distribution of translation for some frequent verbs is being investigated.

Technical Publications : [Hasegawa 90-9] [Inoue 90-9] [Inoue 91-03] [Suzuki 91-3]

2.5.2 Investigation of Some Linguistic Phenomena Specific to Japanese Dialogue

Investigations on some specific linguistic phenomena were carried out for identifying the factors which affect the difference of meaning or usage. These analysis are also used for designing semantic representation of those linguistic phenomena, i.e. da-expressions, etc.

Technical Publications : [Tomokiyo 90-3] [Tomokiyo 90-9] [Tomokiyo 91-03]

2.6 Dialogue Modeling and Context-Based Inferences

It is our belief that the telephone interpretation system should be able to comprehend meaning in context. Major linguistic phenomena peculiar to Japanese spoken dialogues have been investigated from a linguistic viewpoint to construct a discourse-dialogue model that can be implemented on a computer. Among others, research topics concerning elliptical sentences, pragmatics, and intention are being studied, and the results obtained have been integrated step by step as a dialogue interpretation system. Considerable research has been focused on a plan recognition model for understanding a dialogue. Also a computational model for context processing using pragmatic constraints and circumstantial infrmation is being studied. A way to identify differently expressed noun phrases on the basis of domain knowledge is the first step toward dialogue meaning inference.

2.6.1 Plan Recognition Model for Dialogue Understanding

A multi-layered plan recognition model for dialogue structure construction and a method to predict the next utterance using the model was proposed.

The model employs three-typed universal pragmatics in addition to a set of the domain plan describing actions about the target world. The three-typed pragmatics are: "Interaction Plan", which describes a sequence of communicative acts for dialogue turn-taking, "Communication Plan", which determines how to execute or achieve an utterance goal or dialogue goals, and "Dialogue Plan" for establishing a dialogue construction, and a hierarchical order to apply these plans to recognize a goal of an input utterance can be determined in the line of Interaction Plan, Communication Plan, Domain Plan and then Dialogue Plan. The system implemented based on the model can efficiently construct appreciate dialogue structures step by step.

The method of next utterance prediction is based on the model. Using the constructed structure and the plans, the method can predict abstract information, about communicative act type and discourse entities of the next utterance, in the context-sensitive way. An experimental system to reduce the number of

candidates of a speech recognition output was implemented and can improve the number of candidates using the contextual information and linguistic and pragmatic knowledge.

Technical Publications: [Iida 90-04][Iida 90-06][Iida 90-08][Iida 90-10][Iida 90-11][Yamaoka 90-07][Yamaoka 90-08][Yamaoka 90-09][Yamaoka 91-01][Yamaoka 91-03]

2.6.2 Interpreting and Generating Elliptical Sentences in Machine Translation

(1) Identifying the Referents of Zero-Pronouns in Japanese based on Pragmatic Constraint Interpretation

A computational model has been developed to identify the referents of zero-pronouns by interpreting pragmatic constraints on the use of linguistic expressions under the context. The model exploits the constraints about honorific relationships, speaker's point of view and territory of information. These constraints are extracted from the usage of surface linguistic expressions. Therefore this method has the advantage of being less dependent on extra-linguistic knowledge in comparison with previous models of ellipsis resolution.

(2) A descriptive framework to Interpret and Generate Japanese Elliptical Sentences using CircumstantialInformation

A descriptive framework has been proposed to interpret and generate an elliptical / fragmentary sentence in the process of translating a sentence in a dialogue between Japanese and English.

In dialogues, especially Japanese dialogues, elliptical / fragmentary sentences are frequently used. Those sentences can be regarded as efficient in that they can convey a variety of informational contents according to the surrounding circumstances. Existing context processing models concentrate on the mechanism of interpreting elliptical sentences. However, previous methods do not work well in applying to the generation and translation process, because they fail in classifying the type of circumstances under which elliptical sentences can be used appropriately.

This framework aims at using efficient representations to describe the informational contents of elliptical sentences by guaranteeing that those efficient representations are embedded in the appropriate circumstances In addition, a variety of representations specified to different degrees of efficiency can be used to describe the same informational content.

To show that two representations convey the same informational content under an appropriate circumstance, a constraints is given as an equivalence relation between two representations with a condition on the type of circumstance. The process of interpreting a sentence can be modeled as replacing a representation with less efficient one through constraints by referring to circumstantial information as well as the generation process can be modeled as the converse process. Thus this framework has the advantage of applying to both interpretation and generation process. Moreover, the framework serves as an underlying model for the translation process at a variety of representations specified to different degrees of efficiency.

Some constraints has been exemplified to handle elliptical / fragmentary sentences in this framework. Those constraints exploit circumstantial conditions which concern social relationships, speaker's point of view and uniqueness of possible referents in a circumstance.

Technical Publications: [Dohsaka 89-11][Dohsaka 90-08][Dohsaka 91-03-1] [Dohsaka 91-03-2]

2.6.3 Identifying and Understanding Noun Phrases in Dialogue

Noun phrase identifications are considered as a kind of anaphora. Noun-noun relationships are ambiguous, as are noun-pronoun relations. The identification process first checks nouns in a dialogue by using a noun hierarchy system from an element at the domain knowledge, and then proceeds to check conditions in detail by using a predicate. The model has been implemented on an expert system in a Symbolics machine. Furthermore, Japanese NP understanding is being studied to translate and generate English NP.

Technical Publications: [Nogaito 90-03]

2.6.4 Translating Feature Structures to a Kind of Logical Form

Input to an understanding system comes from the semantic parser, which outputs feature structures. One approach to deep understanding is to build an understanding system that reasons using a kind of logical form (see [Yamaoka 90]). In this case, a translator is required to translate the low-level semantic feature structures into the representation. To provide this capability, an extremely fast converter, called "FS-LF", was written to translate the information found in known feature-structures into an equivalent representation. Information available in Technical Report TR-I-162.

A second approach is to build a plan inference system that works directly with feature structures as input and output, and then to translate the domain facts derived by this system into the representation. The NP (Natural-language Plan-

inference) system takes feature structures as input, and uses deterministic plans (with preconditions, decompositions, and positive effects) to recognize the plans of the speakers. The plans and the resulting inferred facts are also represented in the form of feature structures. The system uses a multiple-valued possibility logic and an ATMS-based timeless possible-worlds representation scheme to reason about actual, possible, hypothetical, and inconsistent facts. The system can accept multiple inputs that are possibly observed; this capability becomes important when the parser can output multiple ambiguous results based on uncertainties in parsing or speech-recognition. 50 feature-structure plans were written, and the system was tested on five simple simulated dialogs. Output facts were translated from feature-structures into a kind of logical form.

Technical Publications: [Myers 90-03][Myers-90-04][Myers 90-08][Myers 91-03]

2.7 Distributed Natural Language Processing and Machine Translation

In many conventional natural language processing, the analysis module is centered and the analysis results heavily affect following processes such as machine translation modules, foe example transfer and generation. An analysis-centered natural language processing does not always work well because analyzing relationships between words and phrases, or features on linguistic expressions are grasped from a certain monotonic view, in particular one grammar or one semantic category system. Various kinds of linguistic information must be handled simultaneously and satisfy any requirements made by each processing module which works as a sub-problem solver.

2.7.1 Transfer-Driven Machine Translation(TDMT)

The Transfer-Driven Machine Translation(TDMT) was proposed.

In many conventional machine translation systems, the analysis results heavily affect following processes such as transfer and generation. In contrast TDMT controls an entire translation by transfer, and the transfer engine and transfer knowledge, which is bilingual information, play central roles in this translation method, which aims at translation with high-speed, high quality, and high expandability. Althogh distributed cooperative processing is important to combine transfer knowledge systematically, as a first step sequential mechanism of TDMT was proposed. TDMT assumes that translation is performed by knowledge of various levels and their processes Transfer knowledge data is retrieved to determine how an input sentence should be translated. If necessary, when the retrieval fails the syntactico-semantic analyzer is activated. TDMT adopts the similarity calculation of Example-Based Machine Translation(EBMT)

to determine the most plausible target expression, using the transfer knowledge retrieved. In TDMT, crucial points include that how transfer knowlwdge is established and how broadly it covers sentences in the domain. Transfer knowledge of shallow leves has been established using the ATR corpus in a consistent framework. A Japanese to English translation system for a dialogue conversation about registering for an international conference is implemented. The feasibility of TDMT has been confirmed by an experriment on model conversations.

Technical Publications: [Furuse 90-11]

2.7.2 Generation of English Dialogue

A generation system must handle the illocutionary forces which play an important role in a cooperate smooth dialogue. Bi-directional use of grammar / lexicon is favorable not only because it can increase the maintainability of grammar but also because it helps to describe the relationship between the illocutionary forces and the surface utterances explicitly. Bi-directionality is set to be the main feature of our generation system. The grammar is based on HPSG and is consisted from CFG rules with constraints on the feature structure. The mechanism of the generation is based on the typed feature structure unification system. We have classified the features into several types and can control the application of rules by checking the constraints (called assertions) attached to the grammar rules.

Experimental generation system is developed. It uses the typed feature to controlling the rule application, and it uses disjunction capability for the structure sharing in order to reduce the over-copy of feature structures.

Technical Publications: [Ueda 90-03-1][Ueda 90-03-2][Ueda 90-08][Ueda 90-10][91-03]

2.7.3 Example-Based Machine Translation (EBMT)

In order to establish robust translation technology which resolves rule-based concrete translation problems, example-based paradigm has been proposed. EBMT retrieves similar ecamples (pairs of texts and their translations), adapting the examples to transltae a new input. EBMT has the following features: (1) is easily upgraded; (2) produces a reliability factor; (3) is quick; (4) is robust; and (5) well utilizes translator expertise.

Translation subsystem for noun groups connected by particle "NO" has been implemented. 2,550 examples (noun groups and their English examples) have

been extracted from ATR's corpus consisting of about 300,000 words. The average success rate is 78%. In the same way as the noun phrase type, [Sumita 89-2].

Technical Publications: [Sumita 90-03][Sumita 90-06][Sumita 90-10][Kohyama 90-09]

2.7.4 Local Cohesive Knowledge for Dialogue Translation

Cohesion is a very important idea for understanding a dialogue context correctly. In approach cohesive knowledge which judges cohesion between utterances is given to the system and then the knowledge is used to find cohesion in disarranged context. The knowledge can be defined and built from a dialogue corpus almost automatically.

Technical Publications: [Kudo 90-03][Kudo 90-08]

2.7.5 Parallel Parsing Algorithms

The approach of parallel processing is effective for improving the performance of unification-based parsers. The characteristics of multiprocessore sytems vary according to their organization type such as tightly coupled or loosely coupled. So, it is necessary to consider whether the parallelism in application programs fits the characteristics of multiprocessor system. First, the parallelism in the processing of a unification-based parser is being studied.

A typical unification-based natural language processing system spends most of its processig times for graph unification. We are proposing a parallel quasi-destractive graph unification algorithm that avoids the problems on synchronizations for each recursive call into shared-arcs and on efficient management of lock /unlock scheduling of simultaneous accesses to global shared data structures.

Technical Publications: [Kato 90-03][Kato 90-05][Fujioka 90-11][Tomabechi 91-02]

2.8 Memory-Based Massively-Parallel Spoken Language Processing

It is very important to integrate speech proccesing and natural language processing for the sake of spoken language understanding and translation. A massively parallel constraint propagation network that propagates directed graphs to recognize spoken language inputs is being studied.

2.8.1 MT Architecture Based upon Massively-Parallel Graph-Based Constraint Propagation

We have developed an experiental architecture named MONA-LISA (Multimodal Ontological Neural Architecture for Linguistic Interactions and

Scalable Adaptations) in which we introduced a massively parallel constraint propagation network that propagates directed graphs to recognize natural language input. The low-level signal input is desinged to be provided by the neural network acoustic recognition (TDNN and LPNN). The network is connected to a recurrent neural network which provides subsymbolic contextural recognition and predictions to the constraint propagation network. The model can be viewed as an architecture for symbolic and subsymbolic interactions during machine processing of massively-parallel cognitive activities as well as an experimental model for a new generation natural language processing and machine translation.

The integration of symbolic massive parallelism and subsymbolic neural net PDP processing provides a smooth a posteriori learning to the symbolic system and focused guided learning as well as strong constraints during recognition to the neural network. Through the use of graph-based representation and subsumption-ordered graph-unification, the graph-based constraint propagation network scheme solves the weaknesses of marker-passing-based massively-parallel natural language processing for handling structurally complex recognitions and dynamic configurational assignments. In essence, any modern linguistic theory that is representable using directed graphs can be captured in the network (such as LFG and HPSG).

As the result, the architecture provides the ability to handle strict and structured symbolic constraints during recognition while attaining a smooth contextual prediction ability applied with the least rigidity and learning of input regularities from actual samples. The domain researched so far in this project is natural language understanding for demonstration purposes;however, the architecture is expected to show equal strength in other modal channels such as visual inputs. We hope to extend the coverage of modal channels to other sensory inputs capturable by neural net recognition in the future. In fact, the input to our future systems is assumed to be through the real-world multi-dimensional modal channels of all human senses and the output of the system will provide signals to all human sensorty inputs, i.e., a creation of a virtual reality to the users of the systems.

Technical Publications: [Tomabechi 90-10]

3. Research Staff

The research staff is mainly composed of members from the research institutes and laboratories which support ATR. Also, visiting foreign scientists are included. The following members have participated in language-related research until the end of the March in 1991.

Natural Language Understanding Department (Apr.,1986~Mar.,1991)

Name	*Position*	*Period*
Teruaki Aizawa	Department Head	Apr., 1986 ~ Jun., 1989
Hitoshi Iida	Supervisor	Apr., 1986 ~
Kei Yoshimoto	Senior Researcher	Sep., 1986 ~ Feb., 1989
Kiyoshi Kogure	Senior Researcher	Sep., 1986 ~ Feb., 1990
Osamu Furuse	Senior Researcher	Feb., 1990 ~
Izuru Nogaito	Researcher	Apr., 1986 ~Aug., 1989
Hiroyuki Maeda	Researcher	Sep., 1986 ~ Aug., 1988
Ken-ichi Itsumi	Researcher	Sep., 1986 ~ Aug., 1988
Hidekazu Arita	Researcher	Sep., 1986 ~ Feb., 1989
Ikuo Kudo	Researcher	Apr., 1987 ~ Mar., 1991
Masako Kume	Researcher	Jan., 1987 ~ Mar., 1990
Toshiro Hasegawa	Researcher	Aug., 1987 ~ Oct., 1990
Yoshihiro Ueda	Researcher	Mar.,1988 ~ Mar., 1991
Koji Dohsaka	Researcher	Mar., 1988 ~
Eiichiro Sumita	Researcher	Jan., 1989 ~ Mar., 1991
Masaaki Nagata	Researcher	Mar., 1989 ~
Takayuki Yamaoka	Researcher	May., 1989 ~
Susumu Kato	Engineer	Apr., 1987 ~ May, 1990
Christian Boitet	Invited Researcher (GETA, France)	Apr. ~ Jul., 1988
Toon Witkam	Invited Researcher (BSO,Netherlands)	Jul. ~ Aug., 1990
Gayle K. Sato	Visiting Researcher(Hawaii-Manoa Univ.)	Apr.1988 ~ Mar.1989
Tadasu Hattori	Visiting Researcher (Kyoto Univ.)	May, 1988 ~ Dec., 1989
Martin C. Emele	Visiting Researcher (Stuttgart Univ.)	Sep., 1988 ~ Sep., 1989
John K. Myers	Visiting Researcher	Sep., 1988 ~
Rémi Zajac	Visiting Researcher (GETA, France)	Apr., ~ Sep., 1989
David Carter	Visiting Researcher (SRI Cambridge)	Sep., ~ Dec., 1989
Hideto Tomabechi	Visiting Researcher (C.M.U.)	Apr. ~ Oct., 1990

Data Processing Department (Apr.,1986~Mar.,1991)

Name	*Position*	*Period*
Tsuyoshi Morimoto	Department Head	Mar.,1987 ~
Terumasa Ehara	Supervisor	July, 1989 ~
Toshiyuki Takezawa	Researcher	Oct., 1989 ~
Kentaro Ogura	Senior Researcher	Sep., 1986 ~ Feb., 1990
Masami Suzuki	Senior Researcher	Aug., 1989 ~
Koji Kakigahara	Researcher	Oct., 1986 ~Sep., 1989
Naomi Inoue	Researcher	Aug.,1987 ~ Mar., 1991
Kenji Kita	Researcher	Sep., 1987 ~
Kazuo Hashimoto	Researcher	Sep., 1987 ~ Mar., 1990
Toshiya Sakano	Researcher	Sep., 1988 ~ Aug., 1990
Hideo Kohyama	Researcher	Apr., 1989 ~ Mar., 1991
Gen-ichiro Kikui	Researcher	Feb., 1990 ~
Naoko Shinozaki	Engineer	Sep., 1986 ~ Mar., 1989
Junko Hosaka	Visiting Researcher (Stuttgart Univ.)	Oct., 1988 ~
Mutsuko Tomokiyo	Visiting Researcher (Paris Univ. 7th)	Apr., 1990 ~

4. Research Facilities in the language-Related Departments

The two language-related departments have common computer systems which consists of VAX 8600/8800 with ULTRIX systems, various types of workstatons such as Symbolics 3675 / 3650 / 3620 / XL-1200 / Mac-Ivory, Xerox 1121, Explorer II, SUN 3/4, SPARC 2 , an iPSC parallel computer by INTEL Corp, and a Sequent / symmetry by Sequent Computer Systems, Inc. They are connected through the Ethernet network. Common Lisp and C are the major programming languages used in our departments.

List of Technical Publications
of the
Natural Language Understanding Department
and the
Data Processing Department
for **Nov. 1989 ~ Mar. 1991**

General Form

[*Reference ID*] *Authors* (*Affiliation other than ATR*) :
「*Japanese Title*」(Only for a paper written in Japanese.)
"*English Title*",
Conference or Journal (*Date*) - - - (page).

[Morimoto 89-11] Tsuyoshi Morimoto :
"Spoken language processing by stepwise utilization of linguistic information",
The 2nd Japanese-Australian Joint Symposium on Natural Language Processing (1989-11) - - - (1)

[Dohsaka 89-11] Kohji Dohsaka :
「対話登場人物を指示する日本語ゼロ代名詞の同定」
"Identifying Zero-Pronouns Referring to Persons in Japanese Dialogue",
IPSJ Symposium on Discourse Understanding and Its Application (1989-11) - - - (10)

[Hanazawa 89-12] Toshiyuki Hanazawa, Kenji Kita, Satoshi Nakamura, Takeshi Kawabata and Kiyohiro Shikano :
「HMM-LR音声認識システムの性能評価」
"HMM-LR speech recognition system performance ",
IEICE (1989-12) - - - (22)

[Sakano 89-12] Toshiya Sakano and Tsuyoshi Morimoto :
「音声認識における正規文法活用の有効性」
"Efficiency of Regular Grammar for Speech Recognition",
IEICE (1989-12) - - - (30)

[Hashimoto 89-12] Kazuo Hashimoto, Kentaro Ogura and Tsuyoshi Morimoto :
「フレーム表現による検索機能を有する言語データベース管理システム」
"A Linguistic Database Management System with Frame-Based Retrieval"
IPSJ Symposium on Advanced Database Systems (1989-12) - - - (38)

[Kita 90-01] Kenji Kita, Takeshi Kawabata and Toshiyuki Hanazawa :
"HMM Continuous Speech Recognition using Stochastic Language Models",
IEICE (1990-01) - - - (42)

[Kogure 90-01] Kazunori Matsumoto and Kiyoshi Kogure :
「国際パージング技術ワークショップ参加報告」
"The Report on the International Workshop on Parsing Technologies ",
WGNL Meeting of IPSJ (1990-01) - - - (46)

[Ueda 90-03-1] Yoshihiro Ueda and Kiyoshi Kogure :
「タイプ付き素性構造を用いた生成過程の宣言的制御」
"Declarative Control of the Generation Process using Typed Feature Structures",
WGNL Meeting of IPSJ (1990-03) - - - (52)

[Nagata 90-3-1] Masaaki Nagata, Masako Kume and Kiyoshi Kogure :
「単一化に基づく枠組みにおける日本語対話文解析用文法の記述とその計算的側面」
"A Unification-based spoken-style Japanese grammar and its computational aspects",
WGNL Meeting of IPSJ (1990-03) - - - (60)

[Kudo 90-03] Ikuo Kudo :
「文と文の結束性を捕らえるための知識」
"Local Cohesive Knowledge",
WGNL Meeting of IPSJ(1990-03) - - - (68)

[Tomokiyo 90-03] Mutsuko Tomokiyo and Masami Suzuki :
「日本語会話文における『だ』型表現の分析」
"Investigation of 'da'-expressions in Japanese Spoken Dialogue",
IPSJ Spring Meeting (1990-03) - - - (72)

[Kato 90-03] Susumu Kato :
「素性構造の単一化処理の分散手法A」
"Distribution Method of Feature Structure Unification Procss",
IPSJ Spring Meeting (1990-03) - - - (74)

[Hasegawa 90-03] Toshiro Hasegawa :
「音声.言語日英翻訳システムの変換過程における書き換え規則の制御」
"The Rewriting Rule Control Method in the Transfer Process of Spoken Language Translation System ",
IPSJ Spring Meeting (1990-03) - - - (76)

[Hashimoto 90-03] Kazuo Hashimoto, Kentaro Ogura, Terumasa Ehara and Tsuyoshi Morimoto :
「対話データベースを用いた各種言語現象の検索」

"Retrieving Various Linguistic Phenomena from a Dialogue Database",
IPSJ Spring Meeting (1990-03) - - - (78)

[Nogaito 90-03] Izuru Nogaito and Hitoshi Iida :
「英語定名詞句生成のための日本語名詞句の理解」
"Japanese NP Understanding for English Definite NP Generation",
IEICE Spring Meeting (1990-03) - - - (80)

[Nagata 90-03-2] Masaaki Nagata and Kiyoshi Kogure :
「文法規則の構造共有による選言的素性構造段単一化の効率化」
"Efficiency of the Disjunctive Feature Structure Unification using Structure sharing in the Grammar Rules",
IPSJ Spring Meeting (1990-03) - - - (81)

[Ogura 90-03] Kentaro Ogura, Kenji Kita and Tsuyoshi Morimoto :
「慣用表現を利用した形態素情報収集法」
"Morphological Analysis Method using Idioms",
IPSJ Spring Meeting (1990-03) - - - (83)

[Ueda 90-03-2] Yoshihiro Ueda and Kiyoshi Kogure :
「タイプ付き素性構造による生成過程の制御」
"Controlling Generation using Typed Feature Structures",
IPSJ Spring Meeting (1990-03) - - - (85)

[Sumita 90-03] Eiichiro Sumita, Hitoshi Iida and Hideo Kohyama :
「用例に基づいた翻訳」
" Translating with Examples",
IPSJ Spring Meeting (1990-03) - - - (87)

[Ehara 90-03] Terumasa Ehara, Kentaro Ogura and Tsuyoshi Morimoto :
「電話対話ベースの構築」
"Constructing a Dialogue Database",
IPSJ Spring Meeting (1990-03) - - - (89)

[Hosaka 90-03] Junko Hosaka, Kiyoshi Kogure and Kentaro Ogura :
「音声認識のための連鎖制約としての文法」
"Word junction constraint for speech recognition",
IPSJ Spring Meeting (1990-03) - - - (91)

[Myers 90-03] John K. Myers :
"NP: An ATMS-based plan inference system that uses feature structures",
IPSJ Spring Meeting (1990-03) - - - (93)

[Kume 90-03] Masako Kume, Masaaki Nagata and Takashi Toyoshima :
「話言葉翻訳のための日本語アスペクト処理」
"Analysis of Japanese Aspect for Dialogue MT",
IPSJ Spring Meeting (1990-03) - - - (95)

[Inoue 90-03] Naomi Inoue Terumasa Ehara and Kentaro Ogura :
「係り受け関係から見たキーボード会話と電話会話の比較」

"Comparison of Keyboard and Telephone Conversation from the point of KAKARIUKE data",
IPSJ Spring Meeting (1990-03) - - - (97)

[Hanazawa 90-03] Toshiyuki Hanazawa, Takeshi Kawabata, Kenji Kita, Satoshi Nakamura and Kiyohiro Shikano :
"ATR HMM-LR Continuous speechrecognition system ",
Readings in speech recognitionMorgan Kaufmann Publishers (1990-03) - - - (99)

[Kita 90-03-1] Kenji Kita, Takeshi Kawabata and Hiroaki Saito :
「HMM 音韻認識と拡張LR構文解析法を用いた連続音声認識」
Transactions of IPSJ Vol.31 No.3 (1990-03) - - - (103)

[Kita 90-03-2] Kenji Kita, Takeshi Kawabata and Toshiyuki Hanazawa :
「HMM-LR音声認識システムにおける統計的言語情報の利用」
"HMM Continuous Speech Recognition Using Stochastic Language Models",
ASJ(1990-03) - - - (112)

[Hanazawa 90-04] Toshiyuki Hanazawa, Kenji Kita and Satoshi Nakamura :
"ATR HMM-LR Continous speech recognition system",
ICASSP '90 (1990-04) - - - (114)

[Takezawa 90-04] Toshiyuki Takezawa and Katsuhiko Shirai :
"Interactive design environment of VLSI architecture for digital signal processing ",
ICASSP '90 (1990-04) - - - (118)

[Kita 90-04] Kenji Kita, Takeshi Kawabata and Toshiyuki Hanazawa :
"HMM speech recognition using stochastic language models",
ICASSP '90 (1990-04) - - - (122)

[Kurematsu 90-04] Akira Kurematsu:
"Overview of telephone speech input/output application in Japan: Present and future",
Speech Tech 1990Media Dimension inc. (1990-04) - - - (129)

[Iida 90-04] Hitoshi Iida:
「コンピュータ言語学における談話構造分析」
Monthly Journal of "GENGO" pblished by Taishukan (1990-04) - - - (133)

[Myers 90-04] John Myers :
"Methods for handling spoken interruptions for an interpreting telephone",
WGNLC Meeting of IEICE (1990-05) - - - (141)

[Kurematsu 90-05] Akira Kurematsu :
「ATRにおける音声認識の研究」
"Research on Speech Recognition at ATR"

Symposium on the State of Automatic Speech Recognition Processing and the Future (at Tohoku Univ.) (1990-05) - - - (149)

[Kato 90-05] Susumu Kato:
「素性構造の単一化に基づくパーサの並列化手法の効率」
"Performance Evaluation of Parallel Algorithms for Unification-Based Parsers",
WGNL Meeting of IPSJ (1990-05) - - - (156)

[Sumita 90-06] Eiichiro Sumita, Hitoshi Iida and Hideo Kohyama:
"Translating with examples: a new approach to machine translation",
The 3rd MT Conference (1999-06) - - - (164)

[Kogure 90-06] Kiyoshi Kogure, Masako Kume and Hitoshi Iida:
"Illocutionary act based translation of dialogues",
The 3rd MT conference LRC (1990-06) - - - (174)

[Sakano 90-06] Toshiya Sakano and Tsuyoshi Morimoto :
" Efficiency of linguistic grammar for speech recognition",
IASTED I'tl Conference (1990-06) - - - (183)

[Iida 90-06] Hitoshi Iida and Hidekazu Arita:
「4階層プラン認識モデルを使った対話の理解」
Journal of IPSJ Vol.31No.6 (1990-06) - - - (187)

[Yamaoka 90-07] Takayuki Yamaoka and Hitoshi Iida :
「文脈を考慮した音声認識結果絞りこみ手法」
"Using Contextual Information to Select Correct Speech-Recognition Candidates",
WGNL Meeting of IPSJ (1990-07) - - - (199)

[Nagata 90-07] Masaaki Nagata :
「音声言語日英翻訳実験システムSL-TRANSにおける日本語解析」
"A Japanese Analysis Module in a Spoken Language Translation System SL-TRANS",
WGNL Meeting of IPSJ (1990-07) - - - (207)

[Stanwood 90-07] Ryo Stanwood and Masami Suzuki :
"Some computational applications of lexical functions",
WGNLC Meeting of IEICE (1990-07) - - - (215)

[Ogura 90-07] Kentaro Ogura and Tsuyoshi Morimoto :
「形態素解析への慣用表現と頻度情報適用による定量的効果」
"Quantitative Effects of Applying Idioms and Frequencies to Morphological Analysis",
IEICE (1990-07) - - - (223)

[Kume 90-07] Masako Kume and Masaaki Nagata :
「単一化に基づく日本語対話文の意味解釈と意味表現」
JSAI Annual Meeting (1990-07) - - - (231)

[Hasegawa 90-07] Toshiro Hasegawa :
「素性構造の書き換えシステムのSL-TRANS変換過程への適用」
JSAI Annual Meeting (1990-07) - - - (235)

[Carter 90-08] David Carter :
"Efficient disjunctive unification for bottom-up parsing",
Coling 90(1990-08) - - - (239)

[Ueda 90-08] Yoshihiro Ueda and Kiyoshi Kogure :
"Generation for the dialogue translation using typed feature structure unification",
Coling 90' (1990-08) - - - (245)

[Iida 90-08] Hitoshi Iida, Takayuki Yamaoka and Hidekazu Arita :
"Three typed pragmatics for dialogue structure analysis ",
Coling 90 (1990-08) - - - (248)

[Kogure 90-08] Kiyoshi Kogure :
"Strategic Lazy incremental copy graph unification",
Coling 90 (1990-08) - - - (251)

[Kudo 90-08] Ikuo Kudo :
"Local Cohesive Knowledge for a Dialogue-Machine Translation System",
Coling 90 (1990-08) - - - (257)

[Myers 90-08] John K. Myers :
"A Project Report on NP : an Assumption-based NL Plan Inference System that uses Feature Structures",
Coling 90 (1990-08) - - - (260)

[Dosaka 90-08] Kohji Dosaka :
"Identifying the referents of zero-pronouns in Japanese based on pragmatic constraint interpretation",
9th ECAI (1990-08) - - - (263)

[Yamaoka 90-08] Takayuki Yamaoka and Hitoshi Iida :
"A method to predict the next utterance using a four-layered plan recognition model ",
9th ECAI (1990-08) - - - (269)

[Hosaka 90-08] Junko Hosaka, Kentaro Ogura and Kiyoshi Kogure :
"Word sequence constraints for Japanese speech recognition",
9th ECAI (1990-08) - - - (275)

[Hasegawa 90-08] Toshiro Hasegawa :
"A rule application control method in a lexicon-driven transfer model of a dialogue translation system",
9th ECAI (1990-08) - - - (278)

[Nagata 90-08] Masaaki Nagata and Kiyoshi Kogure :
"HPSG-based lattice parser for spoken Japanese in a spoken

language translation system",
9th ECAI (1990-08) - - - (281)

[Kita 90-09-1] Kenji Kita, Toshiyuki Takezawa, Junko Hosaka, Terumasa Ehara and Tsuyoshi Morimoto :
「2段階LR構文解析法を用いた文認識」
"Continuous Speech Recognition Using Two-Level LR Parsing",
ASJ Fall Meeting (1990-09) - - - (287)

[Nagata 90-09] Masaaki Nagata :
「音声言語翻訳のための日本語解析A」
"Japanese Analysis Method for Spoken language Translation",
IPSJ Fall Meeting (1990-09) - - - (289)

[Kohyama 90-09] Hideo Kohyama and Eiichiro Sumita :
「用例をもちいた依存関係単位の翻訳」
"Translation by Dependency Units of Examples",
IPSJ Fall Meeting (1990-09) - - - (291)

[Sakano 90-09] Toshiya Sakano and Tsuyoshi Morimoto :
「対訳テキストの意味空間における分類A」
"Quantification of Dialogue Texts in a Semantic Space",
IPSJ Fall Meeting (1990-09) - - - (293)

[Yamaoka 90-09] Takayuki Yamaoka and Hitoshi Iida :
「音声言語処理システムへの文脈の適用手法」
"Contextual Information Application Method to a Spoken-Language Processing System",
IPSJ Fall Meeting (1990-09) - - - (295)

[Ehara 90-09] Terumasa Ehara :
「対話データベースからの統計情報の抽出」
"Extraction of Statistical Data from a Dialogue Database ",
IPSJ Fall Meeting (1990-09) - - - (297)

[Tomokiyo 90-09] Mutsuko Tomokiyo and Masami Suzuki :
「日本語会話文における『だ』型表現の分析」
"Investigation of 'da'-expressions in Japanese Spoken Dialogue",
IPSJ Fall Meeting (1990-09) - - - (299)

[Kita 90-09-2] Kenji Kita and Tsuyoshi Morimoto :
「音声認識システムにおける確率文法の有効性」
"Probabilistic Context-Free Grammar for Speech Recognition ",
IPSJ Fall Meeting (1990-09) - - - (301)

[Inoue 90-09] Naomi Inoue and Toshiyuki Takezawa :
「対訳情報を用いた単語のクラスタリングに関する考察」
"Consideration of the Clustering Result Using Correspondence English Words",
IPSJ Fall Meeting (1990-09) - - - (303)

[Hasegawa 90-09] Toshiro Hasegawa :
「対話データベースからの日英変換規則の抽出」
"A Method to Extract Japanese-English Transfer Rules from Dialogue Database ",
IPSJ Fall Meeting (1990-09) - - - (305)

[Hosaka 90-09] Junko Hosaka, Toshiyuki Takezawa and Terumasa Ehara :
「話しことばにおける接続助詞終止とその音声認識への応用」
"Sentence Final S. -Postposition in Spoken Language and its Application to Speech Recognition",
IPSJ Fall Meeting (1990-09) - - - (307)

[Iida 90-10] Hitoshi Iida and Takayuki Yamaoka :
"Dialogue structure analysis method and its application to predicting the next utterance",
German - Japanese Workshop on Logic and Natural Language (1990-10) - - - (309)

[Tomabechi 90-10] Hideto Tomabechi :
"Symbolic and subsymbolic massive-parallelism for speech-to speech translation: hybrid time-delay, recurrent, and coustraint propagation connectionist architecture",
Info-Japan'90 (1990-10) - - - (320)

[Sumita 90-10] Eiichiro Sumita, Hitoshi Iida and Hideo Kohyama :
"Example-based Approach in machine translation",
Info Japan'90 (1990-10) - - - (328)

[Kogure 90-10] Kiyoshi Kogure, Hitoshi Iida, Toshiro Hasegawa and Kentaro Ogura :
"Nadine: an experimental dialogue translation system from Japanese to English",
Info-Japan'90 (1990-10) - - - (336)

[Morimoto 90-10] Tsuyoshi Morimoto, Hitoshi Iida, Akira Kurematsu, Kiyohiro Shikano and Teruaki Aizawa :
"Spoken languege translation: toward realizing an automatic telephone interpretation system ",
Info-Japan'90 (1990-10) - - - (344)

[Kurematsu 90-10-1] Akira Kurematsu :
「自動翻訳電話--異言語間のコミュニケーションを目指して」
"Automatic Telephone Interpretation --Towards a Communication between Different Languages",
IEICE (1990-10) - - - (352)

[Kurematsu 90-10-2] Akira Kurematsu :
「自動翻訳電話の基礎研究」
"SCAT LINE" published by Support Center for Advanced Telecommunications Technology Research (1990-10) - - - (360)

[Ueda 90-10] Yoshihiro Ueda, Sondra Ahlen and Kiyoshi Kogure :
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IPSJ : Information Processing Society of Japan

IEICE : The Institute of Electronics, Information and Communication Engineers

ASJ : The Acoustical Society of Japan

ACH : Association for Computers and theHumanities

ALLC : Association for Literary and Linguistic Computing

ACL : Association for Computational Linguistics

JSAI : Japanese Society for Artificial Intelligence

WGNL : Working Group of Natural Language

WGNLC : Working Group of Natural Language Understanding and Communication

IASTED : International Conference Signal Processing and Digital Filtering

ICASSP : International Conference on Acoustics,Speech and Signal Processing

ECAI : European Conference on Artificial Intelligence

PRICAI : Pacific Rim International Conference on Artificial Intelligence

ICSLP : Internaitonal Conference on Spoken Language Processing

COLING : International Conference on Computional Linguistics

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TR-I-0155	日本語解析文法の意味表現について **Semantic Representations Used in Japanese Analysis Grammar**	Masako Kume Masaaki Nagata	1990-3

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TR-I-0146	キーボード会話解析ツール解説書 **A Keyboard Dialogue Analysis Tool**	Ikuo Kudo	1990-3
TR-I-0150	自動翻訳電話研究用言語データベースの構成 **ATR's Linguistic Database Structure**	Kazuo Hashimoto Kentaro Ogura Terumasa Ehara Tsuyoshi Morimoto	1990-3
TR-I-0153	言語データベースADDの検索システム **A Retrieval System for th ADD (ATR's Linguistic Database)**	Kazuo Hashimoto Kentaro Ogura Tsuyoshi Morimoto	1990-3
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