Contextual Language Processing Model

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0. Introduction

Contextual Language Processing Model is a model designed to interpret sentences in the way that we use their contexts. In the model, contexts of given sentences are inferred, combined consistently and then used for the interpretation of the sentences. The idea which underlies the treatment of contexts is as follows.

1) Context inference rules are based on the analysis of paraphrasic expressions of languages. They are applied each time when a certain occasion is given.

2) Newly inferred contexts during the process of the applications of the above rules, are combined together with old contexts. The combined one is checked in terms of consistency.

3) Sentences are transformed into their correct logical expressions which include contexts in a certain explicit form.

Thus, to treat contexts is broken down into three steps, which are to formalize inferences, to indicate the manner of combining contexts, and to express them logically.

In the case which for a given sentence S there exists some context W such that in W, S is true, we may say that we can infer some W such that S in W is true. Here 'true' means 'be recognized' or 'be accepted' or 'be understood' by a hearer.

We have the assumption that principal parts of contexts are able to be inferred as additional information which is necessary to give a sufficient and correct interpretation for a given sentence. In many cases the contexts are directly related to each sentence.

In Japanese, subject noun phrases are usually omitted in everyday conversation. However, we can easily recover omitted phrases, though they have important roles as grammatical constituents. The recovery of them is necessary conditions for an appropriate interpretation of the sentence. In everyday conversation this operation is effectuated in the human brain. Probably we used to recover the omitted parts in the contexts inferred by a certain manner. According to already known contexts, the sentence is interpreted and once the sentence has been interpreted, the sentence itself provides some new contexts for the interpretation of the following sentence.

Asuming that principal parts of contexts necesary for the interpretation of a sentence can be inferred from the sentence itself, we try to systematize to infer, to combine and to use the contexts. Here 'contexts' means 'worlds' or 'occasions' in speech act theories. In addition to factors such as speaker, hearer, time, place, etc. it must include other factors necessary, relevant etc. for finer interpretations. If, in systactic analysis, it is found that a subject phrase or an object phrase or another important phrase is omitted, then it must be recovered in order to obtain the grammatical correctness.

Contexts are inferred according to the grammatical role of the assumed phrase; such a phrase should be interpreted as a part of presupposition, not as a part of the assertion. Not only syntactic analysis but also semantic and pragmatic analysis provide to infer the contexts. The inferred contexts are explicitly expressed under consideration of presupposition, expectation or topics with regard to the assertion.

Usually sentences and their contexts are not mutually independent: Preceding sentences prepare the contexts of the following sentences. Temporal order or temporal location is a good example for it. That the sentence and its contexts are not unilaterally but mutually related can be compared with the relation between the foreground and the background of a picture.

In order to express the relation, we use the form W P(W for contexts and P for a statement)and we introduce this form into an intensional logic.

At first, how to infer contexts on our model will be showed by a simple example briefly.

1. Illustrative explication

The sentence (1) has at least three interpretations depending on the contexts W11, W12 and W13.

(1) Mizu wo nomu.
Water object-marker drink(v)

W11: Universal context
in the case which the actor is not definite or vague
in the world when the sentence is uttered.
W12: The act is present.
or
W13: The act is habitual or customary.
in the case which the actor is definite
in the world when the sentence is uttered.

These contexts are inferable from the characteristics of the verbal aspects.

The sentence (2) as a variant of other verbal aspects has also at least three interpretations depending on the contexts W21, W22 and W23.

(2) Mizu wo non da.

W21: The act is asserted, and the actor is definite.
W22: The act is asserted, the actor is definite,
and the actor is thirsty.
W23: the act is asserted, the actor is definite,
the actor is thirsty,
and he could just take a cup of water.

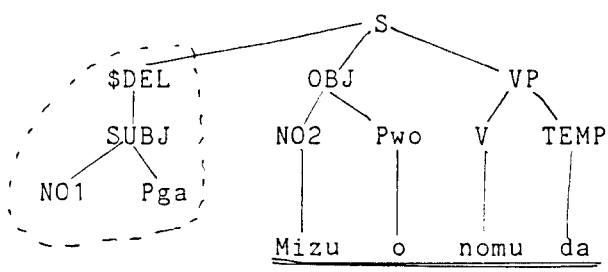
These contexts are inferred by context inference rules which include keys of verbal aspects.

Our model analyses the sentence (2) by syntactic rules (Fig.1), detects the omitted subject phrase, and recovers partially (Fig.2).

Fig. 1 Syntactic Rules

S ---> SUBJ ⌒ OBJ ⌒ VP
SUBJ ---> NO1 ⌒ Pga
OBJ ---> NO2 ⌒ Pwo
Pga ---> ga
Pwo ---> wo
NO2 ---> mizu
VP ---> V ⌒ TEMP
V ---> nomu
TEMP ---> da

Fig. 2 A Structure



Next the rules which include '$DEL-SUBJ' and some verbal aspects, are activated as keys, and the recovered part is rewritten like that,

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.......($DEL (SUBJ NO1 Pga)).....

-------->  ......($DUM (SUBJ
             (NO1 X[ identified with an actor in W ] ) Pga))...
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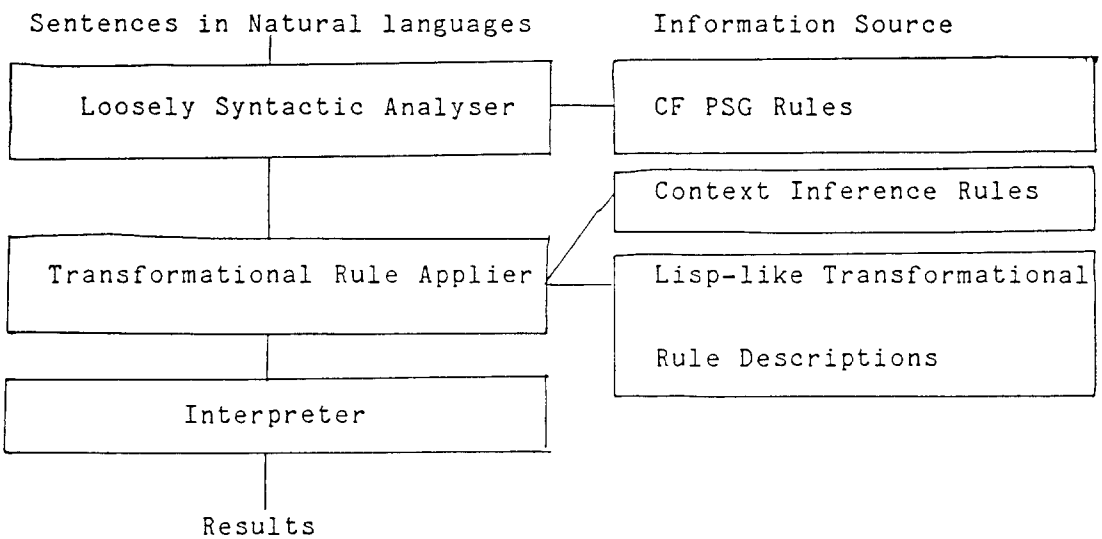
and its context W is updated like that,
W: An actor exists and is definite.

The symbol $DUM in the rewriten part, symbolies to give some hidden, implicit meaning and not to work as assertion.

2. Construction

Natural language sentences are given to Eval function and flow like the diagram of Fig.3. Internally they are transformed into Lisp-like intensional logical expressions. On the process, context inference rules are applied under conditions. After then the induced contexts are explicitly expressed.

Fig.3. A Flow Diagram of Eval Function



3. loosely syntactic analyser

Sentences are analysed by CF phrase structure grammar rules, which have been prepared as standard ones. Not only for well-formed sentences, but also for ill-formed sentences, plausible syntactic structures are produced as results of analysis. The degrees of plausibility are calculated by the number of insertions, or deletions, which are applied to reform those ill-formed sentences.

For example, in the case of Japanese grammar rules, we suppose to assume a subject phrase as an obligatory one. A subject phrase might be recognized by a key word 'Pga' (subject-marker). If a sentence without a subject phrase is given as an input, the loosely syntactic analyser produces a tree, which includes a sub-tree ($DEL (SUBJ (NO NOUN Pga))). The symbol '$DEL' symbolies an omitted part in the sentence.

4. Context Inference Rules

The sub-tree ($DEL (SUBJ (NO NOUN Pga))) has to be rewritten into a tree to maintain the meaning which is the omitted subject phrase. At the same time, it might cause to express relevant contexts with clearity. In this case, there are some kind of relations between the rewritten sub-tree and the induced contexts.

In the example(Sec. 1), the noun of the subject phrase is expressible as a variable in a logical expression, and the variable is equated to some part (which is probably a principal actor) in the contexts.

These are done by context inference rules. The rules are a kind of transformational rules (Sec. 6)

In that case, the symbol '$DEL' in the tree acts as a trigger, which determines whether or not a certain context inference rule has to be applied. So, in the rule, the existence of the symbol '$DEL' in a tree to be transformed is described as a necessary condition.

5. Combination of contexts

Another type of context inference rules are considered with regard to presupposition analysis.

We can rewrite the typical results (Karttunen 1973,1974) as examples of combination of contexts.

In complex sentences, subordinate sentences, in many cases, describe some contexts of main sentences. In these cases, the contexts could become clear when the subordinate sentences are evaluated. So, it is necessary to evaluate partially a tree on the way to transform into a final logical expression.

6. Transformational Rule Applier

The produced tree of a sentence is transformed into an expression in a lisp-like intensional logic with backgrounds 5). It is assumed that the logical expressions 1) are expressible in tree form.

Transformational Rule Applier is a kind of tree-tree transformers under linguistic constraints, and much different from mathematical transformers. It transforms the tree by a given set of transformational rules.

The discription of each rule consists of three parts.

The first is of necessary condtions to be applied.

The second is of obligatory or optional condtions on sub-trees to be transformed in sentence structures.

The last is how to transform.

Its characteristics are

1) in lisp-like form,

2) expressible for finer requirements, because a lot of operations are prepared (ADJACENT, FORBID, CONTEXT, NEAREST, REFRAIN), and

3) transformable dynamically by labeling or tagging nodes.

Moreover, combinations of such rules by AND, and OR, context-sensitive conditions on applications could be described in lisp-like form. So, they are

4) programmable, and

5) combinationable.

By those characteristics, such-that function, pronoun assignment function, and definite article become expressible (Ref.8).

7. Conclusion

A part of contexts could be inferred only from some internal information, without any other external information, on the process of interpretation, although, of course, external contexts are important for correct interpretation. We suppose contexts necessary for correct interpretation become to be generated by finer analysis of paraphrasic linguistic phenomena, such as results of diverse discussions about presuppositions, verbal aspects, temporals, and so on. So, we will try to show an implemental method to realize them on a computational model in more details (ref. Fig. 3)in near future.

References

1)Montague,R (1970) The Proper Treatment of Quantification in Ordinary English, in Formal Philosophy(Yale)

2)Pratt,V (1976) Semantical Considerations in Floyd-Hoare Logic, in Proc. 17th IEEE symp. on FOCS pp.109-121

3)Harel,D (1978) First Order Dynamic Logic, Dissertation, MIT

4)Hausser,R (1976) Presuppositions in Montague Grammar, Theoretical Linguistics, 3-3, pp.245-280

5)Igarashi,J (to appear) Language Processing with Background Information, Bull. of ETL,

6)Igarashi,J,and Yamada,S (1980) Logical Analysis of Verbal Aspects, Bull. of ETL, 44-6

7)Lyon,G (1974) Syntax-Directed Least Error Analysis for Context-Free Language, CACM 17-1, PP.3-14

8)Sakai,T (ms) Trans Manual