Dialogue Understanding based on Situation Semantics and Pragmatics

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1. Introduction

We have been studying a dialogue understanding model based on Situation Semantics. The object is to investigate how the context including the beliefs of conversational participants are developed under the grammatical and pragmatic constraints.

In the first year, we studied the constraints of so-called presupposition. We analyzed the problems around presupposition, especially on the projection problem which is the relation between the presupposition of the whole sentence and those of its parts. Furthermore, we formalized the presupposition from the point of inverse information, and described some related phenomena.

In the second year, we studied 'definiteness' and 'negation' in Japanese, because our team's common theme is 'Representation and Understanding of Concepts', and defineteness and negation are the concepts which are hard to understand and should be investigated in more detail. Furthermore, we studied on the descriptions of conceptual structures in lexicon in order to make a dialogue system.

In the third year, we have analyzed several data from novels and dialogue using 'talk' to find how the information flows and how the participants of dialogue control the flow. Our research discussed in 2.1 is related to the fundamental aspect of the nature of the flow of information. The research discussed in 2.2 handles situation dependency of the dialogue from the point of view of negation. 2.3 discusses how to organize lexical knowledge to handle the dynamic aspect of interpretation of utterances. Finally 2.4 discusses some constraints which are found by analyzing adnominal clauses in corpus.

2. Summary of our research

2.1 Dynamic Interpretation of Utterances

We have attempted to apply basic ideas of Dynamic Logic to natural language semantics (and pragmatics), focusing on the notion of presupposition (in discourse) concerning the formal treatment of Japanese noun-phrases. The point here is how to make our underlying logical system 'dynamic', to the extent that we can possibly formulate significant aspects of these phrases in the dynamic context of utterance. One of our findings is that we will at least have to take thought of 'partial assignment' in the interpretation of logical model, though much more amendment is needed in order to fully 'dynamize' our logical system.

If we want to go further, we must give serious consideration to the interpretation process of utterances in the transition of discourse. Above all, we will have to face with the 'linearization' of natural language utterance, as well as its fundamental nature of situation dependency. For instance, as recent studies of Dynamic Logic in their application of natural language semantics have already shown, the standard law of commutativity will not generally hold for our actual use of utterances.

Furthermore, a lot of difficulties will be caused if the basic unit of utterances should be taken to be as large as (full) sentences. Parts of them, at least as small as clauses, have to be treated directly; we must provide them with their own provisional interpretation in terms of the speaker's information state at that processing stage. This point will apply as well to the aspects of so-called 'speech acts'. Here, we have to consider these aspects not simply at the point of completion of sentences, but also within their inner structure (for the more concrete discussions, see Shirai (1994, 1995)). Generally, in Japanese, the semantic (and pragmatic) connection between adjoining clauses, whether they are syntactically connected within the sentence or not, will play a crucial role in their naturalness. Here, the notion of 'cost' have to be employed in addition to, or instead of, the traditional notion of grammaticality.

2.2. Negative Quantified Sentences and Situations

In this project we investigate a situation-dependency of uses of sentences with negation and quantification (negative quantified sentences). Using the framework of Situation Semantics, we argue that

(i) whether the polarity of an infon with negation and quantification is 1 or 0 depends on (non-)existence of objects in a situation, whose quantity is expressed by a quantifier used in a sentence, and that
(ii) the meaning of a verb determines whether or not it is when the objects in question exist in a resource situation that an infon is 1 (or 0).

To see (i) and (ii), let us compare (1) with (2).

(1) Two professors have not come yet in the room.
(2) Two professors are not breathing in the room.

In (2), if there are two professors somewhere outside of the room, the polarity of the infon (or the state of affairs) is 0; otherwise, 1. On the other hand, in (1), if there are more than two professors in the room, the polarity is either 1 or 0; otherwise, (vacuously) 1. (It is possible for (2) to have the same condition as (1).

As (1) and (2) show, what makes (1) differ from (2) is the meanings of the verbs. We propose that verbs are classified as at least into three types of them, depending on whether they require existence of objects in resource situations or not -

(i) movement verbs ('come', 'appear'), copula with a phrase expressing a place ('be on the street'), accomplishment verbs ('lay (eggs)'),
(ii) verbs that expresses (basically) visible acts ('breathe', 'yawn', 'run'), and
(iii) verbs that can be used to express generic meanings ('own (a car)', 'love (a woman)').

Verbs in (i) and (iii) do not require that objects in question exist in resource situations. As for verbs in (iii), they need to be investigated in terms of 'persistence', and we will leave them for another opportunity of discussion.

2.3. How we refer to lexical knowledge in a dialogue

When we consider ways to refer to lexical knowledge in a dialogue, it is essential to assume an over-all design of the lexicon. Pustejovsky (1991a, 1991b, to appear) has proposed a 'generative lexicon' approach as such. In this study, along the general line of the generative lexicon approach, we have examined three phenomena important in considering how dialogues are performed:

i. dynamic use of lexical knowledge
ii. unconventional use of lexical knowledge: coercion
iii. context-dependent use of lexical knowledge: omission of heads

2.3.1 dynamic use of lexical knowledge

Consider the lexical description of 'daidokoro'(kitchen). First, the sense 'part of a house' must be given. Secondly, as in the phrase 'daidokoro-wo tetudau'(to help kitchen = kitchen work), it can refer to the work to be done in the place. This sense seems to be shared by many Japanese people and should be regarded as a registered sense in the lexicon. When an appropriate context given, nouns which refer to a place can be used as the sense of the work to be done in the place. But it is redundant to give a 'work' sense to every word which can refer to a place in the lexicon. This example indicates that lexical knowledge stored in the lexicon is not simply retrieved from the registered senses, but dynamic use of lexical knowledge should be reflected in the There are, at least, two ways to treat such examples:

i) example-based approach: As a particular example exists, similar extensions come to be possible by analogy.
ii) semantic-extension-rules approach: If we assume a set of semantic features, we can capture semantic extensions by rules like 'PLACE –> WORK TO BE DONE IN THE PLACE'

Note that these two may not be exclusive each other.

2.3.2 unconventional use of lexical knowledge: coercion

Lexical knowledge is not always used in conventional ways. In some cases, we are coerced to interpret incomplete or anomalous phrases. Pustejovsky (1991a, 1991b, to appear) dubbed some of the cases as examples of 'coercion'. In a narrow sense of coercion, it means a phenomena where some (semantic) type changes occur. Put semantic features which are often used to classify nouns aside, there are other types of semantic changes. In Japanese there are , at least, two types of degree adverb, that is, gradable and non-gradable. Let's assume unification-based grammar and that degree adverbs have information about the restrictions on adjectives they modify (see Tonoike 1990). Consider the following two adjective phrases:

a.	kare-ha	se-ga	totemo	takai.
	he	height	very	high
	He is very high in his height.			
b.	?kare-ha	se-ga	hotondo	takai.
	he	height	almost	high
	He is almost high in his height.			

'totemo' places a restriction as 'gradable' on adjectives and 'hotondo' places a restriction restriction 'non-gradable' on adjectives. 'takai' is listed in the lexicon as a gradable adjective and there is no semantic anomaly in a. Although sentence b is unnatural, it still makes some sense, i.e., there is a border from which a height can be regarded as 'takai', and his height is near the border. It is necessarry to provide some devices to cope with examples of coercion, which can be easily found in dialogues.

2.3.3 context-dependent use of lexical knowledge: omission of heads

In everyday dialogues, any word or a sequence of sounds is not necessarily used as registered senses in the lexicon; dialogues can be performed heavily depending on the context at hand. We can imagine a question in a dialogue as follows:

Denwa-wo osiete? (Please tell me (the/your)phone(number)?)

It is not desirable to list 'denwa-bangoo'(phone number) as a sense of 'denwa'(phone) in the lexicon. Why can we understand the sentence above? If we can restrict the number of possibilities often depending on the context, we can only give information necessary for the context. Such examples cannot be treated without reference to contextual information.

We have discussed three phenomena in which we should do something more than simple retrievals of information given in the lexicon.

2.4 How resource situations are specified and utilized — constraints on adnominal clauses

Dialogue participants utilize several kinds of resource situations including described situations, discourse situations, belief states, etc. If the resource situation the speaker is utilizing is easily identifiable, that is, the search cost is reasonably low, then taking it as 'presupposed', she introduces items and/or propositions into discourse.

Generally speaking, adnominal clause has the following functions:

(1) Restriction: speaker introduces a new item designated by the head noun. Adnominal clause restricts the property or the set of the item.
(2) Identification: Adnominal clause is a cue to identify the item in the discourse.
(3) Background Information/Statement: speaker supplies an additional or background information with the adnominal clause.

Thus restrictive adnominal clause describes the property which holds in some (resource) situation. However, how the speaker specifies and utilize the resource situation?

Fox(Fox, 1990) reports that they find the following tendency in American conversation:

(A). Human head noun which plays object role in the embedded clause tends to play object role in the relative clause
(B). Non-human head noun which plays subject role in the embedded clause tend to play object role in the relative clause

We find that (A) holds in Japanese but (B) does not. Thus we may think that (A) is a universally strong constraint when speaker introduces a human into discourse. We may provide the following possible explanations:

(i) People are concerned with what kind of act the person does or what kind of property she has,
(ii) Situations are classified by the state of affairs where people does something

Another constraint we find is as follows:

(C) Linking by the subject in the adnominal clause makes easy to specify a temporal point or some specific situation

Actually more than 90% of temporal point designation with adnominal clauses have non-zero subjects or zero-subjects co-referred with the subject in the main clause or with the speaker/hearer.

We find the same tendency in subject-head adnominal clauses. We may think that these data supports (ii).

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