

SOME FRILLS FOR THE MODAL TIC-TAG-TOE OF DAVIES AND ISARD;
SEMANTICS OF PREDICATE COMPLEMENT CONSTRUCTIONS

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ABSTRACT

Predicate complement constructions are a rich source of semantic problems. The semantics of these constructions is explored in the context of the tic-tac-toe game playing setting of Davies and Isard (1972). Even in this limited setting, the implementations of these constructions are quite nontrivial, suggesting that such restricted settings provide a good testing ground for many key linguistic problems.

Descriptive terms: language understanding systems, semantics, game playing, predicate complement constructions, presuppositions.

1. Introduction

Restricted settings such as those considered by Winograd (1972) and Davies and Isard (1972) appear to be useful for studying many key linguistic problems.

In this paper, we will try to explore the semantics of predicate complement constructions (i.e., verbs requiring predicate complements e.g., prevent, force, pretend, help, etc.) in the context of the tic-tac-toe game playing setting of Davies and Isard (1972).

After giving a short sketch of the predicate complement constructions and briefly describing the work of Davies and Isard, we will give a number of examples to illustrate the problems involved in the implementations of these constructions. The major conclusions have been summarized in Section 4.

This system is being implemented in LISP.

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2. Predicate Complement Constructions:

Predicate complement constructions are a rich source of linguistic problems (e.g., see Rosenbaum (1969), Karttunen (1970)). We are concerned here with verbs requiring predicate complements. Some examples are:

- (1) John forced Bill to accept the job.
- (2) I want you to go.
- (3) He refrained from smoking.
- (4) We managed to finish the job.
- (5) John prevented Bill from winning the game.
- (6) Jim had an opportunity to visit China.
- (7) I admit that I have lost.

These verbs (henceforth to be called predicate complement verbs, or pc-verbs) differ from each other with respect to the shape of their complements; e.g., the complement is from Ving (from smoking) in (3), to V N (to finish the job) in (4), and that S (that I have lost) in (7). The missing subject or object in the predicate complement is either the subject of the main verb or the direct object of the main verb; e.g., in (2), you is the subject of go, in (1), Bill is the subject of accept, and in (4), We is the subject of finish, etc.

The semantics of these verbs is very rich. There appear to be at least seven important classes (Kiparsky and Kiparsky (1969), Karttunen (1970)). Verbs such as manage are called implicative because asserting (4) obliges the speaker to accept (4a) as true and asserting the negation of (4) forces him to accept the negation of (4a) as true.

- (4a) We finished the job.

Following Karttunen (1970), we will write this as $v(S) \supset S$, $\sim v(S) \supset \sim S$, where v is a pc-verb and S is the complement sentence. Verbs such as be in a position are called only if ($\sim v(S) \supset \sim S$). By asserting the negation of (6) the speaker is committed to the claim that

- (6a) Jim did not visit China.

Similarly, verbs such as force, persuade, etc. are called if verbs ($v(S) \supset S$). Verbs such as prevent are negative-if verbs ($v(S) \supset \sim S$); asserting (8) requires the speaker to accept the truth of (8a).

(8) Bill prevented Mary from leaving.

(8a) Mary did not leave.

Verbs such as fail are negative implicative verbs ($v(S) \supset \sim S, \sim v(S) \supset S$). Two other classes are factive and counterfactive. An example of a factive verb is realize.

(9) John realized that Mary stayed home.

(9a) John did not realize that Mary stayed home.

Asserting (9) or (9a) requires the speaker to presuppose the truth of (10),

(10) Mary stayed home.

It should be clear now what is meant by a counterfactive verb. An example of a counterfactive verb is pretend.

It appears worthwhile exploring in some detail implementations of these constructions in the tic-tac-toe game playing setting of Davies and Isard (1972). Admittedly, many of these constructions receive sterile interpretations in this context, but many others, together with the modal constructions of Davies and Isard, raise some interesting problems concerning their implementation.

We will illustrate these problems by several examples and try to draw some general conclusions about implementation of these constructions in the type of settings mentioned above.

3. Modal tic-tac-toe of Davies and Isard and the semantics of some pc-verbs:

3.1 Davies and Isard (1972) have chosen the setting of a game of tic-tac-toe in order to explore the semantics of modal verbs (might, can, will, etc.) and hypotheticals (if you had). This is a simple enough, yet nontrivial, setting. It provides them a universe of discourse in which they can discuss the notion of possible courses of events — what might happen in the future as well as what might have happened, but did not. Their program plays tic-tac-toe against a human opponent and can answer questions about the course of the game.

We will use this setting to explore the semantics of some pc-verbs. In particular, we will be interested in constructions in which both a modal and a pc-verb occur. Some pc-verbs will require consideration of the possible courses of events even without the presence of a modal verb.

There appear to be at least four different factors we have to consider. These are as follows. (Let R and M denote the human opponent and the machine respectively.)

A. Instead of just one possible course of events, we will be concerned with a set or sets of possible courses of events.

B. M will be concerned with possible courses of events not only with respect to its own play but also

with respect to H's play because M is required to act as if it is H.

C. Whether or not certain presuppositions hold has to be checked by M not only with respect to one possible course of events but also with respect to a set of possible courses of events.

D. M has to deal with possible courses of events because M has to act as if its own goal is changed.

It was not clear from Davies and Isard (1972) whether all these factors were considered by them. A referee has pointed out to us that their program does cope to some extent with these factors.

3.2 We shall see the effect of these factors in a number of example situations.

Notation: H: human opponent; M: machine; m,n ...: position of square on the tic-tac-toe board. The squares are numbered 1, 2, 3 ..., 9 from left to right and from top to bottom. Y, Z: number of move; Y will range over M's moves and Z over H's moves.

prevent (not in the sense of forbid) (negative-if verb):

(1) H: Could I have prevented you from taking m on the Yth move?

In order to answer affirmatively, M has to check that there is at least one possible course of events up to the (Y-1)th move such that if this course of events had actually occurred it would not have been wise for M to take m on the Yth move. Thus M is required to construct a set of possible courses of events and check whether at least one of them satisfies a certain property.

M also has to check the presupposition that the actual course of events was such that indeed on the Yth move M took m; otherwise the question about preventing M does not arise. The presuppositions of prevent are not always completely clear. For example, consider "Not only could I have prevented you from winning, I could even have prevented you from drawing the game." There appears to be no presupposition for the second prevent. (This example is due to a referee.) Of course, here we have a composition of prevent and not only - but also. In general, whenever we have a composition of two pc-verbs or a pc-verb and a connective, the presuppositions become less obvious. We will come across this phenomenon several times in the following.

(2) H: On the Zth move, could I have prevented you from winning?

M has to start with the actual state of affairs as of the (Z-1)th move and check whether, on the Zth move, there was a nonlosing strategy for H. Alternatively, it has to check whether, for any Zth move of H, M has a winning strategy. If so, the reply is affirmative; otherwise, it is negative.

Again we see that M has to verify a certain property for a set of possible courses of events rather than a specified course of events.

The presupposition here is that M did win; otherwise, the question of preventing M from winning is

unnatural. Again if we have a composition such as "It was still possible for you to win as late as the 6th move, but I could have prevented you from winning as early as the 3rd move", the presuppositions are less obvious (example is due to a referee).

We can also consider the possibility of M reflecting on its performance by asking questions as in (2) to itself and coming out with uninvited responses such as the following.

- (3) M: On the Yth move, I could have prevented you from winning.
- (4) M: I realize that, on the Yth move, I could have prevented you from winning.

(Note that we have here a composition of pe-verbs: realize and prevent. Realize in our context is semantically almost vacuous.)

Parallel to (3) and (4) we could also have

- (3') M: On the Zth move, you could have prevented me from winning.
- (4') M: I realize that, on the Zth move, I could have prevented you from winning.

force (if verb):

- (5) M: On the Zth move, could I have forced you to lose?

Starting with the state of affairs as of the (z-1)th move, H checks to see whether there was a winning strategy for H.

The presupposition is either (i) at least after the Zth move, M was still not forced to lose, or (ii) H did not lose. The second presupposition seems more natural, at least for the rather trivial game under consideration.

have the opportunity, be in a position, etc. (only-if verbs):

- (6) M: On the Yth move, were you in a position (did you have the opportunity) to win?

We have two interpretations here: M checks whether

- (i) On the Yth move, there is a winning strategy for M.
- (11) On the Yth move, there is *no* winning strategy for H.

There is a third possibility (unnatural in such a trivial game as tic-tac-toe) which is as follows. Yth move could have finished the game with M winning, but somehow M missed the opportunity.

The presupposition is either (i) M did not win or

(ii) N won, but H is asking the question because H wants to know when M's win was guaranteed. The first presupposition is consistent with be in a position being an only-if verb; however, the second one is not.

We can compose force and have the opportunity as follows.

- (7) H: On the Yth move, were you in a position to force a win?

The answer is affirmative if, on the Yth move, there was a winning Strategy available to M; otherwise, it is negative.

The presupposition seems to be that M did not force a win on or before the Yth move.

- (8) H: On the Yth move, could you have forced a win?

The interpretation and the presuppositions are the same as in (7) above.

help (if-verb):

Assume that it is H's turn. Prior to making his move H asks M the following question.

- (9) H: Can you help me?

The understood complement is either to win or not to lose. Let us assume that it is to win. H has to see whether there is a winning strategy for H. One way is by switching turns i.e., by acting as if it is its own turn and checking to see whether it has a winning strategy. If there is such a strategy, M tells H the next move.

If the understood complement is not to lose, we replace "winning strategy" by "nonlosing strategy" in the above interpretation.

H can put the question not as in (9) but as in (10) below where no pc-verb occurs.

- (10) H: What would be your move, if you were me?

M would interpret (10) in exactly the same way as it did (9). There is a difference, however. In (10), H is explicitly asking M to switch turns and thereby indirectly helping H. In (9), M has to switch turns if it wants to help H. If it didn't switch turns, H wouldn't really be helping H. As a matter of fact, this is exactly the way M would have to behave if it has to respond to the following question.

- (11) H: What would be your move, if you were pretending to help me (to win)?

Note that pretend is a pc-verb (counter*active

verb). We have here a composite pc-verb — pretend-help.

Thus the set of possible courses of events considered by M depends on whose turn H is taking; its own or H's. Of course, there remains the possibility of M responding to (9) as if it is responding to (11) i.e., it will not switch turns when it ought to have.'

There is yet another way H can ask M'a help. Assume that it is M's turn. H is about to make its move and H asks M the following question.

(12) H: Can you help me?

Assume that the understood complement is to win. M has to check whether there is a winning strategy for H. This can be done by M by switching its normal goal of not losing to losing. Hence, M must have the ability to play the game with its goal being either not losing or losing.

The possible courses of events M has to consider, therefore, depend on whether M switches turns or goals.

4. Conclusions

1. The examples in the previous section clearly show that the implementations of the predicate complement constructions are not trivial in the setting considered.

2. pc-verbs can be composed, although not all products are possible. Any semantic account of pc-verbs has to explain how it can be extended to the products. This is rarely done in any great detail (see Karttunen (1970) for some examples). The restricted settings we have considered are good places to carry out this kind of detailed checking. We have seen already that the compositions (of pc-verbs, pc-verbs and modals, or pc-verbs and connectives) are far from clear in their presuppositions.

3. In our restricted setting many pairs of verbs are very nearly synonymous. As an example (perhaps not thoroughly convincing) consider

(13) H: What would be your move, if you were helping me (to win)?

(14) H: What would be your move, if you were allowing me to win ?

(13) is perhaps more natural than (14), but in our setting (14) would be interpreted in the same way as (13). Thus help and allow (not in the sense of giving permission, but in the sense of making it possible) appear to be locally synonymous (i.e., synonymous in our setting).

The whole class of pc-verbs is very rich. There are subtle differences between apparently synonymous verbs. However, one has the feeling that even in ordinary discourse, we often ignore these differences when the setting is well understood. It might be interesting to study settings from the point of view of the local synonymies they induce.

4. The last comment is somewhat paradoxical. Our restricted setting, which appears to be clearly defined, may not be so well defined after all; we have some difficulty in deciding on the correct interpretation for some of our examples.

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