

HOW TO RESTRICT AMBIGUITY OF DISCOURSE

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ABSTRACT

We single out a class of prototypes i.e., a class of constructions forcing the obligatory coreference or obligatory noncoreference. An essential feature of prototypes is their undistinctiveness. In this sense they are the most natural and efficient means of communication in discourse.

The non-application of prototype should be well motivated. This leads to the rule of restricted choice stating that whenever it is possible the application of a prototype should be preferred.

The rule of the restricted choice suggests the general outline of interpreting ambiguous sentences, strictly speaking, the method of ordering admissible interpretations: those which can be equivalently expressed by means of a prototype are less probable. In other words, the rule of the restricted choice can be regarded as some kind of mechanism ordering the hypotheses for computation.

INTRODUCTION

The crucial problem in discourse analysis is the appropriate transposition of all expressions occurring in it, into reality (see, for instance, the framework provided by Kamp in (Kamp, 1981)). Even preliminary analysis shows that one real object can be identified by various surface constructions. This forces the necessity of dividing surface expressions into classes denoting identical individuals.

The above problem can formally be stated as follows. To each discourse D we assign some reality which can be understood as a set ID of individuals (semantic discourse domain) together with a set of relations defined on ID . The semantic discourse domain can be interpreted twofold:

- 1° as a set of real objects i.e., objects existing in actual world;
- 2° as a set of mental objects i.e., objects existing in language user's mind.

Although the first interpretation is more natural, it leads to some ontological problems, concerning the distinction of fictitious and non-fictitious entities. Since there is no such distinction from linguistic perspective the

second interpretation seems better motivated.

The next step is to define syntactic discourse domain, denoted by S_D , i.e., a set of discourse expressions referring to individuals (set of individuals). The mapping assigning individuals to syntactic expressions will be called the reference function and denoted by R . Formally, $R : S_D \rightarrow 2^{ID}$.

Example

(D_1) John and Peter admire winter. They are often skiing together.

$S_{D1} = \{ \text{"John"}, \text{"Peter"}, \text{"winter"}, \text{"they"} \}$

$ID_1 = \{ \text{John}, \text{Peter}, \text{winter} \}$

$R(\text{"John"}) = \{ \text{John} \}$

$R(\text{"Peter"}) = \{ \text{Peter} \}$

$R(\text{"they"}) = \{ \text{John}, \text{Peter} \}$

$R(\text{"winter"}) = \{ \text{winter} \}$

We say that discourse expressions x and y are coreferential, what we denote by xCy , if and only if they refer to the same set of individuals.

Formally,

for each $x, y \in S_D$, xCy iff $R(x) = R(y)$

It is readily verified that C is an equivalence relation. Obviously each equivalence class of C contains coreferential expressions. The set of equivalence classes of C will be called the reference state of discourse and denoted by RSD .

Example

($D2$) John took a knife.

($RSD2$) $\{ \text{"John"} \}, \{ \text{"a knife"} \}$.

($D3$) John took a knife. He hurt himself.

($RSD3$) $\{ \text{"John"}, \text{"he"}, \text{"himself"} \}, \{ \text{"a knife"} \}$.

We can observe here that adding new utterance to the discourse changes its

reference state. In this sense RSD is a dynamic notion. Let us note also that the problem of anaphora solution can be regarded as defining the relation C for the whole discourse.

Both the speaker, while constructing a discourse, and the hearer, while analysing it, try to achieve the identity of RSD at each step of the discourse. We argue in this paper that to accomplish this effect, the speaker has at his disposal (at each moment) a more restricted set of linguistic constructions than it seems intuitively. Let us notice that expressions belonging to one equivalence class have various syntactic shapes at different steps of discourse. It can be shown that the syntactic form of expressions at particular moments is not accidental, i.e., elements of indicated equivalence class are not interchangeable.

PROTOTYPES

Recent discourse theories provide several levels of language analysis: morphological, syntactic, semantic and sometimes pragmatic. Each of these levels determines a characteristic set of notions and mechanisms. It is assumed here that the analysis of an utterance on each level of language should yield complete information obtainable by tools available on this level.

Classical anaphor resolvers act on semantic level on discourse analysis. We take the position that for inflexional languages the coreference relation can be partially described on the syntactic level. An essential feature of this partial characteristic is defining the coreference relation quite apart from real individuals, i.e. without specifying the reference function.

To fix some ideas let us consider an utterance containing the noun phrases NP_1, \dots, NP_n . If there is no information regarding coreference, all we can do is to assert that the coreference relation is included between the "minimal" relation, i.e., relation identified by the unit equivalence classes NP_1, \dots, NP_n and the maximal one, i.e. admitting in one class all number-gender agreeable phrases.

We very seldom deal with such a situation in practice. Almost always we can assign to an utterance a syntactic level information stating obligatory coreference or obligatory noncoreference of some expressions.

The surface constructions carrying this kind of information with respect to pronouns and zero pronouns (in the case of elided subject) will be called prototypes. In other words prototypes can be regarded as syntactic means forcing obligatory coreference or obligatory noncoreference between pronouns or zero pronouns and other surface expressions.

Let us consider few instances of prototypes. Because the ideas presented here are implemented for the Polish language, the notion of prototype will be illustrated with a number of Polish sentences. An elided subject specific for inflexional languages can be observed here. It is denoted by \emptyset . Because elided subject expresses some aspects of thematic continuity, its interpretation seems to be an important step during discourse analysis. English translations of presented examples preserve their syntactic shape. Unfortunately they are sometimes incorrect as English sentences.

(1) Piotr obudził się, \emptyset_1 podszedł do okna, \emptyset_2 otworzył je i \emptyset_3 wyskoczył.
Peter woke up, \emptyset_1 came to the window, \emptyset_2 opened it and \emptyset_3 jumped out.

Expressions:

Peter, $\emptyset_1, \emptyset_2, \emptyset_3$ are coreferential. Another interpretation is unadmissible. In (1) we deal with obligatory coreference of expressions (denoted by $a \leftrightarrow b$).

(2) \emptyset_1 Obudził się, \emptyset_2 podszedł do okna, \emptyset_3 otworzył je i \emptyset_4 wyskoczył.

\emptyset_1 Woke up, \emptyset_2 came to the window, \emptyset_3 opened it and \emptyset_4 jumped out.

In (2), similarly as in (1) (co-ordinate clauses) and in (3), (4) (subordinate clauses) the only acceptable interpretation is explicitly showed.

(3) Zanim \emptyset_1 wyszedł, \emptyset_2 zgasił światło.

Before \emptyset_1 left, \emptyset_2 turned the light off.

(4) \emptyset_1 Zgasił światło, zanim \emptyset_2 wyszedł.

\emptyset_1 Turned the light off, before \emptyset_2 left.

The next examples concern the obligatory noncoreference of expressions (denoted by $a \nleftrightarrow b$).

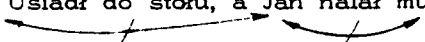
(5) Ona lubi ją.

She likes her.

(6) \emptyset zapytał Piotra, czy Jan pójdzie

do teatru.

\emptyset Asked Peter, whether John would go to the theatre.

- (7) \emptyset Usiadł do stołu, a Jan nalał mu wina.

 \emptyset Sat at the table, und John poured
 him out some wine.

The above examples pose the question of how the class of prototypes should be singled out. This problem can be solved by specifying a collection of rules concerning the obligatory coreference and obligatory noncoreference. The exact format of these rules is beyond the scope of this paper. For inflexional languages they depend on the type of considered sentence, the sentence-level functions of considered phrases and their syntactic shape. As a simple example of such a rule let us consider the basic criterion of excluding coreference:

If the object is expressed by means of a reflexive pronoun, then it is coreferential with the subject; in other cases the referential identity of the subject and object is excluded.

This criterion can be applied both for determining coreferents of objects - blocking the subject, and in testing the possible antecedents of the subject - blocking the objects. This is exactly the case we have in (5).

THE RULE OF RESTRICTED CHOICE

A conclusive criterion of being a prototype results from analysing a given sentence in isolation. If it is possible to assert or to exclude the referential identity of some expressions of the sentence, independently of its context then the sentence can be regarded as an instance of prototype. An essential feature of prototypes is that they are completely indistinctive and in this sense they are the most proper tool for expressing a certain relationship in the utterance. This strong relationship makes it possible to eliminate some interpretations, which in other cases should be regarded as probable too.

If we agree that achieving unambiguity of discourse is the major goal both for the speaker and the hearer, then the non-application of prototype, as the most natural and efficient means of communication should be well motivated. When such a special reason is lacking, the speaker should apply a prototype. Under this assumption the set of linguistic tools available to the speaker is restricted.

The notion of prototype can be naturally applied on the syntactic level of discourse analysis to limit the number of hypotheses for further consideration. But it can also be useful on the higher levels to interpret ambiguous discourses. Strictly speaking the properties of prototype suggest the general outline of interpreting ambiguous sentences, more precisely a method of ordering possible

interpretations with respect to their plausibility.

From the set of possible interpretations of a sentence, those that can be equivalently expressed by means of prototype, should be regarded as less plausible. The justification of this choice is clear: if the speaker wanted to point out such an interpretation, he would naturally achieve it by applying a prototype.

In view of the above we can formulate the rule of restricted choice. It states that whenever it is possible the application of a prototype should be preferred.

It is important to notice that the rule of restricted choice can be viewed from the perspective both of the speaker constructing the discourse and the hearer modelling it. The speaker should apply prototypes whenever it is possible. The hearer should take this fact into consideration.

Let us try to interpret the concrete sentences with the help of the rule of restricted choice.

- (8) Zanim \emptyset 1 wyszedł, Jan zgasił światło.
 Before \emptyset 1 left_{masc}, John turned_{masc}
 the light off.

There are two interpretations here:

- (9) Zanim \emptyset 1 wyszedł, Jan zgasił światło.
 Before \emptyset 1 left, John turned the light off.
 (10) Zanim \emptyset 1 wyszedł, Jan zgasił światło.
 Before \emptyset 1 left, John turned the light off.
 (\emptyset denotes the reference to the context).

But the first interpretation can be expressed by means of prototypes.

- (P1) Zanim \emptyset 1 wyszedł, \emptyset 2 zgasił światło.
 Before \emptyset 1 left, \emptyset 2 turned the light off.
 (P2) Jan zanim wyszedł, \emptyset 1 zgasił światło.
 John before left, \emptyset 1 turned the light off.

According to the rule of restricted choice the first interpretation should be regarded as less probable (note that it can be expressed by prototype). Hence the second interpretation should be chosen.

Another example is more complicated.

- (11) Zanim on wyszedł, $\emptyset 1$ zapytał go,
czy $\emptyset 2$ pójdzie do kina.

Before he left_{masc}, $\emptyset 1$ had asked him,
whether $\emptyset 2$ would have gone to the
cinema.

In the embedded clause

$\emptyset 1$ zapytał go

there acts the rule of obligatory noncoreference
excluding the referential identity of subject and
object in this sentence:

Zanim on wyszedł, $\emptyset 1$ zapytał go,
czy $\emptyset 2$ pójdzie do kina.

According to our definition the above sentence
is an instance of a prototype.

Excluding the coreference of pointed
expressions decreases the number of possible
interpretations, but does not clear up all
referential relationships in this ambiguous
sentence. Although there are no further
syntactic premises to resolve this ambiguity
we can specify the less probable interpretation
by applying the rule of restricted choice. If the
speaker wanted to express the following
sense:

- (12) Zanim X wyszedł, X zapytał go,
czy $\emptyset 1$ pójdzie do kina.

he should have used the following (structural)
prototype:

- (13) Zanim \emptyset wyszedł, $\emptyset 1$ zapytał go,
czy $\emptyset 2$ pójdzie do kina.

(In such a sequence of clauses in the
sentence the rule of obligatory coreference
demands that \emptyset and $\emptyset 1$ should be identified).

It follows therefore that the interpretation:

- (14) Zanim on wyszedł, $\emptyset 1$ zapytał go,
czy $\emptyset 2$ pójdzie do kina.

is the less probable and should be computed
as the last one.

NONMONOTONICITY OF THE RULE OF RESTRICTED CHOICE

Consider the following example:

- (15) Kiedy $\emptyset 1$ podszedł do Piotra,
był on zdenerwowany.

When $\emptyset 1$ came near Peter,
he was nervous.

There are two possible interpretations

- (16) Kiedy $\emptyset 1$ podszedł do Piotra, był on
zdenerwowany.

- (17) Kiedy $\emptyset 1$ podszedł do Piotra, był on
zdenerwowany.

Because the second interpretation can
unambiguously be expressed by the prototypical
construction:

- (18) Kiedy $\emptyset 1$ podszedł do Piotra, był $\emptyset 2$
zdenerwowany.

When $\emptyset 1$ came near Peter $\emptyset 2$ was
nervous.

according to the rule of restricted choice the
first interpretation should be preferred.

The rule of restricted choice is based on
the assumption that whenever it is possible
people use unambiguous constructions.
Although usually valid this assumption cannot
be regarded as general truth. This means that
the rule of restricted choice enables one to
jump to plausible but not ironclad conclusions.
Typically, such conclusions can be invalidated
when new information is available. In our
example the preferred interpretation might be
overturned when we extend our discourse as
follows:

- (19) Kiedy $\emptyset 1$ podszedł do Piotra,
był on zdenerwowany.

Był to wynik wcześniejszej kłótni
z Piotrem.

When $\emptyset 1$ came near Peter he was
nervous.

That was the result of an earlier
quarrel with Peter.

The necessity of changing the preferred interpretation follows from the fact that new information is available. The property of drawing plausible but defeasible inferences characterizes non-monotonic reasoning. Various forms of this kind of reasoning are now being developed (see (AAAI-84)).

It is now widely recognized that discourse understanding requires nonmonotonic mechanisms in many aspects. The rule of restricted choice is an example of such a nonmonotonic tool.

CONCLUSIONS

(1) While constructing discourse the speaker wants the hearer to understand him correctly. Even if he uses ambiguous constructions he intends to communicate the unique interpretations, and not to create in hearer's mind a set of all possible hypotheses. It follows that constructing NLU systems, which generate all admissible interpretations, contradicts common sense reasoning. So the essential problem is to determine methods of choosing the most appropriate interpretation. If this plausible interpretation fails, it should be revised.

(2) Employing the rule of restricted choice assumes the existence of some mechanism which determines whether a given construction can be regarded as a prototype. This can be achieved by specifying a set of rules qualifying the obligatory coreference and noncoreference of referring expressions. A partial set of such rules for the Polish language has been presented in (Dunin-Kępicz, 1983).

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