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Casual conversation as logical constraint satisfaction

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Abstract

Casual conversation seems to be the last domain in which logic may be successfully applied. We want to demonstrate here that this intuition is incorrect. On the contrary, logic offers a new perspective on conversation, not at the behavioural level, but at the argumentative level. By studying the way arguments are logically linked together, we can observe new phenomena, like conflicting beliefs or conflicting desires that are shared by participants, and strategies to escape from such situations. From this new perspective, conversation emerges as a logical constraint satisfaction process.

Keywords: conversation, argumentation, logic, pragmatics

1. Introduction : logic and argumentation during conversation

The importance of logic in casual conversation has often been overlooked. Participants' behaviour is not considered as logically constrained: "If people were logical, disagreement would never occur!". This simple statement is often uttered together with "people are illogical" or "she reason with her own logic". Conversation topics may have little to do with truth. When we speak about beauty, love, art or wine, logic often seems to be absent. Moeschler, considering examples like "I am too late, but I will have a coffee", concludes that language, unlike classical logic, does not care about logical contradictions (Moeschler, 1985:48).

Our purpose here is to show that logic cannot be avoided if we look at the argumentative level of language. There is no question here of finding truth in language use. Rather, we will use logic as a way to describe how arguments are linked together. In some way, it is a return to logic's original use, as developed by Aristotle. The originality of our approach is that we work on *spontaneous* conversations. As it turns out, and quite surprisingly, it is in the spontaneous use of language that logic is most apparent.

We will first analyse an example of conversation to show how a logical description can be both powerful enough and indispensable to predict important phenomena. Then we will slightly extend the logical formalism to take a wider range of conversations into account. This will give us the opportunity to make interesting parallels between *a priori* unrelated forms of spontaneous reasoning. Lastly, we will see that our logical description of spontaneous argumentation gives us a new characterisation of what can be considered as 'shared knowledge'.

2. Example of logical conversation analysis

To illustrate our approach, let us consider the following example from (Tannen, 1984:62):

context: A,B and C were speaking about sociology, and B showed a fairly good knowledge of Erving Goffman's books. A and C are surprised, since they thought this author was known only among specialists.

A1- But anyway. ... How do you happen to know his stuff ?
B1- Cause I read it.
C1- What do you do ?
A2- *[? ?]* are you in ... sociology or anything ?
B2- Yeah I read a little bit of it. *[pronounced reed]*
A3- Hm ?
B3- I read a little bit of it. *[pronounced red]*
A4- I mean were you... uh studying sociology ?
B4- No.
A5- You just heard about it, huh ?
B5- Yeah. No. I heard about it from a friend who was a sociologist, and he said read this book, it's a good book and I read that book 'n
A6- I had never heard about him before I started studying linguistics.
B6- Really ?
A7- Yeah.

This excerpt is interesting, because A and C's puzzle is strongly expressed (A1 through A5), and also because B's initial explanation (B's reading of Goffman's books) is repeatedly rejected, while the explanation given in B5 is accepted. Our claim is that logic allows us to predict this phenomenon, and that this prediction would not be possible in a system that would not include logic.

Notice that the logical description we will give does not exhaust all what can be said of this excerpt. Of course not! For instance, D. Tannen accounts for B's reluctance to answer A and C's questions by explaining that B experienced A1 and C1 as an inquisitorial aggression. We do not consider this level of description, which involves participants as persons. This social level has been addressed by many authors, including those working in the Gricean trend or in the Speech Acts paradigm. Our concern is rather the logical connection that exists (and often must exist) between arguments, regardless of who uttered them.

Let us come back to the logic of this excerpt. In the preceding conversation, B appeared to have a very good knowledge of Ervin Goffman's books, which was surprising since they are intended for sociologists. To quote D. Tannen, who is A in this excerpt: "Both C and I expected B to tell how his life - and more likely his work or education - led him to Goffman's books". In the absence of such information, A and C are puzzled, and this puzzle can be easily translated into logic:

context of A1: 'Only sociologists know Goffman's books'

$$knows(\mathbf{X}, Goffman's\_books) \Longrightarrow sociologist(\mathbf{X})$$

We can express the puzzle by rewriting and instanciating this piece of knowledge:

$$[\, knows(B, Goffman's\_books) \,\&\, \text{not}\ sociologist(B) \,] \Longrightarrow \mathbf{F}$$

Notice that logic is used here in a very natural way to express an incompatibility between two states of affairs. Conversely, it is hard to conceive of any system that would be able to express the above incompatibility and that would not include at least propositional logic as a subsystem.

Now we can make a prediction. Whenever such a puzzle is expressed, an explanation is required. An admissible explanation will be any move that cancels the puzzle. One such move is to deny one term of the incompatibility. We thus expect replies like "Actually I don't know Goffman's books, I just read a review of his work in a journal" or "I am teaching sociology" are perfectly admissible answers to A and C's amazement. As far as we can tell, this prediction seems to be correct.

Let us see now how B5 works. It does not deny any term of the incompatibility. Why is it admissible ? After B5, there is no further reason to be surprised at B's knowing of Goffman's books. He came upon them because they were recommended to him. This latter fact blocks the amazement, by changing the initial statement:

context of A1: 'Only sociologists and people who were recommended to read them know Goffman's books'

knows(***X****, Goffman's_books)* ==>
[*sociologist (* ***X****)* v *recommends(****Y****,* ***X****, Goffman's_books)*]

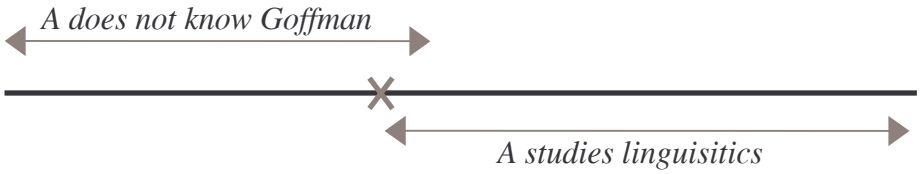
This can be rewritten and instanciated as follows :

[*knows(B, Goffman's_books)* & not *sociologist (B)*
& not *recommends(****Y****, B, Goffman's_books)*] ==> **F**

We see now why B5 acts as an explanation, by denying a term of this augmented context. At this point, the reader may object that this latter mechanism is not falsifiable. It seems that any additional term *T* could act as an explanation of any puzzle [*T1* & *T2*] ==> **F**, simply by changing it into [*T1* & *T2* & not *T*] ==> **F**. Fortunately, this is not correct. The augmented context must be recognised as part of the shared knowledge[1]. It is true in our example, as it would be after the mention of, say, "I know Goffman personally, he is my neighbour". But very few terms would be accepted by participants as premises of the incompatibility.

This logical description of the excerpt and of the expected effect of explanations allows us to account for B1's rejection. B1 accounts for the fact that B does know the books. However, mentioning B1 does not change anything to the current incompatibility, which continues to hold. This explains A and C's behaviour (C1, A2, A4, A5), which would appear as quite strange otherwise.

We see that a logical description at the argumentative level allows us to predict precise facts that remain obscure in non-logical descriptions. We can verify that it also accounts for the content of A's utterance A6. A correct translation of A6 into logic presupposes that the sentence is reliably represented at the semantic level. You should imagine a temporal line, with a point indicating the beginning of A's studies.



What A is saying is that the period during which she had not heard about Goffman contains the period during which she did not know linguistics (we ignore semantic differences between linguistics and sociology or between knowing Goffman and knowing his books):

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[1] The notion of shared knowledge is controversial. We will comment on this below.

A6: "I had never heard about him before I started studying linguistics."
not *sociologist(A)* ==> not *knows(A, Goffman's_books)*

We recognise here a contrapositive and instanciated version of the initial context. Probably, A feels obliged to make the context more obvious to B after his repeated apparent hesitation.

A mere generalisation from our example suggests that this kind of logical analysis can be applied to any conversation based on an initial amazement. The study of spontaneous conversations at the argumentative level shows that amazement is indeed quite frequently used by interlocutors to initiate new conversational topics (Dessalles, 1993). This fact has remained unnoticed, presumably because few authors were concerned both with spontaneous language use and with its argumentative logical organisation.

Can we generalise further ? Is logical description suitable for all types of conversations ? Surely not. However, as we will see now, it is not limited to conversations based on an initial incompatibility.

3. Logic and pragmatic attitudes

Argumentation may be about possibility, as in the preceding example, but also about preference or decision making. Quite often, conversations deal with questions of preference or of undesirable outcomes that should be avoided. Is logic of any use when it comes to choosing a good, or at least not too bad solution when facing a practical problem ? This seems unlikely, if we think that artificial decision making devices make use of production rules, heuristics, optimisation, statistics or risk calculus, but seldom of logic. Our claim, however, is that logic plays a central role in the conversational counterpart of decision making. Moreover, we suggest that the logical processes at work are the same as for discussion based on an initial amazement. To verify this, let us consider the following excerpt from (Liddicoat, 1995):

D1- still, it's a lot of work to renovate a house,
you'd need to make a lot of money to make it
worth it
E1- we-well look, when we- we bought this house
cheap, right, and we- we got it cheap and we did
it up, and then we sold it and made twice the
money we put in and that was in five years

D insists on the amount of work required to renovate a house, and wonders if benefits are worth the effort. E's utterance comes to bring a positive answer. In such conversations, participants are weighing pros and cons. How can logic come into play ? Consider a further example (translated from French) :

context : in a small concert hall ; F and her friend have been waiting for a long time for the concert to begin.

F1- It's not too bad that they did not start yet.
Because otherwise people who are late are making
noise.

Again, there is a balance between the trouble of waiting a long time (implicit here), and the disturbance of late people making noise. Let us concentrate on the logical meaning of 'Because otherwise':

concert_late ==> *waiting* ; *waiting* ==> **UND**

not *concert_late* ==> *noisy_arrival_of_late_people*

noisy_arrival_of_late_people ==> **UND**

UND stands here for *undesirability*. This modality denotes a pragmatic attitude. It is easy to introduce such a modality into logic, without changing anything to logical semantics. We may even consider that truth and falsity (we used **F** to denote the latter) are pragmatic attitudes too. Now we may give a logical account of F1, which results from the preceding knowledge:

not **UND** ==> *concert_late*

The proposition *concert_late*, which inherited its undesirable side from *waiting*, now inherits a new desirable aspect from *not noisy_arrival_of_late_people*. Logic does not help in deciding which effect is stronger, but it allows to make the balance between desires explicit.

Our logical description of these excerpts shows an unexpected phenomenon. F's argument works exactly in the domain of preferences like *reductio ad absurdum* in the domain of possibilities. Whenever you want to prove *P*, you may show that *not P* leads to impossible consequences. Here, to show that *concert_late* is acceptable, F shows that its negation leads to undesirable consequences. The process is exactly the same, only the modality changes. Logic allows us here to bring together two *a priori* unconnected reasoning processes, which is interesting from both cognitive and computational perspectives.

4. Escaping from conflicting beliefs or desires

As illustrated by the preceding examples, some conversations, when described at the argumentative level, seem to be constructed on an initial incompatibility. In some cases, it is a question of possibility (conflicting beliefs), in other cases it is a question of preference (conflicting desires)[2]. We must emphasise again the fact that the conflict exists between arguments, not necessarily between participants. In other words, each participant may try to solve the conflict, without any of them being necessarily attached to one side of it. For instance, D1 makes the incompatibility between the necessity to renovate and the wish to avoid tough work explicit, without particularly advocating one option against the other.

Once we get such a conflict, it seems that logic has nothing further to say. An incompatibility or a balance between pros and cons are blocking situations that logic can only reveal. However, conversation is a dynamic phenomenon, and logic helps us keep track of it. Consider the following segment (translated from French) :

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G1- I have to repaint my doors. I've burned off the
    old paint. It worked OK, but not everywhere. It's
    really tough work!
[...]
H1- You have to use a wire brush
G2- Yes, but that wrecks the wood
H2- It wrecks the wood...
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The conflict results from two incompatible desires : G wants to remove the old paint, and he wants to avoid tough work. The role of *H1* appears then clearly : by using a wire brush, *G* could remove the old paint easily, and the conflict vanishes. G acknowledges this fact in *G2*, but also

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[2] Not all conversations are based on such conflicts. For instance, many conversations start with the mention of an improbable event (see (Dessalles, 1993)) .

points to a new conflict : using a wire brush is desirable (to avoid tough work), but it has undesirable consequences since the wood gets wrecked.

As illustrated by this example, logic gives us a quite new way of looking at conversation. If we forget about individuals involved to concentrate on the arguments only, we see that the interaction starts with an overconstrained situation. Together, the observed facts and background knowledge produce a logical conflict (incompatibility between beliefs or desires). Then further utterances aim at escaping this logical conflict. There are only few ways to get out of a conflict [3]:

i- negate one term of the incompatibility (ex. A2)

ii- negate a hidden premise of the incompatibility (ex. B5)

iii-balance the conflict with another conflict (ex. F1)

Logic does not tell us how to perform this, but it tells us whether the objective has been reached. For instance, B1 is unacceptable because it does not have any logical effect on the conflict.

Conversation appears in such cases to be a process through which participants try to find their way out of a constraint network. It is particularly obvious with H1. This utterance succeeds in suppressing the conflict expressed in G1 (removing paint is tough work). Unfortunately, it provokes a new conflict, revealed by G in G2 (the wire brush would wreck the wood). In the remainder of the conversation (not shown), H will make other unsuccessful attempts to solve the conflict. Notice, one more time, that both participants would like to get out of the conflict. It is not a conflict between both of them, it is a conflict between them and the 'world' which does not conform to their desires.

We may thus present conversation as a way to solve a constraint satisfaction problem, starting from a situation where satisfaction seems impossible. The dynamic process through which participants try to apply strategies (i)-(iii) depends on their ability to find a weak point in the set of constraints and to produce new arguments through abductive reasoning (Dessalles, 1998).

5. 'Shared' knowledge

Behind the preceding development lies a controversial hypothesis. Our description of conversation represents participants working on the same material, namely the set of logical constraints that led to the logical conflict. This presupposes that this set of constraints is *shared* by participants. Is such an assumption plausible ? Our approach, which limits itself to the argumentative level, may shed new light on this old debate.

The possibility of such common knowledge has been either supported (Clark & Schaeffer, 1989) or strongly criticised (Sperber & Wilson, 1987). The main argument against the existence of shared knowledge is infinite regress: interlocutors have no criterion to decide whether a piece of information is hold by others, and they are bound to make recursive assumptions ('maybe she believes that I think that she knows that X'). If we think of conversation not as a social episode between persons, but as a logical process involving arguments, then we obtain such a criterion. Whenever I perceive a logical conflict after some utterance, then my best hypothesis must be that:

. the speaker is aware of the conflict and intended to communicate it

. the speaker knows the terms of the conflict I detected

. the speaker shares the knowledge that I used to establish the conflict

The same has to be true when I make an attempt to solve a previous conflict. If my interlocutor recognises my attempt as such, then s/he must hold the knowledge necessary for this. For instance,

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[3] A fourth possibility consists in denying or minimising the conflict itself. We do not consider it here.

if G recognises H1 (wire brush) as an attempt to solve the conflict expressed in G1, then he must be aware of the logical link through which this solution operates (*e.g.* a wire brush is hard enough to remove the old paint, it will not burn when used with a blow torch). Again, to understand the logical role of G2, H must be aware of some logical links (the wire brush is hard and thus damages to the wood ; this is undesirable since we want to obtain a beautiful surface). In other words, requiring that utterances have some definite logical effect that is recognised by interlocutors puts heavy constraints on what interlocutors know.

6. Conclusion

In this paper, we tried to show how logic may significantly improve our understanding of conversation. Many of our casual interactions start from a logical conflict detected in a given situation. This conflict may come from incompatible beliefs or from incompatible desires. Then further arguments appear as attempts to solve the conflict or to express new conflicts.

Many aspects of conversation are not addressed by this description. Nothing is said of the linguistic or social behaviour of participants. For instance, H1 may be socially interpreted as an attempt to help G, whereas at the logical level, it merely appears as an attempt to invalidate an incompatibility between conflicting desires. However, this logical description, since it introduces new requirements on the well-formedness of conversation, allows to make new predictions, such as the rejection of B1.

We are currently working on a argument generative model that implements the principles exposed here. A previous version has been implemented (Dessalles, 1993), but we are trying to design a much simpler model by taking into account necessity dominance between propositions (Dessalles, 1998). Necessity values are computed, updated and propagated through the logical constraint network, until a proposition with low necessity can be negated. This computational model of argument generation, when operational, will be used to design a computer assisted learning system based on a conversational interaction with the student.

7. References

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