Reasoning Incrementally with Underspecified Enthymemes

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Abstract

In this paper we suggest a way of analysing mismatch in perceived common ground which is the result of dialogue participants adopting different *topoi*, or inference rules, based on which they interpret enthymematic (logically incomplete) arguments in dialogue. A contributing factor to this kind of mismatch is the use of *underspecified* enthymemes, that is enthymemes which are more general than the topoi that underpin them. We will account for an example of such reasoning using a game board style semantics cast in Type Theory with Records (TTR).

1 Introduction

In this paper we will show how one argument may be interpreted differently by two dialogue participants depending on the underpinning topoi they assume the argument to be based on. This is possible since arguments in dialogue are almost always *enthymematic* i.e. drawing on tacit premises and principles of reasoning. In the particular case we will look at the argument is not only enthymematic, it is also an example of an *underspecified* enthymeme. Generally, an underspecified enthymeme is one where the information given in the premise of the enthymeme is sparse, the consequence being that a wide range of topoi potentially could be used to underpin it. This kind of mismatch of topoi may go unnoticed in cases where consensus is reached. After all, if the interlocutors agree on the conclusion of the argument there is often no reason to argue about the rationale for agreeing. However, in the example below in (1) it is made explicit that the speaker and the listener interpret the enthymeme in (1a) drawing on different topoi.

(1)

a. P: Metal was actually the reason I started doing hip hop.

b. P: ...Because I hated metal

c. J: Oh, I thought you were going to say something completely different!

This snippet of dialogue is taken from a radio program where discussion alternates with music. The interviewee is Swedish hip hop artist Petter, and much of the dialogue relates to the songs being played in the music sections. Just before the dialogue a song by a metal band has been played. Petter is being asked for his opinion of the song. The sample suggests that incrementality in interaction concerns not only, as previously reported, phonetic and syntactic aspects of language, but also pragmatic inferences. We will suggest update rules needed to account for the reasoning performed by the speaker J, as well as other cases where an enthymematic argument used in dialogue is less specific than the topos it draws on. We will also suggest a formal definition of what it means for an enthymeme to be underspecified in relation to a topos.

2 Background

2.1 A Dialogue Semantics for Rhetorical Reasoning

In dialogue we frequently draw conclusions which are not, in a strict sense, logical. Following (Breitholtz and Cooper, 2011; Breitholtz, 2011; Breitholtz, 2014), we will use the Aristotelian term *enthymeme* in connection with such inferences. An enthymeme is an argument which appeals to what is in the listener's mind, i.e. an interlocutor must draw on background knowledge or contextual information to correctly interpret the argument. If

a dialogue participant presents the argument P therefore Q, an interlocutor must supply a warrant that P is a valid reason for Q in order for the argument to be successful. These warrants are often referred to as *topoi* (Aristotle, 2007), (Ducrot, 1988), (Ducrot, 1980). When we interact we expect topoi to be common ground, or to be accommodated (adopted by dialogue participants) during the course of the interaction.

The topoi in the resources of an agent may be drawn on to invent and interpret different kinds of enthymemes. Consider for example the dialogue excerpt in (2)

(2)
Anon 3: the monarchy are non political <pause >and therefore, when they choose to speak it's usually out of a genuine concern for that problem
(BNC FLE 233)

In situations such as the one where (2) occurs, the speaker typically assumes that the topos accessed by other conversational participants to interpret the argument, is similar to that which the speaker himself had in mind. However, sometimes our individual takes on the conversation do not match. It is possible that agents involved in dialogue accommodate different topoi which satisfy the criteria for underpinning a particular enthymeme, while not being the ones assumed by the speaker. To model the correspondence and differences between the topoi accessed by conversational participants we use a game board style semantics cast in TTR, similar to analyses found in (Ginzburg, 2012), (Breitholtz and Cooper, 2011), (Cooper and Ginzburg, 2015) (Schlöder et al., 2016). We model enthymematic arguments and the underpinning topoi in the dialogue participants' resources as functions which return types (dependent types). Subtyping is also essential in our account of how topoi may be employed in different enthymemes.

3 Analysis

Let us now return to the example in (1) where

P's first utterance in (1a) – "metal was the reason I started doing hip hop" – is in fact in itself an enthymeme – there is *something* about metal that made Petter start doing hip hop. Thus it may be described as a function from a situation of a type where the music genre "metal" occurs to a type of situation where P starts "doing hip hop", as seen in (3). We refer to this enthymeme as $\mathcal{E}_{reason}$.

(3)
$$\mathcal{E}_{reason} = \lambda r{:}\ \begin{bmatrix} \text{T=music:}\textit{Type} \\ \text{x=metal:T} \\ \text{z=Petter:}\textit{Ind} \\ \text{c}_1\text{:relevant(T)} \end{bmatrix} \cdot \begin{bmatrix} \text{y=hiphop:}r\text{.T} \\ \text{c}_2\text{:do(r.z,y)} \end{bmatrix}$$

There might be several topoi accessible to J which could be drawn on to underpin the enthymeme $\mathcal{E}_{reason}$. Judging from J's utterance she is surprised by P's assertion that he hated metal. We cannot say exactly in which way Petter hating metal is "completely different" from what J expected. However, it seems reasonable to assume that she expected metal being the reason for P starting to "do" hiphop to be due to some favourable relation between him and metal. Thus, a possible topos could be one saying that if two things are of the same type, and the speaker has a favourable attitude to one of them, that thing may cause someone to "do" the other thing. This principle does not follow classical logic, but still seems to be productive in everyday argumentation. Think of examples like "My grandma had poodles, that is what made me start breeding dalmatians", "Karate got me interested in Kung Fu", etc. We see a formalisation of this topos, $\mathcal{T}_{similar}$ in (4).

(4)
$$\mathcal{T}_{similar} = \lambda r{:}\ \begin{bmatrix} \text{T:}\textit{Type} \\ \text{x:T} \\ \text{z:}\textit{Ind} \\ \text{c}_1\text{:relevant(T)} \\ \text{c}_2\text{:like(z, x)} \end{bmatrix} \cdot \begin{bmatrix} \text{y:r.T} \\ \text{c}_3\text{:do(r.z, y)} \end{bmatrix}$$

(Breitholtz, 2014) suggests update rules for integrating topoi on the shared DGB, similar to the one in (5)

5 is a function from a situation of a type where a speaker has access to a topos (in the private field of the DGB) to another function from a type of situation where one such topos is a specification of the max eud, to a situation type where the topos in question is integrated on the shared DGB. This function thus only applies when the domain- or antecedent part of the enthymeme is a subtype (less specific or identical to) of the corresponding part of the topos. Secondly, the result of applying the enthymeme to a record r must be a subtype of the result of applying the topos to the same record.

In the case of $\mathcal{E}_{reason}$ the antecedent type is *not* a subtype of the antecedent type of $\mathcal{T}_{similar}$, since it lacks the constraint c_2: like(z, x). Both requirements for a standard update of shared topos

(5)

$$\mathcal{F}_{integrate\_shared\_topos} = \lambda r{:}\begin{bmatrix}\text{private:}\begin{bmatrix}\text{topoi:list(}\textit{Topos}\text{)}\end{bmatrix}\\ \text{shared:}\begin{bmatrix}\text{eud:list(}\textit{Enthymeme}\text{)}\\ \text{topoi:list(}\textit{Topos}\text{)}\end{bmatrix}\end{bmatrix} \cdot \lambda e{:}$$

$$\begin{bmatrix}\text{t:}\textit{Topos}\\ \text{c}_1\text{:in(t, r.private.topoi)}\\ \text{c}_2\text{:specification(fst(r.shared.eud), t))}\end{bmatrix} \cdot \begin{bmatrix}\text{shared:}\begin{bmatrix}\text{topoi=[e.t | r.private.topoi]:list(}\textit{Topos}\text{)}\end{bmatrix}\end{bmatrix}$$

is thus not met. However, since dialogue participants sometimes do accommodate topoi based on underspecified enthymemes, we want to be able to model how topoi may be integrated based on less strict requirements. In order to do this we introduce an additional update rule – $\mathcal{F}_{integrate\_topos'}$ – for integrating topoi based on underspecified enthymemes, as seen in (6).

According to $\mathcal{F}_{integrate\_topos'}$ – which is to be applied if there is no topos that is a more general version of the max eud – we may integrate a topos which is more specified than the enthymeme evoking it. We say that an enthymeme $\mathcal{E} = T_3$ is underspecified in relation to a topos $\mathcal{T}$ if $\mathcal{T} = T_1 \cdot T_2$, $\mathcal{E} = T_3 \cdot T_4$, $T_1 \sqsubset T_3$ and, for any r, $\mathcal{E}(r) \sqsubseteq \mathcal{T}(r)$

After the application of $\mathcal{F}_{integrate\_shared\_topos'}$, J's information state is of the type in (7).

(7)

$$\begin{bmatrix}\text{shared:}\begin{bmatrix}\text{eud=[}\mathcal{E}_{metal\_reason}\text{]:list(}\textit{Enthymeme}\text{)}\\ \text{topoi=[}\mathcal{T}_{similar}\text{]:list(}\textit{Topos}\text{)}\\ \text{l-m:}\begin{bmatrix}\text{prev:}\textit{Rec}\\ \text{e:}\begin{bmatrix}\text{x:}\textit{Ind}\\ \text{y:}\textit{Ind}\\ \text{z=Petter:}\textit{Ind}\\ \text{s:}\textit{Ind}\\ \text{c}_1\text{:metal}\\ \text{c}_2\text{:hiphop}\\ \text{c}_3\text{:spec(x, s)}\\ \text{c}_4\text{:spec(y, s)}\\ \text{c}_5\text{:start\_doing}\\ \text{c}_6\text{:reason(z, c}_5\text{, c}_2\text{)}\end{bmatrix}\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

After P's second utterance in (1b) – "Because I hated metal" – a new enthymeme, $\mathcal{E}_{reason'}$, is integrated at the top of the list of enthymemes under discussion.

(8) $\mathcal{E}_{reason'} =$

$$\lambda r{:}\begin{bmatrix}\text{T:}\textit{Type}\\ \text{x=metal:T}\\ \text{c}_1\text{:relevant(T)}\\ \text{z=Petter:}\textit{Ind}\\ \text{c}_{hate}\text{:hate(z, x)}\end{bmatrix} \cdot \begin{bmatrix}\text{y=hiphop:}r\text{.T}\\ \text{c}_2\text{:do(}r\text{.z,y)}\end{bmatrix}$$

We need an update rule making sure that shared topoi is updated with a topos which supports the max eud. The rule $\mathcal{F}_{update\_topoi}$ in (9) says that if there is an information state where a topos on shared.topoi supports the max eud, we are licensed to update that information state so that the topos in question is moved to the max topoi position at the top of the list of topoi. If b is a list and $a \in b$, the function μ applied to b, $\mu(a, b)$, moves a to the top of list b regardless of what position a has had previously.

The update rule in (9) applies when a topos which is already integrated on the shared gameboard is being actualised by an enthymeme. However, in cases such as this the topos available seems to be incompatible with the enthymeme: $\mathcal{E}_{reason'}$ says that since Petter hated metal, he started doing hip hop, and the topos $\mathcal{T}_{similar}$ says that if someone likes something s/he might start doing something similar. The antecedents include concepts that we would probably want to model as mutually exclusive, namely *like* and *hate*. The formula in (10) is our version of a meaning postulate, and reads " T_1 precludes T_2", that is there is no situation in which both T_1 and T_2 apply (for a thorough discussion of preclusion in TTR, see (Cooper, in prep).)

(10) If $\begin{bmatrix}\text{x:}\textit{Ind}\\ \text{c:hate(x)}\end{bmatrix} = T_1$ and $\begin{bmatrix}\text{x:}\textit{Ind}\\ \text{c:like(x)}\end{bmatrix} = T_2$ then $T_1 \perp T_2$

When we engage in conversation we normally try to interpret underspecified or implicit content drawing on information already introduced on the dialogue gameboard. This is the case with for example resolution of anaphora. Thus it seems reasonable that an algorithm for applying update rules meant to pick out a topos to underpin the enthymeme currently under discussion first tries to apply the rule $\mathcal{F}_{update\_shared\_topoi}$ which looks for a suitable topos already on the DGB, and not until that fails, apply a rule which looks into the long term memory of the conversational participant (modelled here as private.topoi).

The only topos on the list of shared topoi at the point where J has just integrated $\mathcal{E}_{reason'}$ is such that the max eud cannot be a specification

(6)

$$\mathcal{F}_{integrate\_shared\_topos'}(r) = \lambda r{:}\ \begin{bmatrix}\text{private:}\begin{bmatrix}\text{topoi:list(}\textit{topos}\text{)}\end{bmatrix}\\ \text{shared:}\begin{bmatrix}\text{eud:list(}\textit{Enthymeme}\text{)}\\ \text{topoi:list(}\textit{Topos}\text{)}\end{bmatrix}\end{bmatrix} \cdot$$
$$\lambda e{:}\ \begin{bmatrix}\text{t:}\textit{Topos}\\ \text{c}_1\text{:in(t, r.private.topoi)}\\ \text{c}_2\text{:underspec.(fst(r.shared.eud), t))}\end{bmatrix} \cdot$$
$$\begin{bmatrix}\text{shared:}\begin{bmatrix}\text{topoi=[e.t | r.private.topoi]:list(}\textit{Topos}\text{)}\end{bmatrix}\end{bmatrix}$$

(9)

$$\mathcal{F}_{update\_topoi} = \lambda r{:}\ \begin{bmatrix}\text{shared:}\begin{bmatrix}\text{eud:list(}\textit{Enthymeme}\text{)}\\ \text{topoi:list(}\textit{Topos}\text{)}\end{bmatrix}\end{bmatrix} \cdot$$
$$\lambda e{:}\ \begin{bmatrix}\text{t:}\textit{Topos}\\ \text{c}_1\text{:in(}r\text{.shared.topoi, t)}\\ \text{c}_2\text{:specification(fst(}r\text{.shared.eud), t)}\end{bmatrix} \cdot \begin{bmatrix}\text{shared:}\begin{bmatrix}\text{topoi=[}\mu(e\text{.t, }r\text{.sh.topoi)]:list(}\textit{Topos}\text{)}\end{bmatrix}\end{bmatrix}$$

of it, nor can the topos be a specification of the max eud, since $\mathcal{E}_{reason'} \perp \mathcal{T}_{similar}$. Thus the conditions for applying $\mathcal{F}_{update\_topoi}$ are not fulfilled. So, we move on to once again applying rule $\mathcal{F}_{integrate\_topoi}$. A topos that would work here would be one capturing the notion of " the lesser of two evils", or any other topos saying that dislike of something may cause someone to do some activity of the same type. $\mathcal{T}_{l\_t\_e}$. The point is that in the first assumed topos, the focus is on the *similarity* between two things of the same type, in the second it is on the *dissimilarity*.

(11) $\mathcal{T}_{l\_t\_e} = \lambda r{:}\ \begin{bmatrix}\text{T:}\textit{Type}\\ \text{x:T}\\ \text{y:T}\\ \text{z:}\textit{Ind}\\ \text{c}_1\text{:relevant(T)}\\ \text{c}_2\text{:hate(z, y)}\end{bmatrix} \cdot \begin{bmatrix}\text{e:do(r.z, r.x)}\end{bmatrix}$

We assume thus, that J's information state, T_{IS_J}, when she has integrated $\mathcal{E}_{reason'}$ is of the type in (12).

(12)
$$\begin{bmatrix}\text{priv:}\begin{bmatrix}\text{topoi=[}\mathcal{T}_{l\_t\_e}\text{]:list(}\textit{Topos}\text{)}\end{bmatrix}\\ \text{shar:}\begin{bmatrix}\text{eud=[}\mathcal{E}'_{reason}, \mathcal{E}_{reason}\text{]:list(}\textit{Enthymeme}\text{)}\\ \text{topoi=[}\mathcal{T}_{similar}\text{]:list(}\textit{Topos}\text{)}\end{bmatrix}\\ \end{bmatrix}$$

Since the application of update rule $\mathcal{F}_{update\_shared\_topoi}$ fails in this situation, we move on to once more apply $\mathcal{F}_{integrate\_topoi}$. The resulting type has a max topos that is a specification of the max eud, which is what we would typically expect after integration of a topos on the shared game board.

(13) $\mathcal{F}_{integrat\_topoi}(T_{IS_J}) =$
$$\begin{bmatrix}\text{shared:}\begin{bmatrix}\text{eud=[}\mathcal{E}'_{reason}, \mathcal{E}_{reason}\text{]:list(}\textit{Enthymeme}\text{)}\\ \text{topoi=[}\mathcal{T}_{l\_t\_e}, \mathcal{T}_{similar}\text{]:list(}\textit{Topos}\text{)}\end{bmatrix}\\ \end{bmatrix}$$

4 Conclusion

When a dialogue participant sets about to interpret an enthymematic utterance, they try to access a topos that may serve as underpinning for the enthymeme. typically this means a topos which is a more general than the enthymeme. We looked at an example providing evidence that we may actually start reasoning before an argument is fully spelled out, in the sense that there is a topos that warrants the enthymeme by being a generalised version of it. This indicates that the way we process rhetorical structure is analogous to the way we process sentential and non-sentential utterances as described in e.g. (Eshghi et al., 2015) – by incrementally constraining the search space. We have suggested rules to account for information state updates based on fully specified as well as underspecified enthymemes. In further work we want to investigate to what degree underspecified enthymemes are actually used. Intuitively, in situations where dialogue participants know each other very well and/or the context allows it, they may well infer topoi based on underspecified enthymemes, which turn out to be exactly the ones intended by the speaker. Furthermore the possibility of asking follow up questions and other types of feed back may make it efficient to reason based on underspecified enthymemes in situations where the stakes are not too high.

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