How to Put an Elephant in the Title: Modelling humorous incongruity with enthymematic reasoning

Ellen Breitholtz and Vladislav Maraev
Centre for Linguistic Theory and Studies in Probability (CLASP),
Department of Philosophy, Linguistics and Theory of Science, University of Gothenburg
{ellen.breitholtz,vladislav.maraev}@gu.se

Abstract

In humour theories incongruity is a crucial feature in characterising a humorous event, and giving it a formal definition is important for accounting for why something is considered amusing. In this work we address the problem of formalising incongruity within a computational framework, thereby exploring the ability of a machine to detect the source of humorous incongruity and being able to adapt its behaviour accordingly. In our formalisation we draw attention to dialogical and incremental perspectives on humour. To capture mismatches between the information states of dialogue participants, we adopt the notions of enthymemes and topoi as instances and types of defeasible argumentation items.

1 Introduction

Consider the following dialogue:

(i)

1	A	How do you put an elephant into a fridge?
2	B	Hmm, I don't know?
3	A	Open the door, put the elephant inside, close the door.
4	B	Haha okay
5	A	How do you put a giraffe into the fridge?
6	B	Open the door, put the giraffe inside, close the door?
7	A	Wrong! Open the door, get the elephant out, put the giraffe inside, close the door.

Jokes such as the one above rely on dialogicity and the expectations of interlocutors to reason in a certain way based on certain assumptions about acceptable reasoning. In this work we suggest an account of humourous events that calls attention to the dialogical nature of humour, and the underlying reasoning warranting interpretations giving rise to humour.

Studies of humour often underline the importance of comprehending a temporal sequence of events for understanding a joke as it unfolds (Suls, 1972; Ritchie, 2018). However, such sequence might be interpreted differently by different interlocutors. Moreover, when telling a joke, a speaker often takes advantage of the potential to interpret a move in different ways to create a humorous exchange. Thus, to account for how a speech event is perceived as humourous, we must consider this incrementality from an interactive point of view. In our account we use techniques from dialogue semantics where game boards are used to represent the information states of interlocutors, which are updated during the course of an interaction (Cooper and Ginzburg, 2015; Ginzburg, 2012; Larsson, 2002). To capture mismatches between the information states of dialogue participants, we adopt the notions of *enthymemes* and *topoi* as instances and types of defeasible argumentation items. This approach has been used in formal analysis of dialogue to account for inferences based on background assumptions, and to account for incremental interpretation of argumentation in dialogue (Breitholtz et al., 2017). Very similar approach based on topoi and enthymemes was utilised to account for laughter-related incongruity in dialogue (Ginzburg et al., 2015; Mazzocconi et al., 2018).

In the rest of the paper we will first provide some theoretical background to humour and dialogical reasoning (section 2). We will then look at the joke above in more detail (section 3) providing an informal description that we discern in the process of its comprehension. In section 4 we will move on to describe the relevant updates of this joke using TTR, a type theory with records

(Cooper, 2012). In the final section, we will discuss the limitation of our approach in connection to dialogue systems.

2 Related work

2.1 Humour research

In the past decades competing visions on humour have been developed, introducing such notions as ‘incongruity’, ‘incongruity resolution’, ‘semantic script’, ‘superiority’, ‘relief’, ‘pseudo-logic’ and many others as key components of humour. Ritchie (2004) emphasises the importance of explicating these so-called ‘theory-internal’ concepts in ‘theory-external’ terms which will arise from more general explanations relying on underlining cognitive processes, such as text comprehension (Ritchie, 2018) and, in our case, incremental reasoning in dialogue.

Notable linguistic theories of humour, such as Semantic-Script Theory of Verbal Humour (SSTH, Raskin, 1985) and General Theory of Verbal Humour (GTVH, Attardo and Raskin, 1991; Hempelmann and Attardo, 2011) are mainly about humour competence. They abstract away from the actual process of joke comprehension and do not include processing as a crucial condition for humour (Ritchie, 2018). Acknowledging Ritchie’s claim about a deficiency of actual explanations regarding how jokes are processed as text, we view the dialogicity of joke processing as a crucial condition for getting humorous effect that may result in amusement or laughter.

One important consequence of the dialogicity of jokes is the presence of the possibility that interlocutors might interpret the same piece of discourse in distinct ways. This is often taken advantage of in humour, and one way to account for this is using a theory of enthymematic arguments warranted by topoi.

2.2 Computational humour

A considerable amount of literature has been published on computational humour, highlighting the importance of understanding humour for dialogue systems (e.g., Raskin and Attardo, 1994; Hempelmann, 2008; Binsted et al., 1995).

A number of authors have investigated *humour generation*, mainly using template-based approaches inspired by humour theories. Examples of generated humorous texts are puns (Ritchie, 2005), lightbulb jokes (Raskin and Attardo, 1994), humorous names (Ozbal and Strapparava, 2012) and acronyms (Stock and Strapparava, 2005).

Much of the current literature on *humour recognition* pays particular attention to either detecting salient linguistic features, such as stylistic features (Mihalcea and Strapparava, 2005), handcrafed humour-specific features (Zhang and Liu, 2014) and N-gram patterns (Taylor and Mazlack, 2004), or latent semantic structures, (Taylor, 2009; Yang et al., 2015). Yang et al. (2015), in addition, focus on humour anchors, i.e. words or phrases that enable humour in a sentence.

So far, however, there has been little discussion about detecting humour in an interactive setting. For example, recent studies were mostly concerned with scripted dialogues, such as TV series like ‘Friends’ and ‘The Big Bang Theory’. Purandare and Litman (2006) used both prosodic and linguistic features and Bertero and Fung (2016) used a text-based deep learning approach. Both of these studies marked utterances followed by laughs as humorous, and the rest as non-humorous. The main weakness of this approach is that in real dialogues laughter is not necessarily associated with humorous content: it is not always triggered by humour and can express wide range of emotions, such as amusement, aggression, social anxiety, fear, joy and self-directed comment (Poyatos, 1993; Provine, 2004) and may also be used to convey propositional content (Ginzburg et al., 2015). In addition to this, not all events that are perceived as humorous provoke laughter. Even though laughter in conversations can be predicted with a fairly high accuracy (Maraev et al., 2019), it is still not indicative of whether the preceding content was humorous as opposed to, for example, the laughter having been used to soften a bold opinion expressed by of one of the interlocutors.

Therefore, in the current paper we employ a dialogue-driven rather than a humour-driven framework. In Section 2.3 we will give a brief account of enthymematic reasoning in dialogue and relate it to jokes and humour.

2.3 Rhetorical reasoning and humour

The *enthymeme* is originally a key device in the Aristotelian theory of persuasion. However, as we shall see, the concept has broader use. An enthymeme is an argument where the conclusion does not follow by necessity, usually because one or more premises are not explcit in the discourse. Presenting an argument based on implicit information is possible since the members of an audience or participants in a conversation have knowledge and beliefs regarding the world around them, which they automatically supply to arguments where they fit. The implicit information can be of different kinds – general knowledge, contextually relevant information, socio-cultural assumptions, etc. In rhetorical theory, the rule of thumb underpinning an enthymeme is referred to as a *topos*. As noted by Jackson and Jacobs (1980), enthymemes do not only belong in rhetorical discourse, but are frequently occurring in conversation. This idea is in line with the semantic theory of topoi in Ducrot (1988, 1980); Anscombre (1995), where topoi are seen as essential for meaning that exceeds the semantic content conveyed by an utterance. So, what does enthymematic reasoning in dialogue in fact mean? In (ii) (Wilson and Sperber, 2004) we find an example of a reply to a question requiring enrichment with implicit assumptions in order to be seen as a relevant answer to the question.

(ii)	Peter	Would you drive a SAAB?
	Mary	I wouldn't drive any Swedish car.

The implied answer to the question in (ii) is that Mary would not drive a SAAB. This conclusion is based on the fact that a SAAB is a Swedish car. In approaches to implicit meaning like Gricean (or Neo-Gricean) pragmatics and Relevance theory (Wilson and Sperber, 2004), this conclusion is based on an assumption of relevance – why would Mary answer the way she does unless a SAAB is indeed a Swedish car? However, this view ignores the fact that Peter might not interpret the answer correctly if it is unsupported by assumptions in his information state. In Aristotelian dialectic and rhetoric, (ii) would be warranted by a topos – for example that if something is true for a particular *genus*, then it is also true of a *species* (subtype) of that genus – and a premise, in this case that a SAAB is a species of the genus car. If an interlocutor is not aware of either the topos or the premise, the answer given by Mary bears no relevance to the question. In our analysis we will not distinguish between topoi and premises. Following Ducrot (1988), we will refer to all rules or principles used to underpin reasoning as topoi.

In (iii) we see an example of where enthymematic reasoning underpinned by topoi creates a humorous effect.

(iii)	1 A	Are the bagels fresh?
	2 B	No.
	3 A	What about the muffins?
	4 B	Better get the bagels.

The context of the joke is that A goes into a bakery, presumably to buy bread or cakes. A first asks about the freshness of the bagels. The shop assistant, B, responds that they are not fresh. A, thinking about getting muffins instead, asks whether *those* are fresh, and B responds that A better get the bagels. This short dialogue is underpinned by two topoi – one saying that if some food is not fresh, you should not buy it, and one saying that if you have to choose between two food items, and one is fresher that the other, you should choose the fresher one:

$$\frac{\text{not\_fresh}(x)}{\text{not\_buy}(x)} \tag{1}$$

$$\frac{\text{fresher\_than}(x, y)}{\text{buy}(x)} \tag{2}$$

Let us think of the updates of the dialogue above: After the first utterance the inquirer/customer, A, has communicated that they are considering buying some bagels, and that the freshness of the bagels will have impact on their willingness to buy them. When B has replied "no", we know that the bagels are not fresh, and indeed, A starts inquiring about the freshness of other types of bread. We can assume that a topos along the lines of 'don't buy non_fresh food' is accommodated in the dialogue. If B had not agreed with this, they would have said something like 'they are not fresh, but they are actually best when they are a few days old, or similar'. The second exchange evokes the topos that if one food item is fresher than another, you should buy the fresher one. Both of these topoi seem acceptable, and most people would agree with them. However, in this case, two topoi are accommodated which, when instantiated in this particular context, lead to inconsistent conclusions. That is, one of the topoi says that A should buy the bagels and one that they should not, and this is of course, a type of incongruity. So the fact that a topos is accommodated which clashes with a previously accommodated topos, regarding the same question under discussion, seems to create the humorous effect in this case.

In the next section we will look at another example where humorous incongruity is achieved through clashes between reasoning items.

3 The elephant-in-a-fridge riddle: An analysis

Let's consider the example in (i), as it could be told in a dialogue situation. We use a made up example[1] because it allows us to abstract away from complex cultural and social assumptions as well as situational context, and treat the discourse on a level of very basic assumptions.

This joke is a good illustration of how interlocutors build a common ground incrementally, agreeing on and refuting topoi drawn on to underpin the dialogue.

3.1 An elephant

In the first part of the joke, in (iv), the question evokes a topos about how to put things in fridges, which is in some way restricted to the kitchen domain. In this context, the idea of how to put something into a fridge is obvious, and also restricted to things that are (usually) food, and of the right size. This leads the interlocutor, B, to say that he does not know how to put an elephant into a fridge.

(iv)	1 A	How do you put an elephant into a fridge?
	2 B	Hmm, I don't know?
	3 A	Open the door, put the elephant inside, close the door.
	4 B	Haha okay

The joke-telling genre indicates in this instance that A's question ('How do you put x in a fridge') is not really a request for information but has an answer which is known to A and which is to be revealed to B. On the other hand, the question is odd, which leads B (or the audience) to expect a non-trivial answer. It is important to draw attention to this because it is this oddity that provokes a light chuckle from the listener when the triviality is revealed.

One way of characterising "oddity" is in terms of congruity (or incongruity) with regard to salient topoi. The activity of putting something in a fridge is associated with a particular sequence of events. However, this sequence of events or actions will work more or less well to create the state of x being in the fridge. We can think of a scale of oddity for these kinds of questions (Table 1):

Degree	Example
Trivial	'How do you put a cheese in a fridge?'
Tricky	'How do you put a big cake in a fridge?'
Odd	'How do you put an elephant in a fridge?'

Table 1: Degrees of oddity

We can think of *trivial* and *odd* as eliciting incongruity. The trivial question addresses something that is considered to be known, and the odd one addresses something ridiculously impossible. A nice example of a trivial question is 'Why did the chicken cross the road'? Questions are usually not supposed to address knowledge that can be easily inferred from the question (crossing the road entails getting to the other side of it).[2] This can be also be explained by violation of Grice's Maxim of Quantity: The answer 'to get to the other side' does not provide any additional information, and is thus superfluous.

A *tricky* question requires some non-trivial resolution, for example:

(v) A: How do you put a wedding cake in a fridge?
B: You will need to remove one of the shelves.

3.2 A giraffe

Given the answer (3 A), B relaxes the implausibility of the elephant being put inside a fridge with no additional non-trivial actions. B accepts the required sequence of actions and acknowledges that (4 B). But is this enough to answer the question about a giraffe?

(vi)		
	5 A	How do you put a giraffe into the fridge?
	6 B	Open the door, put the giraffe inside, close the door?
	7 A	Wrong! Open the door, get the elephant out, put the giraffe inside, close the door.

B gives an answer based on his newly acquired storyworld, where elephants fit into fridges. But,

[1] This joke appears at: http://jeremy.zawodny.com/blog/archives/009023.html

[2] The authors are aware of another, suicidal, interpretation of the chick riddle.

apparently what B has acquired is not enough: putting a giraffe into the fridge requires several other assumptions to be accommodated.

1. Even given that the fridge is 'magical', and big enough to fit an elephant, it is still not big enough to fit two big animals.

2. The joke-teller is talking about the very same fridge (this is especially important for languages in which there is no definite article)

3. Even if B understands that A is talking about the same fridge, it is not obvious that it already has an elephant inside, since it has never been explicitly said that an elephant has been put into a fridge.

3.3 Summary

An important quality of this example is that it illustrates how common ground is built gradually and following contributions exploiting the previous updates, the joke relies on A's priming tricks and on not specifying what exact assumptions B should accept. If, in the earlier stage, the assumptions were characterised more precisely (e.g., 'A: It is just a really huge fridge'), then the riddle would not work, or at least would be less funny.

The joke relies on an ambiguous and uncertain setting which creates the possibility of resolutions which generate humorous effects.

4 Formal account

The formal framework we will use is *Type Theory with Records* (TTR), a rich type theory successfully employed to account for a range of linguistic phenomena, including ones particular to dialogue (Cooper and Ginzburg, 2015).

In TTR agents perceive an individual object that exists in the world in terms of being *of a particular type*. Such basic judgements performed by agents can be denoted as "a : Ind", meaning that a is an individual, in other words a is a *witness* of (the type) Ind(ividual). This is an example of a *basic* type in TTR, namely types that are not constructed from other types. An example of a more complex type in TTR is a *ptype* which is constructed from predicates, e.g. $\mathit{fresher\_than}(a, b)$, "$a$ is fresher than b". A witness of such a type can be a situation, a state or an event. To represent a more general event, such as "one individual item is fresher than another individual item" *record types* are used. Record types consist of a set of fields, which are pairs of unique labels and types. The record type which will correspond to the aforementioned sentence is the following:

$$\begin{bmatrix} \mathrm{x} & : & \mathit{Ind} \\ \mathrm{y} & : & \mathit{Ind} \\ \mathrm{c_{fresh}} & : & \mathit{fresher\_than}(\mathrm{x}, \mathrm{y}) \end{bmatrix} \quad (3)$$

The witnesses of record types are *records*, consisting of a set of fields which are pairs of unique labels and values. In order to be of a certain record type, a record must contain at least the same set of labels as the record type, and the values must be of a type mentioned in the corresponding field of the record type. The record may contain additional fields with labels not mentioned in the record type. For example, the record (4) is of a type in (3) iff $a : \mathit{Ind}$, $b : \mathit{Ind}$, $s : \mathit{fresher\_than}(a, b)$ and q is of an arbitrary type.

$$\begin{bmatrix} \mathrm{x} & = & a \\ \mathrm{y} & = & b \\ \mathrm{c_{fresh}} & = & s \\ \mathrm{c_{price}} & = & q \end{bmatrix} \quad (4)$$

TTR also defines a number of type construction operations. Here we mention only the ones that are used in the current paper:

1. *List types*: if T is a type, then $[T]$ is also a type – the type of lists each of whose members is of type T. The list $[a_1, \ldots, a_n] : [T]$ iff for all i, $a_i : T$. Additionally, we use a type of non-empty lists, written as $_{ne}[T]$, which is a subtype of $[T]$ where $1 \leq i \leq n$. We assume the following operations on lists: constructing a new list from an element and a list (cons), taking the first element of list (head), taking the rest of the list (tail).

2. *Function types*: if T_1 and T_2 are types, then so is $(\lambda r : T_1.T_2)$, the type of functions from records of type T_1 to record type T_2. Additionally, T_2 may *depend* on the parameter (the witness of type T_1 passed to the function).

3. *Singleton types*: if T is a type and $x : T$, then T_x is a type. $a : T_x$ iff $a = x$. In record types we use manifest field notation to a represent singleton type. Notations $\begin{bmatrix} \mathrm{a} & : & T_x \end{bmatrix}$ and $\begin{bmatrix} \mathrm{a = x} & : & T \end{bmatrix}$ represent the same object.

4.1 Dialogue Gameboards in TTR

Following Ginzburg (2012) and Larsson (2002) we will model the progress of dialogues in terms of the *information states* of the dialogue participants. In our analysis we will focus on the part of a dialogue participant's information state that is shared. That is, what has in some way been referred to in the dialogue, or what is necessary to integrate in the information state for a dialogue contribution to be interpreted in a relevant way. We will refer to this shared part of an interlocutor's information state as the *Dialogue Game Board* (DGB) of that participant. We are particularly interested in how individual agents draw on individual (and sometimes distinct) resources. We will therefore use separate DGBs for each agent, rather than letting the DGB represent a God's eye notion of context. For example, although a topos may be of central relevance in the dialogue, it does not appear on the DGB until it has been made explicit, or until something has been said which has caused it to be accommodated. We model the DGB as a record type where labels are associated with types, as in 5.

$$\begin{bmatrix} \text{rhet\_resources} : \begin{bmatrix} \text{topoi} : [\textit{Topos}] \end{bmatrix} \\ \text{dgb} : \begin{bmatrix} \text{eud} : [\textit{Enthymeme}] \\ \text{topoi} : [\textit{Topoi}] \end{bmatrix} \end{bmatrix} \tag{5}$$

The record type in 5 represents the type of the information state of a dialogue participant with regard to enthymematic reasoning. In the DGB we find the enthymemes under discussion and the topoi that have been evoked in the conversation. For a topos to be added to the dgb of a dialogue participant, it must have been accommodated by the participant. The field rhet_resources (rhetorical resources) represents the topoi that are available to a speaker for inventing and interpreting arguments.

4.2 Enthymematic Reasoning in the Elephant Joke

We model enthymematic inferences and the topoi that underpin them as functions from situations of particular types to other types of situation. For example, one topos relating to the situation described in the elephant dialogue in (iv), could be represented as a function from a situation of a type where someone opens the door of the fridge, puts an object inside, and shuts the door, to a type of situation where the same object is in the fridge. We see this topos, τ_1, in (6):

$$\tau_1 = \lambda r : \begin{bmatrix} \text{x} & : & \textit{Ind} \\ \text{y} & : & \textit{Ind} \\ \text{z} & : & \textit{Ind} \\ \text{c}_{\text{fridge}} & : & \textit{fridge}(\text{x}) \\ \text{c}_{\text{agent}} & : & \textit{agent}(\text{y}) \\ \text{c}_{\text{open}} & : & \textit{open}(\text{y}, \text{x}) \\ \text{c}_{\text{put}} & : & \textit{put\_in}(\text{y}, \text{z}, \text{x}) \\ \text{c}_{\text{small}} & : & \textit{small}(z) \end{bmatrix} . \begin{bmatrix} \text{s} : \textit{in}(r.\text{z}, r.\text{x}) \end{bmatrix} \tag{6}$$

A topos is to be seen as a non-monotonic principle of reasoning (Breitholtz, 2014), and as such the conclusion does not follow necessarily and in all cases. Just like the principle that if x is a bird, x flies, does not apply to situations where the bird in question is a penguin, there might be a number of situations where a topos about how food gets into a fridge does not apply. Relevant to the situation at hand is an exception regarding the size of the object. Thus, we include the constraint "small" to restrict the use of the topos to things that are small enough to fit into a fridge. τ_1 is part of B's rhetorical resources, that is, a collection of topoi that are available for B to use as warrants in reasoning. The situation suggested by A's question conveys an enthymeme ϵ_1 like that in (14).

$$\epsilon_1 = \lambda r : \begin{bmatrix} \text{x} & : & \textit{Ind} \\ \text{y} & : & \textit{Ind} \\ \text{z} & : & \textit{Ind} \\ \text{c}_{\text{elephant}} & : & \textit{elephant}(\text{z}) \\ \text{c}_{\text{fridge}} & : & \textit{fridge}(\text{x}) \\ \text{c}_{\text{agent}} & : & \textit{agent}(\text{y}) \\ \text{c}_{\text{open}} & : & \textit{open}(\text{y}, \text{x}) \\ \text{c}_{\text{put}} & : & \textit{put\_in}(\text{y}, \text{z}, \text{x}) \end{bmatrix} . \begin{bmatrix} \text{s} : \textit{in}(r.\text{z}, r.\text{x}) \end{bmatrix} \tag{7}$$

In order to integrate a topos based on an enthymeme under discussion, the topos accessed in the rhetorical resources of the dialogue participant must be relevant with regard to the enthymeme conveyed in the discourse. We define this as the enthymeme being a *specification* of the topos. An enthymeme ϵ is a specification of a topos τ iff the antecedent type of ϵ is a subtype of the antecedent type of τ, and, for any situation r, the result of applying ϵ to r, is a subtype of the result of applying

τ to r. as shown in (8).

$$\begin{array}{ll} \tau & = T_1 \to T_2 \\ \epsilon & = T_3 \to T_4 \\ T_3 \sqsubseteq T_1 & \\ \text{for any } r, \epsilon(r) \sqsubseteq \tau(r) & \end{array} \quad (8)$$

However, since the antecedent type of τ_1 involves a constraint "small", which is not present in the antecedent type of ϵ_1, ϵ_1 is not a specification of τ_1. Interlocutor B does not have access to other relevant topoi regarding how do you put an elephant into a fridge, and replies that he does not know the answer to the question.

A's next utterance evokes another topos — τ_2 — where the size constraint is removed, and the enthymeme under discussion is thus a specification of τ_2, which is integrated in A's DGB according to the update rule in (10) below.

$$\tau_2 = \lambda r : \begin{bmatrix} \text{x} & : & \mathit{Ind} \\ \text{y} & : & \mathit{Ind} \\ \text{z} & : & \mathit{Ind} \\ \text{c}_{\text{fridge}} & : & \mathit{fridge}(\text{x}) \\ \text{c}_{\text{agent}} & : & \mathit{agent}(\text{y}) \\ \text{c}_{\text{open}} & : & \mathit{open}(\text{y}, \text{x}) \\ \text{c}_{\text{put}} & : & \mathit{put\_in}(\text{y}, \text{z}, \text{x}) \end{bmatrix} . \begin{bmatrix} \text{s} & : & \mathit{in}(r.\text{z}, r.\text{x}) \end{bmatrix} \quad (9)$$

$$\begin{array}{l} \mathcal{F}_{integrate\_shared\_topos} = \\ \lambda r : \begin{bmatrix} \text{rhet\_resources} : \begin{bmatrix} \text{topoi} : [\mathit{Topos}] \end{bmatrix} \\ \text{dgb} : \begin{bmatrix} \text{eud} : [\mathit{Enthymeme}] \\ \text{topoi} : [\mathit{Topos}] \end{bmatrix} \end{bmatrix} . \\ \lambda e : \begin{bmatrix} \text{t} : \mathit{Topos} \\ \text{c}_1 : r.\mathit{rhet\_resources}.\mathit{topoi}(\text{t}) \\ \text{c}_2 : \mathit{specification}(\mathsf{fst}(r.\text{dgb.eud}), \text{t}) \end{bmatrix} . \\ \begin{bmatrix} \text{dgb} : \begin{bmatrix} \text{topoi} = \mathsf{cons}(e.\text{t}, r.\text{dgb.topoi}) : [\mathit{Topos}] \end{bmatrix} \end{bmatrix} \end{array} \quad (10)$$

B then moves on to the second punchline of the joke, asking how to fit a giraffe into the fridge. Which enthymeme that is under discussion at this point is not obvious – B could interpret the situation in (at least) two ways. Either, the question is how to fit a giraffe into any fridge, or into the fridge that is already occupied by the elephant. On any of these interpretations, the enthymeme under discussion ϵ_2 (in 11) is similar to ϵ_1, with the exception that the individual z is associated with the constraint "giraffe" rather than "elephant", or that an individual is added which is associated with the constraint "giraffe" without any other individual or constraint being removed.

$$\epsilon_2 = \lambda r : \begin{bmatrix} \text{x} & : & \mathit{Ind} \\ \text{y} & : & \mathit{Ind} \\ \text{z} & : & \mathit{Ind} \\ \text{c}_{\text{giraffe}} & : & \mathit{giraffe}(\text{z}) \\ \text{c}_{\text{fridge}} & : & \mathit{fridge}(\text{x}) \\ \text{c}_{\text{agent}} & : & \mathit{agent}(\text{y}) \\ \text{c}_{\text{open}} & : & \mathit{open}(\text{y}, \text{x}) \\ \text{c}_{\text{put}} & : & \mathit{put\_in}(\text{y}, \text{z}, \text{x}) \end{bmatrix} . \begin{bmatrix} \text{s} & : & \mathit{in}(r.\text{z}, r.\text{x}) \end{bmatrix} \quad (11)$$

However, since the size constraint is now gone, it should not matter. B's DGB now looks like this:

$$\begin{bmatrix} \text{dgb} : \begin{bmatrix} \text{eud} = [\epsilon_2, \epsilon_1] : [\mathit{Enthymeme}] \\ \text{topoi} = [\tau_2] \quad : [\mathit{Topoi}] \end{bmatrix} \end{bmatrix} \quad (12)$$

B evaluates whether the enthymeme ϵ_2 is underpinned by the topos already integrated in the DGB, and since the the addition of a giraffe, including or excluding the elephant, does not matter since the size restriction from τ_1 is dropped in τ_2, which means that τ_2 can be used to warrant ϵ_2. B thus replies, in accordance with this reasoning, that you behave in the same way to put a giraffe into a fridge as you do with an elephant, that is, you open the door, put the giraffe in, and close the door.

$$\begin{array}{l} \mathcal{F}_{evaluate\_enthymeme} = \\ \lambda r : \begin{bmatrix} \text{dgb} : \begin{bmatrix} \text{eud} : [\mathit{Enthymeme}] \\ \text{topoi} : [\mathit{Topos}] \end{bmatrix} \end{bmatrix} . \\ \lambda e : \begin{bmatrix} \text{t} : \mathit{Topos} \\ \text{c}_1 : r.\mathit{dgb}.\mathit{topoi}(\text{t}) \\ \text{c}_2 : \mathit{specification}(\mathsf{fst}(r.\text{dgb.eud}), \text{t}) \end{bmatrix} \cdot r \end{array} \quad (13)$$

A takes advantage of the fact that B draws on the topos on his DGB, τ_2. However, A's final punchline evokes a third topos, τ_3, which introduces a new constraint regarding the ability of an elephant and a giraffe to be in the fridge at the same time, possibly some kind of size restriction. Which is of course incongruous in relation to B's previous information state. Thus, taking advantage of the set up of B's DGB at each exchange in the dialogue, A is able to create mismatches in B's DGB, making use of at least one of *her* available topoi, τ_3, (see the end of section 3 for other possible topoi which challenge B's τ_2). In the case that A would be asked to justify this punchline, the answer could be along the following: 'The fridge is huge but not enormous enough to fit two big animals'.

$$\tau_3 = \lambda r : \begin{bmatrix} \mathrm{x} & : \mathit{Ind} \\ \mathrm{y} & : \mathit{Ind} \\ \mathrm{z} & : \mathit{Ind} \\ \mathrm{c_{size}} & : \mathit{huge\_not\_enormous}(\mathrm{x}) \\ \mathrm{c_{fridge}} & : \mathit{fridge}(\mathrm{x}) \\ \mathrm{c_{agent}} & : \mathit{agent}(\mathrm{y}) \\ \mathrm{c_{open}} & : \mathit{open}(\mathrm{y},\mathrm{x}) \\ \mathrm{c_{put}} & : \mathit{put\_in}(\mathrm{y},\mathrm{z},\mathrm{x}) \end{bmatrix} . \quad \big[\mathrm{s} : \mathit{in}(r.\mathrm{z}, r.\mathrm{x})\big] \tag{14}$$

5 Discussion

The aim of the present research was to examine how reasoning required for joke processing in dialogue situations can be explained by means of enthymemes and topoi.

The scope of this study was limited in terms of using constructed examples and abstracting away from real dialogue data. A further study with more focus on data from spoken language corpora is therefore suggested. Nevertheless, in modelling reasoning patterns, one needs to abstract away from certain local processing issues, such as speech processing and clearing out misunderstandings that do not rely on argumentation requiring common sense reasoning.

The current study indicates the importance of having resources such as topoi, that enable an agent to reason using non-logical arguments, for building future dialogue systems with a capability to recognise and understand humour. An issue that was not addressed in this study was whether topoi can be bootstrapped from any available sources, such as WordNet or massive amounts of textual data. Considerably more work needs to be done to describe how to choose the most salient topos from the available resources. A reasonable approach to tackle these issues could be to employ Bayesian networks, following Maguire (2019) who combines them with topoi to represent world knowledge in order to model conditionals.

Notwithstanding these limitations, this study offers some insight into formalising how humour can be processed in a dialogue setting.

6 Acknowledgements

This research was supported by a grant from the Swedish Research Council for the establishment of the Centre for Linguistic Theory and Studies in Probability (CLASP) at the University of Gothenburg. In addition, we would like to thank Robin Cooper, Christine Howes and our anonymous reviewers for their useful comments.

References

Jean-Claude Anscombre. 1995. La théorie des topoi: Sémantique ou rhétorique? *Hermés*, 15.

Salvatore Attardo and Victor Raskin. 1991. Script theory revis (it) ed: Joke similarity and joke representation model. *Humor-International Journal of Humor Research*, 4(3-4):293–348.

Dario Bertero and Pascale Fung. 2016. A long short-term memory framework for predicting humor in dialogues. In *Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*, pages 130–135.

Kim Binsted et al. 1995. Using humour to make natural language interfaces more friendly. In *Proceedings of the AI, ALife and Entertainment Workshop, Intern. Joint Conf. on Artificial Intelligence*.

Ellen Breitholtz. 2014. Reasoning with topoi - towards a rhetorical approach to non-monotonicity. volume Proceedings of the 50:th anniversery convention of the AISB, pages 190–198. AISB.

Ellen Breitholtz, Christine Howes, and Robin Cooper. 2017. Incrementality all the way up. In *Proceedings of the Computing Natural Language Inference Workshop*.

Robin Cooper. 2012. Type theory and semantics in flux. In *Handbook of the Philosophy of Science*.

Robin Cooper and Jonathan Ginzburg. 2015. Type theory with records for natural language semantics. *Handbook of Contemporary Semantic Theory, The*, pages 375–407.

Oswald Ducrot. 1980. *Les échelles argumentatives*.

Oswald Ducrot. 1988. Topoï et formes topique. *Bulletin d'études de la linguistique française*, 22:1–14.

Jonathan Ginzburg. 2012. *The Interactive Stance: Meaning for Conversation*. Oxford University Press.

Jonathan Ginzburg, Ellen Breithholtz, Robin Cooper, Julian Hough, and Ye Tian. 2015. Understanding laughter. In *Proceedings of the 20th Amsterdam Colloquium*.

Christian F Hempelmann. 2008. Computational humor: Beyond the pun? *The Primer of Humor Research. Humor Research*, 8:333–360.

Christian F Hempelmann and Salvatore Attardo. 2011. Resolutions and their incongruities: Further thoughts on logical mechanisms. *Humor-International Journal of Humor Research*, 24(2):125–149.

Sally Jackson and Scott Jacobs. 1980. Structure of conversational argument: Pragmatic bases for the enthymeme. *Quarterly Journal of Speech*, 66(3):251–265.

Staffan Larsson. 2002. *Issue Based Dialogue Management*. Ph.D. thesis, University of Gothenburg.

Eimear Maguire. 2019. Enthymemetic conditionals: Topoi as a guide for acceptability. In *Proceedings of the IWCS 2019 Workshop on Computing Semantics with Types, Frames and Related Structures*, pages 65–74.

Vladislav Maraev, Christine Howes, and Jean-Philippe Bernardy. 2019. Predicting laughter relevance spaces. In *Proceedings of the International Workshop on Spoken Dialog System Technology*.

Chiara Mazzocconi, Vladislav Maraev, and Jonathan Ginzburg. 2018. Laughter repair. In *Proceedings of SemDial 2018 (AixDial)*, pages 16–25.

Rada Mihalcea and Carlo Strapparava. 2005. Making computers laugh: Investigations in automatic humor recognition. In *Proceedings of the Conference on Human Language Technology and Empirical Methods in Natural Language Processing*, pages 531–538. Association for Computational Linguistics.

Gözde Ozbal and Carlo Strapparava. 2012. Computational humour for creative naming. *Computational Humor 2012*, page 15.

Fernando Poyatos. 1993. *Paralanguage: A linguistic and interdisciplinary approach to interactive speech and sounds*, volume 92. John Benjamins Publishing.

Robert R Provine. 2004. Laughing, tickling, and the evolution of speech and self. *Current Directions in Psychological Science*, 13(6):215–218.

Amruta Purandare and Diane Litman. 2006. Humor: Prosody analysis and automatic recognition for f* r* i* e* n* d* s. In *Proceedings of the 2006 Conference on Empirical Methods in Natural Language Processing*, pages 208–215. Association for Computational Linguistics.

Jonathan D Raskin and Salvatore Attardo. 1994. Nonliteralness and non-bona-fide in language: An approach to formal and computational treatments of humor. *Pragmatics & Cognition*, 2(1):31–69.

Victor Raskin. 1985. *Semantic mechanisms of humor*. Synthese language library, 24. Reidel, Dordrecht.

Graeme Ritchie. 2004. *The linguistic analysis of jokes*. Routledge.

Graeme Ritchie. 2005. Computational mechanisms for pun generation. In *Proceedings of the Tenth European Workshop on Natural Language Generation (ENLG-05)*.

Graeme Ritchie. 2018. *The Comprehension of Jokes: A Cognitive Science Framework*. Routledge.

Oliviero Stock and Carlo Strapparava. 2005. Hahacronym: A computational humor system. In *Proceedings of the ACL 2005 on Interactive poster and demonstration sessions*, pages 113–116. Association for Computational Linguistics.

Jerry M Suls. 1972. A two-stage model for the appreciation of jokes and cartoons: An information-processing analysis. *The psychology of humor: Theoretical perspectives and empirical issues*, 1:81–100.

Julia M Taylor. 2009. Computational detection of humor: A dream or a nightmare? the ontological semantics approach. In *2009 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology*, volume 3, pages 429–432. IEEE.

Julia M Taylor and Lawrence J Mazlack. 2004. Computationally recognizing wordplay in jokes. In *Proceedings of the Annual Meeting of the Cognitive Science Society*, volume 26.

Deirdre Wilson and Dan Sperber. 2004. Relevance theory. In Laurence Horn and Gregory Ward, editors, *Handbook of Pragmatics*, pages 607–632. Blackwell.

Diyi Yang, Alon Lavie, Chris Dyer, and Eduard Hovy. 2015. Humor recognition and humor anchor extraction. In *Proceedings of the 2015 Conference on Empirical Methods in Natural Language Processing*, pages 2367–2376.

Renxian Zhang and Naishi Liu. 2014. Recognizing humor on twitter. In *Proceedings of the 23rd ACM International Conference on Conference on Information and Knowledge Management*, pages 889–898. ACM.