

# Poznań Reasoning Week

*Question processing 2017 | Fallacies: Strategy, Error, Shortcut*

## ABSTRACTS

4–7 July 2017, Poznań

## About

Consisting of two workshops, Poznań Reasoning Week 2017 (PRW2017) brings together experts from various disciplines whose research offers both systematic and historical contributions to the study of individual as well as group-reasoning processes. This particularly includes, but is not restricted to, modelling these processes formally.

Recent years have witnessed a cognitive turn in logic, resulting in the inclusion of research areas in, among others, cognitive science, psychology, and computer science into logic's hard core. As a consequence, logic has become more capable of modelling actual cognitive activities of real rather than idealized agents.

Far from creating rivalry with mathematical logic, this marks a next step in the development of logic. But it also reminds us that logic had for many centuries entertained a close and rather natural relation to the study of human reasoning and, insofar as externalized reasoning is concerned, also to rhetoric and dialectic.

In 2017 we would like to address:

- Question processing (QuestPro 2017).
- Fallacies: Strategy, Error, Shortcut (SES 2017).

## Key-notes

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(QuestPro) *Emmanuel Genot* (Lund University, Sweden)

(QuestPro) *Jonathan Ginzburg* (Université Paris-Diderot, France)

(QuestPro) *Andrzej Wiśniewski* (Adam Mickiewicz University, Poland)

(SES) *Iris van Rooij* (Radboud University and Donders Institute for Brain, Cognition and Behavior, Nijmegen, The Netherlands)

(SES) *Patricia Rich* (Philosophy, Hamburg University, Germany) in Poznań)

## Acknowledgements

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**Part I**  
**Program**

Poznań Reasoning Week 2017  
4-7.07.2017

**QuestPro 4th July (Tuesday)**

- 10.15-11.15 [Key-note] Andrzej Wiśniewski, *Basic concepts of Inferential Erotetic Logic in view of generalized entailment*
- 11.15-11.30 Coffee
- 11.30-12.15 Moritz Cordes, *Semantic Approaches to Questions and Pragmatised Languages*
- 12.15-13.00 Paweł Łupkowski, *Erotetic Decomposition Principle and Paraphrasing Questions*
- 13.00-14.30 Lunch
- 14.30-15.30 [Key-note] Emmanuel Genot, *The Sherlock Holmes Sense of Revision*
- 15.30-16.15 Paweł Świeczka, *Application of e-scenarios for investigation and formalisation reasoning's included in Summa theologica by st. T. Aquinas*
- 16.15-16.55 Michal Peliš, Paweł Łupkowski, Ondrej Majer, Mariusz Urbański, *(Dynamic)Epistemic interpretation of Erotetic Search Scenarios*
- 18.00 PRW kickstart reception

**QuestPro 5th July (Wednesday)**

- 10.30-11.30 [Key-note] Jonathan Ginzburg, *How Questions Emerge*
- 11.30-11.45 Coffee
- 11.45-12.30 Ahmet Kilinc, Sirin Yilmaz, *Investigation of the soundness of teachers' questions using inferential erotetic logic*
- 12.30-13.15 Christos Kyriacou, *Expressivism, Question Substitution and Evolutionary Debunking*
- 13.15-14.30 Lunch
- 14.30-15.30 [Key-note] Edgar Onea Gáspár, *Raising and answering questions in discourse and grammar*
- 15.30-16.30 General discussion (moderator: Andrzej Wiśniewski)

Poznań Reasoning Week 2017  
4-7.07.2017

**SES 6th July (Thursday)**

- 10.30-11.30 [Key-note] Iris van Rooij, *The tractability fallacy of bounded or ecological rationality*
- 11.30-12.10 Ulf Hlobil, *Choosing Your Nonmonotonic Logic: A Shopper's Guide*
- 12.10-12.50 Iris van de Pol, *Reasoning about Referential Language Games in Dynamic Epistemic Logic*
- 12.50-14.00 Lunch
- 14.00-14.40 Benjamin Eva, *Bayesian Argumentation and the Value of Logical Validity*
- 14.50-15.30 John Huss, *Informal Fallacies as Hidden Heuristics: How Much Depends Upon a Dual-Process Model of Cognition?*
- 15.30-16.10 Coffee
- 16.10-16.50 Jerzy Pogonowski, *Mathematical Mistakes*
- 19.30 Official dinner

**SES 7th July (Friday)**

- 10.00-11.00 [Key-note] Patricia Rich, *Better Lessons from Ecological Rationality*
- 11.10-11.50 Yong Lu, *Risk-Averse or Risk-Seeking? The Influence of Loss in Preference Reversal*
- 11.50-12.30 Michel Dufour, *The fate of fallacies: The Port-Royal turn*
- 12.40-14.00 Lunch
- 14.00-14.40 Marcin Lewiński, *Disagreement, misunderstanding and the straw man fallacy: The good, the bad and the ugly in argumentation*
- 14.50-15.30 Martin Hinton, *Fallacies of Language*
- 15.30-16.10 Coffee
- 16.10-16.50 Tomáš Ondráček, *Critical discussions, Ought-propositions, and Is-propositions*

## **Part II**

# **Question processing (QuestPro 2017)**



## *Raising and answering questions in discourse and grammar*

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As argued in van Kuppevelt (1995), assertions play a dual role in the erotetic structure of discourse. On the one hand, they answer some question under discussion, but on the other hand, they may also act as “feeders” for novel questions to be discussed in discourse. While the first aspect has been very much discussed in recent linguistic literature following up on Roberts (1996), the second aspect has gone widely unnoticed, because there was no grammatical implication of the claim. In Onea (2016) I have argued that natural language grammar is sensitive to this dual nature of assertions, showing for example how the semantics of indefinites relates to the way in which questions are licensed by assertions in discourse. In the talk I will concentrate on nominal appositives and non-restrictive relative clauses. I will propose an analysis of these constructions as answering a QUD raised by the host matrix clause. In trying to formally capture this, I will introduce the notion of potential questions and propose a certain number of constraints on the erotetic structure of discourse. One important topic will be the asymmetry of speaker and addressee based handling of the common ground information and assumptions about salient questions at any time in discourse development.

## *The Sherlock Holmes Sense of Revision*

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In the late 1980s, Merill B. and J. Hintikka proposed a reconstruction of the “Sherlock Holmes sense of deduction” (Hintikka & Hintikka, 1983, 1989). Before the Hintikkas, the consensus about Sherlock Holmes’ deductions, at least among philosophers and logicians who have considered the questions, had been that Holmes’ deductions were either enthymematic or ampliative. The Hintikkas argued that, appearances notwithstanding, Holmesian inferences were indeed ampliative, but that deduction played a strategic role in ampliation: Holmes draws conclusions by strengthening the premises he reasons from with answers to questions (ampliation) but select the questions based on the anticipation of the deductive consequences of their potential answers (deduction). An important aspect of the Hintikkas’ model was the idea that the source of answers can be thought of indifferently as external to the inquirer (Nature) or internal (Inquirer’s memory), as part of a naturalistic agenda.

After M.B. Hintikka’s demise, Hintikka went on to develop the logical foundations of the model which became the Interrogative Model of Inquiry (IMI). The naturalistic agenda was all but forgotten, as well as the relation between question-selection and memory. The formal results of the IMI focused on the relations between deduction simpliciter and deduction-cum-interrogation, and established in particular in which sense the role of deduction can be thought of as instrumental. Hintikka and his collaborators also discussed the relations between the IMI and other trends in formal epistemology, in particular nonmonotonic logics, and AGM belief revision theory, from a critical standpoint. They proposed an extension of their model and conjectured that it could be strengthened to offer an alternative to AGM revision and nonmonotonic logics (Hintikka, Halonen & Mutanen, 1999).

The conjecture was later proved correct but with some qualifications: Hintikka’s method for handling nonmonotonic reasoning was provably related to well-known contraction operators that do not verify all the AGM axioms (Genot 2009, Genot 2011a). Hence, Hintikka’s misgivings were also by the same token proved partially ill-founded. However, these results did not respond to the main criticism addressed by Hintikka to AGM and non-AGM belief revision operators, namely that it collapses revision into a one-shot operation that presupposes a “fall-back theory”, whereas selecting candidates for revision is also a strategic process (Genot, 2011b).

In this presentation, I will argue that the key to understand this process is to look at it as an inquiry process that involves the inquirer’s memory and perception, not only for the purpose of choosing what to retain and what to cut out, but also what new information to take on board. I will support my argument with a recent re-evaluation of the Hintikkas’ program (Genot, 2017) and will illustrate it with one of the Hintikka’s favorite examples, Holmes’ reasoning in *The Case of Silver Blaze* (Hintikka & Hintikka 1989; Hintikka & Halonen, 2005; Genot & Jacot, 2012; Genot, 2017).

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## *How Questions Emerge*

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In this talk I will address two related issues. The first is how children begin to understand questions.

I will present data from corpora in English and experiments in German about the order of emergence of questions. I will suggest that the data goes against some obvious semantic complexity notions of questions and will propose an explanation based on how questions are grounded in interaction. I will also consider how questions structure conversations (or 'language games' [Wittgenstein] or 'speech genres' [Bakhtin]). I will sketch a general structure for these, which argues for different complexities of such games. It is within a certain class of such games that the understanding of questions emerges.

# *Basic concepts of Inferential Erotetic Logic in view of generalized entailment*

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Generalized entailment (cf. [2]) is a semantic relation between a family of sets of well-formed formulas and a set of well-formed formulas. Both single-conclusion entailment and multiple-conclusion entailment can be modelled in terms of generalized entailment. Moreover, one can explicate interrogative entailment understood in the Hamblin-Groenendijk/Stokhof manner by means of generalized entailment. In my talk I will point out some connections between generalized entailment and the basic concepts of Inferential Erotetic Logic (cf. [1]).

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# *Semantic Approaches to Questions and Pragmatised Languages*

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In Inquisitive Semantics the unification of items from declarative and inquisitive languages is occasionally presented as a major advantage with regard to Partition Semantics. My talk will question that advantage on the basis of it being only a relative advantage compared to Partition Semantics. With regard to scenarios of asking and answering in science and everyday life the unification result of Inquisitive Semantics seems artificial and actually excludes linguistic phenomena that are on a par with questions. In the latter part of the talk an approach is briefly sketched that, from the outset, locates declarative and inquisitive sentences within one continuum by sticking to pragmatised languages.

Partition Semantics and Inquisitive Semantics are two approaches to questions that have received a lot of attention in the last two decades. Both approaches are semantic in the sense that they start from a set of possible worlds and then try to assemble certain set theoretic constructs that are meant to represent questions. Partition Semantics [3] sees questions as at least two-element sets of mutually exclusive, non-empty sets of possible worlds that together exhaust the set of all possible worlds. Every member set of such a partition represents a direct answer. Since there are at least two such member sets there is always a true choice between at least two direct answers. And since the set of all possible worlds is exhausted questions cannot exclude any possibilities by way of a presupposition.

Inquisitive Semantics [2] drops both features. Questions are still sets of sets of possible worlds but neither are they exhaustive nor are they mutually exclusive. That way Inquisitive Semantics manages to implement presuppositions and no-choice-“questions” that present only one option. Of course, when only one option is presented and when that option excludes some possible worlds, what you have is equivalent to a proposition in the sense of the model theoretic counterpart of a statement. Thus, Inquisitive Semantics allows to represent declarative and inquisitive sentences as the same kind of model theoretic entities. This is the Inquisitive Semantics unification result.

This result can be recognized as an advantage of Inquisitive Semantics against Partition Semantics. But with respect to natural language it is hard to see what that unification result tells us. Do we now know that what we mean by question sentences and what we mean by declarative sentences is the same kind of thing? This does not seem plausible since there are still considerable differences between both kinds of sentences. And what does the unification result mean for other kinds of sentences, say, imperatives? Do we mean something else by imperative sentences, unless there is a unifying semantic apparatus which we may or may not discover some day? – There are other difficulties with Inquisitive Semantics. Since this is a semantic

approach the syntactic question of how to express a question in object language symbols is subordinated to model theoretic considerations. In fact, the syntactics of Inquisitive Logic are subtle in a way that makes it hard to distinguish a question sentence from a declarative sentence *at its surface*. This might make for an interesting study of formal syntax but it is unsuited for applications in natural language situations.

The latter criticism suggests that it may be better to start from a syntactical side and possibly build a semantic on top of it. That way one is forced to decide right from the beginning whether the distinction between questions and declaratives should be expressed at the surface of the sentences. In my talk this question is answered in the positive. The first criticism then suggests that the syntactic representation should take into account that next to declaratives and questions there might be other linguistic phenomena that should be seen on the same level. What is needed is a device that unifies a broad spectrum of these phenomena while making questions instantly recognizable.

Categorial approaches [1] or Inferential Erotetic Logic [5] with their overt syntactical devices seem to fare better in signalling what is a question and what not. But any kind of semantic or syntactic unification seems out of reach since the symbols invented in both systems are specific to question logic. What we are acutally looking for is a way to enhance standard declarative logic in a way that is not just tailored to a question logic. The enhancement should lift declarative sentences to the same level as inquisitive sentences and it should be open to accomodate other kinds of sentences, too. A pragmatished language [4] seems to allow for that kind of unification. In this kind of language illocutionary expressions constitute the separate syntactical category of *performators* which work very much like their natural language counterparts. Thus sentences may look like this:

SUPPOSE $\exists x(\text{Dinosaur}(x) \wedge \text{Is-alive-in}(x, 2030))$	(Assumption)
THUS $\exists x(\text{Dinosaur}(x) \wedge \text{Is-alive-in}(x, 2030))$	(Inference)
WHETHER $\exists x(\text{Dinosaur}(x) \wedge \text{Is-alive-in}(x, 2030))$	(Whether-question)
WHY $\exists x(\text{Dinosaur}(x) \wedge \text{Is-alive-in}(x, 2030))$	(Why-question)
MUST $\exists x(\text{Dinosaur}(x) \wedge \text{Is-alive-in}(x, 2030))$	(Imperative)

The talk closes with first mentioning some relevant features of that approach: its fulfillment of formal requirements (adequate calculus), the inclusion of rules for asking and answering, the inclusion of special kinds of questions (why, how). Second, some unresolved issues are formulated, especially one that honors the starting point of the talk: What is the role of semantics in the suggested question language? An answer can be hinted at.

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# *Investigation of the soundness of teachers' questions using inferential erotetic logic*

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## **Introduction**

Teachers ask many questions in routine classroom hours. Even though most of these questions target recall of certain facts that the teachers taught or prescribed in the textbooks, they sometimes benefit from open-ended questions to which even they do not know direct answers (e.g., Scott, Mortimer, & Aguiar, 2006). Many international documents (e.g., OECD, 2010) and national educational reforms (e.g., National Research Council, 2000) emphasize the importance of second type of questions for reaching students who have strong inquiry skills that are necessary for coping with the challenges of 21st century.

Even though educational scientists emphasize the importance of questions and inquiry processes in different branches, previous studies show that researchers focus particularly on the classification of questions and psychometric conditions for efficient inquiry-based learning (e.g., Girlie, 2011). Such growing body of knowledge is crucial but weak because it does not benefit from philosophical considerations. Particularly the validity and soundness of the teachers' questions have not been studied, to our best knowledge. At this point, the purpose of present research is to investigate the soundness of teachers' questions using inferential erotetic logic (IEL) that is developed by philosophers in the last three decades (Wisniewski, 2013).

## **Methods**

We first observed ten science teachers using dialogic inquiry observation form (Reznitskaya, 2012). This form determines the nature of classroom discourse (monologic vs dialogic) and covers question-answer-feedback relationships. We selected three teachers (monologic, dialogic and both monologic and dialogic) using this form and conducted interviews with these teachers in order to uncover teachers' EIL.

For uncovering IEL, we first produced four scenarios including different contexts. In the interviews, we first presented these scenarios to the teachers and then asked them to write questions that would make their students who read same scenario deeply think. In other words, the teachers used the scenarios as premises and produced questions based on their EIL.

For determining the soundness of the questions, we benefited from Wisniewski (2013)'s conditions of soundness. These conditions are given below:

**Condition 1:** No direct answer to question belongs to premise(s).

**Condition 2:** No direct answer to question is entailed by premise(s).

**Condition 3:** If all the formulas in premise(s) are true, the question must have a true direct answer.

**Condition 4:** Each presupposition of question is entailed by premise(s).

**Condition 5:** Question does not have a true direct answer in every case, but question must have a true direct answer if all the formulas in premise(s) are true.

## Results

Due to space limitation, we present results for one of the teachers. In addition, we present the results for two out of four scenarios. In the following examples, we share the scenarios first and then the questions that the teacher produced and finally our classification of the questions in terms of their soundness (+ meets the condition, – does not meet the condition).

### SCENARIO 1: SONYA AND SEVIL

Sevil and her family go to their villages each year in order to visit their relatives. Their village attracts the attention of many tourists due to its beautiful nature and pretty paths. Even the villagers have initiated to adapt to tourism. In such a beautiful summer day, a scream has received the attention of thousands of sunbathing tourists: Help! Help! An English tourist appears on the water and then disappears. Sevil has heard this voice while sunbathing at the garden of her aunt living near the coast. Sevil who has got many medals on swimming and has participated in life-saving courses has jumped into the water without any doubt. She has been swimming as fast as she could certainly win a new medal if she joined a race. At that day, she has saved a girl who has been almost at the ages of her and whose name is Sonya she has learned afterwards. Sonya's family has been informed and the crowd in the cost has initiated to congratulate Sevil. Sonya and Sevil have become very good friends in coming years and frequently visited each other.

*Think that your students read the story above. If you ask two questions that will make them deeply think, which questions would you prefer?*

**The questions that the teacher produced on Scenario 1:**

**Q1.** Why has Sevil swum such fast that she could win a medal in a race?

**Q2.** What are the reasons for the fact that Sevil and Sonya have become close friends in coming years?

**Soundness:**

	C1	C2	C3	C4	C5
Q1	-	-	+	+	-
Q2	-	-	+	+	-

## SCENARIO 2 : TEROMEKET ENERGY

The production mechanism of Teromeket Energy is given below:

Purmo ions come together and constitute Pilokeseke. This structure activates Milota. Once they have been activated, some types of Milota, which are called Karok, produce Teromeket via the Cinomer mechanism. Cinomer is a sequential Folomatic reaction. In these reactions, Teromeket Fillurs bond each other with Folomatic bonds and produce Probek chains via an irreversible process. These chains produce a Kozmoterik field together with Purmo ions. In this field, Purmo ions produce Teromeket energy.

**The questions that the teacher produced on scenario 2:**

**Q1.** Please explain the importance of Teromeket energy for human life.

**Q2 .** What are the negative impacts of Teromeket energy on living things?

**Soundness:**

	C1	C2	C3	C4	C5
Q1	+	+	-	-	-
Q2	+	+	-	-	-

## Discussion and Implications

The results (presented in the text and to be presented in the congress) showed that no teacher question meet all of the conditions of soundness. We can particularly argue that the questions of the teacher are problematic in terms of redundancy (Conditions 1 and 2). The teacher tried to produce questions to which the direct answer existed in the premises (scenarios). Even though we emphasized the questions that would make students deeply think, consistent with existing literature (e.g., Scott, Mortimer, & Aguiar, 2006), the teacher raised the questions in order to understand whether the students comprehend the conceptions and/or relationships in the scenario. However, we also noticed that this redundancy problem disappears when the scenario (Teromeket Energy) does not include any knowledge structure that the teacher may previously know. It seems that the IEL of the teacher is influenced by the contexts and the teacher's knowledge background.

These results have the potential to open new doors for teacher education studies. Incorporation of the nature of IEL and soundness of the questions into (pre-service and in-service) teacher education programs, for example, may produce promising outcomes that are emphasized by national (National Research Council, 2000) and international (OECD, 2010) educational reforms.

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# *Expressivism, Question Substitution and Evolutionary Debunking*

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Expressivism is currently a blossoming meta-semantic framework that has been applied to a wide spectrum of normative domains like morality, rationality, justification, modals, conditionals, probability, knowledge and truth.<sup>1</sup> One core expressivist strategy has been to suggest that instead of asking about the nature of a certain kind of value, we should be asking about the nature of the value judgment in question.<sup>2</sup> According to expressivists, this question substitution opens theoretical space for the elegant, economical and explanatorily powerful expressivist treatment of the relevant domain. For example, Gibbard (2003:6), a prominent expressivist, writes: “The expressivists’ strategy is to change the question. Don’t ask directly how to define “good” ...[rather] shift the question to focus on judgments: ask, say, what judging that [something] is good consists in”. Carter and Chrisman (2012:323) call this question substitution ‘the core expressivist maneuver’, and I shall follow the terminology.<sup>3</sup>

The purpose of this paper is to place the core expressivist maneuver in the perspective of experimental work in cognitive psychology about question substitution and examine what this might suggest about this expressivist strategy. In particular, I have in mind the pioneering work of Nobel laureate Daniel Kahneman (2011) (and the late Amos Tversky) on the psychology of judgment.<sup>4</sup> I will first introduce the findings of Kahneman (2011) about how question substitution works, what its function in our cognitive economy is and suggest an evolutionary explanation of its causal origins akin to Kahneman’s (2011) own understanding of the evolutionary

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<sup>1</sup>See Ayer (1936), Hare (1952), Gibbard (1990; 2003), Blackburn (1984, 1993, 1998) Chrisman (2007), Ridge (2006; 2007), Kappel (2010), Field (2000, 2009), Kyriacou (2012), Yalcin (2012).

<sup>2</sup>I do not mean to imply that it is the only extant expressivist dialectical strategy, but it is surely one that prominent expressivists, such as Gibbard (2003:6) and Carter and Chrisman (2012:323) explicitly endorse. More ambitiously, it could be argued that this is the fundamental expressivist strategy stemming out of a commitment to ontological naturalism, but such an argument would have been both risky and arduous and would inevitably take us too far afield. I will therefore restrict the target of discussion to one core expressivist strategy.

<sup>3</sup>This is a dialectical maneuver characteristic of value antirealism more generally and I suspect that the same style of argument could be run against other sorts of antirealism as well. But I choose to focus on expressivism for three reasons. First, prominent defenders of expressivism like Gibbard (2003) and Carter and Chrisman (2012) explicitly accept the question substitution. Second, expressivism is one of the most popular forms of antirealism in recent debates. Third, expressivists often appeal to evolutionary considerations in support of their position, something that will prove important in the ensuing discussion.

<sup>4</sup>As Kahneman (2011) acknowledges, much of this work, (the so-called ‘heuristics and biases approach’ and also ‘the prospect theory’ that won him the Nobel Prize for behavioral economics) has been carried out and published in journals with his lifelong friend and collaborator Amos Tversky. Unfortunately, Tversky passed away prematurely in 1996. Kahneman’s (2011) book is dedicated to Tversky.

origins of our cognitive architecture. Afterwards, I will apply, with some clarifications, Kahneman's (2011) findings to the question substitution of the core expressivist maneuver itself and explore what the application implies of expressivism.

I will argue that Kahneman's findings support two interesting implications for the core expressivist maneuver: (a) that it is dubious whether the core expressivist maneuver is apt and (b) that an evolutionary debunking argument against expressivism can be run.<sup>5</sup> The latter result comes as a surprise because it is often considered that the antirealist position of expressivism is supported by evolutionary debunking arguments, not undermined by them.<sup>6</sup> Hence, if the argument is on the right track, it turns the tables on the expressivist's appeal to evolutionary debunking arguments because such arguments may cut both ways: in favor and against expressivism. If we can appeal to evolutionary debunking arguments in order to undermine value realism and support expressivism, we can just as easily appeal to evolutionary debunking arguments to undermine expressivism.

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<sup>5</sup>For ease of exposition, henceforth with 'expressivism' I will refer to the strand of expressivism that relies on the core expressivist maneuver.

<sup>6</sup>See for instance Gibbard (1990, 2003) and Blackburn (1998).

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# *Erotetic Decomposition Principle and Paraphrasing Questions\**

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## **Abstract**

The main aim of this research is to analyse a linguistic phenomenon of rephrasing questions in dialogues in the light of the question decomposition principle. I am interested in situations where a question is paraphrased by one of a dialogue participants in order to facilitate the answering process. Examples of such paraphrased questions are retrieved from natural language corpora: Erotetic Reasoning Corpus (a data set for research on natural question processing), The Basic Electricity and Electronics Corpus (tutorial dialogues from electronics courses) and The British National Corpus.

Let us start with the erotetic decomposition principle as it is presented in [5, p. 103]:

**EDP** (*Erotetic Decomposition Principle*) Transform a principal question into auxiliary questions in such a way that: (a) consecutive auxiliary questions are dependent upon the previous questions and, possibly, answers to previous auxiliary questions, and (b) once auxiliary questions are resolved, the principal question is resolved as well.

In [3] idea behind EDP is analysed in the context of information seeking dialogues. What is characteristic for the examples analysed there is that the initial question is asked by one of the dialogue participants, while question-answer is asked by the second one. This may be observed in the following example.

- A: Do you want me to <pause> push it round?  
B: Is it really disturbing you?  
[BNC:FM1, 679-680]

What is the reason behind B's decision to respond with a question to A's question in this case? Why would B not simply provide an answer to A's question? B has a piece of information that allows for the process of A's question and produces a dependent auxiliary question. When we

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investigate the example we may notice that this is the case—B’s question-answer in this case is certainly a dependent question (cf. *Whether I want you to push it depends on whether it really disturbs you*)<sup>1</sup>. This additional information is something that B probably accepts in this dialogue situation (but is not explicitly given by B). One of the possibilities in this case might be: “I want you to push it round if and only if it is disturbing you”. If we accept this premise, our example will appear as below. We may consider this additional information to play the role of enthymematic premise in the analysed erotetic inference [see 5, p. 51–52].

- A: Do you want me to <pause> push it round?  
B: I want you to push it round iff it is disturbing you.  
B: Is it really disturbing you?

In the situation presented above A’s question might be interpreted as an expression of a problem/issue to solve. In other words, after the announcement of the question “Do you want me to <pause> push it round?” it becomes a problem to be solved by B. We may say, that this question becomes B’s initial question that has to be processed. Interpreted this way it allows us to grasp the rationale behind B’s dialogue move in the example. Now we are focused only on B’s side, because the question about pushing the thing around is B’s initial question. After the initial question is processed B comes to the question “Is it really disturbing you?”, which is later asked to A.

This time I will be interested in the situations where the same dialogue participant replaces the initial question with another one. It seems that the mechanism behind such a dialogue step is analogical to the one described above, i.e. to facilitate the answering process for the initial question. The motivational example for this study is presented below.

- A: Question six (pause) okay for anybody who’s interested in eating, as we are, *pate de foie gras* is made from what?  
A: Right we’ll be even more specific right, a help for ya, *pate de foie gras* is made from the liver of what?  
[BNC: KDC, 20–21]

As it is visible in the example, A asks the initial question and afterwards s/he replaces it with another one. What is interesting, s/he clearly states the intention behind this move: “a help for ya”. What is more s/he points out why her/his second question should facilitate the answering process: “we’ll be even more specific right”. The first question is more general than the second one, and one should agree that it is easier to answer the second question.

In the talk I will present and analyse examples of such paraphrased questions retrieved from three language corpora:

1. the British National Corpus (BNC, [1]), large, balanced corpus containing free conversations;
2. the Basic Electricity and Electronics Corpus (BEE; [4]), which contains tutorial dialogues from electronics courses;
3. the Erotetic Reasoning Corpus (ERC, [6]), which constitutes a data set for research on natural question processing. The corpus consists of the language data collected in the previous studies on the question processing phenomenon.

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<sup>1</sup>See the details in [2] and in [3, Chapter 3].

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# *(Dynamic) Epistemic Interpretation for Erotetic Search Scenarios*

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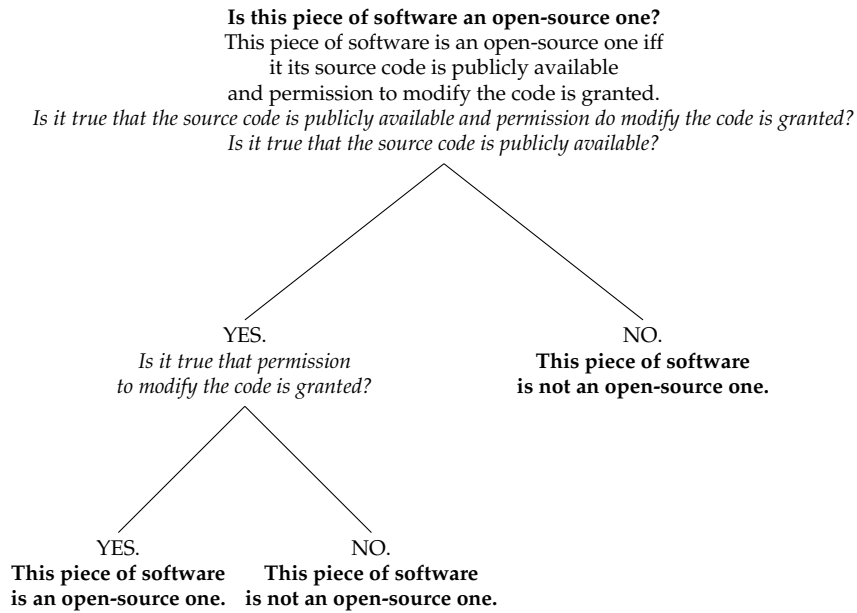
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As a point of departure in this paper we take the ideas from A. Wiśniewski's Inferential Erotetic Logic (IEL, [3, 5]), however we rely on *epistemic erotetic logic* proposed and discussed in details in [2, 1]. Such an approach allows us to discuss problem-solving and strategic questioning in the context of agents' interaction. We do this by the means of providing an epistemic interpretation of erotetic search scenarios (a tool from IEL). We introduce concepts of askability and epistemic erotetic implication. Finally we discuss epistemic erotetic search scenarios for the one-agent setting and suggest the multi-agent setting.

## **Erotetic search scenarios—the original idea**

The pragmatic intuition behind the erotetic search scenario (e-scenario for short) is that it '(...) provides information about possible ways of solving the problem expressed by its principal question: it shows what additional data should be collected if needed and when they should be collected. What is important, an e-scenario provides the appropriate instruction for every possible and just-sufficient, i.e., direct answer to a query: there are no "dead ends".' [4, p. 110].

Let us imagine that, for example, we are asking, if a given piece of software is the, so called, *open-source* software. We know, that it would be so, if and only if the source code of this software would be publicly available and permission to modify the code would be granted. How can we cope with this problem? A solution may be offered by an e-scenario. We can present this e-scenario as a downward tree with the initial question as the root and direct answers to it as leaves. The relevant e-scenario for our exemplary problem is:



As it might be noticed in the example, e-scenario provides a search plan for an answer to the initial question. This plan is relative to the premises a questioner have, and leads through auxiliary questions (and answers to them) to an answer for the initial question.

### Epistemic erotetic logic

As such e-scenarios provide a natural framework for modelling agent’s interaction in an epistemic setting. Thus our attempt to provide an unified approach for epistemic logic with questions that allows to incorporate the scenarios.

For our purpose we take S5 epistemic logic supplemented with questions—as described in details in [2, 1]. A questioning structure

$$?_x \{ \alpha_1, \alpha_2, \dots, \alpha_n \}$$

where  $\alpha_1, \alpha_2, \dots, \alpha_n$  are formulas of our language and  $x$  is the ‘name’ of an agent or of a group of agents.

Afterwards we introduce central concepts of *askability* and *epistemic erotetic implication* (e-e-implication). The intuitions behind the askability are the following. Asking (publicly) the question  $?_i \{ \alpha, \beta \}$  the addressee obtains the following information: (i) the agent  $i$  does not know whether  $\alpha$  or  $\beta$ ; (ii) the agent  $i$  considers  $\alpha$  and  $\beta$  as her epistemic possibilities; (iii) the agent  $i$  expects a complete answer leading to  $\alpha$  or to  $\beta$ .

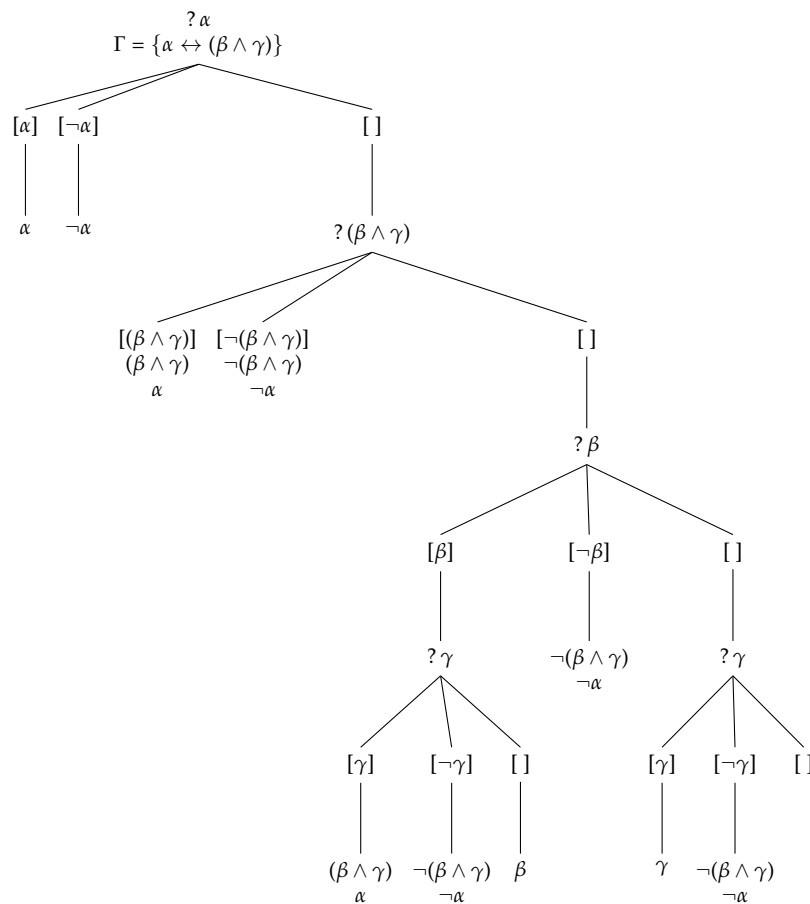
The notion of askability allows us to say that question  $Q_1$  e-e-implies question  $Q_2$  (in a state  $s$  for an agent  $i$ ) whenever askability of  $Q_1$  (in  $s$  for  $i$ ) implies askability of  $Q_2$  (in  $s$  for  $i$ ). We can also consider the situation when  $Q_1$  e-e-implies  $Q_2$  (in a state  $s$  for an agent  $i$ ) *on the basis of* a finite set of declaratives  $\Gamma$ . For this to hold, the askability of  $Q_2$  is implied by the askability of  $Q_1$  together with the validity of  $\Gamma$ .

The notion of e-e-implication allows us to grasp the rationale behind queries (i.e., questions on the branching points) of epistemic erotetic search scenarios. Each query appearing in e-e-scenario is e-e-implicated by the question that precedes it in the tree (possibly with respect to

the set of declarative premises). This requirement guarantees that e-e-scenario will lead to the solution of the initial question through auxiliary questions.

### Epistemic erotetic search scenarios—single-agent case

Let us get back to our simple example. Our agent wants to know whether it is the case that a piece of software is an open-source one. We will represent this question as  $?\alpha$ . This question becomes the initial question of her e-e-scenario. What is more, she knows that: the piece of software is an open-source one if and only if its source code is publicly available and permission to modify the code is granted ( $\alpha \leftrightarrow (\beta \wedge \gamma)$ ). This piece of knowledge becomes the  $\Gamma$  of our considered e-e-scenario. Her questioning strategy established as e-e-scenario is presented below.



The intuition behind this structure is clear. E-e-scenario consists of paths, which represent the possible ways in which the questioning might unfold (depending on the answers obtained). The leftmost and the middle path present the situation when after our agent asks a question, a direct answer is provided immediately (which is represented by  $[\alpha]$ ,  $[-\alpha]$  respectively). The rightmost path is more interesting. It is the case where after the initial question is asked, no answer is provided (which is represented by  $[\ ]$ ). Afterwards our agent decomposes the initial question with respect to her knowledge and gets the query of the form  $?(\beta \wedge \gamma)$ —if no one

knows the answer to  $?\alpha$  maybe it is the case that the new question might be resolved. One may observe that the answer to the new auxiliary question will provide our agent with the answer to the initial question (see the leafs of the e-e-scenario).

### **Plan of the talk**

We will introduce the formal definitions of the used epistemic erotetic terms (*askability*, *e-implication*, *e-e-scenarios*) and mention all important properties related to them. The idea of e-e-scenarios will be demonstrated on the single-agent version of *public announcement logic*. We will also propose the extension to multi-agent settings where e-e-scenarios serve as a questioning strategy in revealing of distributed (implicit) knowledge. We will also discuss the key differences between e-scenarios and their epistemic interpretation, especially when it comes to goal-directness idea.

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# *Application of e-scenarios for investigation and formalisation of reasonings included in Summa theologica by st. T. Aquinas*

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## **Background**

The purpose of the speech is to demonstrate how to apply the erotetic logic of A. Wiśniewski to formalize fragments of *Summa theologiae* by Thomas Aquinas [1].

Despite the passage of centuries text of *Summa theologiae* still remains actual and vital in the field of classical philosophy. Especially for disciplines such as metaphysics or philosophy of God or ethics this treatise can still play a key role.

In my opinion, there are two important reasons which make *Summa* so popular nowadays. First one, is the matter of the treatise – which describes structure of reality, an existence and properties of God – the most fundamental issues of philosophy. Second reason is a specific, strict and clear form of *Summa* which, unfortunately, seems to be completely forgotten after Middle Ages.

The *Summa* consists three parts. First one, deals with God's existence and structure of nature. Second one deals with ethics, moral theology, psychology and morality and the third one is dedicated to Jesus Christ and his work (this part is unfinished).<sup>1</sup> Each part consists of *Quaestio*'s which are, in fact, categories, for certain issues such as existing of God, simplicity of God, perfection of God etc. *Quaestio* contains articles which are basic units of *Summa* and can be considered separately, but issues included into them can be assembled into a bigger wholeness. For example, the *Questio* "Of the Simplicity of God" is divided into such articles as "Whether God is a body?", "Whether He is composed of matter and form?", "Whether in Him there is composition of quiddity, essence or nature, and subject?" etc. As a rule each of the article is titled by a question.<sup>2</sup> Then, after the question Aquinas shows premises for asking the questions – arguments for showing that answer for main question (the question asked in the title of the article) is not obvious. Furthermore, there is *sed contra* part – that is the most interesting part for philosopher concerning reasoning (proof) for answering the main question. At the end Aquinas explains doubts expressed after main question.

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<sup>1</sup>At first look one may think that *Summa* remains only theological work but it isn't. Indeed the third part of treatise has strong theological content but the first part has valuable philosophical influence. For instance if that part was theological only Thomas wouldn't proved existence of God.

<sup>2</sup>Esp. *whether* question.



In my opinion, there are two mutual points which connect Wiśniewski's and st. Thomas Aquinas methods. Firstly, at the beginning of Aquinas' reasoning the whether-question is set up. Secondly, before answer to that question some kind of proof has to be given (obviously Aquinas couldn't use formalised proofs).

The main task of my work is to reconstruct reasoning of st. Thomas Aquinas by using e-scenarios of A. Wiśniewski.<sup>3</sup> My intention is to achieve this objective in two ways. First one by using existing proofs carried out by modern philosophers (modern logicians) and include them into e-scenarios. Eventually, I am trying to find and correct some fallacies which may have occurred. Second way is to create proofs from the beginning and also include them into e-scenarios.

To reconstruct proofs I am using classical first order predicate calculus [4] enriched by separate system of axioms. Both axioms and proved theses are suggested in the original text of *Summa* (relevant references included).

On the basis of the proof I have created an e-scenario showing consequences of changing axioms. The main question in e-scenario is the question formed in the title of the article. Usually the "golden path" in e-scenario is a proof carried out before. Queries included into e-scenario may be considered as an opportunities for investigating another possibilities inferenced from another assumptions (which are in fact answers for queries).

## Example

Let have a look at original text of *Summa* and formalise it as simple as possible.

Thirdly, because every composite has a cause, for things in themselves different cannot unite unless something causes them to unite. But God is uncaused, as shown above. [1, I, q. 3, a. 7, co]

Because an "abstract" is rather short genre I have chosen short and simple fragment to analyse. So there is no necessary to present proof I usually present in the first phase of formalization. Let  $Cx$  stands for  $x$  is composite,  $Cx$  stands for:  $x$  has a cause,  $Gx - x$  is God. Let assume two axioms. First one comes from sentence: every composite has a cause, another one comes from: God is uncaused. These two is enough to draw an e-scenario below:

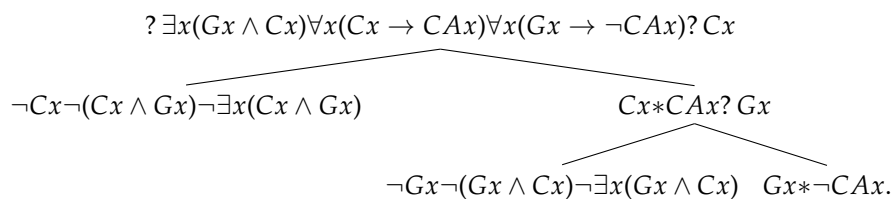


Figure 1: e-scenario "Whether God is altogether simple? "

As showed above no matter if considered individual is composite or not – in both possibilities the main thesis is proved – that is: cannot exists God who is composite. Two of three leafs of the graph have such form but the third one is contradictory that means answer  $Gx$  is paradoxical.<sup>4</sup>

<sup>3</sup>I use e-scenarios described in [2].

<sup>4</sup>In this interpretation. About contradictions in paths of e-scenarios see at [3].

Nevertheless there are few difficulties. According to definition of e-scenario<sup>5</sup> such a graph is not proper one. The reason for that is not because of consisting contradiction in one of the paths but because of the question such as  $?Gx$ . According to notation applied by Wiśniewski after questioning mark should be a sentence (or set of sentences) but  $Gx$  is not a sentence - it is predicate term. However proofs included in e-derivations are valid. Problem is caused by generalization rule<sup>6</sup> – in my opinion it would be a loss if that rule couldn't be applied in e-scenarios. My proposition to solve that problem is to assume that individual  $x$  is a variable which may have any value but in this e-scenario can be treated as a parameter (with any but solid value).

To conclude e-scenarios may be proper way to formulate formalisms taken out from the *Summa Theologica* but should be used carefully and possibly with some adaptations. I hope that this method would be considered as valuable because it shows in genuine way different possibilities inferenced from changing premises of Aquinas' reasonings. In my opinion questioning premises and considering them once again is immanent feature of philosophy and fulfilling this task by using e-scenarios as well as modern logics may revive and shed new light on classical and important text of *Summa*.

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<sup>5</sup>[2] Definition 9.4 p. 113.

<sup>6</sup>That is:  $\alpha(v) \vdash \forall v\alpha(v)$ .

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## **Part III**

# **Fallacies: Strategy, Error, Shortcut (SES 2017)**

# *The tractability fallacy of bounded or ecological rationality*

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Fallacies are often explained by the fact that rational reasoning is beyond the computational powers of resource-bounded minds like our own. For instance, rationality defined in terms of axioms of logic or probability theory is provably intractable (e.g., NP-hard). Therefore, so the argument goes, humans must resort to short-cuts or heuristics, and fallacies are a natural consequence. Some researchers have objected to this bleak view of the mind and proposed that humans are rational after all, albeit in a 'bounded' or 'ecological' sense. Here 'bounded' refers to the non-optimality of the reasoning, and 'ecological' to its presumed fit to the environment of adaptation. This proposal seems to be based on the belief that these alternative senses of rationality are tractable. In this talk, I will demonstrate why this belief is itself a fallacy. The upshot of this is not that humans aren't rational or irrational in some sense. Rather, it shows that intractability is a more general challenge for accounts of rationality than previously thought. Moreover, the solution is not to be found in short-cuts per se, but requires a careful analysis of the conditions that make rationality tractable, be it classical, bounded, ecological or otherwise.

## *Better Lessons from Ecological Rationality*

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Ecological Rationality is sometimes defined as the “match between mind and environment”; for example, a simple heuristic is more ecologically rational in a given context the better it will perform in that context. I heartily endorse this approach to rationality, with some caveats: I endorse what I see as the substance of Ecological Rationality rather than its rhetoric (which, for example, is unduly unfriendly towards formal logic). Furthermore, I see Ecological Rationality as an excellent framework into which we can integrate other tools (e.g. logic and probability theory) rather than as a wholesale replacement of them (again, as the rhetoric might suggest).

In the context of reasoning and argumentation, Ecological Rationality is most often appealed to in order to criticize or cast doubt on particular claims, for example about whether subjects commit an error in some reasoning task. In this talk, I argue for a more constructive use of Ecological Rationality as a systematizing framework which naturally unifies the descriptive, normative, and pedagogical aspects of reasoning and argumentation. An important benefit of this framework is that it can help us to focus on the right (most helpful) questions.

As one example, inquiry should focus on processes – such as simple heuristics – rather than outcomes; ideally processes can be simulated so that performance statistics can be gathered. Whether e.g. the notorious response in the Linda Problem is an error or not matters much less than the question of how often the reasoning process that produced it can be expected to lead to poor results in the relevant context, and just how grave those poor results will be. Furthermore, rationality judgments should consist of comparisons between processes that people may actually use, including ones that we might teach them; it isn't helpful to complain that a person's reasoning process is error-prone unless one has a better, implementable alternative to offer. Other examples pertain to the omnipresent issue of the correct normative standards, and to the categorization of errors.

## *The fate of fallacies: The Port-Royal turn*

Michel Dufour

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Almost half a century ago, Hamblin worried about the absence of a genuine theory of fallacies. Today, there is still no consensus on a definition of fallacies beyond a possible agreement on the vague general idea that it is a reasoning that goes wrong in some way. Perhaps, no theory is needed to do what has been done for centuries, namely to give more or less famous examples of fallacies, a practice quite compatible with the idea that this field is fluctuating and has fuzzy borders. Yet, a salient feature of fallacies studies is the importance of tradition. For instance, most contemporary theoretical approaches have something to say on all or parts of the Aristotelian fallacies. There are also national traditions. The study of fallacies has been a lively topic in the anglo philosophical tradition but is no topic at all in the French philosophy of the three last centuries.

If you compare some recent books with other ones written a few centuries ago, the field seems to grow. On the other hand, some fallacies seem to have disappeared or to have become negligible or to have been clouded by others. Think, for instance, to the Aristotelian paralogism of accent or the difference between the old and the contemporary version of the composition and division fallacies.

How and why some arguments win or lose the status of fallacy? This is a whole research program. Translation seems to be an acceptable answer in the case of the fallacy of accent, since not all languages are accentuated. The rise of probabilistic reasoning could also explain the introduction of some inductive fallacies.

I will discuss the important changes made by the *Port-Royal Logic*, published in 1662. It made an influential turn not only in the field of fallacies but in the whole field of logic. As far as fallacies are concerned, it discarded some traditional fallacies that it considered as “too rude” to deserve a serious attention and it also introduced others of a new type. My point is that the sharp updating made in its two chapters on fallacies is a consequence of deeper changes motivated by important contemporary philosophical, religious and political points of views that had broad consequences not only in other parts of the book, but beyond.

A first radical change is that the *Port-Royal Logic* respectfully stood aloof from Aristotle, and then from his theory on paralogisms. The *Logic* drops the distinction between *intra* and *extra dictionem* fallacies and the number of «sophisms» (the very term used by the *Logic*) inspired by Aristotle is reduced to seven. Six of the thirteen fallacies of *On sophistical refutations* disappeared or have been disqualified. This attitude towards Aristotle is not an exception at this time, but it is a significant shift from the tradition on fallacies, roughly faithful to the Philosopher.

Three modern influences shape the chapters on fallacies: the Cartesian philosophy, the Jansenist ethic and the taste of the century for a pleasant rhetoric. Three types or styles of discourse

can be associated to these three influences, each of them having its own requirements and goals that contribute to challenge the supremacy of the juridical style of the disputes of the School. Textual evidence of these influences can be found in the chapters on fallacies.

The *Logic* makes an eulogy of Descartes and explicitly borrows from his philosophy in many places. More specifically, it follows Descartes in his project of a reasoned search for truth that can't be satisfied by a disputative dialectic, only good to provide short already known explanations, while Descartes's discursive scientific model requires the geometers' fertile «long chains of reasons». The impact of Cartesianism on the *Logic* includes the introduction of two inductive sophisms inspired by the very principles of Descartes's method.

Like their friend Blaise Pascal, the authors were jansenists, then fervent supporters of a rigorous Augustinianism. One of its tenets is that without God's grace, men are condemned to sin. Hence the frequent explanations calling to the bad morality of arguers and the introduction of a surprising distinction between scientific fallacies and fallacies made in daily and/or «civil» life. For the *Logic*, the second kind of fallacy is morally more important, since science is a futile distraction when compared to the duty to be a good person. This justifies the existence of two separate chapters. This moral precedence could also be the reason of the inflation of the second chapter between the first and the second edition of the book. The discursive style of this chapter, far from dialectical disputes, is closer to the concern of a priest who has to make a sermon addressed to sinners to help them not to become the victims of their self-love and to resist the temptations of heresy or skepticism.

The influence of the taste of the century for a pleasant rhetoric cannot be as easily linked to a figure patronizing the *Logic*, like it was previously the case with Descartes or Pascal. Yet, especially if we look at the content of the second chapter on fallacies, we can recognize the general tendency of the century to link clear and good ideas or reasoning with the use of a «natural» and «easy» verbal expression which was held as a sign of the right use of reason. This pleasant naturalness is also associated with the civil and elegant use of language by “gentlemen”. Textual evidence of this tendency can be found in the second chapter on fallacies.



# *Bayesian Argumentation and the Value of Logical Validity*

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We often make arguments based on uncertain premises. In such cases, the conclusion of the argument does not follow with certainty, even if the underlying argument pattern is deductively valid. This raises the questions ‘what is so special about deductively valid arguments?’, and ‘what advantage do we gain by using them?’. We will provide a novel answer to this question. In doing so, we will introduce the distance-based approach to probabilistic updating. Unlike the many updating rules that have been considered in the philosophical literature (such as conditionalization, imaging, and Leitgeb-Pettigrew updating), this approach takes seriously the idea of updating on non-propositional evidence. We conclude that the distance-based approach is the only probabilistic updating method that is able to provide a philosophically satisfactory account of arguments with uncertain premises.

## *Fallacies of Language*

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The principal aim of this paper is to establish how, by looking at the fallacies of argumentation from a linguistics perspective, a number of them which have not previously been classified as fallacies of language are, in fact, committed due to errors in the understanding and use of language rather than of reasoning. Before this task can begin, however, some groundwork must be done on how fallacies are to be understood: specifically, it should be shown that fallacies are to be considered errors rather than violations, which requires a rejection of the Pragma-Dialectic conception of fallacy theory.

Once an outline of the understanding of fallacies to be employed has been made, some discussion of the role of language in arguments will follow along with reference to a number of fallacies which would be well categorised as linguistic in nature, though not due to an obvious ambiguity of meaning.

There are two clear conclusions which can be drawn from Hans Hansen's thorough 2002 review of the 'traditional' understanding of fallacies. The first is that, the conception of the Standard Treatment put forward by Hamblin (1970) and since repeated frequently by the authors of the Pragma-Dialectic (P-D) approach to argumentation, van Eemeren and Grootendorst, is not supported by the facts: the charge that a fallacy theory based in the notion of logical invalidity could not properly account for the many poor arguments listed as fallacies is itself an example of a 'straw man' since Hansen shows that no such theory was ever prevalent amongst influential authors. The second is that the most common phrase used in those definitions is 'error in reasoning'. This exact form of words is applied by Creighton (1905), Sellars (1917), Cohen and Nagel (1934), Black (1952), and Copi (1961). Several others of the surveyed writers refer to 'errors', 'mistakes' and, in the case of Sidgwick (1884), 'confusion'.

The standard treatment, then, if one actually existed, allowed that arguments could go wrong in a number of ways and considered fallacies to be mistakes made in reasoning. It is a little odd, therefore, that van Eemeren continues to claim that under the pre-Hamblin theorists there was only one 'standard of reasonableness – logical validity' (2012: 448) and see the P-D view as a reaction to this. It is also something of a jump to re-interpret the concept of fallacy as 'speech acts which hinder in any way the resolution of a dispute' (Van Eemeren & Grootendorst, 1987: 284) when it is clear that these acts may well be of a deliberate nature, and not really 'errors' at all. The degree to which they hold the employment of these fallacies to be an act of sabotage is unclear: although they say it is 'not tantamount to unethical conduct' (1987: 284) they also note that 'the presence or absence of deliberate calculation is not decisive' (1987: 297) suggesting that poor manners or irrelevant blustering should be categorised in the same way as a genuine misunderstanding or slip.

It might be argued that while the P-D approach helps link argumentation with speech act

theory and the study of discourse, its conception of fallacies is a corruption of how the term has been used in argumentation theory itself and does little to solve the most interesting questions of how they come about and why they are initially attractive. Indeed, my main objection to the P-D conception of fallacies as infringements of a rule is that it makes them rather uninteresting since, as van Eemeren and Grootendorst happily admit, it is a rare occasion when anyone tries to play by the rules anyway.

If fallacies can be defined as errors, then it is obvious that a linguistic error, a misunderstanding, could be at the root of some of them. Since almost all the argumentation we consider is rendered in language this might be considered a trivial point. The relationship between language and thought, however, is a complex and subtle one, and the study of fallacies from this perspective may help shed light on where the boundary lies separating errors of reason from errors of understanding.

An example of a fallacy that treads this line is the very-badly named 'Lord Scroop fallacy' identified by Herman Stark (2000). He lists phrases such as 'Everything is a matter of opinion' as examples of the kinds of premises advanced by some of his students, although they are self-defeating statements. Obviously, a valid argument can be made using such a premise; the error is in the use of language, rather than of logic.

Other fallacies might also be understood as linguistic errors: *argumentum ad verecundiam* depends on a misconception of the terms 'authority', 'expert', 'opinion' or 'field'; 'no true Scotsman' relies on a mistaken belief that a position can be rescued by re-defining the meaning of certain terms; 'Straw Men', when not constructed on purpose, are, presumably the result of a misunderstanding of the position stated by one's opponent.

This paper will consider these and other fallacies and examine the extent to which linguistic error lies at their root.

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# Choosing Your Nonmonotonic Logic: A Shopper's Guide

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You want to model actual reasoning in our logic? Since actual reasoning is virtually always defeasible, this means that you will probably need a nonmonotonic logic. This paper offers some guidance for choosing the nonmonotonic logic that is right for you. Many think that every consequence relation,  $\vdash$ , must obey the following two principles:

$$\forall A \forall \Gamma (\Gamma, A \vdash A). \quad (\text{Containment})$$

$$\forall A, B \forall \Gamma, \Delta (\text{If } \Gamma \vdash B \text{ and } \Delta, B \vdash A, \text{ then } \Gamma, \Delta \vdash A). \quad (\text{Mixed-Context Cut})$$

Unfortunately, these two conditions together imply monotonicity. For suppose that  $\Gamma \vdash A$ . By Containment,  $\Delta, A \vdash A$ . By Mixed-Context Cut,  $\Gamma, \Delta \vdash A$ . So if you are in the market for a nonmonotonic logic, you must give up at least one of these principles. Relevance logicians give up Containment and move to Reflexivity (i.e.  $A \sim A$ ). They want to avoid fallacies of relevance. Nonmonotonic logics in the tradition of KLM, by contrast, give up Mixed-Context Cut [2]. Advocates of such logics typically want to codify defeasible material inferences, like: "Tweety is a bird. Therefore, Tweety can fly."

If you take the second option and give up Mixed-Context Cut, you can retreat to a shared-context version of Cut:

$$\forall A, B \forall \Gamma (\text{If } \Gamma \sim B \text{ and } \Gamma, B \sim A, \text{ then } \Gamma \sim A). \quad (\text{Shared-Context Cut})$$

This means, however, that you cannot have a conditional that obeys the Deduction Theorem:

$$\forall A, B \forall \Gamma (\Gamma \sim A \rightarrow B \text{ iff } \Gamma, A \sim B). \quad (\text{Deduction Theorem})$$

After all, the Deduction Theorem would allow you to run a version of the argument for monotonicity presented above. Just let  $\Delta$  be a superset of  $\Gamma$ , and move the difference between the two sets back and forth across the turnstile via the Deduction Theorem. So you will have to give up Shared-Context Cut or the Deduction Theorem. Logicians in the tradition of KLM give up the Deduction Theorem.

Let's take stock. If you want a nonmonotonic logic, you have the following menu of options.

1. Rejecting Containment (relevance logics). You can keep Mixed-Context Cut, the Deduction Theorem, and Reflexivity.
2. Rejecting Mixed-Context Cut and the Deduction Theorem (KLM). You can keep Shared-Context Cut and Containment.

### 3. Rejecting Shared-Context Cut. You can keep Containment and the Deduction Theorem.

We know a lot about relevance logics and logics in the tradition of KLM. In this paper, I will compare and contrast two less prominent approaches. The first approach is to adopt the third option on our menu and to reject Shared-Context Cut. The second approach is to construct a logic that incorporates both, relevantist considerations and the aim of codifying defeasible material inferences. I will flesh out these two approaches by presenting various sequent calculi.

I want to explore these less familiar approaches because I find the first two options on our menu philosophically unacceptable. This is because I am a logical expressivist [see 1]. That means that I believe, firstly, that there are defeasible material consequences. A set of atomic sentences,  $\Gamma_0$ , e.g., may imply an atomic sentence  $p$  that is not in  $\Gamma_0$ , and some superset of  $\Gamma_0$  may not imply  $p$ . That is how most actual ordinary reasoning works. Second, I believe that it is the function of logical vocabulary to let us argue and reason about such material implications. In order to argue and reason about material consequence, however, we need sentences in our (object) language that express the material consequence relation. For that we need a conditional that obeys the Deduction Theorem, or so I shall argue.

Logical expressivists cannot accept standard relevance logics because these logics don't capture defeasible material inferences. And they cannot accept logics in the KLM tradition because the conditional of these logics does not express what is good ordinary reasoning, according to the logic in which it occurs.

I will first present two nonmonotonic logics that reject Shared-Context Cut but obey Containment and the Deduction Theorem. One is supra-classical; the other is supra-intuitionistic. These logics are similar to Ripley's [2013] non-transitive logic. I will point out some attractive features of these logics. Unfortunately, these logics have two drawbacks. First, they don't obey any version of Cut. Second, if you want to avoid fallacies of relevance and reject Containment, these logics won't preserve Reflexivity.

As an alternative to these nontransitive nonmonotonic logics, I am developing a nonmonotonic logic that avoids fallacies of relevance and also captures defeasible material inferences. I do this by tweekening Tennant's [1984] intuitionistic relevance logic. The resulting logic preserves Reflexivity, is conservative, enjoys Cut elimination, and obeys the Deduction Theorem. The logic doesn't license any of the standard fallacies of relevance. The main drawback of this logic is that the connectives behave in counter-intuitive ways. We must use either the additive or the multiplicative rules for conjunction. If we choose the additive rules, it can happen that  $\Gamma, A \& B \vdash C$  although  $\Gamma, A, B \not\vdash C$ . If we choose the multiplicative rules, it can happen that  $\Gamma \vdash A \& B$  although neither  $\Gamma \vdash A$  nor  $\Gamma \vdash B$ .

I end with some philosophical reflections on the choice logical expressivists are facing: go relevantist and have connectives that behave in counter-intuitive ways, or go non-transitive and have intuitive connectives and a much stronger logic.

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# ***Informal Fallacies as Hidden Heuristics: How Much Depends Upon a Dual-Process Model of Cognition?***

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In the literature relating informal fallacies to the heuristics and biases research program of Tversky and Kahneman, recourse is made to Kahneman's dual-process model of cognition. Heuristics we rely on in everyday reasoning often lead to biased judgments (e.g., of probabilities, of quantitative estimates) when applied to scenarios that seem similar to the everyday context, but in which crucial conditions (usually suppressed) are not met. Thus, heuristics that work reliably enough in everyday contexts can be shown systematically to lead to bias in other contexts. Often this is attributed to the use of fast-track cognitive processing rather than the slow-track processing characteristic of more deliberate slow-track cognition. In this paper I will examine to what degree this standard analysis of the heuristic nature of informal fallacies relies upon the dual-process model. Drawing upon the history of the debate between Gigerenzer and Kahneman and Tversky over the reliability of heuristics, I offer an account of the heuristic nature of informal fallacies that is independent of the dual process model.



# *Disagreement, misunderstanding and the straw man fallacy: The good, the bad and the ugly in argumentation*

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The goal of the paper is to investigate the criteria for distinguishing between rational disagreements (the good), genuine misunderstandings (the bad: error), and manipulative uses of the straw man fallacy (the ugly: illicit strategy) in argumentative discussions. These three seem in principle easily discernible, but in many actual cases of ordinary exchanges, it may be remarkably hard to tell them apart. Part of the reason for that is that they all rely on the fundamental issues of linguistic interpretation. Without attempting to clarify some of these issues, argumentation theorists would not know when a dialectical fallacy has been committed.

The paper takes as a point of departure an understanding of argumentation as a communicative activity of producing and exchanging reasons in the context of doubt or disagreement (Lewiński & Mohammed, 2016). It is, in this sense, a dialogical achievement of all parties to a conversation. A regular, successful, smooth conversation, whether aimed at exchanging information, coordinating activities, or some other goals, is conducted under the conditions of mutual understanding, agreement and openness – in general, rational cooperation. Grice's (1989) model of rational conversation based on the Cooperative Principle and the maxims of quality, quantity, relevance and manner is likely the most famous and philosophically rich account of such conditions.

However, things go wrong in our conversations. One crucial problem is being at variance with each other, a situation when one person affirms what another denies (Wittgenstein, 2005, 30e). Being at variance, however, is a surface manifestation of three above-mentioned distinct, yet often confused, phenomena: (substantive) disagreement, misunderstanding (including the more severe lack of understanding), and the straw man fallacy. The distinction between disagreement and misunderstanding has drawn particular philosophical attention. Arguably, disagreement presupposes understanding: we can only respond  $\neg p$  to our interlocutor's  $p$  – a case of straightforward substantive disagreement – once we correctly identify what she means by  $p$ . Because of this, it has been argued, many cases of disagreement can be cleared up as mere misunderstandings: “whenever you meet a contradiction you must make a distinction” (James, 1987/1905, p. 505); “assertions startlingly false on the face of them are likely to turn on hidden differences of language” (Quine, 1960, p. 59). But how do we know? Given the phenomena of semantic under-determination and indeterminacy, no fast and hard criteria for distinguishing between “disagreements stemming from difference of interpretation” and “disagreements of

substance" can be proposed (Dummett, 1975; see Davidson, 1973, 1974; Quine, 1960).

These classic topics in the philosophy of language have immense and direct relevance to the treatment of dialogical fallacies in argumentation theory, notably the straw man fallacy. To start with, disagreement is seen as an essential pre-condition for argumentation: in both a pragmatic sense (we don't need to argue for unchallenged speech acts) and a dialectical sense (no argumentation without contradiction) (van Eemeren & Grootendorst, 2004). Disagreement does not only instigate argumentation but, in the form of critical questions and counter-arguments, sustains argumentation, often in an unquestionably reasonable way. It is, in short, the good of argumentation.

Misunderstandings, by contrast, are bad for argumentation as they may undermine the very conditions of the possibility for rational argument. Following Hempel, it has often been argued that misunderstandings require explanation, rather than argumentation (Govier 1987). Within an argumentative discussion, problems of misunderstanding ("How do you mean?") are solved by resorting to "language usage declaratives" ( $p$  means  $p_1$ ) rather than to arguments ( $p$ , because  $q$ ) (van Eemeren & Grootendorst, 2004). However, in natural dialogues these distinctions often collapse: questions such as "What do you mean?!" can express both a semantic clarification request and an argumentative doubt (or even an outright challenge!).

Misunderstandings understood as disagreements stemming from "differences of interpretation" as thus inherently murky. Yet they are perilous (both theoretically and practically) for an additional, key reason. They leave the door wide open for the ugly part of argumentation – fallacies. In particular, they easily slide into the straw man fallacy, a dialectical fallacy of criticism, based on a misattribution of commitments of the original arguer, whom the "strawmanner" attacks (Lewiński, 2011). It is, shortly, a misinterpretation that amounts to a deceptive manipulation of the other's words. Again, clear-cut criteria for deciding between such fallacious misinterpretations and genuine misunderstandings – think of ambiguous cases such as "by saying  $p$  you must have meant  $p_1$ , then. . ." – are notoriously hard to formulate, although some progress has been made. Lewiński (2011, 2012; Lewiński & Oswald, 2013) suggested the criteria of contextual plausibility (precise or loose interpretations called for) and charity (critical or constructive interpretations called for). In this paper I further advance this line of investigation. I discuss conditions for an interpretative dialogue between arguers, where a metalinguistic negotiation over the contested passage takes place. I argue that these conditions are in the positive sense tied to the contextual plausibility of interpretations and, in the negative sense, to the manipulative game of commitment misattribution, whereby arguers strategically abuse some basic rules of pragmatic interpretation for an argumentative win.

The final aim is to propose conditions for non-fallacious argumentative interpretation that go beyond simple instructions that "a party's attack on a standpoint must relate to the standpoint that has indeed been advanced by the other party" (van Eemeren & Grootendorst, 2004, p. 191).

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# *Risk-Averse or Risk-Seeking? The Influence of Loss in Preference Reversal*

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## **Introduction**

The anomalous effect that people's preference under different, albeit formally equivalent, measures for elicitation (e.g., choice, monetary valuation) often fails to lead to the same preference ordering is termed *preference reversal* (PR) [1]. In a *standard PR* experimental design, participants are firstly requested to choose between two risky lotteries of a roughly similar expected value with a deliberate wide disparity in winning probabilities: (1) P-bet which has a high probability of winning a modest amount and zero otherwise and (2) \$-bet which yields a low to moderate probability of winning a large amount and zero otherwise. In the second stage of the experiment, participants are asked to give their willingness-to-pay (WTP) prices on both of the two types of bets. Furthermore, *predicted PR* happens when a decision maker chooses P-bet over \$-bet within a choice task, but places a higher WTP price on \$-bet within an evaluation task. An opposite tendency called *unpredicted PR* happens when a decision maker chooses \$-bet over P-bet within a choice task, but places a strictly higher WTP price on P-bet.

Over the past four decades' research, evidence showed that in the standard PR experiments, majority of participants are risk-averse within choice tasks (i.e., P-bet chosen; e.g., [2]). There has been also accumulative studies indicating that when the lotteries are composed of probabilities of losses, most participants are prone to convert as risk-seekers, in case the difference of losses between P-bet and \$-bet is much smaller than the difference of gains (e.g., [1]).

However, the majority of previous PR experiments in the well-documented studies has not emphasized, if any, the influence of loss on preference and usually employed a paradigm in which the absolute value of loss was not significantly higher than gain in P-bet. Furthermore, to our knowledge, little is known about whether the underlying influence of the magnitude of loss is susceptible to elicit different preferences within choice tasks of PR. Therefore, in the next section, we report on one experiment that aims to preliminarily test whether in a PR task containing both gains and losses, people's preference within choice tasks reverses when the extent to which (1) the absolute value of loss varies from smaller to larger than gain in a P-bet and (2) the differences of loss between one pairwise of P-bet and \$-bet vary from smaller to significantly larger than another pairwise of P-bet and \$-bet.

## Experiment

### Participants

Forty eight undergraduate students from Tianjin University between 18 to 22 years old ( $M = 20.5$ ; the female percentage was 41.2%) volunteered to participate in the experiment. Participants did not receive financial compensation since the task took only a few minutes to complete. Nevertheless, participants received an extra course credit in exchange for participating in the experiment.

### Design, Materials, and Procedure

A within-subjects design was used. Materials were three pairwise two-outcome bets (see Table 2). The pairwise bet 1 has a relatively big difference of the losses (-10 vs. -200) as those of the gains (110 vs. 920) between the P-bet and the \$-bet. The pairwise bet 2 has a much smaller difference of the losses (-10 vs. -15) compared with the gains (120 vs. 395) between the P-bet and the \$-bet. The pairwise bet 3 has a relatively larger absolute value of the loss (i.e., 210) than the gain (i.e., 137) in the P-bet. The expected values (EVs) in the respective three pairwise bets yield the same except for a slight difference in the pairwise bet 3. The EVs and whether those bets are P-bet or \$-bet were not shown to participants in the experiment.

Participants were asked firstly to complete the choice tasks on the three pairwise bets, then to give their WTP prices for the six bets. We also counterbalanced the three pairwise bets' sequences that were presented to participants.

Table 2: The Pairwise Bets and Their Expected Values<sup>a</sup>

No.	Pairwise Bets	EVs
1	P-bet = (110, 9/12; -10, 3/12)	80
	\$-bet = (920, 3/12; -200, 9/12)	80
2	P-bet = (120, 9/12; -10, 3/12)	87.5
	\$-bet = (395, 3/12; -15, 9/12)	87.5
3	P-bet = (137, 9/12; -210, 3/12)	50.25
	\$-bet = (800, 3/12; -200, 9/12)	50

<sup>a</sup> Probabilities were expressed as multiples of 1/12.

### Results, General Discussion, and Conclusion

We excluded one participant who did not give her WTP price on the \$-bet in the pairwise bet 2 and another one participant who did not give his choice in the pairwise bet 3 from analyses. We use an alpha level of .05 for all significance tests.

For the three pairwise bets, percentages of participants in choice and WTP evaluation procedures are shown in Table 3. The overall results indicate that, first, overestimating \$-bet mainly accounts for PR. However, the reversal rates were not significantly different among the three pairwise bets ( $\chi^2(4) = 5.328$ ,  $p = 0.255$ ) and therefore do not vary much in strength when the absolute value of loss is less or more than gain in P-bet. Second, the rates of predicted and unpredicted PR are influenced by the relative magnitudes of loss in P-bet and \$-bet. When the absolute value of loss in \$-bet is significantly more than that in P-bet (e.g., 20:1 in the pairwise bet 1), the rate of predicted PR is more explicitly than that of unpredicted PR. On the contrary,

when the losses are relatively less distinct between P-bet and \$-bet (e.g., 3:2 and 20:21 in the pairwise bets 2 and 3, respectively), the rates of predicted and unpredicted PR are not significantly different.

Table 3: Summary of Results

Valuation	Choice (%)		
	P-bet	\$-bet	Total
<i>Pairwise Bet 1:</i>			
P-bet > \$-bet	18.75	4.17	22.92
\$-bet > P-bet	33.33	10.41	43.74
P-bet = \$-bet	25.00	8.33	33.33
Total	77.08	22.92	N = 48
<i>Pairwise Bet 2:</i>			
P-bet > \$-bet	10.64	14.89	25.53
\$-bet > P-bet	14.89	25.53	40.42
P-bet = \$-bet	10.64	23.40	34.04
Total	36.17	63.82	N = 47
<i>Pairwise Bet 3:</i>			
P-bet > \$-bet	14.89	6.38	21.27
\$-bet > P-bet	12.77	34.04	46.81
P-bet = \$-bet	14.89	17.02	31.91
Total	42.55	57.44	N = 47

The overall results across the three pairwise bets show that the preference rates within the choice tasks were significantly different between the pairwise bets 1 and 2 ( $\chi^2(1) = 16.204$ ,  $p < 0.001$ ) and between the pairwise bets 1 and 3 ( $\chi^2(1) = 11.798$ ,  $p = 0.001$ ), while were not significantly different between the pairwise bets 2 and 3 ( $\chi^2(1) = 0.401$ ,  $p = 0.337$ ). The reason for the significantly different preference rates between the pairwise bet 1 and the other two pairwise bets within the choice tasks probably because the difference of the losses between the P-bet and the \$-bet in the pairwise bet 1 (i.e., 1:20) is much larger than the differences of the losses in the other two pairwise bets (i.e., 2:3 and 21:20 in the pairwise bets 2 and 3, respectively).

Thus, we draw the following a novel theoretical inference: Risk preference within choice tasks of PR is significantly influenced by the change of ratio between losses. Concretely to say, when the loss in a \$-bet is significantly larger (more negatively) than that in a P-bet, risk-averse preference (P-bet chosen) is significantly more than risk-seeking preference (\$-bet chosen) within choice tasks (i.e., predicted PR rate is significant higher than unpredicted PR rate), compared with that when the losses between a P-bet and a \$-bet are not distinct, risk-averse and -seeking preferences within choice tasks are not significantly different.

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# *Critical discussions, Ought-propositions, and Is-propositions*

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According to the problem of Hume's gap there are two main types of propositions, is-propositions and ought-propositions, and we cannot proceed from the former to the latter [4, p. 302]. In argumentation, arguing for an ought-proposition by an is-proposition is usually called the naturalistic fallacy or the is-ought fallacy [1, p. 145]. The same is true vice versa, i.e. arguing for an is-proposition by an ought-proposition. This is called the moralistic fallacy [6, p. 162–3]; [2] or the reverse naturalistic fallacy [7, p. 257–8]. Even though these moves are generally regarded as fallacious, they are often used in practice.

Take for an example the Pfizer Animal Health case [8][3]. In this case it was argued that a practice (using antibiotics as growth promoters for animals) is going to be prohibited on the premise that it should not be done without knowing its outcome (the precautionary principle).

The goal of this paper is to present an appropriate description of such cases where an is-proposition was justified by an ought-proposition in an unfallacious manner. The description is done using the pragma dialectical approach and the PVF-model. Within this approach, it is also necessary to examine a possible structure of starting points.

The pragma dialectical approach distinguishes four stages of critical discussion [10]: confrontation, opening, argumentation, and concluding stage. In the confrontation stage, a difference of opinion is established. In the opening stage, starting points are established. Starting points are divided into two groups: procedural starting points, covering the rules of a given discussion, and material starting points, accepted statements or propositions upon which the argumentation can be built up. In the argumentation stage, arguments for or against a statement in question are put forward. In the concluding stage, an assessment of the resolution of a difference of opinion takes place. It is necessary to note that there can occur some changes in starting points during the argumentative stage. Starting points are usually taken as granted and do not need to be explicitly mentioned, but they could be questioned during argumentation in meta-discussions (for procedural starting points) or sub-discussions (for material starting points) [9, p. 242].

Some of the possible uses of the ought-proposition in argumentation can be described with the help of the so called PVF-model of debate propositions [11]. There are three types of propositions: policies (P), values (V), and facts (F). It seems feasible to categorize ought-propositions as values.

Consider the already mentioned example:

We will prohibit using antibiotics as growth promoters for animals, because we



should not use agents with an unknown impact on human consumers in farming industry and we do not know the impact of such use of antibiotics on the human consumer.

In this example, we can see that there are the following propositions:

- P: Prohibition of using antibiotics as growth promoters for animals.
- V: The precautionary principle: We should not use agents with an unknown impact on human consumers in farming industry.
- F: We do not know the impact of antibiotics as growth promoters for animals on human consumers.

In this description of the argument, a few questions arise regarding ought-propositions. Firstly, what is the original form of the ought-proposition? Secondly, how can the process of interpretation of the original ought-proposition be described? Thirdly, what are the possibilities of dismissing an ought-proposition?

I will argue that ought-propositions are usually at the beginning of a discussion accepted in a form which is vague and provides many interpretations. I believe that these interpretations are restricted during the discussion regarding other accepted starting points especially those which consist of is-propositions. This is done by the obligations of ought-propositions. These obligations are in the form of is-propositions [5]. This makes possible the description of a discussion in which it is acceptable to argue from an ought-proposition to an is-proposition in an unfallacious manner. Although it seems that there is no way to eliminate Hume's gap, there is a way to bypass it. Such a bypass is made possible by the need of a definitive decision at least for the moment (a result of critical discussion especially in judicial context). This also leads to a more delicate structuration of material starting points, because it seems wrongful and too hasty to dismiss as fallacious or irrational the cases in which we need to decide, yet do not have all the necessary facts.

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## *Mathematical Mistakes*

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The talk is divided into two parts. First of them concerns a few famous mistakes discovered in the history of mathematics. The second part is a brief summary of mistakes typical for the students of humanities who attend a mathematically oriented course.

Famous mistakes became famous mostly because they contained roots of subsequent mathematical discoveries. New ideas are frequently born in situations in which one struggles with an antinomy or tries to explain a paradox. Resolution of paradoxes, in turn, reveals new, more subtle intuitions. We will discuss a few examples from algebra, topology and analysis illustrating these processes.

The second part of the talk is based, among others, on our experiences in teaching introduction to mathematics for freshmen in cognitive science as well as in teaching mathematical problem solving for more advanced such students. We will discuss the observed cognitive biases of these students which, in our opinion, are connected with e.g.: misuse of language, illegitimate reduction of abstract notions to more basic ones, too rigid application of intuitions imposed by the school to new mathematical contexts. It should be stressed that we limit ourselves to analysis of mistakes made by students and we do not formulate any claims about mathematical education of children.

# *Reasoning about Referential Language Games in Dynamic Epistemic Logic*

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Human communicators can establish communicative success far beyond the literal meaning of language. Imagine for instance a situation where two people with glasses are standing next to each other and only one of them wears a hat. If I were to say ‘my friend is the one with the glasses,’ you would probably understand that I mean the person without the hat, because otherwise I would have said ‘my friend is the one with the hat’ [4]. How people do this exactly is an interesting puzzle: what kind of problem are people solving when they are engaging in such forms of referential communication? This is a challenging question to answer. There could be many different kinds of reasoning processes capable of establishing successful communication in these settings, and there is no direct measure to determine which processes people are actually using. A way to approach this is to hypothesize a certain form of reasoning by means of a computational model, and compare its properties and its predictions to observed human communicative behavior. We discuss two existing models and introduce our own model based on a different interpretation of Gricean reasoning. We argue that to explain the variation in human communicative behavior, instead of focusing on creating a better fit between experimental data and model predictions by using add-ons like smoothing, it is more informative to study the properties of the underlying reasoning processes that lie at the core of the model.

Two similar computational models have been proposed that model such referential communication as a form of Gricean reasoning, i.e., as conversational implicatures [2, 1]. They model a specific instance of referential language games, where the available objects and the available messages are fixed. At the core of these models lies a specific view on referential language use, where speakers are hypothesized to use Grice’s maxim of quantity: ‘be as informative as required’ [3]. In the Iterated Best Response (IBR) model by Degen and Franke [1] speakers and listeners are modeled as starting from the literal meaning of language and then iteratively reasoning about each other. The maxim of quantity is interpreted here by means of the ‘size principle’ [5], which prescribes the speaker to choose a message that refers to the least amount of objects. Note that this interpretation of Gricean reasoning leads to a particular definition of a correct Gricean answer and thereby also defines what counts as deviations thereof.

The Rational Speech Act (RSA) model by Frank and Goodman [2] is based on the IBR model. It is a Bayesian model that has the same interpretation of Gricean reasoning and that additionally contains two elements to model the deviations from the correct Gricean answer. First, the RSA model uses a smoothed best response rule instead of an optimal one. It models communicators as having the tendency to use the iterated best response rule, but not always imple-

menting this perfectly. Second, the RSA model uses prior probabilities over the available objects. We argue that, instead of modeling deviations by implementing a general assumption of bounded rationality (by means of a smoothed decision rule), it can be more informative to compare different reasoning processes in terms of what they classify as correct answers and how they categorize items as easy versus difficult.

We present a model that also interprets referential communication as a form of Gricean reasoning, where we use a different, more specific, interpretation of the maxim of quantity. The reasoning process that we model uses the notion of tell-tales. A message is a tell-tale for an object if it refers to that object uniquely. For instance, when looking at a red circle and two green circles, the message 'red' is a tell-tale for the red circle. Our model is based on a reasoning process that prescribes that if you can use a tell-tale message to refer to an object, you should always use this tell-tale message. This principle is used, in an iterative manner, to give a ranking to all message-object pairs in a given context. When a speaker hears a particular message, they look at the message-object pairs for this message and choose the object that gives the highest ranking. We implement this model in dynamic epistemic logic, where the objects are the worlds in an epistemic model, the available messages are properties of those worlds, and the ranking of object-world pairs is done by an update rule based on the principle of strategically using tell-tales.

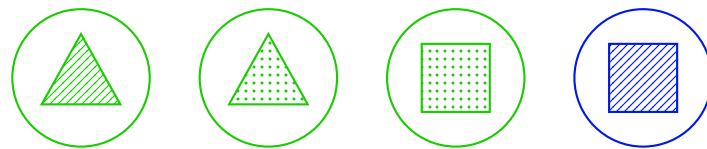


Figure 1: Example of a referential language game. The available messages are: 'striped', 'dotted', 'green', 'blue', 'circle', 'triangle', and 'square.'

This interpretation of the maxim of quantity also leads to a classification of correct Gricean answers, which we compare to that of the IBR model. In Figure 1, when a listener hears the message 'circle', according to our reasoning schema the speaker is referring to the middle green circle, while according to the IBR model all circles are equally likely. Furthermore, we use the number of iterations that are needed in the ranking process of our model as a measure of the difficulty of an item, and compare this to a measure of difficulty derived from the IBR model. In Figure 1, the IBR model predicts that a sender needs to be of at least level three to pick out 'striped' as the best message to refer to the left-most circle, while according to the tell-tale method, two levels of iterated reasoning are already sufficient. Future work includes testing our predictions empirically, where we will investigate items for which our model and the IBR model identify different answers and different levels of difficulty.

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