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DATA-DRIVEN DIALOGUE MODELS: APPLYING FORMAL AND COMPUTATIONAL TOOLS TO THE STUDY OF FINANCIAL AND MORAL DIALOGUES

Abstract. This paper proposes two formal models for understanding real-life dialogues, aimed at capturing argumentative structures performatively enacted during conversations. In the course of the investigation, two types of discourse with a high degree of well-structured argumentation were chosen: moral debate and financial communication. The research project found itself confronted by a need to analyse, structure and formally describe large volumes of textual data, where this called for the application of computational tools. It is expected that the results of the proposed research will make a contribution to formal systems modelling and the evaluation of communication from the point of view of argument soundness.

Keywords: data driven dialogue systems; corpus studies; computational tools in argument analysis.

1. Introduction

The paradigm of dialogue systems has now been under development for over half a century. New models continue to be constructed for the purpose of representing different aspects of human reasoning processes (Kacprzak & Yaskorska, 2014; Visser et al., 2017). Nevertheless, such models have tended to be somewhat schematic and not readily applicable to real-life dialogues. Aiming only to evaluate the soundness of arguments performed during the dialogue in question, they do not fully capture the specificity of communication as it occurs in context. This element of simplification is also reflected in those systems that have come to be implemented, in which agents are only able to perform a highly limited set of communicative intentions within a given dialogue, in terms of a simplified dynamics that fails

to reflect any actual communicative context. Starting, for instance, from the locution rules furnished by standard dialogue systems, what we find is that these are defined solely for the purpose of conducting argumentation itself, whereas natural communication is, in reality, replete with a variety of different communicative intentions, such as *assertive questioning* as used in debates, or the *request for elaboration* popular within financial discourse.

The two discourse types chosen here exhibit the diversity and context-dependency typical of natural communication. The contextual constraints of the genre shape not only the topic and the argumentative means, but also the dynamics of the communication itself. Where dialogues occurring within the discourse of finance were concerned, those investigated turned out to be highly regulated. Right from the outset of the analysis, it was evident that the dynamics of such a dialogue would consist in questions put by financial analysts, together with the replies of corporate representatives. The rational interaction between the participants is construable as the corporate representative's grasping what type of communicative action the analyst expects to receive when posing some particular question, and furnishing an adequate response. On the other hand, in the case of the radio program *The Moral Maze*, we encounter another kind of situation. Even though the discussion is regulated by the program's chairperson, the reply structure is more dynamic. The aim of participants in the debate is not just to ask or reply to questions, but is also that of persuading a wider audience, which itself then constitutes a third party to the dialogue. A given participant may deploy various types of question or assertion in order to introduce their own argument, to challenge that of their opponent, etc. In such a situation, any attempt to predict or make assumptions about what sorts of replies are typical or count as rational looks to be meaningless.

Given these initial differences, dialogues conducted in both contexts were modelled via the application of two distinct approaches. The model for ECC dialogues was built on assumptions about how participants of the conversation ought to behave. These assumptions were made after preliminary research into the corpus, and on the basis of knowledge about the communicative context of the dialogues in question. After the features of the dialogues had been described, they were verified in the corpus itself. I shall refer to such an approach as the "top-down method" for describing dialogical dynamics. In the case of moral debates, the description of rules commenced with a statistical account of the occurrences of transitions. Such statistical data was then taken to furnish the

basis for formulating the schemes employed when describing typical sequences of moves. Such a method can be characterized as “bottom-up”. Both approaches, however, necessarily involved analysing significant volumes of text and applying certain fairly straightforward statistical tools to the latter. Such tasks were managed through the application of computational tools.

With respect to the structure of the present paper, the next section outlines the state of the art where the study of formal communication modelling and its applications to computing are concerned. Section 3 then presents a dialogue model for financial communication, while Section 4 furnishes a descriptive model for debates. In both of these parts, the context responsible for shaping communication – in financial discourse and debates, respectively – is described, as are the computational tools used for purposes of data analysis. Section 5 draws attention to certain features of data-driven models that allow the gap between simplified dialogue systems and real-live dialogues to be illustrated. Finally, in Section 6, I conclude my presentation of the research discussed by considering its possible further applications.

2. Formal dialogue modelling

Standard dialogue systems are defined around three concepts. The first of these is the *dialogue move*, which is a propositional content p performed with a communicative intention. In most dialogue systems, a standard set of such intentions is defined. The elements of such a set include *claim* p for introducing a standpoint, *question* p for triggering a yes/no response from the opponent, *challenge* p for requesting a justification, *arguing* p since ψ for justification, and *retract* p for claiming that one does not believe some statement or other (see Prakken, 2006). Communicative intentions are used as part and parcel of the operating of participants’ *commitment stores* – an absolutely core concept where dialogue systems are concerned. Commitments are sets of propositions with respect to which a participant manifests their belief, and we can read them thanks to dialogue moves, as each communicative intention is itself defined as this or that operation on the commitment store. For example, in performing *claim* p a participant places p in their commitment store, while to remove this proposition they should perform *retract* p and so on. Meanwhile, the machinery for proper reasoning is described with reference to the normative requirement that any such commitment adhere to standards of consistency: participants cannot com-

mit to contradictory statements. The third concept to be invoked here is what is known as a *dialogue protocol*. This specifies the dynamics of a dialogue: i.e. which move can be performed at some particular stage of the dialogue. For example, a common rule for dialogue systems is the one instructing a participant to perform *arguing p since ψ* after he or she has been *challenged*. Subsequent to the introduction of this idea, and using the assumptions of Hamblin (1970) as a basis, a large number of dialogue games have been constructed. These include the following systems: DC by Mackenzie (1979), CB by Woods and Walton (1998), PPD and RPD by Walton and Krabbe (1995), TDG by Bench-Capon (1998), and ASD by Reed and Walton (2007).

Such a set up for dialogical reasoning has found multiple applications within the sphere of Artificial Intelligence. For example, in multi-agent systems, the implementation of a dialogue protocol allows communicating agents not only to send a single message, but also to engage in a dialogue (Parsons et al., 2003). For interdependent agents in a multi-agent system, the ability to evaluate statements received from one another also proves crucial when it comes to making rational choices about their actions. Dialogue games implemented with some means for holding the machinery of argument to account, where the agent can analyse the pros and cons of a particular statement, are certainly helpful when pursuing such a goal, and such implementations have been extensively investigated. For example, Parsons and Jennings (1996) present an implementable protocol illustrating a reasoning process for negotiating agents. Parsons et al. (2003) propose protocols for information seeking, enquiry and persuasion dialogues. Schroeder et al. (1998), on the other hand, present a language for autonomous agents which enables an argument analysis to be constructed with reference to two kinds of argument: attacking the conclusion of an existing argument, which they call *rebut*, and attacking its premise, which they call *undercut*. The aim of such an approach is to allow agents to resolve conflicts by uncovering false assumptions.

Dialogue models are also applied in contexts of human-computer interaction. Black and Hunter (2012) and Wells and Reed (2012) propose languages in which formal dialogue systems for argumentation can be implemented that allow a machine to comprehend a conversational protocol. Dialogue Game Execution Platform (DGEP), as proposed by Bex et al. (2014), enables the implementation of a dialogue protocol in accordance with this sort of coding language. Such an implementation can then be executed in Arvina (Lawrence et al., 2012), an interface for the conducting of argumentative dialogues between humans and computers. For example, a dialogue

system enabling a user to provide mathematical proof in a dialogical way (Pease et al., 2014) can be executed between a human and a machine in this framework. Such applications can engender hybrid initiatives for purposes of argumentation, with humans being able to collaborate with machines in a dialogue in order to construct argumentation (Reed & Wells 2007; Snaith et al., 2010).

To be sure, all of the above-mentioned applications have the potential to make sizeable contributions within the domain of the understanding and imitation of human reasoning. Yet all of them are based on the same simplified and unrealistic models, resting as they do on what are, essentially, philosophical assumptions. It remains visibly the case that the existing set of communicative intentions present in such dialogues fails to meet our goal of capturing our actual human ways of communicating. The state of the art, as presented thus far, therefore leads to the conclusion that we stand in need of dialogue systems that will be more “human-like” if we are to arrive at a deeper understanding, and a more precise imitation, of human communication as it relates to reasoning.

What if, however, instead of embracing assumptions about human intentions, we actually investigate them? Such a research question opens up a new task – that of giving a formally consistent description of discourse on a large scale, of a sort that will allow us to capture the dialogical dynamics featuring within the discourses that are of interest to us. Such a task, where the field of discourse studies is concerned, requires a certain use of computational tools to be introduced into the realm of our more purely philosophical investigations – one that will enable the analyst to deal effectively with large amounts of data.

3. Dialogue structure in the context of financial communication

In this section, we present the reply structure for dialogues conducted within the discourse of finance. This model was designed using the top-down method, based on an analysis of transcripts of earnings conference calls. The corpus was managed using the UAM corpus tool (O’Donnell, 2008), which had been created for the purpose of conducting corpus analysis in the field of computational linguistics in order to build a training set for use in statistical language processing.¹ It was chosen as this functionality allowed for the annotation of multiple texts using a single annotation scheme. Corpus annotation is visualised in Figure 1.

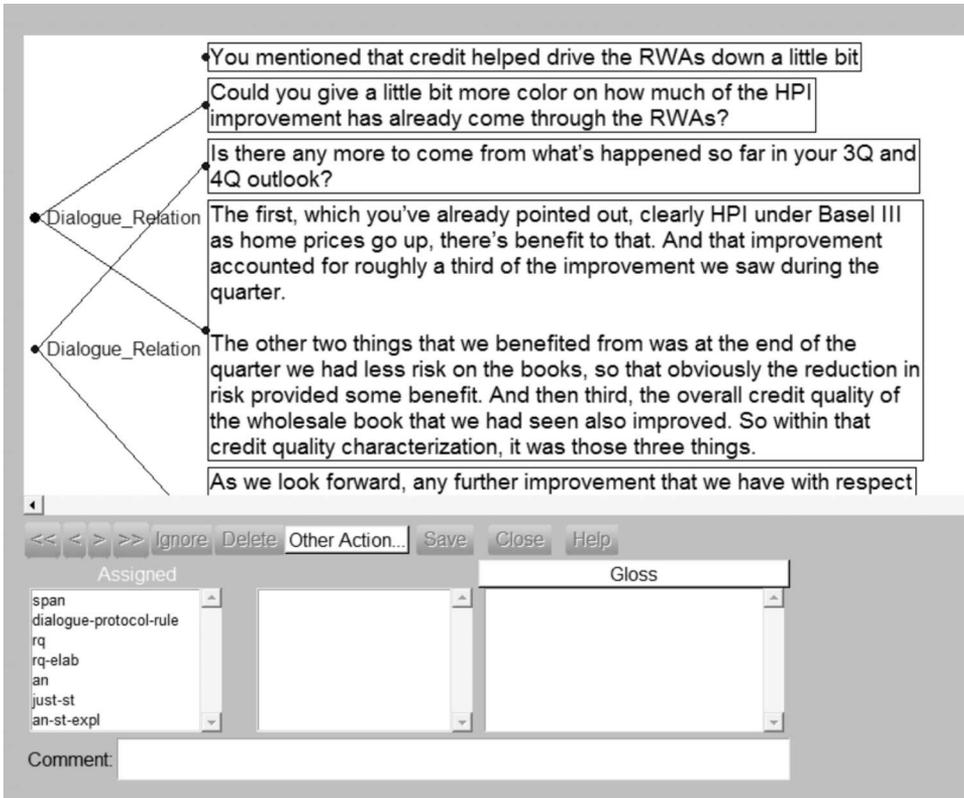


Figure 1. Fragment of the corpus annotation with the UAM corpus tool

The UAM corpus tool was employed for purposes of textual annotation along with the application of a presumed annotation scheme. The analysis was conducted in two steps. Firstly, fragments of texts were marked as corresponding to participants' moves in the conversation, and to each of those moves a communicative intention from the annotation scheme was assigned, this having already been presented in the work of Palmieri et al. (2015) already mentioned above. In the second step, which forms a part of the study presented here, consecutive *request-reply* pairs were annotated as corresponding to sequences of communicative intentions. Both stages of the financial dialogue description were followed by a verification of the proposed rules in the corpus. For example, Figure 2 shows the verification of responses to the request for an evaluative opinion using the UAM tool. The tabular representation has three columns, with all the suggested responses listed in the first of these. Meanwhile the second column gives the number of instances of each reply, and the third a percentage-based characterisation.

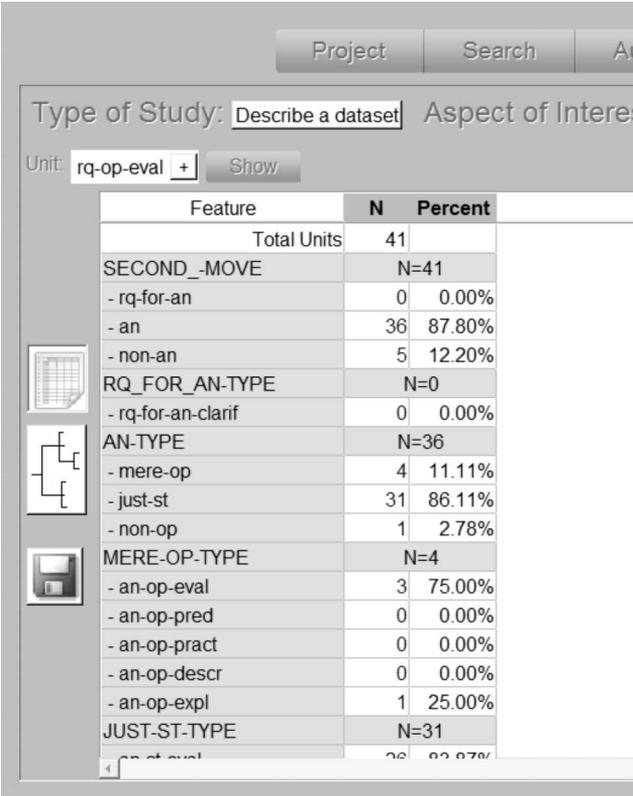


Figure 2. Verification of possible replies to the request for evaluative opinions in financial dialogues

3.1. The context of financial communication

Earnings conference calls (ECC) constitute a genre of voluntary financial data disclosure associated with financial communication. In order to furnish a more telling account of the shape and goals of an ECC meeting, more details about the participants are needed. The participants in such conference calls can be divided up into three categories. The first of these consists of corporate representatives. Due to the importance of ECC meetings, these will be individuals who are senior managers of the company involved: i.e. the Chief Executive Officer (CEO), Chief Financial Officer (CFO), Chief Operating Officer (COO), and often also the Head of Investor Relations. The second group of participants can be called the “investment community”, as represented by the financial analysts who regularly follow the fortunes of the company. Such analysts may work directly for investors, or for a bank (and thus indirectly for the latter’s clients). The third party present at the meeting will be the “operator”: an external person from

an independent specialised firm. All parts of the meeting are led by this individual.

ECC meetings mainly fall into two parts. The first consists of a corporate presentation (CP) (for more details, see Palmieri et al., 2015), during which corporate representatives introduce performance-related results for the company from the last quarter. The second, meanwhile, consists of a question-and-answer session (Q&A). During the latter, financial analysts are invited to direct further questions to the presenters. The task of the operator is to chair the conversation: i.e. to manage the timing of the CP part, and to direct the conversation during the Q&A part by ensuring that the appropriate opportunities arise for analysts to ask questions and for corporate representatives to answer them.

Crawford (2007) provides a more detailed description of the form taken by such meetings. The model also takes into account the opening and closing of the ECC meeting as enacted by the operator. Moreover, the schema shows the cycle of questions and answers that participants engage in during the Q&A. Turn-taking is also regulated by specific mechanisms specifying the people who can take part at this stage: most participants just attend the meeting in listen-only mode, and only previously registered financial analysts can ask questions.

Palmieri et al. (2015) start their work from the hypothesis that one of the most important factors influencing the informativeness of an ECC meeting is the presence of argumentation in both the presentational and the dialogical parts. Inference (i.e. reasoning), as Palmieri et al. point out, plays a crucial role in financial interactions. The role of inference-related processes pertaining to such meetings can, moreover, be detected at various different levels of analysis. Firstly, there is a general level, with the ECC being regarded as a source of arguments to be taken into account by financial analysts when writing their forecasts and recommendations. Then, such financial forecasts will also be taken into account by investors when making decisions about their future investments. In this way, the information obtained during the disclosure process will serve as a set of premises providing a basis for arriving at a conclusion – i.e. making an investment decision. Argumentation can also be encountered at a more local level specific to this or that ECC meeting, inasmuch as participants seek to justify their own points of view in order to persuade audiences to accept them.

3.2. The reply structure for earnings conference calls

The reply structure of ECC dialogues was investigated as two separate sets of rules: locution rules and reply rules. The account of these two steps

is divided into two stages of analysis. Firstly, after the transcripts had been read through, both kinds of rules were analytically assumed, based on the data itself and on analysts' knowledge of the nature of the genre. Once the rules of the dialogue had been spelled out theoretically, they were subsequently verified in relation to the data through the use of simple statistical methods for identifying particular rules' frequency distributions.

Communicative intentions in financial dialogues

Participants in such a dialogue can take on two possible roles: that of analyst (A), and that of corporate manager of the company (C). Each participant role can execute particular communicative intentions within the dialogue, as listed below. Following the tradition relating to dialogue systems for argumentation, these lists give what are known as locution rules (Walton & Krabbe, 1995). A locution, in turn, is defined according to speech-act theory (Searle 1969) as $F(p)$, meaning some propositional content p uttered with some particular intention F . Such a representation is relevant to most of the intentions we are dealing with here. For example, the intention of *request-for-elaboration*, when a speaker wants to gain more information on some topic, can be represented according to speech-act theory as *request-for-elaboration* (ϕ), because we can draw a relation between ϕ and the propositional content (some ψ) of a locution that would count as a reply to the request. In such a case, we can say that “ ψ is an elaboration of ϕ ”. In the same manner, we can represent the relation *request-for-justification* (ϕ) and the propositional content of the reply-locution thus: some “ ψ is a justification of ϕ ”.

Modelling the relation between the propositional contents of the question and response for the illocutionary force of *request-for-opinion* is, however, more complex. Here we encounter the problem of the propositional content of open questions. Nevertheless, based on the fact that analysts tend to specify the kind of the opinion they are expecting to receive (as, for example, an evaluative or explanatory one), we may infer that they tend to assume a certain set of possible responses. Such an assumption is taken into account in, for example, the erotetic logic (IEL) of Wiśniewski (2013). Łupkowski (2017) also provides an account of such a logic in the context of dialogue systems for tutoring. Rules for recording the participants' commitment store are not needed for the purpose of illustrating the dialogical dynamics, so the logical machinery of the reasoning need not form a part of the topic we are exploring here. In order to open up possibilities for further investigation in this direction, the propositional content of the *request-for-opinion* intention will be modelled

as some set X that consists of possible responses expected or assumed by the analyst (A).

Here are the communicative intentions for the analyst:

- AL1: *request-for-elaboration* (ϕ), where a speaker requests that more details be given regarding ϕ ;
- AL2: *request-for-justification* (ϕ), where a speaker requests that ϕ be justified;
- AL3: *request-for-opinion* (X), where a speaker requests that an opinion be offered:
 - AL3.1: *request-for-evaluative-opinion* (X), where X is a set of evaluative opinions;
 - AL3.2: *request-for-predictive-opinion* (X), where X is a set of predictive opinions;
 - AL3.3: *request-for-practical-opinion* (X), where X is a set of practical opinions;
 - AL3.4: *request-for-explanatory-opinion* (X), where X is a set of explanatory opinions;
- AL4: *request-for-confirmation-of-inference* (ϕ because X), where a speaker requests confirmation of an inference to the effect that ϕ because X ;
- AL5: *request-for-clarification* (ϕ), where a speaker requests that the meaning of ϕ be clarified;

And now, here are the communicative intentions for the corporate manager:

- CL1: *non-opinion* (ϕ), where a speaker furnishes data ϕ (without offering an opinion);
- CL2: *mere-opinion* (ϕ), where a speaker offers a simple opinion without justification; more particularly:
 - CL2.1: *mere-predictive-opinion* (ϕ), where ϕ is a prediction of a future state of affairs;
 - CL2.2: *mere-evaluative-opinion* (ϕ), where ϕ is an evaluation of a past or present state of affairs;
 - CL2.3: *mere-practical-opinion* (ϕ), where ϕ is a description of an action that should be undertaken;
 - CL2.4: *mere-explanatory-opinion* (ϕ), where ϕ is an explanation of a casual relation;
- CL3: *justified-standpoint* (ϕ because Y), where a speaker offers an opinion ϕ together with its justification in terms of a set of propositions Y ; more particularly:
 - CL3.1: *justified-predictive-standpoint* (ϕ because Y), where ϕ is a prediction of a future state of affairs;

- CL3.2: *justified-evaluative-standpoint* (ϕ because Y), where ϕ is an evaluation of a past or present state of affairs;
 - CL3.3: *justified-practical-standpoint* (ϕ because Y), where ϕ is a description of an action that should be undertaken;
 - CL3.4: *justified-explanatory-standpoint* (ϕ because Y), where ϕ is an explanation in terms of a casual relation;
 - CL4: *non-answer* (ϕ), where a speaker refuses to give an answer; more particularly:
 - CL4.1: *non-answer-with-justification* (ϕ because Y), where a speaker also furnishes a justification for his/her refusal;
 - CL4.2: *non-answer-without-justification* (ϕ), where a speaker merely refuses to answer;
 - CL5: *request-for-clarification* (ϕ), where a speaker requests that the meaning of ϕ be clarified;
- Finally, let us set out the protocol for interactions in financial dialogue:
- FP1: A starts a conversation with one of his/her requests; C responds to his/her requests;
 - FP2: After *request-for-elaboration* (ϕ), C can perform:
 - FP2.1: *non-opinion* (ψ), where ψ is some data that specifies ϕ ;
 - FP2.2: *mere-opinion* (ψ), where ψ is an elaboration of ϕ ;
 - FP2.3: *justified-standpoint* (ψ because Y), where ψ is an elaboration of ϕ and Y is a set of premises;
 - FP2.4: *request-for-clarification* (ϕ);
 - FP2.5: *non-answer* (ψ).
 - FP3: After *request-for-justification* (ϕ), C can perform:
 - FP3.1: *justified-standpoint* (ϕ because Y), where Y is a set of premises;
 - FP3.2: *request-for-clarification* (ϕ);
 - FP3.3: *non-answer* (ψ).
 - FP4: After *request-for-opinion* (X), C can perform:
 - FP4.1: *non-opinion* (ϕ), where $\phi \ni X$;
 - FP4.2: *mere-opinion* (ϕ), where $\phi \ni X$, and more particularly:
 - FP4.2.1: after *request-for-predictive-opinion* (X), C can perform *predictive-opinion* (ϕ);
 - FP4.2.2: after *request-for-evaluative-opinion* (X), C can perform *evaluative-opinion* (ϕ);
 - FP4.2.3: after *request-for-practical-opinion* (X), C can perform *practical-opinion* (ϕ);
 - FP4.2.4: after *request-for-explanatory-opinion* (X), C can perform *explanatory-opinion* (ϕ);

- FP4.3: *justified-standpoint* (ϕ because X), where $\phi \ni X$; more particularly:
 - FP4.3.1: after *request-for-predictive-opinion* (X), C can perform *predictive-standpoint* (ϕ);
 - FP4.3.2: after *request-for-evaluative-opinion* (X), C can perform *evaluative-standpoint* (ϕ);
 - FP4.3.3: after *request-for-practical-opinion* (X), C can perform *practical-standpoint* (ϕ);
 - FP4.3.4: after *request-for-explanatory-opinion* (X), C can perform *explanatory-standpoint* (ϕ);
- FP4.4: *request-for-clarification* (X);
- FP4.5: *non-answer* (ϕ);
- FP5: After *request-for-confirmation-of-inference* (ϕ because X), C can perform:
 - FP5.1: *non-opinion* (ψ), where ψ is some data confirming (ϕ);
 - FP5.2: *justified-standpoint* (ϕ because X);
 - FP5.3: *justified-standpoint* (*not* ϕ because X);
 - FP5.4: *request-for-clarification* (ϕ because X);
 - FP5.5: *non-answer* (ψ);
- FP6: After *request-for-clarification* (ϕ) posed by A, C can perform:
 - FP6.1: *non-opinion* (ψ), where ψ clarifies ϕ ;
 - FP6.2: *mere-opinion* (ψ), where ψ clarifies ϕ ;
 - FP6.3: *justified-standpoint* (ψ since X), where ψ clarifies ϕ and X is a set of premises;
 - FP6.4: *non-answer* (ψ);
- FP7: After C's *request-for-clarification* (ϕ), A can perform:
 - FP7.1: *request-for-elaboration* (ψ), where ψ clarifies ϕ ;
 - FP7.2: *request-for-justification* (ψ), where ψ clarifies ϕ ;
 - FP7.3: *request-for-opinion* (ψ), where ψ clarifies ϕ ;
 - FP7.4: *request-for-confirmation-of-inference* (ψ because X), where ψ , X and ψ because X clarify ϕ .

4. Reply structure for dialogues in the context of debates

As regards debates, the dynamics was described using a bottom-up approach based on an analysis of MM2012₀. The corpus consisted of transcripts of *The Moral Maze* radio program – with live audition conducted via the BBC radio 4 channel. The dynamics of the communication and reasoning were represented according to Inference Anchoring Theory (IAT)

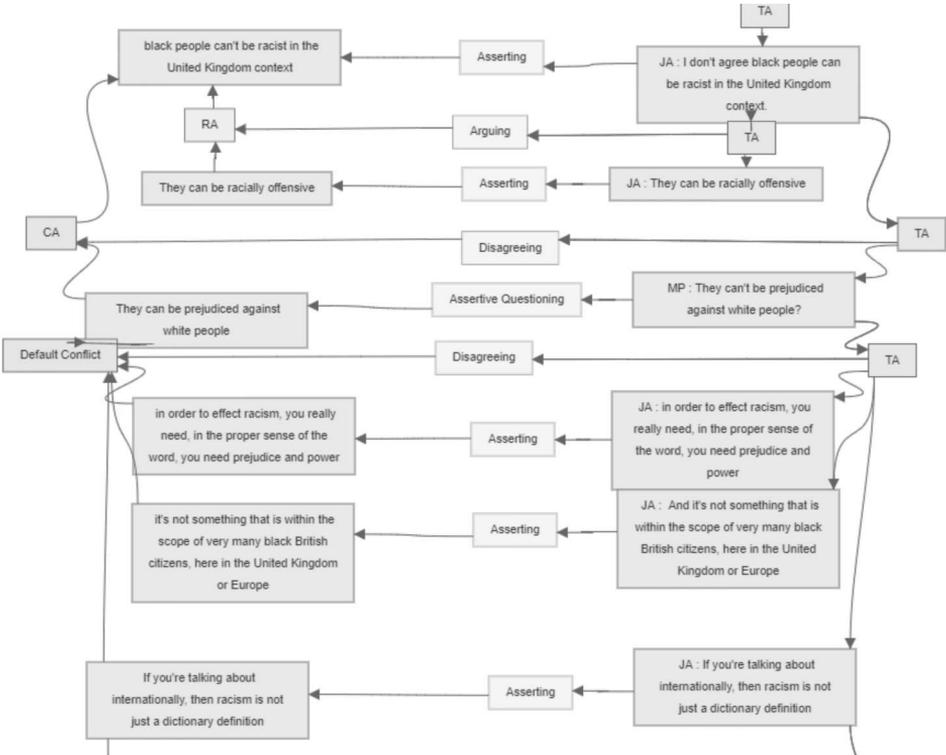


Figure 3. An illustration of corpus analysis for modelling debate

(Reed & Budzynska, 2011), while dialogue-structure was represented using the OVA+ analytical tool (Lawrence et al., 2015).² This tool allows one to store textual data as a graph representing IAT structures in a dialogue. Thus, the MM2012₀ corpus shows up as a set of graphs along the lines of that presented in Figure 3 (for more details, see Yaskorska, 2014), which can be consulted in the AIFdb Corpora,³ a large repository of argument analyses designed so that users can create, share and reuse argument graphs. This is realised through the language of Argument Interchange Format (AIF+), which allows particular elements of the IAT diagram to be translated into what appears in the AIFdb corpus.

4.1. The context of debates in *The Moral Maze*

The characteristics of moral debates were investigated using the BBC4 radio program *The Moral Maze* as a case study. This program is made up of a series of episodes in which participants discuss moral aspects of important social and political issues in Great Britain. The program has

been run by Michael Buerk (who chairs the debates) since 1990. Every episode includes four panellists, who are public figures with a background in social activism (writers, journalists, lecturers, public commentators, etc.). The program also includes discussions with “witnesses”, in the sense of people called on to describe certain aspects of the situation as it relates to the issue being examined. During each program panellists are divided into two opposing camps, corresponding broadly to left- and right-wing viewpoints, so that an attempt is made to investigate the topic from these two competing perspectives.

The topics for the discussion during *The Moral Maze*, together with the way in which it is set up to present a discursive encounter between two opposing political philosophies, suffice to ensure that the data chosen will be relevant to our present area of research. The participants put forward a great many arguments for and against particular statements. As public figures taking part in a radio broadcast, they employ quite typical tactics for introducing, defining and justifying their standpoints.

The transcripts subjected to analysis represented episodes with different topics for discussion. The first was a programme entitled “The British Empire”, in which participants discussed moral aspects of the behaviour of the British army in the British colonies during the 20th century. During this episode, the issue of a High Court decision pertaining to the problem of the murder of Kenyans during the Mau Mau Rebellion in the 1950s was discussed. The second was called “The Welfare State”. In it, participants discussed the concept of a “Welfare State”, together with its moral aspects and possible consequences. Meanwhile, the episode entitled “The Morality of Money” was dedicated to the topic of the morality of getting into debt through making use of the various different credit options currently available. During the program, panellists sought to reach agreement on whether it is morally acceptable to go into debt by taking out bank loans and living a lifestyle beyond one’s actual financial means. The fourth episode, “Problem Families”, was dedicated to determining the reasons for the increasing levels of poverty and growing culture of dependence in Great Britain, as well as possible solutions to this.

Such material was relevant to our investigation not only on account of its highly engaging and controversial topics: the dialogues presented in the transcripts also proved to be highly argumentative. What is more, the arguments the dialogues contained turned out to be fully representative of the complexity of what can be recognized as argumentative structure in natural dialogues.

4.2. A dialogue model for moral debates

Given the contextual parameters surveyed above, we are dealing here with both same-speaker and different-speaker interaction. As this is the case, two separate sets of rules must be specified, one for each of these. Hence, to capture the dynamics of real-life debate, the possibility of performing two moves in a row must also be introduced. In *The Moral Maze* debates, participants would sometimes introduce more than two moves in a sequence. Yet the first version of our data-driven model remains a simplified one, as here the role of the chair is not included. In the current version of the description, a single participant turn will be limited to two same-speaker sequences, and this will exclude the possibility of long monologues. Moreover, in the case of the sequence $L_m^b; L_{m+1}^w$, where $b \neq w$, w should have priority as regards continuing his or her move while following same-speaker transition rules. With these considerations in mind, we can propose rules GT1 and GT2 as serving to define the general governance of such a dialogue. These allow a participant to introduce simple arguments: i.e. one statement and one premise for purposes of justification or attack.

GT1: After a sequence $L_m^b; L_{m+1}^w$, where $b \neq w$, the performer of the second move can perform move L_{m+2}^w or give a turn to his/her opponent;

GT2: In the sequence of moves $L_1; L_2; \dots; L_n$, and where n in N , where $L_m^b; L_{m+1}^w$ (where $1 \leq m \leq n$, and $b = w$) has been performed by one speaker, move L_{m+2} must be performed by another speaker.

Rules for applying same-speaker transitions

STR1: After asserting ϕ , where ϕ does not contain reported speech, a participant can:

STR1.1: argue, via asserting ψ , where $\psi \rightarrow \phi$;

STR1.2: introduce a second statement via asserting ψ ;

STR1.3: agree, via popular conceding ψ , where $(\psi \rightarrow \phi)$;

STR1.4: argue, via assertive questioning ψ , where $\psi \rightarrow \phi$ or $\phi \rightarrow \psi$;

STR1.5: argue, via rhetorical questioning ψ , where $\psi \rightarrow \phi$;

STR1.6: introduce, via rhetorical questioning, a second statement ψ ;

STR1.7: disagree, via asserting L^p , where L^p contains ψ (the reported speech of p), and where $\psi \vdash \circ \phi$.

STR2: After popular conceding of ϕ , where ϕ does not contain reported speech, a participant can:

STR2.1: argue, via asserting ψ , where $\phi \rightarrow \psi$ or $\psi \rightarrow \phi$.

STR3: After pure questioning ϕ , where ϕ does not contain reported speech, a participant can:

- STR3.1: introduce, via pure questioning, another question ψ ;
- STR3.2: introduce, via assertive questioning, another question ϕ .
- STR4: After assertive questioning ϕ , where ϕ does not contain reported speech, a participant can:
 - STR4.1: argue, via asserting ψ , where $\phi \rightarrow \psi$;
 - STR4.2: argue, via assertive questioning ψ , where $\phi \rightarrow \psi$ or $\psi \rightarrow \phi$.
- STR5: After rhetorical questioning ϕ , where ϕ does not contain reported speech, a participant can:
 - STR5.1: argue, via asserting ψ , where $\phi \rightarrow \psi$;
 - STR5.2: introduce another statement via asserting ψ ;
 - STR5.3: argue, via assertive questioning ψ , where $\phi \rightarrow \psi$;
 - STR5.4: argue, via rhetorical questioning ψ , where $\phi \rightarrow \psi$;
 - STR5.5: introduce, via rhetorical questioning, another statement ψ .
- STR6: After assertive challenging ϕ , where ϕ does not contain reported speech, they can:
 - STR6.1: argue, via asserting ψ , where ψ contains reported speech.
- STR7: After asserting L^p , where L^p contains ϕ (reported speech of p), they can:
 - STR7.1: disagree, via assertive questioning ψ , where $\psi \vdash \phi$.
- STR8: After assertive challenging L^p , where L^p contains ϕ (reported speech of p), they can:
 - STR8.1: argue, via asserting ψ , where $\phi \rightarrow \psi$.

Rules for applying different-speaker transitions

- DTR1: After a speaker b has engaged in asserting ϕ , where ϕ is not reported speech, a speaker w can:
 - DTR1.1: disagree via performing a “no” move;
 - DTR1.2: agree via performing a “yes” move;
 - DTR1.3: argue, via popular conceding ψ , where $\psi \rightarrow \phi$;
 - DTR1.4: disagree, via assertive questioning ψ , where $\psi \vdash \phi$;
 - DTR1.5: disagree, via rhetorical questioning ψ , where $\psi \vdash \phi$.
- DTR2: After a speaker b has engaged in assertive questioning ϕ , a speaker w can:
 - DTR2.1: disagree via performing a “no” move;
 - DTR2.2: agree via performing a “yes” move;
 - DTR2.3: agree via asserting ϕ ;
 - DTR2.4: disagree via asserting ψ , where $\psi \vdash \phi$;
 - DTR2.5: execute a non-anchoring move.
- DTR3: After a speaker b has engaged in popular conceding ϕ , where ϕ is not reported speech, a participant w can:

- DTR3.1: execute a non-anchoring move, e.g. changing the topic via asserting ψ .
- DTR4: After a speaker b has engaged in pure questioning ϕ , where ϕ does not contain a reported speech, a participant w can:
- DTR4.1: answer the question via asserting ψ .
- DRT5: After a speaker b has engaged in rhetorical questioning ϕ , where ϕ is not reported speech, participant w can:
- DTR5.1: disagree via asserting ψ , where $\psi \vdash \phi$.

5. Features of data-driven dialogue models

The dialogue models described in Sections 3 and 4, respectively, have one feature in common: namely, they provide a formal description of communicative means involved in the process of human argumentation. Due to this feature, both of the models proposed can also be compared as regards the tools used in their analyses. In Section 2, the elements of standard dialogue systems were introduced, while in the present section we shall investigate the process of arguing as it shows up in a particular communicative context, where this will be represented using different analytical tools.

The level of communicative intentions. In both models, communicative intentions are to be developed according to the requirements of the communication context. Where financial dialogues are concerned, a spectrum of open questions is elaborated. Such questions are not especially popular when it comes to modelling dialogue systems for persuasion. However, in the context of open conference calls, it is very important for an analyst to specify what information, exactly, he or she wishes to obtain, and these questions are highly specific as to the kind of propositional content they aim to elicit. On the other hand, public figures participating in opinion-forming debates on live radio shows will tend to be more focused on delivering their own particular viewpoints. Thus, the spectrum of their communicative intentions will be more elaborated in the area of conveying actual propositional content itself.

Within both discourses, some communicative intentions are identifiable whose performance is hardly, if ever, observed. For example, in financial dialogues, *non-answer* is predefined by the policies of the company being presented, and also by law, which latter allows corporate representatives to refuse to give an answer when issues of data security are at stake. Such a situation, though, could hardly be imagined in the context of a BBC radio debate: all of the opinions voiced are expected to be justified and verified by

the participants, whoever they may be. The debate is official designated as being controversial and combative, meaning that participants' standpoints are open to being challenged in every possible way. To refuse to answer some of the questions posed is tantamount to simply losing the debate, without even having attempted to defend one's own viewpoint. On the other hand, *assertive questioning* or *retorical challenging* is very common in debates, insofar as it furnishes the latter with the appropriate sort of dynamics. Conveying one's viewpoint by posing a question also engages antagonists by forcing them to refer to the opinions put forward in the conversation. Such a method would count as misleading in the context of earnings conference calls, where participants are chiefly focused on being clear about their own viewpoints. Moreover, in line with way the conversation is organized, it is not possible to have lively interchanges within this type of dialogue.

Tags representing the communicative intentions performatively enacted during earnings conference calls can also be shown as a tree. For example, *request-for-opinion* can produce sub-branches specifying the particular type of opinion requested (*mere-*, *evaluative-*, etc.). The UAM corpus tool allows such a tree to be represented in order to facilitate corpus verification of the dialogue rules that have been assumed. OVA+ does not afford such an opportunity. The list of tags is linear, and so does not make available any statistical overview of groups of communicative intentions – for instance, say, to check the number of cases of *asserting*.

Dialogue dynamics. The models for the two types of dialogue were defined using different methods. It is important to note that any swapping around of those methods within the first stage of investigating the discourses would inevitably prove misleading. The top-down method, in which the interchange of communicative intentions was first assumed and then verified, was easy to apply given make a highly moderated dialogue. Even on the level of communicative intentions, a participant qua analyst or corporate representative will have a particular set of intentions available to be deployed in the dialogue. Analysts will have chiefly questions at their disposal. A spectrum of claims will be available as replies on the part of corporate representatives to these. It is relatively easy to guess what the model for such a conversation will be like. As is shown in Budzynska et al. (2014a), the number of cases where participants breach the “conversational logic” are insignificant.

On the other hand, where all participants can make use of a broad set of determinate communicative intentions, as in a debate, the dynamics of the dialogue will not be easy to predict. In such cases, the bottom-up method is more applicable. It will certainly be much easier to describe how partici-

pants are behaving on the basis of the available data. The conversation will be more dynamic as regards interchanges between interlocutors, and the moderation of the debate will be mostly focused on the topic of discussion, instead of on the order in which participants are supposed to interact.

Finally, the dynamics of both types of dialogue are bound to be different, due to the slots into which participant utterances have to be accommodated. A move on the part of a participant in a form of financial communication will be longer than that of a participant in a debate. This enforces different, so to speak, “dialogical behaviour” – whose investigation, if it is to be appropriately conducted, calls for a well-chosen method.

Two different analytical tools afford a choice of procedures well-suited to dialogue modelling. The trees of tags implemented in the UAM corpus tool enable verification of assumed dialogue moves under the top-down approach. As shown in Figure 2, this tool provides not only numerical but also proportional descriptions. Investigations of the level of occurrence of replies can be pitched at different levels. So, for example, we can check the amount of *justified standpoints* deployed as replies to instances of *request-for-evaluative-opinion*. AIFdb, meanwhile, includes a tool for providing simple statistics that is called “Analytics”. This allows one to perform simple calculations using the bottom-up method. It gives, though, the description of the summary of the occurrences, without grouping the tags or describing the proportions. Also, there is no interface allowing analysts to inquire about occurrences of a particular transition; access to such data may only be possible via SQL queries of some PHP application on the database, where this could well create some difficulties for them.

Modelling argumentation. The different methods for describing dialogue dynamics resulted in different sorts of description of the process of arguing. In the model for financial conversations, argumentation was indicated by the participants: for instance, when they *request-justified-standpoint* or provide a *justified-standpoint*, constructing their own arguments and then asking for *confirmation-of-inference* in respect of their own reasoning. In the debate genre, meanwhile, the participants focused on persuasion of their audience. They are not asked to put forward an argument. In most cases, a justification follows immediately in the wake of the standpoint to be justified. Also, arguing is the main tool for debating, so it is hard, if not impossible, to find an utterance where a participant is actually asking for justification. The number of cases of *challenging* a communicative intention is insignificant. Usually, participants in the debate will use an *assertive challenging (p)* move. This can be interpreted as a courteous way of attacking *p*.

At this level, the OVA+ tool allows for deeper analysis of the argumentative dynamics, as it is constructed on the basis of the corresponding theory. The IAT theory describes where, exactly, in the text the inference and the argumentative intentions come from. Also, the analytical graph is saved to the corpus just as it is. Interconnected arguments are available on-line. Such tools are not available in the case of the UAM corpus tool, which has broader linguistic applications. Nevertheless, this tool is sufficient to furnish a description of highly organised dialogues in which, at the level of communicative intentions, the argumentative intentions can already be assumed.

To summarise, where the description of dialogue dynamics is concerned, the choice of the UAM corpus tool when pursuing a top-down approach, and of OVA+ for a bottom-up one, can be justified. In a highly organised discourse, the reply structure can be assumed, but we then need a tool to reliably verify our assumptions. On another hand, in the case of dialogues without any initial rules, such as moral debates, say, a deeper analysis of the dynamics of the dialogue is called for.

6. Conclusions

The current paper has sought to present the results of research conducted into formal models of real-life dialogues. The philosophically motivated methods for describing such dialogues were formulated on the basis of corpus studies of two kinds of discourse. At the same time, in order to properly reflect the variety of dynamics pertaining to naturally arising instances of human communication, different computational tools were applied for the purpose of textual analysis. This facilitated the uncovering of peculiarities of communication and argumentation in respect of such naturally occurring dialogues.

The findings of the research suggest significant prospects for its application in the domain of computer science. Let us first mention automated and semi-automated tools for argument extraction from naturally produced texts. The basic method of argument mining in monologues is based in recognition of so-called discourse markers as *since*, *because*, etc., but this will fail to recognise argumentative structures in dialogues, as participants in a conversation tend not to use such inference indicators in that context. Thus, to have a machine recognise an argument in the transcript of a natural dialogue, it must first be introduced to the structure of the dialogue. As we can see from the examples of the two types of real-life dialogue exam-

ined here, standard dialogue systems cannot be employed for such a task. The way in which proposed data-driven systems can contribute to these studies is shown by Budzynska et al. (2014b).

As a result, we must turn to data-driven dialogue models to furnish a formal language for the development of existing languages for agent communication (ACL) and human-computer interaction. There exist artificial languages for agent communication, such as KQML (Finin et al., 1994) or FIPA-ACL (Ametller et al., 2003), which allow agents to perform simple communicative intentions such as *request-if*, which can be translated into Prakken's *question* or *send*, corresponding to *claim*, and so on. Data-driven dialogue models furnish a basis for providing new communicative features, such as can be implemented in ACL ontologies and enable agents to perform more human-like social actions. Furthermore, dialogue protocols for rational agent interaction (Parsons et al., 2003) can, potentially, also be enriched with a formal description of additional features. Ultimately, the protocols proposed can be used for modelling human-computer communications – as with Arvina, based on the DGDL language – where this has the potential to improve human-computer interactions.

N O T E S

¹ <http://www.corpustool.com/>

² <http://ova.arg-tech.org>

³ <http://corpora.aifdb.org>

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