Collaboration, Cooperation and Dialogue Classification

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Abstract

Argument plays a crucial role in agent-agent communication and in human dialogue - though the latter is contextually much richer. Research in informal logic, aimed at devising a metatheory of fallacies (necessary for the analysis of human argumentation), has produced a classification system for dialogue. This classification is summarized, and it is shown that the features used in performing that classification are also important in defining the terms *cooperation* and *collaboration*. In particular, the distinction between the aims of the individual participants and the joint aim to which they both subscribe can be used to identify collaboration and cooperation in dialogue. The characteristics of these two aspects are examined within the dialogue classification system, and their role within embedded dialogues is discussed. The importance of the notion of conflict in classifying dialogue is indicated, and the various sources of conflict are identified. Finally, a summary is offered of the relationship between these different types of conflict and the corresponding dialogue types applicable for their resolution.

1 Introduction

The term *argument* is frequently defined, yet with little consensus - [Blair, 1996] summarizes well over one hundred different definitions offered in recent literature in formal and informal logic. The definitions offered fall into a number of broad categories: argument as reasoning (unit of, process of, or expression of); argument as inference (process of, expression of, or invitation to); argument as linked propositions or claims; argument as dispute or disagreement; etc. Encompassing such a wide range of function, it is unsurprising that argumentation is increasingly being employed for reasoning systems (especially those which need to cope with uncertainty [Das *et al*., 1996]) and for inter-agent communication [Parsons and Jennings, 1996], [Reed *et al*., 1997].

Argument clearly has an important role to play in situations of conflict, whether it is beliefs, desires, or intentions which are in conflict (to borrow the terminology of [Rao and Georgeff, 1992]). Argument can be used by an agent to increase coherence between its beliefs and those of another agent - informally, one agent can persuade another to adopt one or more of its own by offering support for those beliefs and undermining counter-beliefs [Reed *et al*.,1997]. Similarly, arguments can be proposed for the adoption of particular goals, or for the fulfillment of particular desires [Parsons and Jennings, 1996].

Despite this richness, the sense of argumentation construed in multi-agent systems is impoverished by comparison to that describing similar communication with or between humans. For human argumentation involves numerous peripheral issues:

- the precise goal of the argument (to win at all costs, to reach consensus, to impress the audience, to confuse the hearer, to educate, etc.)
- the potential side effects (impressing the audience, affecting the speaker-hearer relationship)
- the potential investment the speaker has in winning/losing (and how that investment is perceived by the hearer)
- the relationship between the speaker and hearer to be created/maintained
- maintaining 'face' goals

A number of these issues are discussed with respect to the generation of natural language argument in [Reed *et al*., 1996], and under the auspices of social psychology and communication theory in [Billig, 1996] and [Gilbert, 1996] .

In addition to these factors affecting the argument itself, there are subsequent issues concerning realization:

- the medium in which the argument is expressed and the multimodal information available
- choices of vocabulary range, use of jargon, structural complexity, and use of enthymematic arguments (which employ tacit premises and conclusions), all based upon various aspects of the (speaker's model of) the hearer's capabilities

– the use of stylistic devices such as repetition and alliteration
– the use of rhetoric, such as ordering premises and conclusions to maximum effect [Reed and Long, 1997]

Together, these aspects enrich the formal, 'bare-bones' view of argument appropriate for agent-agent communication, producing the complex, highly context-dependent natural language argumentation. It is this natural argumentation which forms the subject of investigation of informal logic, from which recent results can be used as the basis for laying out a framework in which the development of computational dialogue systems can be undertaken. This framework also provides a means of defining the terms and subsequently making use of the concepts of cooperation and collaboration.

2 Dialogue Classification

Informal logic is predominantly evaluation-oriented: given an argument in natural language, how is it possible to decide whether or not that argument is 'good'? The tradition has its roots in Aristotle, and one of the major schools of informal logic builds directly on his work, by defining a good argument as one which commits no fallacies[1]. The problem is that the list of fallacies is arbitrary: there is no guarantee that the extant list is exhaustive or even appropriate. In attempting to rectify this problem, Walton and Krabbe [Walton and Krabbe, 1995] attempt to build a metatheory of fallacies, by identifying the presence of a fallacy with a *dialectical shift* from one type of dialogue to another. Their precursory step is to build a taxonomy of dialogue types, and it is this classification which yields a number of interesting insights for the design of computational dialogue systems.

Walton and Krabbe distinguish six main types of dialogue, categorized on the basis of the primary goal, to which both parties subscribe, and the private aims of the participants, which may be at odds.

Persuasion Dialogue. From an initial conflict, both participants adopt the goal of resolving that conflict. Each participant, however, is clearly trying to modify the beliefs of their opponent, whilst avoiding a situation in which their own beliefs need changing. Equally, though, if an agent enters into a persuasion dialogue, it implicitly acknowledges that it is willing to modify its beliefs if necessary (without such tacit mutual acknowledgment, persuasion dialogue would be futile, and consequently would not be employed).

Negotiation. The aim of both participants of a negotiation is to make a deal; again though, each participant has selfish goals of maximizing personal benefit. Negotiation is instigated from a conflict of interests and need for settlement. A common example is bargaining for scarce resources. (This process requires complex value judgments to be made, involving attributing worth to proposals; for this reason, most agent societies probably do not employ *negotiation* in the Walton-Krabbe sense, but goal-driven *deliberation*.) Note that, unlike persuasion, negotiation does not aim for agreement (other than agreeing to a particular deal) - the relevant beliefs of the participants may very well remain at odds after negotiation (for example, if *a* believes there are 10 resource units available, and negotiates with *b* who believes there are 14, *b* may agree to offer *a* 6 units - both parties thinking they are getting the better deal, with no need for consensus on the issue of available resource units).

Inquiry. The aim of each participant accords with their shared aim, *viz.* to substantiate or derive a proof for a claim. In a sense, inquiry represents a pooling of information in a structured way.

Deliberation. Jointly, the participants aim to reach a decision, or form a plan of action. Individually, they aim to influence that decision to benefit themselves. Deliberation differs from negotiation in two important respects. Firstly, participants in negotiation engage from a point of conflict (over, for example, limited resources) - in deliberation, there is no initial conflict. Secondly, deliberation is precipitated by the need for action and is consequently goal-directed, in contrast to the more abstract reasoning characteristic of negotiation.

Information-Seeking Dialogue. One participant elicits information from the other (on the assumption that the information can be provided). The only type which is always asymmetric, the information-seeking dialogue engages both participants in a general goal of 'spreading information', though clearly, the specific aims of each participant are precisely opposite.

Eristics. This is a group of dialogues which represent the colloquial use of the term 'argument', i.e., acrimonious or confrontational exchange, in which each participant aims simply to win. There is also a loose joint aim of reaching some accommodation through such eristic.

3 Cooperation and Collaboration

One interesting application of this six-fold division is in teasing apart the notions of cooperation and collaboration. By considering the initial situation, the joint aim, and the individual aims, it is possible to loosely determine the level of cooperation and collaboration in each type of dialogue.

Before analyzing the six dialogue types in this way, the concepts of cooperation and collaboration need to be defined so that the resultant classification can be of practical use. Cooperation has a number of quite distinct senses in the literature. In particular, the game-theoretic approach of [Zlotkin and Rosenschein, 1990] uses a rigorous definition based on the construct *negotiation set* (roughly, the set of joint plans which agents are prepared to employ), which for a cooperative domain is never empty. In contrast, the linguistic definition of co-

[1] Lists of fallacies are readily available in textbooks such as [Johnson, 1992], and generally include constructs such as appeal to the people (e.g. "God must exist because so many people believe He does"), false dichotomy (e.g. "Either we enforce the death penalty or wind up with convicted murderers on the street"), and so on.

operation frequently draws upon [Grice, 1975], which sets out maxims (of quantity, quality, relevance and manner) to which it can be assumed parties in a dialogue are adhering on an utterance-by-utterance basis. Informal logic has drawn upon the Gricean approach for the *Principle of Communication* defined as the imperative "Be clear, honest efficient and to the point" [Eemeren and Grootendorst, 1992]. Each of these definitions seems to miss the intuitive concept of cooperation associated with natural (i.e. human-human) dialogue, which is less formal than Zlotkin-Rosenchein cooperation and acts at a higher level than does Gricean cooperation. It is proposed that a broader, more intuitive view of cooperation be adopted such that parties can be seen to be cooperating in dialogue if they obey a common set of (dialogue-) rules, and stay within a mutually acknowledge framework. This loose definition accords well with the analyses presented in [Walton and Krabbe, 1995], which set out complex argument 'games', with strict rules and conventions[2]. Furthermore, their conclusions - that fallacies are usually associated with unacknowledged dialectical shifts - also suggest that cooperation might usefully be associated with adherence to dialogue rules (with fallacies being inherently uncooperative). Implicit in this definition of cooperation is the requirement that the agents entering into cooperative dialogue both accept the appropriate joint aim (of resolving conflict, making a deal, etc.).

The term *collaboration* is used less frequently in both multi-agent research and linguistics, but seems to refer to scenarios in which the individual, private aims of the participants are more closely aligned. That is, the interlocutors are in some sense working *together* to reach the desired outcome (expressed as the joint aim), rather than that outcome being achieved through 'selfish' participation constrained by contextual factors (such as the need for resolution or action).

Persuasion dialogue is a cooperative activity, with participants implicitly agreeing at the outset to a number of conventions, such as the potential for own-belief change, mentioned above, and the exchange rules applicable to the situation. Similarly they also both accept the main aim of resolving the conflict at hand. Persuasion is not, however, a collaborative activity: the initial situation is one of conflict (in the simplest case, that one party believes p, and the other $\sim p$). The process of argumentation then refines that initial conflict, to determine where further conflict lies (by following the various chains of supporting propositions). Ultimately, one participant is forced to modify their beliefs either because of a contradiction unearthed by the opponent, or else as a result of new information. The diametrically opposed individual aims present throughout the process preclude it from being seen as a collaborative activity.

Negotiation is similar: it is again an example of cooperation, simply because of the participant's adherence to the rules by which the joint aim (to make a deal) might be realized. But again, the conflict of interests between the participants means that it cannot be viewed as collaborative: each party is out to selfishly get the best it can, rather than to collaborate to produce some 'globally' best deal. For negotiation to be collaborative, each agent would have to be altruistic, putting the good of both agents together above the good of itself[3]. This sort of contrived situation could then barely be called negotiation at all.

Inquiry, like persuasion and negotiation, is also cooperative, for similar reasons. However, it differs from them in being truly collaborative: there is no initial conflict, and both parties have the same private aims - of establishing 'proof'. This accords with intuitions that parties are working together to create a stable solution to which all subscribe.

Deliberation is again a cooperative activity. It is tempting to claim that it is also collaborative since the initial situation is - like inquiry - not one of conflict, and furthermore, the participants are building a plan which may ultimately comprise contributions from both agents. However, this conclusion is rather hasty, for the participants in deliberation have differing private aims: they are trying to influence the resultant plan to selfishly maximize their own benefit. Such a lack of alignment between private goals, in addition to the characteristic selfishness of persuasion and negotiation, strongly suggests that deliberation is not a collaborative process. The non-collaborative nature of deliberation implies that agent-agent communication is also usually non-collaborative since, as explained above, agent 'negotiation' (to use the usual DAI term) can generally be categorized as deliberative dialogue (in the Walton-Krabbe framework). This is as expected, since agents (and especially those with sophisticated communication capabilities) are generally assumed to be selfish, e.g.:

> "Autonomous agents are thus selfish agents. A goal (whether traditionally viewed as 'selfish' or 'altruistic') will always be adopted so as to satisfy a 'selfish' motive." [d'Inverno and Luck, 1996],p529.

Information-seeking dialogue is clearly cooperative, but it is difficult to determine whether or not it is appropriate to classify it as collaborative. The problem is founded upon the inherent asymmetry of information-seeking dialogues (- one party is requester and the other is provider). It could be posited that this asymmetry is present in the private aims of the participants ("give" vs. "take"), and that this would license concluding that there is no collaboration. However, the private aims can be more accurately characterized as "pass-information-from-A-to-B", resulting in the intuitive conclusion that information-seeking is collaborative.

[2] Though such formalization of dialogue games is not new, e.g. [Carlson, 1983], [Hintikka and Kulas, 1983].

[3] Note that this is not the same as benevolence, whereby an agent will agree to perform any task if asked - the altruism mentioned here is an active process of preferring the good of the both over the good of the one.

Eristic dialogue is clearly not collaborative - participants have vehemently opposed private aims. Intuitively, it is not cooperative either, but Walton and Krabbe suggest that there is in fact a shared goal, and even rules associated with various eristic dialogues:

> "In another more global sense, the goal of a quarrel, as a type of dialogue, is to engage in some form of exchange aimed at reaching an accommodation, and, moreover, a form of exchange that is verbal rather than physical" [Walton and Krabbe, 1995], p77.

If it is conceded that participants do tacitly agree to such an over-arching aim and do abide by an albeit small body of rules, then it must also be conceded that eristic dialogue is also cooperative.

These findings are summarized below in Table 1. Two aspects of these results deserve further comment. Firstly, the fact that all dialogue is inherently cooperative. This seems to be a reasonable result, since any instance of true dialogue involves the participants accepting a common goal and working towards that goal within a given set of rules. It follows that noncooperative dialogue can only occur if participants do not accept the same aim, or do not use the same rules. The most common situation in which this could happen is where one party moves from one type of dialogue to another without sufficiently indicating that move to the other party (and this noncooperativeness usually manifests itself as a fallacy)[4]. There are other potential scenarios where participants do not accept a common aim and rules, based upon external factors such as the sociocultural norms which have lead to a particular set of rules.

	Collaborative	Cooperative
Persuasion	×	✓
Negotiation	×	✓
Inquiry	✓	✓
Deliberation	×	✓
Info-seeking	✓	✓
Eristic	×	✓

Table 1. Dialogue Properties

The second comment is on the noticeable rarity of collaboration, present only in inquiry and information-seeking dialogue. Intuitively, it seems inappropriate to claim that persuasion and negotiation can never be seen as collaborative. In order to resolve this anomaly, it is necessary to introduce another aspect of the analysis offered in [Walton and Krabbe, 1995]: the concept of *functional embedding*.

If a persuasion dialogue (or any of the other types) reaches a stage at which the proponent knows considerably more about a topic than her opponent, it is likely that the exchange will temporarily shift into an information-seeking dialogue. When both parties have the appropriate information, the information-seeking concludes and the persuasion dialogue resumes. Similarly, if during an inquiry, one participant forms an intermediate conclusion ahead of the other, it may be appropriate for that participant to shift into a persuasion dialogue to convince her opponent of the veracity of her conclusion. Importantly, these subdialogues are initiated to fulfill a precise purpose in the parent dialogue; when that purpose is fulfilled (one way or the other), the parent dialogue can be resumed at precisely the point it was interrupted, but with the information provided by the subdialogue adduced appropriately.

Not all permutations of functional embedding are permissible: embedding negotiation in persuasion dialogue or inquiry, for example, often leads to a fallacy. However, inquiry and information-seeking dialogue can almost always be functionally embedded successfully[5]. It is for this reason that examples of persuasion, negotiation and deliberation can often have overtones of collaboration: they are employing embedded collaborative exchanges. When this occurs, participants temporarily suspend their selfish goals in favour of conflict-free aims. It is perhaps surprising that agents would be prepared to overturn their selfish goals (albeit temporarily) in favour of collaboration. However, their cooperative commitment to the noncollaborative parent dialogue ensures that collaborative subdialogue can be functionally embedded successfully.

Note also that a collaborative dialogue, such as inquiry, can make use of a noncollaborative subdialogue such as persuasion. In this case, it is the collaborative goals which are suspended and agents become temporarily selfish.

4 Conflict

One of the key features employed for distinguishing dialogue types in the preceding discussion is the notion of conflict. The presence or absence of conflict determines the initial level of collaboration in a dialogue; given such a major role, it is appropriate to examine in more detail the role conflict plays in characterizing dialogue.

Conflict arises from three distinct sources. In the first place, there is the inherent uncertainty of any nontrivial domain: in a dynamic world, one agent may simply have more recent information, for example. Clearly, if one agent is not aware of the newer information (i.e. it has not directly sensed the change), its beliefs will be in direct conflict with those of another agent which is aware of the newer information. Secondly, the world which the agents inhabit may impose sources of conflict, such as offering only limited resources. Finally, designers of multi-agent systems are increasingly assuming agents to be autonomous, and included in this assumption is the fact that a complex society may be composed of heterogeneous agents [d'Inverno and Luck, 1996].

[4] This situation could also be due in part to one party incorrectly inferring what was intended by the other.

[5] Discussion and justification of the validity of various embeddings was offered at a seminar presented at QMW College, London, the notes from which are available at the author's web page.

This heterogeneity is even more apparent when considering human-computer or human-human interaction. In such a complex situation, it is unreasonable to assume that the hearing agent will evaluate or reason in an identical manner to the speaking agent. In particular, the motivations of agents can affect the way in which their limited computational resources are allocated. Thus two agents working from identical premises can still come to conclusions which are in conflict, especially if their computational resources are scarce.

Note that these sources of conflict are the factors responsible for producing the beliefs available at a dialogue encounter. Thus the subsequent uncertainty resulting from potential mismatch between the speaker's model of the hearer and the hearer's actual beliefs is a separate problem. This uncertainty exists in the world of a dialogue system (comprising just the speaker's beliefs and those of the hearer), and is not *responsible* for conflict in the dialogue. It may, however, lead to conflict being uncovered. For example, if the speaker believes that the hearer agrees with her on some point P, and she then finds out that she is mistaken, and he doesn't agree with P, the underlying conflict on this point is detected and brought out for discussion: this is not to say that the process has *created* conflict, since that conflict was already present.

The distinct sources of conflict which have led up to a conflict-resolving dialogue characterize the form that the ensuing dialogue will take. Incomplete or uncertain information is responsible for a situation in which agents hold different beliefs. If it becomes necessary to resolve this conflict of belief, a persuasion dialogue ensues. The joint aim of a persuasion dialogue is to resolve the conflict and reach agreement - persuasion is thus the primary technique for establishing mutual belief in situations in which it was known not to exist previously.

Similarly, conflict imposed by features of the world usually leads to negotiation. Under negotiation the aim is not primarily to reach a consensus on some issue (indeed, as mentioned above, such consensus does not necessarily accompany successful negotiation), but to reach a settlement. The settlement is a resolution of the initial conflict.

Finally, conflict resulting from the differences in the way agents perform their reasoning and evaluation can be resolved primarily through deliberation. By explaining their differing reasoning and evaluation processes, participants can convince one another of the expedience of particular plans of action.

5 Conclusions

The distinction used in [Walton and Krabbe, 1995] between the goals of the participants and the goal of the dialogue as a whole has been shown to assist in forming a definition of the terms cooperation and collaboration. Cooperative dialogue requires that participants subscribe to the aim and adhere to the rules of that dialogue; noncooperation can occur when parties fail to appreciate which type of dialogue is currently being employed (either through their own inability to detect, or else as a result of insufficient notification from the other participant). This notion of cooperation is thus similar to that of Grice, but acts at a higher level - Gricean cooperation is speaker-centered, whereas the proposal here is that cooperation is more objectively discourse-centered. Collaborative dialogue requires that the individual aims of each participant are closely aligned, i.e. are not in conflict. Although this leads to surprisingly little dialogue being classified as entirely collaborative, it has been shown that collaborative subdialogues, functionally embedded in noncollaborative parent dialogues, are common. Collaboration is thus fundamentally dependent upon participants eschewing selfish goals.

Finally, various types of conflict have been described and related to the various dialogues employed to resolve them. Resolving conflict is thus a cooperative activity, but rarely collaborative, since the conflict precipitates selfishness, prohibiting full-scale collaboration.

The paper has outlined an abstract relationship between the concepts of cooperation, collaboration and conflict and the types of dialogue identified in informal logic research. The relationship suggests ways in which particular forms of conflict might be resolved, and offers a broad framework in which to sit dialogue work such as [Reed *et al.*, 1996] on persuasion, [Bussmann and Muller, 1993] on negotiation, [Parsons and Jennings, 1996] on agent-theoretic 'negotiation', more properly termed deliberation, and [Hintikka and Hintikka, 1982] and [Allen *et al.*, 1995] on information-seeking dialogues. In addition to offering a way of relating such disparate research, this work contributes to a richer formalism for inter-agent communication: as agents need to interact in increasingly complex ways, it is important that their communication strategies employ an understanding of the aims and prerequisites of the different dialogue types. From this base, agents will have a battery of techniques for achieving precise communicative aims in complex, uncertain domains.

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