Argumentation and explanation in the context of dialogue

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Abstract. Whilst computational argumentation and computational explanation have both been studied intensively in AI, models that incorporate both types of reasoning are only just starting to emerge. The two forms of reasoning need to be clearly distinguished, as they may influence dialogue protocol and strategy. We show that this distinction can be made by considering the speech acts used to put forth the reasoning structures. Using the language of the Argument Interchange Format, ideas from speech act theory are integrated into a conceptual model that allows us to perform both argumentative and explanatory reasoning.

1 INTRODUCTION

Reasoning can be characterized as the process of moving from certain starting statements, assumptions or premises, to other statements, conclusions [17]. At the same time, reasoning is also the outcome of this process (i.e. the product), a static structure. Reasoning is typically used in the context of argumentation, where premises are offered as proof of a conclusion or a claim often in order to persuade someone or settle an issue. However, reasoning is also used in the context of explanation, where the *explananda* (facts to be explained) are explained by a coherent set of *explanans* (facts that explain). The usual purpose of explanation is not necessarily to convince someone but rather to help someone understand why the explananda are the case. In this paper, we aim to explore the similarities and differences between argumentation and explanation and make a first step towards an integrated computational model of the two.

Both argumentation and explanation are well-presented in their respective sub-fields of AI. A number of computational models of argumentation have emerged and matured in the past twenty-or-so years [10] and the computational aspects of the dialectics of argument (cf. [6]) and of the structure of argument [9] are well understood. Computational models for explanation are mainly based on the technique of abductive (model-based) reasoning, which has been studied in the context of medical and system diagnosis (e.g. [3, 8]); other examples of computational explanation are [4], who models explanatory dialogues, and [14], who uses explanations for natural language understanding. Despite the important role explanations can play in argumentative dialogue, there have not been many attempts to combine argumentation and explanation into one formal model. Perhaps the most thorough work thus far is [2], who combines structured arguments (cf. [10]) with abductive-causal reasoning into one model of inference to the best explanation. Other formal work that mentions both explanation and argumentation is [8].

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Argumentation and explanation are often used in concert when performing complex reasoning: explanations can themselves be the subject of argumentation or they may be used in an argumentative way. Hence, we need a model that integrates argumentation and explanation. In such a model, the two types of reasoning should be clearly distinguished, because argumentation and explanation have different properties and in a dialogical setting the difference can influence protocol and strategies of dialogue. This distinction is not always easy to make because of the overlap between argumentation and explanation and the shifting between them in complex dialogue. It is even more complicated in the case of "reasoning-as-product", that is, distinguishing between static arguments and explanations, which often have a similar (logical) structure.

In our opinion, the only way to distinguish between argumentation and explanation is by looking at the context in which the reasoning was originally performed. In this paper, we concentrate on the contextual property of the intention of the speaker. We are interested in how to represent the connection between the intentions and the static reasoning structure under consideration. In this paper, we show that this connection can be made by using ideas from speech act theory [15]. More specifically, not the propositional contents of a speech act (i.e. that which forms the static reasoning structure) but rather the illocutionary force of the speech act in a dialogue determines whether reasoning is argumentation or explanation. We will use the conceptual model of the Argument Interchange Format [5, 12] so as to provide a model that is not tied to any specific dialogue or argument formalism.

The rest of this paper is organized as follows. In section 2 we elaborate on the (structural and contextual) similarities and differences between argumentation and explanation and we give some intuitive examples of both types of reasoning. Section 3 discusses our ideas for a conceptual framework for argumentation and explanation. Finally, section 4 discusses some preliminary conclusions and ideas for future research.

2 SIMILARITIES AND DIFFERENCES

Argumentation is a type of reasoning used in a specific *probative function*, to prove a claim [17]. By its very nature, it involves some sort of opposition between parties[3] and reasons are not just given to support for a conclusion but also to remove an opponent's doubts about this conclusion. For example, a reasoning $\alpha \vdash \beta$ is argumentation when β is questioned (dubious) and a proponent of this argument uses α not only to support β, but also to remove an opponent's doubts about β. Explanation, on the other hand, has not as its main goal to prove but rather to explicate why something is the case. Explanation

[3] Hence the use of the term "calculi of opposition" for argumentation-theoretic semantics that allow one to calculate the acceptability of arguments.

in its purest form is not inherently dialectical and an explanation is given to help the other party, not to convince them. Consider the following example. Say I arrive at work at ten in the morning and my boss asks why I am late. I can either explain to him that the bridge was open and that I had to wait or I can argue that I am not "late", because my contract does not specify the exact hours I have to be at the office. In first case, I am answering my boss' question by explaining to him what caused my being late. In the latter case, I am arguing against my boss claim that I am late.

Argumentation and explanation are often used in conjunction. Explanations can themselves be the subject of argumentation, as one may argue in support or in opposition of a particular explanation or parts of it. For example, if my boss questions my explanation by arguing that I never cross a bridge on my way to work, I can argue (e.g. by providing evidence) that I do. Furthermore, explanations may be used in an argumentative way, as having someone agree to a particular explanation of a phenomenon might help us to persuade them. For example, if my boss accepts my explanation for being late I might convince him not to fire me.

Because argumentation and explanation are often intertwined in complex reasoning, they can sometimes be hard to distinguish from one another. However, it is important that we do distinguish the two types of reasoning. Apart from providing a measure of conceptual neatness, there are also more concrete reasons for not confusing the two types of reasoning. One of them is that circular arguments are usually considered fallacious while circular explanations are not. Take [18]'s recession example. An economist is asked why the economy is in recession in a certain state at present, and she replies: "Right now a lot of people are leaving the state, because taxes are too high". But when asked why taxes are so high, she responds: "Well, a lot of people are unemployed, because of the recession". The economist has not committed the fallacy of arguing in a circle, because he was explaining human behavior which has inherent feedback loops. The second reason for correctly distinguishing between argument and explanation is that the type of reasoning used might influence the allowed and desired moves in a dialogue. The ways in which to correctly respond to an explanation are different from the ways in which one should respond to argumentation; for example, it does often not make sense for the other party to deny the explananda whilst it does make sense to deny the conclusion of an argument. Similarly, a request for information is often better met by explaining something than by arguing that something is the case.

One possible way of distinguishing between argumentation and explanation might be to look at the product of reasoning, that is, the argument or the explanation put forth, and the structure and type of this product. At first sight, it often seems an explanation is *abductive* and *causal* whilst an argument is modus-ponens style, non-causal reasoning. The basic idea of abductive inference is that if we have a general rule $\alpha \longrightarrow \beta$, meaning α *causes* β, and we observe β, we are allowed to infer α as a possible explanation of β. In contrast, argumentation is often seen as reasoning from a premise α to a conclusion β through an inference rule $\alpha \longrightarrow \beta$, where this rule need not necessarily be causal. However, as it turns out it is also possible to give abductive or causal *arguments* (see e.g. [19]'s argument from evidence to hypothesis and causal argument). Similarly, one may perform explanatory reasoning by taking a rule $\beta \longrightarrow \alpha$, meaning β *is evidence for* α (see [2] for a discussion on evidential and causal reasoning).

In our opinion, the distinction between argumentation and explanation is not one that is inherent to the product of reasoning, the static structure. Rather, the distinction follows from the dialogical context in which the reasoning was originally performed. In order to determine this context, we need not just look at the original intention of the speaker but also at the broader dialogical context, such as the utterance that was replied to by the speaker and the intentions of the other participants. In other words, the context is largely determined by the *speech acts* that were performed (see e.g. [16] for the very basic concepts of the speech act theory needed in this paper).

According to the pragmatic theory of speech act, argumentation and explanation can be treated as different speech acts. A speech act Fα, such as: claimα, whyα, consists of an illocutionary force F and a propositional content α. An illocutionary force is an intention of uttering a propositional content. That is, the performer of a speech act may utter α with an intention of asserting, asking, promising and so on.

Originally, Searle & Vanderveken recognized argumentation as an instance of content's property, i.e. argueα is a speech act consisting of an assertive illocutionary force of uttering α which is a conclusion intended to be supported by premises that the performer of the speech act provides: "When one argues that P one asserts that P and gives reasons which support the proposition that P, normally with the perlocutionary intention of convincing the hearer that P" [16, p. 184]. Observe that in such an account premises of a reasoning are hidden. For example, the argumentation "I am not late, because my contract does not specify the exact hours I have to be at the office" has to be formalized as argue$p$, where p represents the conclusion "I am not late", while the premise "My contract does not specify the exact hours I have to be at the office" remains unexpressed in the formalization.

We use a different approach proposed in [1], where argumentation and explanation are both instances of illocutionary acts that represent a relation between premises and conclusions: argue(α, β) and explain(α, β), where α denotes a conclusion and β denotes premises. The distinction between argumentation and explanation cannot just be made by looking at the original speech act; one also needs to consider the broader dialogical context. In the next section, we show how this can be represented in the AIF$^+$.

3 SPECIFICATION IN THE AIF$^+$

In this section, we present how in general the AIF$^+$ describes argument and its context (Section 3.1). Then, we propose how to model argumentation and explanation in the AIF$^+$ (Section 3.2) and finally we show how they can be represented as a context of reasoning (Section 3.3).

3.1 Architecture of the AIF$^+$

The AIF+ [13] is a dialogical extensions to the Argument Interchange Format, AIF (see e.g. [5]). The AIF is an attempt to bring together a wide variety of argumentation technologies so that they can work together. The AIF$^+$ extends this approach by allowing to explicitly handle the context of dialogue in which a reasoning is put forth. It enables to connect the locutions uttered during a dialogue (argument$_2$) and the underlying arguments expressed by the content of those locutions (argument$_1$).

In the AIF$^+$, the argument$_1$ is represented by two kinds of nodes:

- information (I-) nodes, which refer to data, and
- scheme (S-) nodes, which refer to the passage between information nodes, which are classified into three groups:
  - rule application (RA-) nodes which correspond to inference or support,

– conflict application (CA-) nodes which correspond to conflict or refutation,
– preference application (PA-) nodes which correspond to value judgments or preference orderings.

The argument$_2$ is also described by two types of nodes:

- locution nodes (L-), which refer to utterances and constitute a subclass of information nodes, and
- transition application (TA-) nodes, which refer to the passage between locutions and constitute a subclass of rule application nodes.

The TA-nodes are governed by the protocol of a dialogue system, recording e.g. that a given assertion has been made in response to an earlier question. [12] shows two examples of protocols that can be represented in the AIF+: the Two Party Immediate Response (TPI) [7] and Argument Scheme Dialogue (ASD) [11].

The interaction between argument$_1$ and argument$_2$ is captured by means of two types of illocutionary application (YA-) nodes [12]:

- the YA-nodes between I-nodes and L-nodes, and
- the YA-nodes between RA-nodes and TA-nodes.

For example, an YA-node may represent the relation between an assertion claimα with its propositional content α. The YA-link is determined and warranted (authorized) by the constitutive rules for speech acts [15]. These rules determine what constitutes a successful speech act. For example, an assertion may be unsuccessful and attacked, if its performer did not have enough evidence for the statement or he declared what he actually disbelieves.

3.2 YA-nodes

In this section, we propose the specification of argumentation and explanation in the AIF$^+$. We will illustrate it on the example adapted from [18].

Allen The Evanston City Council should make it illegal to tear down the city's old warehouses.
Beth What's the justification for preserving them?
Allen The warehouses are valuable architecturally.
Beth Why are they so valuable?
Allen The older buildings lend the town its distinctive character.

Walton points out that Allen' first response is argumentation, while a second one is explanation. We follow this assumption without further considerations.

In the dialogue between Allen and Beth (see Fig. 1), the argument$_2$ consists of five speech acts represented by L-nodes (we use abbreviation L$_i$ to denote subsequent locution nodes). The argument$_1$ consists of three propositions represented by I-nodes (I$_i$ means subsequent information nodes). The interaction between the argument$_2$ and the argument$_1$ is described by means of the YA-nodes. The speech acts L$_1$, L$_3$ and L$_5$ have assertive illocutionary force connecting them with propositional contents I$_1$, I$_2$ and I$_3$, respectively. The passage between L$_1$ (resp. L$_3$, L$_5$) and I$_1$ (resp. I$_2$, I$_3$) is represented by YA$_1$ (resp. YA$_4$, YA$_7$). The illocutionary node YA$_2$ (resp. YA$_5$) links the directive L$_2$ (resp. L$_4$) and its propositional content I$_1$ (resp. I$_2$): not all YA-nodes are assertive schemes.

The most interesting is the complex type of illocutionary force which could be treated as intention of arguing and explaining. In the

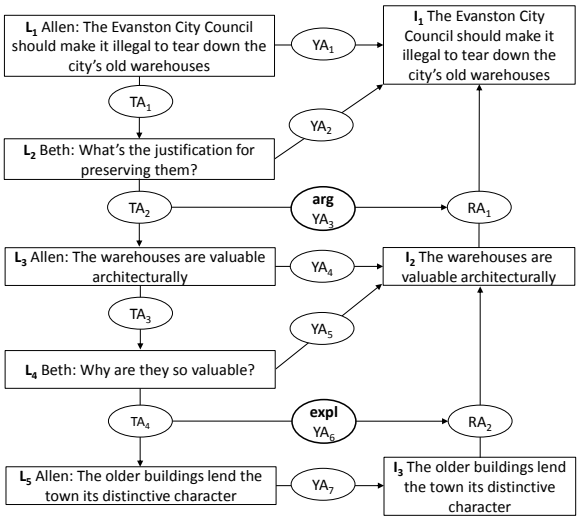

Figure 1. The AIF$^+$ description of the example from [18]

AIF$^+$, the complex illocution is represented by the YA-nodes between RA-nodes and TA-nodes [12]. In Fig. 1, there are two such nodes: YA$_3$ and YA$_6$. According to the assumption made above, YA$_3$ corresponds to argumentation and YA$_6$ to explanation. The illocution YA$_3$ links Allen's response to Beth's challenge (i.e. TA$_2$) with the argument "The warehouses are valuable architecturally" for the claim "The Evanston City Council should make it illegal to tear down the citys old warehouses" (i.e. RA$_1$). This captures the intuition that Allen's argumentation is invoked by Beth's challenge. On the other hand, the illocution YA$_3$ links Allen's response to Beth's request for information (i.e. TA$_4$) with the explanation "The older buildings lend the town its distinctive character" for the claim "The warehouses are valuable architecturally" (i.e. RA$_2$). This captures the intuition that Allen's explanation is invoked by Beth's request for information.

Observe that we could represent argumentation and explanation as YA$_4$ and YA$_7$, respectively. However, in such a representation they are indistinguishable from simple assertion. Assigning argumentation and explanation to the TA- and RA-nodes captures the intuition that they are social processes that emerge from the interaction between agents such that one agent responds to interlocutor's request for justification or explanation.

3.3 Context of reasoning

In Section 2, we emphasized that argumentation and explanation can be distinguished not by the structural properties of an underlying reasoning, but by its contextual properties. In this section, we propose how to model argumentation and explanation as a context of reasoning.

In the AIF$^+$, the context of reasoning structure is represented by argument$_2$, in which a reasoning was performed, as well as by the interaction between argument$_1$ and argument$_2$. The structural indistinguishability of argumentation and explanation means that the same structure may be either argumentation or explanation depending on the intentions of the speaker who performed a given speech act. Consider the following dialogue between John and Ann.

John The warehouses are valuable architecturally.
Ann Why? I don't think so!
John The older buildings lend the town its distinctive character.

Observe that in this dialogue we have the same reasoning structure (argument$_1$) as in the previous dialogue: "The warehouses are valuable architecturally, since the older buildings lend the town its distinctive character", however, the intentions of providing the premise are different in the case of John and in the case of Allen. That is, John utters the premise "The older buildings lend the town its distinctive character" to argue (prove) the conclusion "The warehouses are valuable architecturally", while Allen utters the same premise to explain (make understandable) the conclusion.

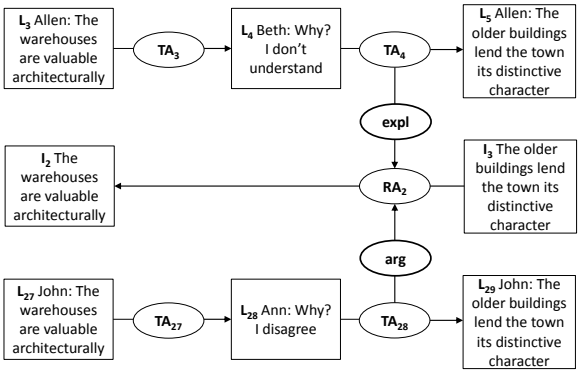

Figure 2. The same reasoning structure in different contexts

Fig. 2 shows how the distinction between reasoning contexts can be captured. Say that the moves in the dialogue between John and Ann are represented by L_{27}, L_{28} and L_{29}. The passage between those moves are modeled by TA_{27} and TA_{28}. The fragment of the previous dialogue (represented by L_3 L_4 L_5 and TA_3, TA_4) generates the reasoning structure modeled by I_2, I_3 and RA_2. Since the John-Ann dialogue refers to the same reasoning structure, the nodes L_{27}, L_{28}, L_{29}, TA_{27} and TA_{28} should be related to the nodes I_2, I_3 and RA_2. In Fig. 2, we focus on the relation that corresponds to the intentions of argumentation and explanation. If Allen's response to Beth's question was intended to explain Beth why the older buildings lend the town its distinctive character, then the node TA_4 should be linked with the node RA_2 by means of an explanatory type of YA-node (denoted as expl in Fig. 2). On the other hand, if John's response to Ann's question was intended to prove Ann why the older buildings lend the town its distinctive character, then the node TA_{28} should be linked with the node RA_2 by means of an argumentative type of YA-node (denoted as arg in Fig. 2).

4 CONCLUSIONS AND FUTURE WORK

In the paper, we propose the basic framework for representing argumentation and explanation as the context of reasoning with the use of the AIF$^+$ language. We propose to model them as the YA-nodes that link together the TA-nodes and the RA-nodes. The TA-nodes correspond to the response of an interlocutor in a dialogue that consists in giving the justification (in the case of argumentation) or explanation. The RA-nodes correspond to the reasoning structure which originates from the interaction between interlocutors in a dialogue. Thus, we show how illucutionary force can be used to distinguish between the two types of reasoning. This presents a good basis for further research on the subject. In particular, it would be interesting to see how the semi-formal AIF+ specification relates to a more formal framework for argumentation and explanation, such as [2].

ACKNOWLEDGEMENTS

We gratefully acknowledge the support of EPSRC under grant EP/G060347/1 for Floris Bex, and the support from Polish Ministry of Science and Higher Education under grant N N101 009338 for Katarzyna Budzynska.

REFERENCES

[1] N. Asher and A. Lascaride, *Logics of Conversation*, Cambridge University Press, Cambridge, 2003.
[2] F.J. Bex, *Evidence for a Good Story. A Hybrid Theory of Arguments, Stories and Criminal Evidence*, Doctoral dissertation University of Groningen, 2009.
[3] T. Bylander, D. Allemang, M. C. Tanner, and J. R. Josephson, 'The computational complexity of abduction', *Artificial Intelligence*, **49**, 25–60, (1991).
[4] A. Cawsey, *Explanation and Interaction: The Computer Generation of Explanatory Dialogues*, MIT Press, Cambridge, MA, 1992.
[5] C. Chesnevar, J. McGinnis, S. Modgil, I. Rahwan, C. Reed, G. Simari, M. South, G. Vreeswijk, and S. Willmott, 'Towards an argument interchange format', *The Knowledge Engineering Review*, (21(4)), 293–316, (2006).
[6] P.M. Dung, 'On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming, and *n*–person games', *Artificial Intelligence*, **77**, 321–357, (1995).
[7] P.E. Dunne and T.J.M Bench-Capon, 'Two party immediate response disputes: Properties and efficiency', *Artificial Intelligence*, **149**(2), 221–250, (2003).
[8] D. Poole, 'Learning, bayesian probability, graphical models, and abduction', in *Abduction and Induction: essays on their relation and integration*, eds., P. Flach and A. Kakas, Kluwer, (1998).
[9] H. Prakken, 'An abstract framework for argumentation with structured arguments', *Argument and Computation*, **1**, (2010). to appear.
[10] H. Prakken and G.A.W. Vreeswijk, 'Logics for defeasible argumentation', in *Handbook of Philosophical Logic*, eds., D. Gabbay and F. Günthner, volume 4, 219–318, Kluwer Academic Publishers, Dordrecht/Boston/London, second edn., (2002).
[11] C. Reed and D. Walton, 'Argumentation schemes in dialogue', in *Dissensus and the Search for Common Ground (Proceedings of OSSA 2007)*, (2007).
[12] C. Reed, S. Wells, K. Budzynska, and J. Devereux, 'Building arguments with argumentation: the role of illocutionary force in computational models of argument', *Submitted to COMMA2010*, (2010).
[13] C. Reed, S. Wells, J. Devereux, and G. Rowe, 'Aif+: Dialogue in the argument interchange format', in *Computational Models of Argument: Proceedings of COMMA-2008*, p. 311323, (2008).
[14] R. Schank, *Explanations Patterns: Understanding Mechanically and Creatively*, Lawrence Erlbaum, Hillsdale, NJ, 1986.
[15] J. Searle, *Speech Acts: An Essay in the Philosophy of Language*, Cambridge University Press, New York, 1969.
[16] J. Searle and D. Vanderveken, *Foundations of Illocutionary Logic*, Cambridge University Press, Cambridge, 1985.
[17] D. Walton, 'What is reasoning? what is an argument?', *The Journal of Philosophy*, ((87)8), 399–419, (1990).
[18] D. Walton, 'Epistemic and dialectical models of begging the question', *Synthese*, (152), 237–284, (2006).
[19] D.N. Walton, C. Reed, and F. Macagno, *Argumentation Schemes*, Cambridge University Press, Cambridge, 2008.