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Kamila Dębowska
Adam Mickiewicz University

Paweł Łoziński
Warsaw University of Technology

Chris Reed
University of Dundee

BUILDING BRIDGES BETWEEN EVERYDAY ARGUMENT AND FORMAL REPRESENTATIONS OF REASONING

Abstract: Argumentation theory, as a subdiscipline of philosophy, concentrates on the human expression of reasoning. It is an ancient area of research which has been enjoying a renaissance over the past thirty years or so with the development of two distinct theoretical branches: informal logic and pragma-dialectics. Both of these areas have influenced the development of mathematical and computational models of arguments that since the mid 90's has seen an explosion in research interest and output: with the area currently supporting two annual workshop series, a biennial conference series, a slew of journal special issues and, from 2010, its own dedicated journal. The links between the philosophical and formal ends of argumentation research, however, have been relatively sparse and ad hoc. This paper aims to build a bridge between the two areas that supports a more rigorous and extensive exchange of ideas and results to the benefit of both fields.

Keywords: argumentation theory, complex real-world argumentation, pragma-dialectics, informal logic, computer science, knowledge representation, argumentation strategy, computational models of argument, Araucaria, Arguing Agents Competition, Argument Interchange Format, argument diagramming

1. Introduction

The aim of this paper is to explore the links between, on the one hand, the philosophical and linguistic study of human reasoning and argumentation expressed in language, and on the other, the formal, logical and mathematical accounts of argument structures. Of course, this is not the first time that this has been attempted. The FAPR conferences from the late 1990's (Gabbay et al. 1996) and the Symposium on Argument and Computation in 2000 (Reed and Norman 2003) both took important steps in

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a similar direction. But since then, there has been an enormous increase in the volume of research in what might broadly be termed Artificial Intelligence models of argument. Popular graph theoretic accounts of the semantics of argument (Dung 1995), coupled with accounts of presumptive reasoning schemes (Walton et al. 2008) have aided the development of an increasing number of software tools (Kirschner et al. 2003) which have in turn allowed a rapid ramp-up in empirical work (Reed 2005) that has fed back into both philosophical and computational research in argument (Moens et al. 2007). And so this 'virtuous circle' has, over the past decade or so, produced a broad and extremely active community examining argumentation from a variety of perspectives (for a recent example, see the special issue of the eponymous *Artificial Intelligence* dedicated to the topic (Bench-Capon and Dunne 2007). As well as summarising some of the key landmarks on this newly emerging research landscape, this paper aims specifically to build a bridge between recent developments in the more computational and more philosophical approaches. The frontier coastlines of these two research landscapes are rugged and irregular, and there are many points at which one might attempt such bridge building. We select as our isthmus here the issue of argument diagramming. From a formal and computational point of view, in order to represent the structure of argument, one needs a clear semantics, a language and a set of clear definitions, and, ultimately, an engineered implementation (or several, in fact). From a philosophical point of view, analysis of argument structure touches most closely upon metaphysics, epistemology, and the philosophies of mind and language. Diagramming arguments is, of itself, of relatively little interest to philosophers (though see, e.g. Rowe et al. 2006) for one of a number of exceptions), and, similarly is of itself, not key to mathematical or computational models (though again there are exceptions such as those described in Tillers et al. 2007). What is important for our purposes is that both communities can see *some* value in the enterprise, and can work with the models that are expressed diagrammatically. After all, the bridge needs to be built before we can expect communities to start making the trek from one side to the other.

By building our bridge, we hope to be able to contribute to translating some of the problems from the two communities, to providing a common vocabulary and to sharing results and resources effectively.

We will start our discussion in section 2 from the presentation of the development of two distinct theoretical branches: informal logic and pragma-dialectics. It will be shown that the philosophical dimension of the two approaches is accompanied by linguistic and cognitive aspects of expression

of human reasoning. In section 3, a foundation for one of the supports of our bridge between philosophical and computational approaches – the Araucaria diagramming programme – will be introduced. The description of Araucaria will be followed by a detailed discussion on the relation between Araucaria, pragma-dialectics and complex real-world argumentation in section 4. In section 5, the focus will be on a number of computational models of argumentation and their relevance to the study of complex real-world argumentation. The problem of evaluation of these models will be addressed with the focus on dedicated computer systems. One example, the Arguing Agents Competition (AAC) will be presented and discussed. Attention will be drawn to the Argument Interchange Format (AIF) – a common language for existing argumentation formalisms. In section 6, the issue of strategy in dialogue and its representation in pragma-dialectics AND mathematical and computer science will be touched upon. A link between strategic maneuvering of pragma-dialectics and argumentation strategy development in AAC will be shown.

2. Background

Argumentation theory is a broad and ancient discipline within philosophy that covers cognitive and linguistic aspects of the expression of human reasoning, as well as intrinsic properties of such reasoning. Excellent textbook introductions can be found in (Walton 2006) and (van Eemeren et al. 1996). Over the past three decades or so, a number of distinct traditions have emerged from the general pool of research in the field. The first is, 'informal logic', named so as to emphasise a parallel with formal logic but to distinguish the field of study as informal (i.e. natural) reasoning rather than its formal counterpart. The second is 'pragma-dialectics', which, as its name too suggests, has roots in the linguistic tradition of studying pragmatics (i.e. linguistic structure at a level above the semantic relations) and the pre-Fregean philosophical tradition of examining dialectics and dialogue, which has been almost entirely eclipsed by the monological and monolectical accounts provided by twentieth century formal logic.

2.1. Informal Logic

Informal logic is a relatively young discipline. Among works that can be called its foundations the most important are Toulmin (1958), Hastings (1963) and Hamblin (1970). However, the establishment of informal logic as an independent field of scientific research is ascribed to works of Ralph

H. Johnson and J. Anthony Blair in the 1970s. In Johnson and Blair (1977) informal logic is defined as follows:

> Reasoning that doesn't feature certainty (e.g. analogy); it's based on the content of the statements being made.

The above definition is based on negation which doesn't seem to be an accident. Logic understood as a field of study on the nature and forms of human reasoning was founded by philosophers of Ancient Greece. Foundations for this field were laid by Aristotle, who defines reasoning to be the goal of his research (vide Aristotle 2008a, 24a, Aristotle 2008b, 100a), and the introduction of Marciszewski 1987) and pursues this goal starting with the definition of the *syllogism* as a basic structure of reasoning. The first and broadest definition of this term can be found in Aristotle 2008a, 24b and Aristotle 2008b, 100b:

> (...) discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so.

But as Stephen Toulmin points out in (Toulmin 2003), mis-interpretation of Aristotle has led to a narrow conception of human reasoning:

> (...) logicians of the 19-th and 20-th century still focus on infallibility as defining feature of proper reasoning.

The requirement of infallibility leads to the development of standards for judging soundness of reasoning that are independent of the subject of reasoning. This can be easily seen when looking at modern formal logic. The characteristic feature of the basic inference mechanisms (such as *modus ponens*) is their deductiveness and complete field-independence. Inference drawn from true premises is *necessarily* true, no matter what the reasoning is about.

The same way of thinking lies at the bottom of Decartes' idea that in order to gain knowledge we need a scientific method that *ensures* its indisputability (vide Tatarkiewicz 1981, p. 47), Toulmin 2003, pp. 229–230).

As a result of this approach, we see a great dissonance between human reasoning that can be observed in real-life scenarios and the type of reasoning that can be found in books on formal logic, or the type of reasoning that is sometimes referred to as scientific reasoning.

As it is noted in (Walton and Godden 2007), informal logic came to being as a voice of opposition against this way of thinking. It is based on a simple observation that people *can* reason about the world around them without certainty. We have to live with the possibility that our conclusions

(e.g. about politics, economy or matters of everyday life) may be wrong and we can deal with this fact. In order to study the nature of human reasoning we have to reexamine how it is *actually* done without holding to the ideals of certainty and universal, context-independent validity of reasoning.

Presumably, this is why Johnson and Blair found negation the shortest way of defining what informal logic seeks to be.

It should be noted that statistical inference is not considered a sufficient replacement of the deductive. While in statistical reasoning the requirement of certainty is relaxed and replaced with statistical confidence, it is bounded to a very specific type of inference where from a certain portion called a *sample* we infer something about a bigger whole called a *population*. The example of inference from *analogy* given in the above definition of informal logic indicates immediately that this field of study doesn't limit itself to statistical reasoning. Some more examples of inferences that are neither deductive nor statistical, and nevertheless useful, are mentioned in the rest of the article.

2.2. Pragma-dialectics

Pragma-dialectics is an argumentation theory which was originally developed in the Speech Communication Department of the University of Amsterdam[1] in the 1970s. Two scholars initiated the work on the project: Frans van Eemeren and Rob Grootendorst. The Amsterdam school of argumentation integrates dialectical, pragmatic and rhetorical insights in their theory. The dialectical perspective of pragma-dialectical theory is rooted in the Aristotelian conception of dialectical syllogism (1966), Stephen E. Toulmin's (Toulmin et al. 1979) rational model for the analysis of argumentation on the macro-level, formal dialectics of Else M. Barth and Erik C. W. Krabbe (1982). The pragmatic perspective of pragma-dialectical theory pertains to the concept of speech acts introduced by John L. Austin in 1962 and developed in by John R. Searle in 1969 and 1979, the concept of cooperative behaviour introduced by Paul H. Grice in 1975, the concept of logical presumptions introduced by Scott Jacob and Sally Jackson in 1983 and the concept of complex relations between arguments introduced by Robert C. Pinto and J. Anthony Blair in 1989. Two other pragmatic notions are also dealt with in the theory: the notion of implicit meanings considered on the micro-level and the notion of qualifying expressions. No specification of the notions is, however, present in the theory. The rhetorical perspective relates

[1] In the twenty first century the Department of Speech Communication was renamed the Department of Speech Communication, Argumentation Theory, and Rhetoric.

to the Aristotelian rhetoric and Chaim Perelman and Lucie Olbrechts-Tyteca's "new rhetoric" (1969).

As mentioned in the previous section, in the contemporary literature on argumentation, the logical framework for evaluating arguments is often still preferred (cf. Eemeren et al. 1996, Snoeck Henkemans 1997). The logical framework deals, however, only with evidently true premises and logically valid inferences (cf. Copi 1982, Kahane 1973, Scriven 1976). In contrast, pragma-dialectics does not focus on monological reasoning and centres on the notions of 'interaction', 'audience' and 'discourse'.

A school of thought introduced by formal dialecticians inspired van Eemeren and Grootendorst (1984) to construct an ideal model of a critical discussion which is the major constituent of the pragma-dialectical theory. The ideal model of a critical discussion establishes a procedure for resolving differences of opinion by critical testing of standpoints. Despite the fact that the model exists only as a theoretically generated system for ideal resolution of a dispute, van Eemeren and Grootendorst (1984, 1992) believe that it can also be applied as a template for the evaluation of reasonableness of argumentation in naturally occurring discussions with externalised disputes. Therefore, the model performs both heuristic and critical functions. The perception of the model of a critical discussion as a series of guidelines emphasises its heuristic function. The evaluation of argumentative moves in terms of their contribution to the resolution of a dispute pertains to the critical function of the model (cf. van Eemeren and Grootendortst 2004, p. 58f). The critical function of the ideal model does not only reflect Toulmin's concept of critical reasoning, but also "the Socratic ideal of subjecting everything one believes in under a dialectical scrutiny" (van Eemeren and Grootendortst 2004, p. 57).

Pragma-dialectics rests on four meta-theoretical principles: the principle of externalisation, the principle of functionalisation, the principle of socialisation and the principle of dialectification (van Eemeren and Grootendorst 1984, p. 4ff). Viewed from the pragmatic perspective two of the principles appear to be the most valuable, the principle of functionalisation and the principle of socialisation. Van Eemeren et al. (1993, p. 104) maintain that the two principles underline the fact that a dispute is not necessarily about "the truth or justifiability of propositions" as the geometrical tradition of reasoning[2] suggests, but may also be about the propriety of speech acts.

[2] Toulmin (1976) differentiates between three ways of reasoning; anthropological, geometrical, critical. Geometrical philosophers believe that only these claims are valid which are true and that the truth must be based on the inconvertible certainty. Anthropo-

They also account for the fact that not only formal fallacies but above all informal fallacies are considered as deviations from the model of a critical discussion. The principle of functionalisation pertains to two conceptions of argumentation, the conception of argumentation as a product and the conception of argumentation as a process. Following Jacobs and Jackson (1982, p. 205ff), van Eemeren and Grootendorst (1984, 1992) believe that argumentation is a speech event which consists of a series of speech acts. The primary function of justificatory or refutatory potential of speech acts is concerned with convincing an interlocutor of acceptability or unacceptability of a standpoint (cf. van Eemeren and Houtlosser 2004, p. 2). The perception of argumentation as a complex speech act refers thus to the process-oriented approach. Following Fogelin (1978, p. v), pragma-dialecticans believe that only simultaneous perception of argumentation as a product and a process allows for the specification of the conditions which must be fulfilled for speech acts to be conceived as argumentation (cf. van Eemeren and Grootendorst 1984, p. 9).

The principle of socialisation underlines the dialogical dimension of the pragma-dialectical theory. In pragma-dialectics, a dialogue may proceed only if speakers take on commitments in a collaborative way (cf. van Eemeren and Houtlosser 2004, p. 2). Adapting Hamblin's idea of a 'commitment store', pragma-dialecticians believe that speakers anticipate each other's reactions and respond to them making use of each other's commitments. The commitment store is established as the discourse progresses. Commitments are not only created by the expression of a standpoint, but also by agreeing and disagreeing with any speech act expressed by an opponent during a discussion (cf. van Eemeren and Houtlosser 2004, p. 2). The principle of socialisation is thus concerned with the rejection of the terminology of the monologic perspective of argumentation and the introduction of the terminology of the dialogic perspective. Terms derived from logic such as 'conclusion', 'minor premise', 'major premise' are not applied in the description of the pragma-dialectical theory (cf. van Eemeren and Grootendorst 1984, p. 9). Instead, new terms are introduced such as 'expressed opinion', 'speech acts', 'argumentative illocutionary force'. The dialogic perspective of argumentation relates also to the role of a protagonist of an expressed opinion

logical philosophers, on the other hand, believe that reasoning and reasonableness are culture-dependent. According to Perelman and Olbrechts-Tyteca (1969), the anthropological tradition is often associated with epistemological approaches in which the knowledge, values and preferences of the audience are taken into account. Eemeren and Grootendorst (2004, pp. 14–15) add that the position of the anthropological philosophers is described in literature as anthrophologico-relativistic.

and the role of an antagonist of an expressed opinion (cf. van Eemeren et al. 1996, pp. 277, 279). Van Eemeren and Grootendorst maintain (1984, p. 10) that an antagonist must accept the pro-argumentation of a protagonist if the attempt at convincing is to be successful.

One feature that is common to both pragma-dialectics and informal logic, and indeed that characterises large swathes of argumentation theory (particularly in its more empirical guises) is the use of sketches or diagrams to capture analysis and the relations between arguments and parts of arguments. There are several reasons for the popularity of such diagrams. In the first place, it provides a quick route to unearthing difficult problems: enthymemes, the linked/convergent distinction, argument identification, circularity, schemes and fallacies all turn up in diagrammatic analysis, and all represent key challenges for argumentation theorists. In the second place, diagrams are (particularly within communities) quick and convenient ways of expressing problematic cases and challenging examples. To the extent that language of diagrams is shared, they can even become a *lingua franca*. Finally, argumentation theory (and its close stablemate, critical thinking) has a strong pedagogic ideal: normative structures of how one should argue in order to promote rationality, harmony or successful interaction, are not purely philosophical ideals. They can, and should be taught. Diagrams represent a way of engaging students and reducing the intellectual barrier to the subject by providing an intuitive entry point. For all these reasons, argument diagramming is almost ubiquitous through argumentation theory, critical thinking, informal logic and pragma-dialectics.

3. Argument Diagramming in Araucaria

To stay with our metaphor of constructing a bridge between everyday argument and formal structures, let us now introduce a pier; a foundation for one of the supports for our bridge. Given that argument diagramming can represent an intuitive and straightforward technique for getting at a formalised structure from the vagaries of text, diagramming might be expected to play some sort of role. There are a number of software implementations of tools that make argument diagramming easy. The one most closely linked with the theory of argumentation (and the one that provides the widest range of argumentation theoretic concepts with which to work) is *Araucaria* (Reed and Rowe 2004).

The technique of argument diagramming is widely used in informal logic (Hurley 2003), and in the teaching of philosophy and critical thinking

(Harrell 2005). It also has a long history going back at least as far as the start of the nineteenth century (Walton 2006a). It has recently been attracting attention in both decision support and computational linguistics, and there are a wide range of software tools available targeted at different markets (see Kirschner et al. 2003, for a good review). Perhaps surprisingly, most of these tools adopt a similar style of diagramming.

Araucaria (Reed and Rowe 2004) is a freely available, open source software package developed over the last few years at the University of Dundee. (See http://araucaria.computing.dundee.ac.uk/ for downloading instructions.) Araucaria allows the text of an argument to be loaded from a file, and provides numerous tools for marking up this text and producing various types of diagram illustrating the structure of the argument contained in the text. It also provides support for defining and marking up argumentation schemes (Walton 1996).

Araucaria allows the user to select a block of text with the mouse and create a node corresponding to this text which can be inserted into a diagram in the main display area. These nodes can be edited and adorned in various ways to add properties such as a label stating the owner of a given proposition in the argument, symbols on the edges connecting the nodes stating the strength of the inference from support to conclusion, and so on.

Araucaria is amongst a small number of diagramming tools that actively support and encourage the use of widely different styles of analysis. The next three sections briefly review three popular and influential styles (each of which reflects a theoretical architecture for argument understanding).

The most common diagramming technique does not have an official name, so we will refer to it simply as a *standard* diagram. A standard diagram is a tree with the conclusion of the argument as the root node. Some authors draw the root node at the top of the tree, while others invert the tree so that the root node is at the bottom of the diagram. We will use the former convention, although Araucaria allows either type of diagram.

Each node in the diagram can be supported by one or more additional nodes, each of which represents a premise in the argument. Premises can be of two main types: *convergent* or *linked*. A convergent premise stands on its own as support for another node, while a linked premise must link with one or more other premises to form support. As an example, the argument "a cat makes a good pet because it is friendly and it can look after itself" consists of a conclusion ("a cat makes a good pet") supported by two convergent premises ("it is friendly" and "it can look after itself"). Either premise provides support for the conclusion without the other, although the two together form a stronger argument than either on its own. A convergent

premise is drawn as a node with a single arrow leading to the conclusion it supports. See Fig. 1.

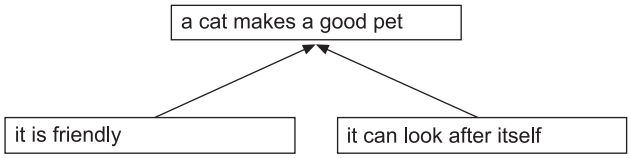

Figure 1. A simple convergent argument in Araucaria

An example of a linked argument would be the following. "Jon understands Newton's laws of motion because Jon got 90% in the first year physics course and the first year physics course covers Newton's laws of motion". Here the conclusion is that "Jon understands Newton's laws of motion" and this is supported by the premises "Jon got 90% in the first year physics course" and "the first year physics course covers Newton's laws of motion". These two premises are linked because neither on its own is sufficient evidence from which to draw the conclusion that Jon understands Newton's laws of motion. Linked premises are shown as connected by a horizontal line which in turn gives rise to a single arrow connecting all linked premises in that group to the conclusion they support. See Fig. 2.

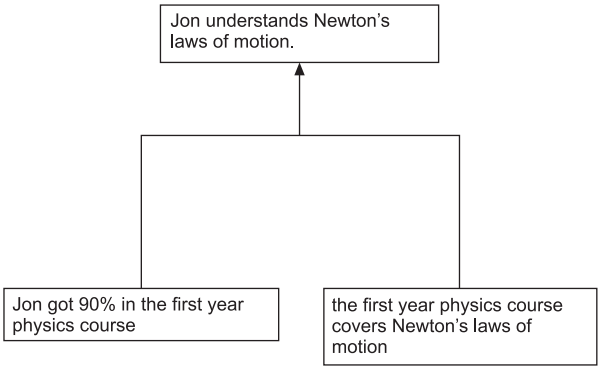

Figure 2. A simple linked argument in Araucaria

Standard diagrams support the notion of a *refutation*, which is an argument that refutes or argues against another node in the diagram. In propositional logic, the notion of refutation is that for a given statement P, there is a statement not-P which is the logical opposite of P. Since each statement can have only one logical opposite, the standard diagram allows only a single refutation for any given node. Of course, in a 'real' argument, there could

be a number of arguments against a given proposition. In the standard diagram, such a situation is represented by creating the single refutation node for the proposition which is to be refuted, and then to draw in the various arguments against the proposition as supports for the refutation. In the example above, the refutation to the conclusion "Jon understands Newton's laws of motion" is "Jon does not understand Newton's laws of motion". This refutation could be supported by the proposition "the first year physics course got a bad review from external assessors" as shown in Fig. 3.

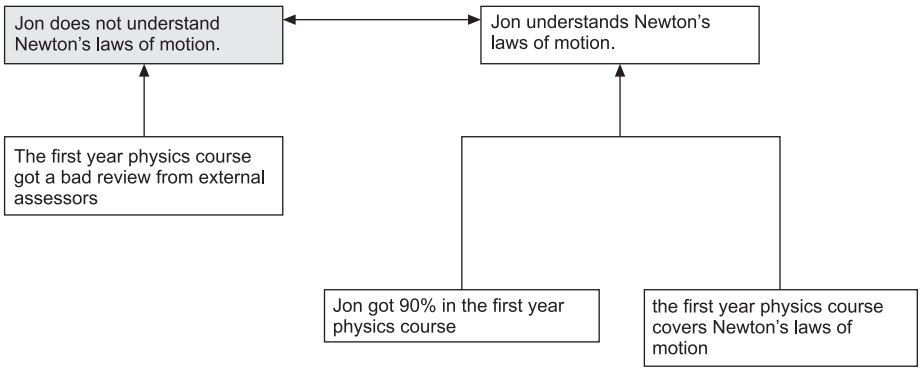

Figure 3. An argument with a refutation

In Araucaria, a refutation is drawn as a node to the left of the proposition it is refuting, and is connected to the proposition by line with arrows on both ends.

In addition to the basic structure of the tree in a standard diagram, Araucaria supports several other features. An argumentation scheme (Walton 1996) is a pattern based on the types of premises used to support the conclusion. For example, the argument "global warming is real and is caused by human activity because a recent UN conference came to this conclusion" is an *argument from expert opinion* because the evidence supporting the conclusion is that a panel of experts says that the conclusion is true. Each argumentation scheme is usually associated with a set of *critical questions* which should be answered in order to verify the validity of the argument. In the case of argument from expert opinion, for example, critical questions could include: "does the presumed expert have experience in an area related to the conclusion?", "is the expert free of bias?" and so on. Numerous other schemes can be defined for arguments of other types.

In Araucaria, a scheme can be drawn by selecting several supports or nodes and then selecting the scheme to which they belong. This is shown in the diagram by a coloured outline of the selected supports and nodes.

Full information on the particular scheme can be obtained by bringing up a dialog box which displays the role of each premise in the scheme and which critical questions have been answered. In addition, Araucaria allows the editing and creation of sets of schemes, so the user can customize existing schemesets or create new ones. The software currently supports approaches to schemes advocated by Walton (1996), Grennan (1997), Perelman and Olbrechts-Tyteca (1969), Katzav and Reed (2004) and Pollock (1995).

In the example above, the refutation and its support could be an example of the scheme "argument from expert opinion", in which a conclusion is stated to be true because experts in the field say it is true. Fig. 4 shows the scheme added to the diagram shown in Fig. 3.

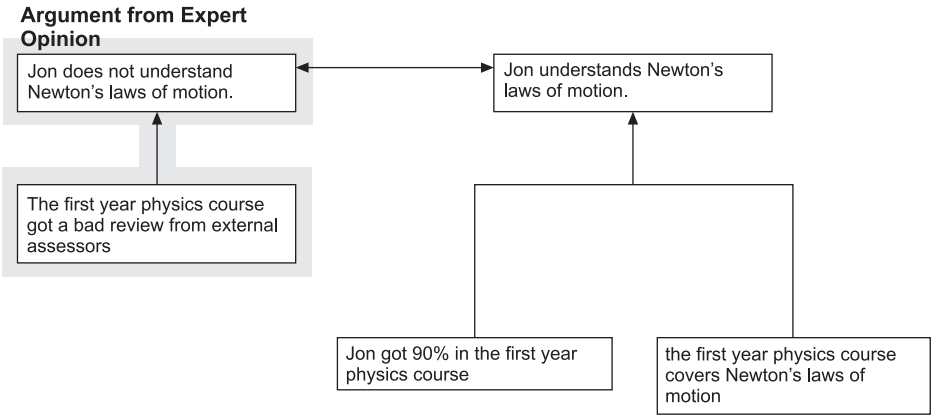

Figure 4. The refutation and its support form an example of the scheme 'argument from expert opinion'

In a natural argument, some propositions will have greater validity or force than others. In a standard diagram, a force can be represented as an *evaluation* of the support line connecting a proposition with its conclusion. Typically an evaluation is just a number such as a percentage value which indicates how strong the inference is between the two nodes. Araucaria allows evaluations to be defined for any support arrow, and evaluations can be any text (not just numbers).

When analyzing text, different propositions can be derived from different sources. For example, in the "cats make good pets" argument above, the various convergent arguments may have been obtained by a primary school teacher asking the class for reasons that cats make good pets, and each convergent argument may come from a different child. In such a case,

a proposition can have an *owner*, which is someone who proposed that argument. Araucaria allows a given proposition to have one or more owners, which can be defined as text strings.

Araucaria allows the saving and export of a marked up argument in the form of a text file using Argument Markup Language, or AML. AML is a form of XML which provides a standard by which argument can be stored and transmitted between software packages. Araucaria also provides an interface with the argument research corpus maintained at the University of Dundee (Katzav et al., 2004), allowing new arguments to be stored in the corpus and providing a search facility for retrieving arguments from the database. AML, however, suffers from a number of limitations, particularly in that it is difficult to share argument resources between the increasing number of tools and systems that are becoming available for processing such resources, including tools for processing the acceptability of sets of arguments based on their interconnections, tools for analysing linguistic coherence of arguments, systems for conducting and generating argument resources using dialogue, and more.

To tackle these challenges, an international consortium has recently produced the Argument Interchange Format (AIF) (Chesñevar et al. 2006). Central to the construction of the AIF is the idea that a single, abstract model of argument should be built, and that this model can be implemented in various ways. What this means is that the abstract model specifies the concepts that the AIF can represent and how these concepts can relate to each other. Once this model has been built, a number of machine-readable reifications of it can be created. In the case of the AIF, the modelling domain is the representation of argument, and the goal is to provide a complete set of concepts that allows all arguments in all argumentation representation systems to be described in a machine-readable way. Once the model has been built, we need to implement it using one or more computer languages. In principle, any computer language could be used, but one of the main purposes of the AIF, as the 'I' in its acronym suggests, is that the *interchange* of arguments should be easy to do. This implies that any implementation of the AIF should be compatible with methods of transmitting data over the web.

XML has been used increasingly often for data transmission over the internet, so a natural medium to use for AIF implementation is some form of XML. XML itself, however, is restricted to data that can be represented in a hierarchical tree structure. Although many arguments can be represented in this way, there are features, such as *divergent arguments*, where one premise can support more than one conclusion, of more gene-

ral arguments that require graphs rather than simpler trees to represent accurately.

For this reason, AIF is usually implemented using some form of Resource Description Framework (RDF), which is a generalization of XML that allows graph-like structures to be represented. In addition, since the specification of an ontology allows relationships between concepts to be defined, it is possible to use reasoners to derive information from the basic RDF representation of an argument. For example, if in a graph of an argument, vertex A supports vertex B, and B supports C, then it can deduced that A also provides support for C, given that the 'supports' relationship is transitive. Various extensions of RDF exist which allow such reasoning to be done. One such extension that is proving increasingly popular is the Web Ontology Language OWL. For examples of RDF and OWL reifications of the AIF, and their use in implemented argument manipulation systems, see (Rahwan et al. 2007).

4. Argument Diagramming and the Pragma-dialectical Model

The discussion in this part of the article will seek to determine whether it is in fact possible to reconcile the idea of understanding complex real world argumentation and formalisation. In other words, the major task here will be to show whether the structure of real-life argumentation may be analysed by the application of formal strategies.

Two formal strategies will be taken into account: the latest version of the argument diagramming programme Araucaria and the pragma-dialectical model. The pragma-dialectical model will serve here as a prototypical structure which has already been proved to be a useful tool for the study of single aspects of complex real world argumentation in dialogical exchanges (van Eemeren et al. 2003a, p. 275ff, 2003b, p. 281ff).

We should note that the analysis of argumentative discourse relates to both written and spoken argumentation viewed as a social practice (see Fairclough 1992, p. 199). Since the pragma-dialectical model is designed to study the real-life argumentative exchanges, its critical evaluation will provide the basis for the assessment of the Araucaria argument diagramming programme in terms of its applicability to the analysis of spoken argumentative discourse.

The pragma-dialectical model is, in comparison to purely logical and dialectical approaches, a substantial advancement in the study of efficacy of argumentation in dialogical exchanges. However, it cannot obtain an al-

together positive evaluation since it appears to neglect aspects of cognitive reinforcement present in natural language understanding process. In the latest approaches to the analysis of spoken discourse (e.g. the post-Gricean approach), attention has been drawn to the fact that pragmatic study of argumentation should rely on the reconstruction of cognitive processes of actual language users (Blakemore 1998, Carston 1993, 1995, 1999, 2002, Recanati 1993, 2006). Viewed from this perspective, pragma-dialectics seems to rest on a narrowed definition of pragmatics. It relates the scope and foci of pragmatics to the inter-play of language structure and the principles of language usage. It does not draw on the significance of the ability of language users to match utterances with the context through the process of inferential understanding.

The reason for the apparent rejection of the concept of contextual inference by pragma-dialecticians relates to its subjective evaluation of meanings in spoken discourse (van Eemeren et al., 1993). It should be noted, however, that, in the natural language study objectivity comes from subjectivity (Walton 2004a). Or in other words, pragmatically developed utterances,[3] local and contextual implicatures emerging from arguments in naturally occurring discussions strengthen the actual objectivity of the discourse analysis (Hobbs 2006, Carston 1998, 2002, Recanati 2002, Jacobs and Jackson 2006). Since they are considered as products of abductive reasoning,[4] they are studied in relation to real or virtual standpoints of disputants which are pragmatically developed (cf. Dębowska 2008a).

As Jackson and Jacobs (2006, see also van Eemeren et al. 1993) emphasise, however, the normative perspective adopted by pragma-dialecticians could be treated as a departure point for the further study of argumentation in non-ideal conditions in which abductive reasoning guides interpretation. The ideal structure appears to have all the aspects needed for the further study of inferential processes. The aspects relate to:

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[3] Pragmatically developed utterances are obtained in the process of reference assignment, disambiguation, saturation and free enrichment, see Carston (2002) and Recanati (2002) for a detailed explanation of these processes.

[4] Abduction is one of the three kinds of reasoning distinguished in contemporary literature on linguistics (cf. Hobbs 2006). The two other kinds of reasoning are induction and deduction. Hobbs (2006, p. 727) states that "In deduction, from P and $P \rightarrow Q$, we conclude Q. In induction, from P and Q, or, more likely, a number of instances of P and Q together with other considerations, we conclude $P \rightarrow Q$." If we can observe Q and we know that $P \rightarrow Q$, then we can abductively conclude that "P must be the underlying reason that Q is true" (Hobbs 2006, p. 727, see also Melrose 1994, pp. 493f). In other words, in abduction P is assumed because it provides explanation for Q.

1. complex argumentation relations
2. refutations/counter-arguments
3. missing premises
4. ownership/the protagonist vs. antagonist division

The first attribute of the inferential modality refers, as mentioned above, to complex argumentation relations. Recanati (2006, p. 450f, see also Jaszczolt 2002, p. 252, Lyons 1987, p. 157) points out that studying the relations between everyday utterances we should not only rely on the semantic representation of linguistically decoded propositions, but also on pragmatically developed propositions and implicatures. Since the process of understanding real-life argumentation is context-dependent, we cannot exclusively focus on the analysis of context-independent semantic representations. In other words, in real-life argumentation the sequential perception of speech acts relates to the consequences of abductive reasoning.

We will attempt to see whether Araucaria is also characterised by the four attributes of inferential modality. The focus will be on the relation between (1) complex argumentation relations (2) refutations/counter-arguments (3) missing premises (4) ownership/the protagonist vs. antagonist division AND pragmatic/abductive features of natural language understanding i.e. (1) sequential perception of pragmatically developed propositions and implicatures, (2) their dynamics and transiency (3) and their mulitidirectionality (see also Walton 1995, Jackson 2007).

The Araucaria diagramming programme allows for the sequential perception of speech acts through the distinction of complex argumentation relations. Thus, using Araucaria, you can provide a diagram of argumentation, in which independent and dependent premises are indicated. As mentioned in section 3, Arauaria provides the templates for the analysis of both convergent arguments considered independently in supporting a conclusion and linked arguments which need to be taken together in supporting a conclusion. Despite the fact that Araucaria does not allow for the indication of implicatures arising from convergent and linked arguments, it can help a teacher to elicit pragmatically developed propositions and contextually appropriate implicatures from students. The externalisation of possible argumentation relations through Araucaria facilitates thus the further actual process of inferential reasoning. Understanding relations created between semantic representations of propositions of arguments, pragmatically developed propositions of argument and implicatures arising from them is thus enhanced by application of the standard 'box-and-arrow' type diagram.

According to pragma-dialecticians (van Eemeren and Grootendorst 1992, p. 73ff, see also Snoeck Henkemans 1997), however, not only conver-

gent relations (known as multiple in pragma-dialectics) and linked relations (known as coordinatively compound argumentation in pragma-dialectics) are to be distinguished in everyday argumentation, but also subordinatively compound relations.

In coordinatively compound argumentation, each argument is believed to support a claim on its own.[5] However, the effective defence of a claim comes into being only when the arguments are considered together. Considered separately, the arguments are not sufficient defence of a claim. In multiple/convergent argumentation, each argument is sufficient defence of a standpoint when considered on its own. In subordinatively compound argumentation, only the first argument supports the claim while the next argument supports the first argument.

Araucaria does not ignore the premises which create subordinatively compound relations. It subsumes coordinatively compound relations and subordinatively compound relations under one heading, namely linked argumentation.

As stressed above, pragma-dialecticians maintain that definitions of interdependency and independency of real-life arguments should not only relate to the monological line of reasoning but also to dialogical one (Snoeck Henkemans 1997, p. 37). They emphasise that from a dialogical perspective complex argumentation comes into being only if two conditions obtain. The first condition refers to a critical reaction of an antagonist to an argument expressed by a protagonist. The second refers to a response of the protagonist to the critical reaction of the antagonist. If the argumentative moves by the proponent of an expressed opinion are to count as subordinatively or coordinatively compound argumentation (linked argumentation), then the response by the protagonist must be an attempt to overcome the criticism by the antagonist. Withdrawing the previous argument by the protagonist and advancing a new argument results in multiple argumentation. Snoeck Henkemans (1997, p. 131) argues also that the protagonist may anticipate the critical reaction of the antagonist. In such a case, the protagonist may introduce a counter-argument against his or her standpoint or argumentation and subsequently refute the counter-argument. In this way, the protagonist shows that his argumentation is defensible.

[5] Pragma-dialecticians indicate that coordinatively compound argumentation is either of a complementary subtype or a cumulative subtype. In the cumulative argumentation, each argument lends some support to the claim, but with each additional argument the support in strengthened. In contrast, in complementary argumentation, arguments complete each other to construct a successful defence of a claim.

According to the pragma-dialectical model, we can distinguish the critical reaction of an antagonist concerned with the acceptability of a pro-argument, the sufficiency of a pro-argument or the relevancy of a pro-argument. Two types of critical reactions of an antagonist may generate subordinatively compound argumentation. If an antagonist challenges an argument expressed by a protagonist because it seems unacceptable to him and the protagonist supports the previously expressed argument, then subordinatively compound argumentation is created between the two arguments expressed by the protagonist (cf. Snoeck Henkemans 1997, p. 92). If an antagonist challenges an argument expressed by a protagonist because it seems irrelevant to a standpoint and the protagonist overcomes the criticism by externalising an unexpressed premise, then also subordinatively compound argumentation is created between the two arguments expressed by the protagonist (cf. Snoeck Henkemans 1997, p. 92). Two types of critical reactions of an antagonist may generate coordinatively compound argumentation in pragma-dialectical terms. An antagonist may either cast doubt on a protagonist's argument or advance a counter-argument against the pro-argument's acceptability, sufficiency or relevancy (cf. Snoeck Henkemans 1997, p. 92). In the first case, the protagonist may overcome the criticism by advancing an additional argument. In the second case, the protagonist may refute the antagonist's counter-argument.

If we take into account the possibility of the indication of ownership in Araucaria, then it appears to offer dialogical diagramming of argumentation. In Araucaria, as mentioned in section 3, the nodes representing premises, refutations and claims can be labelled to specify who expresses them. Thus, in fact, we can ascribe the ownership to a protagonist or an antagonist of a certain claim. Creating the protagonist in linked or convergent argumentation, we can then analyse separately a possible counterargument introduced by the antagonist. The analysis of the counter-argument (or counter-arguments) facilitates further discussion among students in class. They may provide reasons for the particular reaction of the antagonist and then specify types of relations between pro-arguments resulting from the introduction of the counterargument. Moreover, the possibility of ascribing the ownership facilitates drawing out inferences to the best explanation of a claim from the convergent or linked argumentation separated by a critical reaction of an antagonist. Pragmatically developed propositions of linked and convergent pro-argumentation, pragmatically developed propositions of counter-argumentation and implicatures arising from them point to multidirectional perception of meaning.

The last point we are about to consider is concerned with the role of missing premises in Araucaria. As Jacobs and Jackson (2002, p. 121) note, real-life exchanges may involve premises which are implicit or tacit. Such premises, usually called enthymemes, can be inserted in Araucaria diagramming programme.

Discussing enthymemes, pragma-dialecticians refer to the concept of 'pragmatic optimum'. The concept introduced by Eemeren and Grootendorst (1992) allows for the study of implicit meanings in agreement with the goal of resolution of a dispute. Within pragma-dialectical standards of reconstruction, all argumentative moves which do not appear to purse the dialectical goal are rejected from the analysis. Pragma-dialecticians believe, however, that a potentially fallacious move can be saved if the pragmatic optimum externalises the link between the move and a standpoint. The indication of pragmatic optimum relates thus to the determination of pragmatic relevancy of an argument. If an argument does not appears to fulfil the 'logical minimum', then its pragmatic optimum should be ascertained. Both the 'logical minimum' and the 'pragmatic optimum' are concerned with referring an argument expressed by a speaker to the standpoint of the same speaker. The 'logical minimum' has the form of modus ponens "If p, then q", where 'p' refers to an argument advanced by a speaker and 'q' refers to the standpoint of the speaker. The 'logical minimum' is thus an unexpressed premise of an argument which externalises no new information. The generalised form of the logical minimum which refers to closest possible context of the speech act is called the 'pragmatic optimum'. The 'pragmatic optimum' does not ascribe any additional commitments to the speaker than those present in the speech act (cf. van Eemeren and Grootendorst 1992, p. 62ff). In agreement with the critical function of the pragma-dialectical model, the pragmatic optimum of an argument should be determined only if an analysed argument appears to be inappropriate justification of a standpoint.

According pragma-dialectical standards, the 'pragmatic optimum' should be specified in line with the Interaction Principle. The term 'interaction principle', introduced by van Eemeren and Grootendorst (1984, see also van Eemeren and Grootendorst 1992) refers to four principles, namely the principle of clarity, the principle of honesty, the principle of efficiency and the principle of relevance. The 'principle of clarity' determines the propositional content condition and the essential condition for the performance of a complex speech act carrying an argumentative illocutionary force at the higher textual level. The 'principle of honesty' determines the responsibility conditions for the performance of a complex speech act carrying an argumentative illocutionary force at the higher textual level. The 'effi-

ciency principle' determines the preparatory conditions for the performance of a complex speech act carrying an argumentative illocutionary force at the higher textual level. The 'principle of relevance' pertains to the relation between different speech acts in a speech event. Both the relations between speech acts of the same speaker and the relations between speech acts of interlocutors are taken into account. The principle does not, however, determine any speech act condition.[6]

If the determination of the pragmatic optimum does not involve the closest possible context or some additional commitments are ascribed, or the Interaction Principle is not observed, then the argument is not validated. Van Eemeren and Grootendorst (1992, p. 65) provide the following example of the reconstruction of the logical minimum and the pragmatic optimum of argumentation:

> Standpoint: Maggie is progressive.
> Argumentation: Maggie is liberal.
> Logical minimum: [If Maggie is liberal, then Maggie is progressive]
> Pragmatic optimum: [Liberals are progressive]
> (van Eemeren and Grootendorst 1992, p. 65)

The pragmatic optimum "Liberals are progressive" of the argument "Maggie is liberal" is an acceptable defence of the speaker's standpoint "Maggie is progressive" as it complies with the Principle of Clarity, the Principle of Honesty, the Principle of Efficiency, and the Principe of Relevance and no extra commitments are attributed to the speaker.

The Araucaria diagramming programme allows for the indication of a missing premise in the form of pragmatic optimum. Therefore, it does not concentrate on the fixed meaning of logical minimum but allows for a more dynamic and transient perception of meaning. The use of Araucaria facilitates the discussion on the significance of emergent meanings in externalisation of the relations between missing premises and evaluation of the reasonableness of complex argumentation. The non-monotonic nature of inferences is thus taken into account. Certain argumentative moves may carry the potential to misdirect, suppress or fabricate and may not appear to support a claim when analysed by the application of a standard box and arrow approach in Araucaria. Still, they may turn out to be reasonable when the missing premise is linked to other arguments through emergent meanings

[6] See van Eemeren and Grootendorst (1992, p. 31) for a detailed description of the felicity conditions of a complex speech act carrying an argumentative illocutionary force at the higher textual level.

such as the pragmatically developed propositions and implicatures which ascribe additional commitments to the speaker.

The discussed points clearly indicate that Araucaria proposes a construction of a network of features needed for the comprehension of real-life argumentation. It points to the interdependence of the creation of complex argumentation relations, the introduction of counterarguments, the ascription of protagonist and antagonist roles and the externalisation of missing premises. This interdependence underlines the process of natural argumentation occurrence in dialogical circumstances.

5. Argument Representations and Computer Science

As discussed in earlier sections, representing real world argumentation is a very difficult problem. This is in large part due to lack of a single, easily extractable formal structure that every argument would reveal. Research in fields that somehow overlap with argumentation theory (e.g. philosophy, logic and law) gave birth to a number of formalisms that try to capture the structure of arguments and the rules governing dialogues in which arguments are exchanged.

5.1. Argumentation Frameworks

One of the approaches to formalisation of argument's inner structure (found e.g. in Vreeswijk 1997 and Prakken 2005) is a definition which, with accuracy to vocabulary, states that arguments are structures of the form $p_1, \ldots, p_n \rightsquigarrow c$, where $p_1, \ldots, p_n \in L$ are propositions called *premises* and $c \in L$ is a proposition called *conclusion*. The jagged arrow $\rightsquigarrow$ indicates that the inferences are in general defeasible. L is most generally a set of propositions that constitutes the language in which subject of argumentation can be expressed.

This definition can be extended in order to distinguish between various types of inferences: $p_1, \ldots, p_n \rightsquigarrow_{ai} c$, where $\{\rightsquigarrow_{a1}, \ldots, \rightsquigarrow_{am}\}$ is a set of legal inferences (they correspond to *argumentation schemes* in argumentation theory). But even this broad definition can be deemed insufficient. Some formalizations (e.g. Gordon and Walton 2006) define alongside arguments *for* proposition c arguments *against* c, which are not captured by the above definition. There are approaches to modeling a counter-argument against c as an argument for $\neg c$ or as an argument pro some proposition s which is asserted to be in conflict with c. It is not obvious whether all these approaches are interchangeable.

With a specified definition of argument we are able to make the next step in formalizing monologic argumentation which is to define how arguments relate to each other. Definition of this relation, arguably with the definition of an argument itself, form what is referred to as an *argumentation framework* or *argumentation system*. There exist a number of various argumentation frameworks, out of which the simplest and most popular in common literature is Dung's Argumentation Framework defined in (Dung, 1995) as a pair (A, *attacks*) where A is a set of arguments and $attacks \subseteq A \times A$ is an attack relation. This approach abstracts from the inner structure of arguments.

A more elaborate, yet still very abstract formalism can be found in Vreeswijk (1997) where we find a set L called a language and two types of inference rules: *defeasible* and *strict* which can link elements of L into tree-like structures. A formal system based on the more conventional conception of argument is Carneades Argumentation Framework defined in Gordon and Walton (2006), which sees argument as a kind of conditional linking of a set of premises to a conclusion. It is also the first formal argumentation framework which takes into account, in a nontrivial way, the concept of argument's *context*.

5.2. Bringing Theories Together

Informal logic has produced a number of models of monologic and dialogic argument. This naturally produces the need to evaluate and compare these models. The most important question is of course: how good are those models in expressing natural argumentation? More specifically, it is important to determine whether specific models are able to express every possible form of natural argumentation and if not, what sets of monologic/dialogic arguments are left out. It is then interesting to explore the relation between expressiveness of different models and their suitability for further research on argumentation, e.g. development of measures for *persuasiveness* in dialogues (Amgoud and Dupin de Saint Cyr 2008). In order for this evaluation research to yield significant results, it has to be based on large scale argumentation data. The problem of acquisition and processing of this data implies the application of dedicated computer systems, and with a plethora of such systems becoming available, the key challenge is interchange between them. This is the job tackled by the newly proposed Argument Interchange Format (Chesñevar et al. 2006). The AIF is essentially an ontology (McGuinness and van Harmelen 2008) which can be instantiated in various ways in order to represent specific models of monologic argument. On its own this is not enough to cover areas of argumentation theory, such as pragma-dia-

lectics, that have a strong dialogical component. Various authors including Modgil and McGinnis (2007) and Reed et al. (2008) introduce extensions to the AIF intended to cater for dialogic argumentation.

5.3. Argument Interchange Is Knowledge Representation

Any nontrivial information system needs to have a method of representing knowledge about the domain it is designed to process. Such a method, in order to serve its purpose needs to satisfy certain conditions. As stated in (Baader 1999) such a formalism should first of all allow for the symbolic representation of all the knowledge relevant in a given application domain. Moreover, it should satisfy the following requirements:

- it must be equipped with a *declarative semantics* – the meaning of the entries in a knowledge base must be defined independently of the programs that operate upon it;
- a notion of "truth" must be defined;
- there must be an *"intelligent" retrieval mechanism*, which allows inference of knowledge not explicitly present in the knowledge base.

Additionally, knowledge representation formalisms are usually required to allow for *structured representation* of the knowledge.

Knowledge Representation methods, especially logic-based KR methods like first-order predicate logic or Description Logic generally comprise of two elements: a way of describing fact-graphic knowledge (i.e. *knowledge base*) and a generic (fact-independent) inference mechanism (*knowledge query mechanism*) that allows to draw conclusions from gathered facts. To give an example, in the case of Description Logic we have a knowledge base (comprising general TBox statements and specific ABox statements) that can be viewed as a set of facts along with the terminology they are expressed in, and a set of standard inference mechanisms: satisfiability, subsumption, etc.

Argument representation provides an interesting version of this approach. Regarding the fact that an atomic argument contains a set of premises and a conclusion which are propositions, we see that any argument representation that takes into account arguments' inner structure is built upon a propositional knowledge base. But the formalism doesn't stop here and provides a neat and intuitive way of representing the atomic inferences that can be made between propositions from this knowledge base. This means that formal argument representation has the ability of modeling one of the key features of informal logic: inference that is dependent on the subject of reasoning. To cite Johnson and Blair (1977) again: formal argument representation models inferences "based on the content of the statements being made".

To have a formalism that truly is an alternative to standard knowledge representation methods we need what Baader calls an "intelligent" retrieval mechanism which would allow inference of knowledge not explicitly represented in the knowledge base by propositions or arguments. This is the role of formal strategic argumentation. We can say that a proposition not explicitly present in the knowledge base is true/false if one can successfully argue for/against it.

Given this interpretation, we can say that formal argument representation *is* a knowledge representation method. Moreover, it is a KR method of great potential as it overcomes the main limitation of formal reasoning pointed out in Toulmin (2003), namely, being detached from the domain of discourse it takes place in. The AIF can thus serve as a contextualised knowledge representation format that works particularly well for information that is in conflict and that is relativised to particular agents.

5.4. Putting Argument Interchange to Work: The Arguing Agents Competition

There is an increasing need for development of a platform which would allow for massive evaluation of various argumentation models against different argumentation scenarios within a single environment. This would also give a solid base for research on automated argumentation strategies. Following successful initiatives within multi-agent systems, the international community has posited a competitive platform for this environment: the *Arguing Agents Competition* (AAC) project described in Yuan et al. (2008) and Wells et al. (2008). AAC is a competitive environment in which heterogeneous agents argue against one another according to the rules of one of a number of dialogue games, and with a specific set of argumentation resources available. The project aims at providing a multi-agent platform which would allow specification of dialogue games based on different argumentation models and provide an easy way of developing agents which could compete in those games. Statistical data collected as a result of such competitions would be an invaluable resource in research on both argument representation and automated argumentation strategies.

The project is challenging, especially looking from the information systems design perspective. In order to create an environment in which heterogeneous agents (e.g. implemented using various agent definition frameworks) could have free access to various argumentation competitions the system must be distributed, i.e. it must allow participants of a competition to execute on different machines (preferably around the world). The system also needs to implement a way of distributing argumentation in-

formation between participants and enforcing rules of a given dialogue game on them.

An initial server side component, called *Argumento* developed at the University of Akureyri in Iceland has been repurposed to provide an prototype back-end for AAC, which has been integrated with agent based middleware from the University of Dundee (Yuan et al. 2008). This will now be further developed at the Warsaw University of Technology to provide an infrastructure for distributed, competitive play providing:

- management of graphs of arguments which agents use to argue with one another; and
- enforcing rules of the dialogue game by checking the legality of every move being made in a competition.

Teams at IRIT in France, at the Asian Insititute of Technology in Thailand, and at the University of Groningen in the Netherlands are also planning to contribute to the initial stages of work.

Though it is a preliminary step towards creating a fully developed AAC it already reveals a number of interesting information systems design issues. For instance, the assumption is that agents receive all information about the argumentation graph allows them to plan their argumentation strategy very carefully, with respect to all possible consequences of their moves. This approach is often referred to as *closed world assumption* which, generally speaking, means that the system has full knowledge of the world it reasons about. This is of course a good start to work on argumentation strategies, but in case of real-world argumentation domains this can be very resource-consuming and is inefficient, because eventually only a subset of the domain will be used in the dialogue. Additionally, it limits the system's ability to approximate the natural dialogue, because only in fairly simple cases humans are able to grasp and process the whole domain of dispute at once, especially at the beginning of the discussion.

Relaxing the closed world assumption constitutes a key challenge facing AAC. To allow situations where agents have only access to certain argumentation subgraph at any moment of the dialogue makes computation more challenging – and the competition more interesting. Of course, their subgraphs must overlap in order to make any dialogue possible. For example, a referee (e.g. located at the server) could initiate the dialogue by sending each participant a certain subgraph of arguments, and than provide them with more knowledge as needed. The agents could also acquire the knowledge from each other during the course of dialogue.

The function of AAC as a tool for evaluating argumentation strategies gives rise to both computational and argumentation theoretic issues. On the

computational side, the fact that agents participating in a discussion run on different, remote machines makes comparing strategies a complex problem. Obviously, the faster the machine is, the more agentive deliberation can take place in a given amount of time. So from the fact that a certain agent won a dialogue (without specifying what exactly this means) it does not immediately follow that it has a better strategy. Additionally, in a distributed environment it is always difficult to determine how much time was spent on processing of the information and how much on inter-agent communication. On the argumentation theoretic side, we first of all need a definition of what does it mean that an agent *wins* a dialogue, and consequently, what does it mean that a given strategy is *better* than another. The current prototype of AAC implements a very simple rule: "the agent that puts forward an argument that has no attackers wins" but, of course there is more then one answer to this question for any given argumentation model. Retaining flexibility in defining the evaluation criteria would allow to use AAC for verification of the criteria themselves (e.g. using "benchmark" manually analysed dialogues).

The Arguing Agents Competition is primarily a project of creating a platform for evaluation of various argumentation theoretical concepts and algorithms ranging from formal argumentation models to dialogue strategies which will be tackled with more detail in the following section. Though challenging in its design, such a platform could form an important tool in advancing the state of the art in the understanding of argumentation theory in both computational and philosophical guises.

6. Strategy in dialogue

To demonstrate how argument diagramming and argument representation in particular might be used to create a bridge we sketch a specific application that is a current 'hot-topic' for both philosophers and computer scientists. The issue is strategy. Where much argumentation theory, both philosophically and computationally, has focused on normative models that describe what is argumentative moves are permitted, there is an additional step that is much less well understood: determining what argumentative moves are good or effective. This is the topic of argument strategy, and although it has some parallels in formal logic (e.g. in proof strategy) it is a relatively new idea in both communities. In argumentation theory, it is the pragma-dialecticians who have the most developed theoretical components in their account of strategic manoeuvring. In mathematical and computer

science, it is in multi-agent systems and distributed computing that strategic considerations come first to the fore.

Pragma-dialecticians assume that in each stage of a critical discussion – confrontation, opening, argumentation and conclusion – disputants simultaneously pursue the rhetorical aim of making a strongest case and the dialectical aim of resolution of a difference of opinion. The concept of 'strategic manoeuvring' was introduced by van Eemeren and Houlosser (2002a, 2002b) to talk about the employment of reasonable argumentation in a critical discussion by maintaining a balance between the simultaneous pursuit of the dialectical and rhetorical aim. It is assumed, however, that the rhetorical and dialectical objective will not always be balanced. If a dialectical objective is overruled by a rhetorical objective, then the derailment of strategic manoeuvring is said to occur (cf. van Eemeren and Houtlosser 2003a, pp. 290, 291). Van Eemeren and Houtlosser (2002b, p. 142) maintain that "all derailments of strategic manoeuvring are fallacious and all fallacies can be regarded as derailments of strategic manoeuvring." Since every violation of a rule of a critical discussion[7] points to an evidently rhetorical nature of an argument, it is considered a 'derailment of strategic manoeuvring'.

Van Eemeren and Houtlosser (2007) adopt the idea to integrate the rhetorical and dialectical perspective from Johnstone's (1978) idea of philosophical argumentation. Johnstone (1978, p. 92) believes that a philosophical argument is to a large extent rhetorical, but the "final account of philosophical argumentation will have to be given by a philosophy which endorses dialectics." Van Eemeren and Houtlosser (2007) indicate, however, that in pragma-dialectics the rhetorical perspective is included into the dialectical one, not vice versa.

Let us now focus on the inclusion of rhetorical perspective in each of the stages. In the confrontation stage of an ideal model of a critical discussion, the main objective of the parties is the determination of a disagreement space. From the rhetorical perspective, each party aims at the most beneficial framing of the disagreement for him or her. This means that in a mixed discussion speakers try to express their standpoints in the way which allow them to discuss the aspects of an issue they favour. Rhetorical part of strategic manoeuvring focuses thus on "acquiring the most expedient burden of proof" (van Eemeren and Houlosser 2002a, p. 22). In the opening stage, the

[7] See van Eemeren and Grootendorst (1992, p. 208f) for the description of the pragma-dialectical rules for rational conduct, known also as 'Ten Commandments' of a critical discussion.

rhetorical objective of the parties is the determination of starting points[8] and discussion roles. This influences the possibility of discharging the burden of proof in the argumentation stage. While deciding on the common starting points in the opening stage each party tries to reject those propositions which could discard his or her standpoint. The determination of the mutual concessions influences the allocation of the discussion roles. Both the challenge expressed by one of the speakers and acceptance of the challenge by the other speaker is framed in a way that not only upholds the commitment incurred by the expression of a standpoint but also predicts 'the argumentative duties' of each speaker (cf. van Eemeren and Houlosser 2002a, p. 23). In the argumentation stage, the rhetorical objective is concerned with advancing effective argumentation. Each party tries to win the argument by "making the strongest case and launching the most effective attack" (cf. van Eemeren and Houlosser 2002b, p. 139). In the concluding stage, the rhetorical objective refers to making a claim that a party has won a victory in the discussion. Thus, in a non-mixed discussion a protagonist may underline in what ways he has satisfactorily dealt with a burden of proof acquired in the confrontation stage. An antagonist, on the other hand, may indicate all propositions he challenged in the course of the discussion (cf. van Eemeren and Houlosser 2002a, p. 25). Van Eemeren and Houtlosser (2002a, 2002b) note that the introduction of the concept of 'strategic manoeuvring' in the model of a critical discussion emphasises the fact that the dialectical objective of resolution of a dispute is never to be overruled by a rhetorical objective characterising a particular stage.

In pragma-dialectics, the concept of 'strategic manoeuvring' is also related to the concepts of 'topical potential', 'audience demand' and 'presentational devices' (cf. van Eemeren and Houtlosser 2002a, p. 16). Van Eemeren and Houtlosser (2002b) state that the focus on topos is derived from Aristotle ([1959], [1966]). In the case of pragma-dialectical approach, the term pertains to the restriction of a disagreement space in the confrontation stage and to the creation of starting points in the opening stage (cf. van Eemeren and Houtlosser 2002b, pp. 139, 140). Both disagreement space and starting points are to be based on the same topos. The term 'au-

[8] The pragma-dialectics differentiates between two kinds of starting points, namely, the 'procedural starting points' and the 'material starting points'. The 'procedural starting points' refer to propositions describing the rules for rational conduct. The 'material starting points' refer to propositions describing the aspects of an issue under discussion on which disputants agree. Van Eemeren and Houtlosser (2004a, p. 12, 2005, p. 351) emphasise that in an ordinary discussion starting points may be "temporary or locally distributed" and are not neccesserily expressed in the opening stage.

dience demand', as van Eemeren and Houtlosser (2002b) indicate, refers to Perelman and Olbrechts-Tyteca's (1969) idea of particular and universal audience. Van Eemeren and Houtlosser (2002b) note, however, that Perelman and Olbrechts-Tyteca's idea of the stimulation of the immediate adherence of the mind of the audience should be integrated with the idea of the objective consideration of an issue. Special attention is drawn to Perelman and Olbrechts-Tyteca's idea of 'preferable objects of agreement', i.e., values and hierarchies. In the ideal model of a critical discussion, the creation of starting points in the opening stage is assumed to be based on shared values and hierarchies. The meaning of the pragma-dialectical term 'presentational devices' is derived, as Eemeren and Houtlosser (2002b) point out, from Aristotle's and Perelman and Olbrechts-Tyteca's definitions of rhetorical figures. In pragma-dialectics, the main focus is on the application of the figure of conciliatio (cf. van Eemeren and Houtlosser 2002b, p. 141). The figure of conciliatio refers to the presentation of a possible argument of an antagonist by a protagonist to support protagonist's own standpoint. Describing the application of the figure of conciliatio in a critical discussion, Eemeren and Houtlosser (2002b) develop the pragma-dialectical idea introduced by Snoeck Henkemans (1997) that a counter-argument expressed by a disputant may strengthen his pro-argumentation. Only in the case where a protagonist provides direct support for the use of an antagonist's argument is the strategic manoeuvring in the form of conciliatio perfectly balanced. The protagonist of a standpoint should foresee that the acceptance of the justificatory potential will not be automatic and should explain why the application of the antagonist's argumentation justifies his position.

As indicated above, pragma-dialectical concept of strategic manoeuvring in the argumentation stage pertains to the retention of the balance between the dialectical goal of resolution of a dispute and the dialectical goal of launching the most effective attack. Following Walton (1995, see also Walton and Godden 2005, Walton 2006), however, we believe that the concept of strategic manoeuvring in the argumentation stage should take into account potential plurality of rhetorical and dialectical aims. Walton (1995, 2006, 2007) constructs ideal structures for the study of other rhetorical and dialectical goals than the ones specified in the ideal model of a critical discussion, namely persuasion dialogue, examination dialogue, explanation dialogue and clarification dialogue. In this way, he gives priority to the 'educational value' of a dialogue which relates to constructive handling of an issue from different angles, i.e., taking into account different potential goals of participants in a discussion. It should be noted that the persuasion dialogue emphasises also that if in a mixed discussions the rhetorical aim of launching

the most effective attack overrides the dialectical aim of the resolution of a difference of opinion, then a derailment of strategic manoeuvring does not necessarily occur. Launching the most effective attack may not take into account resolution of a dispute. It may, however, be exercised, as Walton (1995, see also Walton and Godden 2005, p. 273ff) emphasises, to increase an insight into a speaker's own and the other party's position. A clarification dialogue provides a framework for the analysis of requests for clarification expressed by one party and subsequent clarifications expressed by the other party (Walton 2007a, p. 127ff). The global goal in the model of a clarification dialogue is partly concerned with the second goal of an examination dialogue. The model of the examination dialogue (Walton 2006) focuses on the exegetical function of a dialogue. Two goals are established in the examination dialogue by Walton (2006b, p. 772): the 'goal of the extraction of information' and the 'goal of the testing of reliability of this information'. It is assumed that in the ideal model of an examination dialogue shifts from 'an argument mode' to a 'clarifiaction mode' may frequently occur in contributions of both speakers. The Waltonian model of an explanation dialogue also partly pertains to the second goal of an examination dialogue. Both explanation dialogue and clarification dialogue may be embedded in the template of the persuasion dialogue (Walton 2006, 2007a, 2007b). However, Walton (2007a, p. 148) emphasises that the speech acts of explanation and clarification have separate felicity conditions. In the clarification dialogue, "the global communal goal of solving a problem caused by ambiguity, obscurity of expression, or some other difficulty that prevents a discussion for moving forward" (2007a, p. 127) is pursued. On the other hand, in the explanation dialogue, the central speech act of explanation pertains to clearing up more complex problems in which 'facts currently known' deny the occurrence of a certain phenomenon (2007a, p. 147). Although all the ideal models of dialogues are designed for the analysis of naturally occurring discussions with externalised disputes, only the Waltonian persuasion dialogue is characterised by the features of an examination dialogue and a critical discussion and thus appears to be the adequate direction for the extension of the pragma-dialectical concept of startegic manovering. The extension would, however, have to involve the determination of special parameters for the specification of the possible relations between the goals. It would have to be indicated step by step which relations between the actual and potential plural goals point to the expression of effective argumentative moves which are non-fallacious. The pragma-dialectical conception of strategic manovering is thus a good starting point for further theoretical and empirical considerations.

Where pragma-dialectics has focused from its outset upon situated, dialogic interaction, many formal and computational models are still tied to the monlogical safety that is familiar from predicate calculus. The next step that is to be made in order to make a connection between argument representation and computer science involves development of formal representations of dialogues that would capture the mechanics of argumentation that occurs between two or more participants.

These formalisms generally base on a concept of *dialogic game* which is known from the studies on *dialogue logic* initiated by Paul Lorenzen. In Lorenzen's dialogue logic *truthfulness* of a proposition t is defined as existence of a winning strategy for t in a dialogic game with t at stake. The game typically can be described as a finite, opened, two-party and zero-sum. The player that starts the game by stating t is called a *proponent* and the player who disagrees with t is called *opponent*. The idea is that with appropriately constructed game rules, the exchange of arguments between players will lead to the winning of one of them and thus prove t or $\neg t$. For a more detailed description of dialogue logic we refer the reader to Lorenz (1987).

A number of formal dialogue games with different properties and different level of formalization have already been specified, e.g. the game of Hamblin (1970) or *Permissive/Rigorous Persuasion Dialogues* defined in Walton and Krabbe (1995). For a detailed analysis of the subject the reader is referred to:

- (Prakken 2005) where a very precisely defined *dialogue framework* for specifying different formal dialogue games is introduced; and to
- (Wells 2006) which features a complete survey of existing dialogue games and introduces a generic format for their representation called *A4A*.

Research on dialogue strategies that could be implemented in autonomous or semi-autonomous agents is still in its infancy. This might be surprising, because strategy is one of a few most vital subjects in argumentation theory and its applications. For example, as was indicated in section 5, we cannot speak about an argumentation-based method for knowledge representation until we have a successful strategy that would allow us to determine through dialogue whether a given proposition is true with respect to knowledge gathered in the information system. Of course, there is a good reason for this being so: to recall our leading metaphor, the bridge between everyday argumentation (where dialogue strategy occurs, and can be studied) and formal representations of reasoning (where until now the focus has been primarily on monological reasoning) is not there yet. Only relatively recently have a number of formal representations of argumentation been developed and

what still makes research on strategic argumentation difficult is the lack of tools for their dynamic use.

The Arguing Agents Competition seeks to overcome these difficulties by providing argumentation strategy researchers with a catalogue of implemented dialogue games to choose from, whether it will be Walton and Krabbe's (1995) Rigorous Persuasion Dialogue, Bench-Capon's (1998) Toulmin Dialogue Game, etc. Such platform allows the researchers to focus solely on implementing arguing agents that, according to various criteria, evaluate and choose moves to make in a dialogue, which is the essence of argumentation strategy. The platform also provides a way of evaluating created strategies by maintaining an environment in which strategies can be played in different games with any competitor around the world and by allowing different criteria of evaluation. Finally, acquisition of information from occurring competitions allows for creating a corpus of dialogues which can that be used as empirical data for further research.

If an argument diagramming tool like Araucaria can be called a pier of our bridge, the Arguing Agents Competition seeks to be a span. There is, as yet, no implemented link between strategic manoeuvring and strategy in AAC. But the bridge we are trying to build here shows how it can be done. By analysing argumentation according to the pragma-dialectical model using Araucaria, we can represent the underlying structure using AIF. The strategic manoeuvring of the interlocutors can be marked up similarly (though we may need to extend AIF to allow this, in much the same way that AIF+ extends AIF to handle dialogue). With an explicit representation of what strategic developments have occurred there are two possibilities. First, those specific representations can themselves be used by autonomous reasoning components that can take the same strategic decisions under identical conditions. This is a direct analog to the computational autonomous re-use of analysed human argumentation explored in (Reed and Walton 2005). Second, those specific representations can be used as the basis for generalisation, in the same way that machine learning techniques are being used on analysed human argumentation to try to derive generalisations about clue word use (Moens et al. 2007). These generalisations about strategy use can be represented in the same way as protocols are represented currently in A4A. The A4A framework allows such representations to be operationalised automatically, so that agents playing the Arguing Agents Competition could directly employ those strategic rules in determining what moves to play. In this way, the theoretical advances in understanding strategic maneouvring in human argumentation can be translated directly into operationalisable programs for autonomous computational systems.

7. Bridging the gap: concluding remarks

The gap between natural argumentative text and formal, machine processable argument structures is wide and challenging. By simultaneously harmonising the concepts and vocabulary, and building practical tools that are specifically designed to be usable by those on either side, we can start to construct a bridge. We have shown how one part of the construction, argument diagramming, can work to solve problems in both domains, and most excitingly, can allow solutions in one to contribute towards solutions in the other. By making use of a common argument representation language, the Argument Interchange Format, we can support the transport of linguistic resources into formal and computational data structures upon which reasoning can be conducted, or autonomous agent behaviour can be configured. With this generic bridge in place, specific issues, such as the hot-topic of strategic argumentation can then be tackled. Though some pieces of the puzzle remain to be worked out (such as how strategic detail is represented in the AIF), the broad shape of the solution becomes clear, and a part of the research programme is mapped out.

As the movement in both formal and informal; philosophical and computational communities of argumentation theory continues to increase in size and pace, these bridges will become vital in supporting rapid uptake, application and testing of new results. And as we have shown, they are already starting to support fruitful exchanges.

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Kamila Dębowska
School of English
Adam Mickiewicz University
Al. Niepodległości 4
61-874 Poznań, Poland
kamila@ifa.amu.edu.pl

Paweł Łoziński
Institute of Computer Science
Faculty of Electronics and Information Technology
Warsaw University of Technology
Nowowiejska 15/19
00-665 Warsaw, Poland
plozinsk@ii.pw.edu.pl

Chris Reed
School of Computing
University of Dundee
Dundee DD1 4HN
Scotland UK
chris@computing.dundee.ac.uk