Reply

Considering Carneades as a Framework for Informal Logic: A Reply to Walton and Gordon

MARCIN SELINGER

Department of Logic and Methodology of Sciences
University of Wrocław
ul. Koszarowa 3/20
51-149 Wrocław, Poland
marcisel@uni.wroc.pl

MARCIN KOSZOWY

Department of Logic, Informatics and Philosophy of Science
University of Białystok
Plac Uniwersytecki 1
15-420 Białystok, Poland
koszowy@uwb.edu.pl

Abstract: The paper offers a critical analysis of the research program for formalizing informal logic proposed by Douglas Walton and Thomas Gordon (2015). Since their proposal is based on employing the Carneades Argumentation System (CAS), this paper aims at answering two questions: what are main benefits of applying CAS as means for formalizing informal logic, and what are possible extensions of Walton and Gordon's research program and modifications in employing CAS?

Résumé: Cet article propose une analyse critique du programme de recherche qui vise à formaliser la logique non-formelle proposée par Douglas Walton et Thomas Gordon (2015). Puisque leur proposition est fondée sur l'emploi de Carneades Argumentation System (CAS), cet article a le but de répondre à deux questions: quels sont les principaux avantages de l'application CAS comme un moyen de formaliser la logique non-formelle, et quelles sont des extensions possibles du programme de recherche de Walton et Gordon et des modifications dans l'usage de CAS ?

Keywords: argument evaluation, argument structure, argument weight, Carneades Argumentation System (CAS), conductive argument, informal logic, premise acceptability, proof standards

1. Introduction

The aim of this paper is to analyze and develop the idea that has been put forward by Douglas Walton and Thomas Gordon (2015)[1], who propose to formalize informal logic by means of the Carneades Argumentation System (CAS). Our paper addresses two questions: what are main benefits of applying CAS as means for accomplishing the program of formalizing informal logic (FIL for short), and what are main directions in which Walton and Gordon's proposal can be extended or modified?

FIL is a research program deriving from the discussion on the relationship between formal and informal logic that took place in the 1970s. At the early stage of this discussion the opposition between informal and formal approach to arguments was strongly emphasized (*cf.* Johnson and Blair 1980; 1994; Walton 1989; Johnson 1996; 2009). During the past two decades the research landscape has changed significantly. Recent development of computational models of argument resulted in the need of grasping some features of natural argumentation by means of formal tools (e.g., Rahwan and Simari 2009; Yuan et al. 2011). Thus, informal logic approaches, as Walton's ideas for instance (see Reed and Tindale 2010), begun to have a substantial impact on computational models of argument (see Reed 2010). Basing on these links, one of the crucial research objectives in contemporary argumentation theory is to bridge the gap between formal and informal approaches, what is in line with the idea of linking informal logic with computer science *via* argumentation theory (Johnson 2006, p. 251).

Walton and Gordon claim that CAS is a suitable instrument for accomplishing the FIL program. The label 'Carneades Argumentation System' (or just 'Carneades' which was used primarily) refers both to the software supporting argument evaluation, construction and visualization, and to the underlying formal, computational model (Gordon 2006, 2010). CAS allows us to construct and reconstruct arguments using a rulebase of argumentation schemes, visualize them by means of diagrams, and critically evaluate with support of proof standards (http://carneades.github.io/Carneades/). Since CAS is still being developed, there are some differences among definitions and solutions included in various papers. In order to avoid the need to refer to various stages of CAS development, in this paper we will focus on the description presented in (Walton and Gordon 2015).

[1] (Walton and Gordon 2015) is an extended version of the paper (Walton and Gordon 2013), commented by us in (Koszowy and Selinger 2013).

Our analysis of key elements of Walton and Gordon's project proceeds as follows. We present an overview of the FIL project (Sect. 2), consider its possible extensions (Sect. 3), and indicate and discuss some features of CAS that in our view should be reanalyzed and modified in the future (Sect. 4). Particularly, we suggest developing or modifying the concept of argument graphs, the account of audience, the scale of premise acceptability, the notion of sufficiency, and finally the use of proof standards as tools for evaluating convergent and conductive arguments.

2. An overview of the program of formalizing informal logic

In this section we offer an overview of those elements of the FIL program that are, in our opinion, particularly inspiring for the future development of informal logic.

It is worth noting at first that the very idea of "formalizing informal logic" may seem controversial for both some formal and some informal logicians. On the one hand, for those logicians who claim that logic is distinctively formal and thus the phrase 'informal logic' is a contradiction in terms (see Johnson 1996, p. 10) any project of formalizing informal logic is *ex definitione* impossible. On the other hand, those informal logicians who defend the autonomy of informal logic as a discipline with its unique subject-matter, aims and methods may claim that the FIL project could undermine the autonomy of informal logic. In other words, since the very origins of the Informal Logic Initiative lay in building the contrast between formal and informal approaches to argumentation, as well as between the formalizable and non-formalizable aspects of everyday arguments (*cf.* Johnson 1996; Blair 2009), some informal logicians could pose a question of whether it is at all commendable to build bridges between formal and informal logic. However, this opposition is recently not as sharp as at an early stage of development of the Informal Logic Initiative. Currently, informal logicians rather claim that formal and informal aspects of the study of argumentation have recently come together—also thanks to AI and an increasing overlap between argumentation theory and computer science (see Walton 2008, pp. xii-xiii; Blair 2009, pp. 62-63). According to Walton, the task of formalizing informal logic is justified mainly by the fact that "standardized forms of argument that represent common species of arguments encountered in everyday conversational argumentation need to have a precise, partly formal structure" (Walton 2008, p. xiii).

In the pronounced manifesto, Walton and Gordon start their inquiry by enumerating the most important "requirements something has to meet to be an informal logic" (Walton and Gordon 2015, p. 509). According to these requirements (or postulates), which have been collected from the literature (e.g., Johnson and Blair 1994; Johnson 1996), informal logic has to recognize (1) the linked-convergent distinction, (2) serial and (3) divergent arguments; apply the so-called RSA triangle, i.e., three following postulates of good argument: (4) relevance, (5) premise acceptability and (6) sufficiency; (7) recognize the importance of conductive (i.e., pro-contra) arguments; (8) be capable of analyzing real-life arguments; (9) help in argument construction; and finally (10) grasp the notion of audience, what is an important goal of the study on argumentation from the rhetorical point of view (see Walton and Gordon, 2015, p. 509). The list collected by Walton and Gordon shows that their approach does not reduce the project just to some selected aspects of argumentation, but that the goal is much more comprehensive.

At first glance it seems that some of the listed issues cannot be included into the project simply because it is extremely difficult to describe them in a formal way. For example, we may ask about the scope and limits of the formalization of audiences behavior (see postulate 10). Since formal description of even most basic notions raises many serious difficulties, one may wonder what is the very rationale for such a project. However, such difficulties do not undermine the possibility of formalizing main aspects of informal logic. Hence we should not think of accomplishing the task in terms of a complete success or a complete failure. If such a project is only partially accomplished, then its results can still be valuable, at least because thanks to them some computer systems have a chance to become capable of grasping yet a couple of features of natural language argumentation.

Moreover, Walton and Gordon's model is in line with the claim that formal and pragmatic accounts of arguments are complementary, and not competing. It is also in accordance with Johnson's (1996) suggestion that in order to capture arguments that occur in real-life contexts, argumentation should be conceived as a teleological process. As Johnson states:

> (...) standard definitions of argument are typically structural in character. An argument is seen as a form of discourse/reasoning that exhibits a certain structure; viz., premises leading to a conclusion. And we have seen that this approach tends to omit reference to the purpose

which this structure serves. Most important here is the *telos* of rational persuasion (Johnson 1996, p. 106).

With regard to this crucial postulate of informal logic, one may observe that Walton and Gordon's program takes into account not only the description of the structure of arguments, but also their goal-driven character. Amongst the goals of argumentation that may successfully be grasped by the proposed model there are: making arguments relevant and sufficient, and making the claim acceptable to an audience. Thus, the RSA triangle with audiences underlines, amongst other features, the teleological nature of argumentation.

The CAS software supporting real-life debates opens up the social context of argumentation to informal logic. Thus, the third advantage of the proposed approach may be noticed—Walton and Gordon aim at giving a possibly broad characteristic of social argumentative procedures. Therefore they take into account not only *inferential*, i.e., premise-conclusion structures, but also *dialectical* and *rhetorical* aspects of argumentation. The *dialectical* approach may be seen in including both *pro* and *contra* arguments, as well as undercutting defeaters, and in employing proof standards in evaluation procedures. The *rhetorical* account may in turn be observed in stressing the need of modeling audiences within the CAS framework.

3. Towards extending the program of formalizing informal logic

As we pointed out in Section 2, apart from some difficulties of accomplishing the FIL research program, ten postulates collected by Walton and Gordon may successfully serve as a coherent methodological framework for building a formal model of natural language argumentation. However, in order to reveal some further theoretical needs, in this paper we propose to enrich the general idea of FIL by adding two further goals. Namely, we suggest that informal logic has to be capable of: (11) expressing the attack relation (Section 3.1.) and (12) applying argument mining methods (Section 3.2.).

3.1 The attack relation

Our first proposal of extending the 10-postulate research program is that a satisfactory formalism should enable us to define the attack relation. The attack relation allows us to describe logical interrelations among arguments and to discuss the logical properties of whole sets of arguments, for example with the help of tools offered by abstract argumentation theory (Dung 1995). Thus, the definition of the attack relation constitutes a sort of a link between informal logic and abstract argumentation theory. In the case of CAS, this work has been done by van Gijzel and Prakken (2012), who mapped it to Dung's Abstract Frameworks via ASPIC+. Such a connection allows us to introduce another aspect of the pragmatic context, by virtue of which some properties of arguments should be analyzed in relation to all other arguments that appear in a discourse. Thus, these properties can be relativized to some (structured by the attack relation) sets of arguments that are in game, i.e., that are invented, recognized and used in social (or individual) practice. Such sets could be called 'domains of discourses'. The question of how attacks are used or should be used in a dialogue is already an issue of dialectic.

3.2 Argument mining

The second proposal is related to the essential requirement that informal logic should be capable of analyzing real-life arguments (see the postulate 8 in Sect. 2). In our view, the formal language of the computational system such as CAS requires a sort of link to natural language. It can have a form of an auxiliary theory or method serving to extract formally described argument structures from natural language. When seeking such a method we may turn to the existing tools for argument mining (see Lawrence and Reed 2015). For instance, some of those tools are taken from computational linguistics (see Peldszus and Stede 2014) or from argumentation scheme theory (see Walton 2011; Walton 2014). Thanks to the diversity of communication phenomena that constitute the subject-matter of extracting argument structures by means of argument mining methods, the scope of the FIL research program can be significantly enriched. The main reason in support of this claim is that argument mining techniques can indicate interesting ways of formalizing some argument types, such as for example legal discourse (Sartor et al. 2014), biomedical texts (Green 2014), open online collaboration communities (Bex et al. 2014; Schneider 2014), financial dialogues (Budzynska, Rocci and Yaskorska, 2014), social debates (Budzynska et al. 2014), broadcast debates (Medellin et al. 2014) or policy making (Bench Capon et al. 2015). The need to harmonize formal argumentation structures and computational tools with case-based natural language argumentation, which is the key interest of argument mining projects, has been recently exposed by Walton:

> But what needs to be emphasized is that software for argument evaluation and argument construction assistance needs to be used hand-in-hand with the kind of case-based reasoning of individual texts that is the task of informal logic. The application of computational tools such as argument maps depends on dealing with an argument that has been put forward in natural language, such as a legal argument […] The biggest general problem for the AI and law field is to fit abstract models of legal argumentation, generally formal logical reasoning structures of some kind, to natural language argumentation of the kind found in trials and other legal settings. (Walton 2014, p. 1).

Since approaches to argument mining listed above employ diverse conceptual frameworks, the selection of the most satisfactory method should be justified by the particular proposal of a formalism for informal logic. On the other hand, the FIL research program should not simply ignore important properties of real-life argumentation revealed by some text mining methods.

4. Towards extending some particular CAS features

In this section, we analyze CAS's capability to achieve the goal of the FIL project, and propose some possible future modifications of particular CAS features. First, we discuss the formal representations of argumentation structures (Section 4.1.) and of the audience (Section 4.2) in CAS. We also discuss conductive arguments and the role of dialectics in Walton and Gordon's approach (Section 4.3.). Next, we consider some properties of argument evaluation in CAS, namely the issue of premise acceptability (Section 4.4.) and the issue of argument weights with a particular emphasis on the distinction between convergent and conductive reasoning (Section 4.5.). Finally, we take into account the applicability of proof standards to informal logic (Section 4.6.).

4.1 Argument graphs

Argument graphs are defined, as structures of the form <*S*, *A*, *P*, *C*>, where *S* is a set of statement nodes, *A* is a set of argument nodes, *P* is a set of premise edges, and *C* is a set of conclusion edges (*cf.* Walton and Gordon, 2015, p. 512). The proposed definition aims at describing a number of key features of arguments. This task is commendable, but it results in a very complex argument representation. One may here raise an objection that the proposed structure departs from the everyday, intuitive understanding of argumentation, according to which conclusions and (sets of) premises seem to be rather the nodes, and arguments—relations between them, i.e., the edges. This order is reversed in CAS. The fact that premises and conclusions are the edges of the graph may be seen as particularly surprising. It may be technically justified by the software application, but from the methodological point of view the question arises whether it is possible to propose a simpler model of argument representation that will not lose any crucial structural features of argumentation which are encoded in argument graphs.

An alternative proposal (see Selinger 2014; 2015) is to simply represent argumentation structures as sets of triples of the form <*P*, *c*, *d*>, where *P* is a non-empty[2], finite set of premises, *c* is a conclusion, and *d* is a Boolean value representing the direction of the premises (it is true if they are *pro*, and false if they are *con*). Such triples are called 'arguments' by Gordon and Walton (2006) and 'sequents' by Selinger (2015) (obviously, the triples can be equipped with the fourth parameter *s* denoting the strict/defeasible distinction). Within this model argumentation structures can be regarded as relations between sets of statements and single statements (and Boolean values). The inferential order of statements in (convergent and serial) complex arguments, i.e., in the sets consisting of many compound sequents, is encoded in the form of these sequents-components. Namely, it is reflected by the support relation, defined in the range of each argument, i.e., in the set of all the statements being premises or conclusions of a given argument (see Selinger 2014).

The claim that argument graphs result in a sort of deflation of argumentation structures can be additionally supported by the following observation. In order to distinguish argument nodes from one another, Walton and Gordon assign unique identification numbers to them, which is formally correct, but seems to be a somewhat artificial solution. It also leads to a certain technical complication, since instead of one argument graph we obtain many equivalent graphs differing from each other only in the order of the numbering of nodes. A verification of whether two very complex graphs are equivalent in this sense can be computationally a non-trivial challenge. Obviously, a natural solution here would be to give names to argument nodes basing on the

[2] Walton and Gordon allow arguments to have the empty set of premises, but they do not explain why such a possibility is available in CAS, and what intuitions correspond to it.

information about which statement nodes are connected with them by premise- and conclusion-edges, as it was proposed by Walton and Gordon (2006) in a previous version of CAS. But then the argument nodes, extended to the form <*P*, *c*, *s*, *d*>, already contain all the information that is provided by the rest of the structure, i.e., by the related statement nodes, and by the premise- and conclusion-edges connecting both kinds of nodes (the polarity of premises can be omitted if the considered language contains the negation connective; otherwise, Boolean values representing polarity could be assigned directly to the elements of *P*). Thus, instead of dealing only with statements and relations holding among them, we are compelled to consider the very same statements and relations, and in addition a new level of relations which hold between these statements and original relations.

Since argument graphs are bipartite, the defined structure does not provide edges between nodes of the same kind, particularly between two argument nodes. Thus, the representation of the so-called undercutting defeaters (see Walton and Gordon, 2015, p. 524, Figure 7) does not seem to fit the defined form. Undercutting defeaters are premises that determine some limit of applicability of an inference under consideration. Thus, they are used to attack inferences in arguments, and introducing them is important for the aim of defining the attack relation. In the famous Pollock's example: "This object looks red, thus it is red, unless it is illuminated by the red light" (Pollock 1986) the undercutter is the sentence "This object is illuminated by the red light". Walton and Gordon (2015) interpret undercutting defeaters as meta-arguments with the conclusion saying that the object-argument is not applicable. In order to maintain this interpretation in the manner presented in Figure 7 (Walton and Gordon 2015, p. 524), we should expand the definition of argument graph by admitting edges between argument nodes. Otherwise we can only consider two separate argument graphs, namely the attacked object-argument graph and the attacking meta-argument graph. Moreover, we must realize that the language of our theory will contain elements of metalanguage (e.g., the notion of applicability). Thus, the language of our meta-theory, in which we define evaluation, for instance, will be already a meta-metalanguage. Let us also mention that in former versions of CAS different interpretations of undercutting defeaters where considered (see, e.g., Gordon et al. 2007). An alternative proposal is also considered by Selinger (2015), who extends sequents to the form <*P*, *c*, *d*, *R*>, where *R* is a set of linked undercutters. (Obviously, *R* can be empty if there are no such sentences involved.) Another interpretation, maybe the most natural one from the purely logical point of view, would be the recognition of the word ‘unless’ in Pollock’s example as the classical disjunction connective (‘or’) in the conclusion of the simple argument “This object looks red, thus it is red or (it is) illuminated by the red light”.

4.2 The characteristics of audience

Although the importance of grasping the notion of audience by CAS is clear, we would like to consider a slight modification of Walton and Gordon’s proposal. They define *audiences* as tuples <*assumptions, weights*>. In our view, audiences should be also linked with proof standards, because the choice of an appropriate standard in given communicative circumstances is socially determined (by a binding legal system, for instance). Thus, besides *assumptions* and *weights*, the third element should be added in order to grasp the contextual character of audiences, namely a *function assigning proof standards to types of dialogue* (or perhaps *to types of the sentences of a considered language*, i.e., according to the content of conclusion). Such a definition would allow us to explicitly isolate and reveal the whole social context of argument evaluation in CAS.

Another question is whether this definition captures the social context adequately. One may disagree with incorporating into the account of audiences logical properties of arguments, i.e., those regarding the internal strength of inference, such as weights and proof standards. This is the question of relativism in logic: are logical laws relative? Namely, is the relation of inference relative? Is it socially context-dependent? Fregean and Husserlian refutation of psychologism in the philosophy of logic makes us aware of the fact that relativizing logic to the social context can be refuted in an analogous way. Thus, we are reluctant to replace nineteenth century psychologism by a contemporary sociologism, and we are inclined to see the social context only in possible differences among agents’ beliefs, which are represented in audiences by (the set of) assumptions. Agents’ experience, and what follows from these assumptions, obviously depend on the social context, but changing some assumptions does not require changing logic. Thus one should not pose an objection that this way of introducing social context to informal logic may lead to a kind of relativism.

4.3 Conductive arguments

Walton and Gordon define conductive arguments as *pro-contra* arguments (2015, p. 527). This definition allows us to capture a dialectical aspect of argumentation in a single diagram, which is an undoubted benefit. *Pro-contra arguments* help us also to define the notion of attack on the conclusion of an attacked argument (see Selinger 2015). Actually, logic should enable us only to define the attack relation between arguments, leaving aside the analysis of an order of their appearance in a dialogue. From a dialectical point of view, however, arguments in a dialogue are in a game. They are attacked and defended by a proponent and an opponent. The order of moves in this game, which is determined by proof burdens for instance, is important and can affect the final result—as it is in the case of juridical procedures. This effect can no longer be valid if there is no game involved, as for example in an individual decision process of a rational being, who has to consider *pros* and *cons*, and who can simply sum up and weight them in the end. Such a process is just an object of interest of logic. It is only quasi-dialectical, because, informally speaking, the proponent and the opponent is the same entity, so that burdens of proof cannot be distributed between two different parties. Thus, the opponent can be regarded only as a model representation of the proponent's doubts and criticism. We find CAS consistent with this interpretation of dialectical terminology, which is widely used in the description of the system. So, in our opinion, conductive arguments, as they are defined in CAS, introduce no more of a dialectical account to argumentative structures than can be adopted by an essentially logical approach.

At this point, a question arises whether some more complex decision procedures than just pro/contra ones can be modeled in CAS. We mean here in particular a situation such as one in which we have to accept exactly one of many exclusive propositions. For example, we are to choose a place to spend our holidays. Thus we have various propositions: "We should go to *A*", "We should go to *B*", "We should go to *C*", etc., and hence many conductive arguments for each of them. It would be advisable to extend the model in order to guarantee that exactly one (or at most one) of them will be evaluated as acceptable. Actually, if we would have only *pro* arguments involved, the 'preponderance of the evidence' proof standard could be applied here. Although this standard does not reflect the cumulative nature of convergent reasoning (see Section 4.5), it offers an algorithm to solve the problem by simply finding out the strongest argument.

But when *pro* as well as *con* premises are in use, it would be useful to employ a parameter that would allow us to compare the strengths of arguments assigned to all considered options. Hence, our proposal is to employ the degrees of acceptability. We examine this issue more profoundly in what follows.

4.4 Premise acceptability

CAS, in the form considered, does not provide a precise tool that would allow us to evaluate arguments containing premises that are not fully acceptable. Such uncertain and merely probable premises often occur in everyday argumentation (for example due to the criticism or skepticism of the audience), and doubts about them affect the acceptability of conclusions. According to the postulate 8, "informal logic is concerned with analyzing real arguments" (Walton and Gordon, 2015, p. 509). CAS, however, tells the audience to evaluate premises (as well as conclusions) using only three values: *in*, *out*, *undecided*. It follows that if a dubious premise is classified as *in*, any doubt on the part of the audience will be actually ignored, i.e., it will not affect the acceptability of the conclusion. The argument will be overestimated in this case. Otherwise, if a dubious premise is considered as *undecided*, it can entirely block further reasoning, and the argument will be underestimated.

In order to capture reasoning from uncertain premises, at least two additional values should be included: (*i*) between *undecided* and *in* for not fully acceptable statements; and consequently (*ii*) between *undecided* and *out* for their negations. This seems to be a minimal requirement, but the more intermediate values we introduce, the more precisely we can estimate the amount of our doubts. Since in several cases the acceptability of a statement can be identified with its probability, the closed interval <0, 1> of rational numbers seems to be a natural choice. In (Grabmair, Gordon and Walton 2010) such semantics is considered, but in (Walton and Gordon 2015) it is neither recalled, nor applied for the aim of formalizing informal logic.

The absence of intermediate values in CAS allows us to skip an effect of, so to say, "doubts accumulation" while concerning the premises of linked arguments. Since the acceptability of a set of statements can be identified intuitively with the acceptability of their conjunction, it seems reasonable to assume that, by analogy to probability, the conjunction of uncertain but to some degree acceptable (independent) statements can be not acceptable itself (as the probability of the coincidence of many events can be smaller than ½ even if the probability of each of these events taken separately is greater than ½). In this way, the degrees of acceptability determine sufficiency. But in CAS sufficiency is modeled by proof standards, which do not take into account such a situation; so if all not fully certain premises of a single and separate linked argument (i.e., not under attack) would be considered as *in*, then (assuming that the argument node is *in*) the conclusion will be *in*, too. Thus, the postulate of sufficiency of the RSA triangle, as it is modeled in CAS, is not restrictive enough with respect to the domain of linked arguments with uncertain premises.

On the other hand, when an uncertain premise happens to follow from other uncertain premises (or if they are equivalent), then the acceptability of their conjunction can be fallaciously underestimated if this value would be decreased with respect to the one of the dependent premises that is in fact needlessly added. For example, the acceptability of the conjunction of two uncertain, equivalent statements is the same as the acceptability of each of them (these two values are assumed to be equal, since the statements are equivalent). But if two uncertain statements with equal acceptability are independent, then the acceptability of their conjunction should be reduced. Thus, the dependence of uncertain premises impedes the evaluation of arguments. Let us note that the fallacy that can be committed here is just a kind of *the double counting fallacy*. However, otherwise than in the case of the double counting of convergent arguments, it results in the underestimation of argument value. Obviously, it is not harmful for CAS, since the introduction of some "doubled" and needless premise, which is recognized as *in*, cannot change the result of the process of evaluation. In such a way, i.e., by excluding degrees of acceptability, CAS allows us to avoid difficulties concerning the independence of premises in linked arguments.

4.5 Argument weights

Walton and Gordon recommend real numbers in the range <0.0...1.0> to represent relative weights of arguments. However, this scale does not correspond to conditional probabilities, as one might think. Thus neither does 0.0 mean that the negation of an argument conclusion follows from its premises, nor does 0.5 mean that the premises are neutral with respect to the conclusion. Here 0.0 means the neutrality of premises, and 0.5 is only one of intermediate, "positive" weights. Let us note that using the probabilistic scale, conductive arguments could be defined in semantics, since the weights in the range <0.0…0.5) correspond to *con*, and the weights in the range (0.5…1.0> to *pro* arguments (the round brackets mean that the corresponding interval is open, and the angle brackets mean that it is closed).

Despite offering a fairly large number of weight values, CAS does not allow us to estimate the weights of convergent arguments. Summing the weights of such arguments and so strengthening the acceptability of their conclusions seems to be justified when a definitive proof is not at hand. But Walton and Gordon warn us against summing the weights of convergent arguments due to some possible dependence between them that can result in the double counting fallacy (Walton and Gordon, 2015, p. 532). This difficulty is very hard to overcome; however, the question of the relationship between the converging arguments can probably be slightly simplified by reducing it to the question of the relationship between the conjunctions of their premises. It is also noteworthy that an algorithms for summing the weights of independent arguments (Yanal 1988; Selinger 2014) can be still useful, even in this troublesome case, since they define an upper bound for the sum of the weights of arguments that are dependent. Leaving aside the details, let us only mention here the following essential properties of the weight-summing operation: (*i*) the sum of weights of two *pro*-arguments is greater than the weights of each of its components, but (*ii*) if at least one of these components has the maximal weight, then the whole has the maximal weight too, and (*iii*) the function assigning the weight of the convergent argument to the weights of its components is monotonic in the sense that if any of the input values is constant and the other one increases, then the output value increases too.

Instead of dealing with the issue of summing argument weights, CAS offers us proof standards to find out whether the conclusion of the whole argument is *in*, *out* or *undecided*. However, in convergent arguments (without exceptions), once the conclusion is *in*, it will remain the same, regardless of how many convergent components are added. Thus, the final result does not contain any information about the weight of the whole argumentation, which can be useful, for instance in order to compare the effectiveness of different convergent combinations of arguments. Using the 'preponderance of the evidence' proof standard we can only choose the component with the greatest weight. The rest of them cannot affect the final result of the evaluation, so they are in fact useless. It follows that they may play their role only with respect to some *con* arguments (and not on the basis of the 'preponderance of the evidence'). To sum up, it seems that the cumulative nature of convergent reasoning is not reflected by CAS.

The model of relevance in CAS is under construction, and in (Walton and Gordon, 2015) it is only sketched very briefly. Let us note that if we were to take into account the degrees of acceptability when evaluating *probandum*, we could describe the degrees of relevance as follows: the more acceptable a *probandum* is, assuming that the premises supporting it are fully acceptable, the more relevant those premises are.

4.6 Proof standards

The evaluation of conductive arguments that can have convergent components is affected by possible dependencies among these components. Thus, for example, two weak, mutually dependent, but double counted *pro* arguments could unfairly prevail over a *con* one that is stronger than each of the *pro* ones. Proof standards constitute a sort of a specific insurance against this effect. What we can lose by applying these standards is at first glance the precise information about how much the *pros* prevail over the *cons* (or *vice versa*). If proof standards can be linearly ordered with respect to their restrictiveness, then a certain scale would be available. Actually, Walton and Gordon (2015, p. 523) point to proof standards as being more or less restrictive, but the principle by which one could obtain a complete hierarchy is not specified. Even if one gives a satisfactory definition of such a hierarchy, we will still have a rather limited scale (with the number of degrees equal to the number of proof standards), while we dispose the real numbers in the range <0.0…1.0>. Thus, in order to fully exploit this scale, i.e., to map the weights of the whole convergent components of conductive arguments and of conductive arguments as well into the set <0.0…1.0>, some more precise numerical techniques must be developed, and the problem of arguments dependency must be faced.

Actually, such precise information about an argument value, which is to be expressed by the degree of acceptability of its conclusion, may not always be needed. Decision making, determined by yes-or-no questions, can serve as an example. Let us imagine that we wonder whether or not to cross a river. Once we make a decision, say, on the basis of an argument that is acceptable with the degree of 75%, we have to accomplish our task entirely. In other words, we have to cross the whole river, not as one could calculate, a half (or perhaps 75%) of it. The sentence in a criminal court action can be only: guilty (*in*) or not guilty (*out*). Some legal systems allow it to be *undecided* too, but not—75% or 79% guilty. It is fully justified regarding the decision on the penalty (especially the death penalty). On the other hand, the amount of the penalty in the case of a fine or imprisonment could be considered to be relativized to this parameter—say, proportionally. This proposal is quite controversial, but there are some other domains in which a precise, numerical information about the degree of argument acceptability seems to be clearly desired. We mean in particular the dilemmas, trilemmas, etc., mentioned in Section 4.3. We also refer to scientific research, within which methodological criticism requires as precise and accurate information about reasoning as possible (e.g., such information can be suitable to critically analyze results of the use of our decision procedures, even those related to yes-or-no questions). Apart from this purely theoretical interest, an acquaintance with the degree of argument acceptability might simply be useful on such occasions as the forecasting of atmospheric phenomena, risk assessment, etc. So we should neither neglect nor *a fortiori* resign from studies of the independence of arguments and of the evaluation of convergent and conductive arguments in the probabilistic scale.

The absence of a uniform standard for the evaluation of *pro* against *con* arguments motivates us to raise a question regarding the criteria for choosing the most adequate rules for assigning proof standards to types of dialogue. An unconstrained possibility of changing proof standards by simply clicking the menu bar seems to be too liberal solution. Since Walton and Gordon emphasize their interest in legal applications and they indicate the juridical origins of proof standards, this assignment should be relativized to a particular legal system and extrapolated in order to cover statements that occur in extra-judicial practice. But how is one to apply, for instance, an assignment based on Anglo-American jurisprudence to evaluate Frenchmen's arguments about their cuisine? Thus, we think that matching CAS to various types of everyday discourse (as, e.g., those listed by us in Section 2.2) is one of the most important goals of its future development. Obviously, the problem of the proof standards applicability is significant not only in such argumentation areas as everyday conversation, but also—what we want to emphasize—in philosophy and in science. Anyway, doubts about assignments of proof standards can occur, and various arguments can be raised by an audience in this matter. So, our question can be eventually formulated as follows: which proof standard should be used to evaluate arguments concerning types of discourse and the very choice of a proof standard?

Yet, let us note that the applicability of the proof standards can be impeded by the introduction of not fully acceptable premises. *Pro* and *con* arguments with relatively low weights, but with absolutely certain premises, could be stronger than those that have high weights, but whose premises are uncertain. Thus, in order to evaluate such *pros* and *cons*, an algorithm reducing their weights with respect to the acceptability of premises is needed (see Selinger's proposal, 2014).

5. Conclusion

Walton and Gordon's ideas can provoke a further fruitful discussion about interrelations between informal and formal approaches to the phenomenon of argumentation, and turn out to be particularly important in bridging informal logic with computational models of argument. In this paper we have considered CAS as a solid foundation for the formalization of informal logic, and we have shown significant research potential of Walton and Gordon's proposal, which must not be overlooked or underestimated while accomplishing the goal of the FIL project. This belief, however, is accompanied by our attempt to justify the need to modify some elements of the proposal. Our most general remark concerning CAS as a framework for informal logic is that it complicates the structure of argument, on the one hand, while it simplifies the evaluation, on the other.

As a result of our considerations we have specified the list of requirements collected by Walton and Gordon that informal logic has to meet. Particularly, we think that informal logic has to recognize the degrees of acceptability of an argument's premises and conclusions, and to analyze the problem of dependent arguments. Moreover, we have proposed to extend the list by explicitly introducing two further requirements: informal logic has to be capable of (i) defining the attack relation and (ii) applying argument mining methods.

Acknowledgements: We would like to thank Douglas Walton and Thomas Gordon for their helpful remarks and receptivity to our criticism. We also gratefully acknowledge the support of the Polish National Science Centre for Marcin Koszowy under grant 2011/03/ B/HS1/04559.

References

Bex, F., M. Snaith, J. Lawrence and C. Reed (2014). ArguBlogging: An application for the Argument Web. *Journal of Web Semantics* 25, 9-15.

Blair, J.A. (2009). Informal logic and logic. *Studies in Logic, Grammar and Rhetoric* 16(29), 47-67.

Budzynska, K., M. Janier, J. Kang, C. Reed, P. Saint-Dizier and M. Stede (2014). Towards argument mining from dialogue. In S. Parsons, N. Oren, C. Reed, F. Cerutti (Eds.) *Frontiers in Artificial Intelligence and Applications*. *Proceedings of 5th International Conference on Computational Models of Argument COMMA 2014* (pp. 185-196). Amsterdam: IOS Press.

Budzynska, K., A. Rocci and O. Yaskorska (2014). Financial dialogue games: A protocol for earnings conference calls. In S. Parsons, N. Oren, C. Reed and F. Cerutti (Eds.) *Frontiers in Artificial Intelligence and Applications*. *Proceedings of 5th International Conference on Computational Models of Argument COMMA 2014* (pp. 19-30). Amsterdam: IOS Press.

Dung, P.M. (1995). On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. *Artificial Intelligence* 77, 321-357.

Gijzel, B. van and H. Prakken (2012). Relating Carneades with abstract argumentation via the ASPIC+ framework for structured argumentation, *Argument and Computation* 3(1), 21-47.

Gordon, T.F. (2010). An overview of the Carneades Argumentation Support System. In C. Reed and C.W. Tindale (Eds.), *Dialectics, Dialogue and Argumentation. An Examination of Douglas Walton's Theories of Reasoning* (pp. 145-156), London: College Publications.

Gordon, T.F., H. Prakken and D. Walton (2007). The Carneades model of argument and burden of proof. *Artificial Intelligence* 171, 875–896.

Gordon, T.F. and D. Walton (2006). The Carneades Argumentation Framework. In P.E. Dunne and T.J.M. Bench-Capon (Eds.), *Computational Models of Argument: Proceedings of COMMA 2006* (pp. 195-207). Amsterdam: IOS Press.

Grabmair, M., T.F. Gordon and D. Walton (2010). Probabilistic semantics for the Carneades Argument Model using Bayesian networks. In P. Baroni, F. Cerutti, M. Giacomin and G.R. Simari (Eds.) *Computational Models of Argument: Proceedings of COMMA 2010* (pp. 255-266).Green, N. (2014). Towards creation of a corpus for argumentation mining the biomedical genetics research literature. In *Proceedings of the*

First Workshop on Argumentation Mining (pp. 11-18). Baltimore, Maryland: Association for Computational Linguistics.

Johnson, R.H. (1996). *The Rise of Informal Logic. Essays on Argumentation, Critical Thinking, Reasoning and Politics*. Newport News, VA: Vale Press.

Johnson, R.H. (2006). Making sense of "informal logic". *Informal Logic* 26, 231-258.

Johnson, R.H. (2009). Some reflections on the Informal Logic Initiative, *Studies in Logic, Grammar and Rhetoric* 16(29), 17–46.

Johnson, R.H. and J.A. Blair (1980). The recent development of informal logic. In J. A. Blair and R. H. Johnson (Eds.), *Informal Logic, The First International Symposium* (pp. 3–28), Inverness, CA: Edgepress.

Johnson, R.H. and J.A. Blair (1994). Informal logic: past and present. In R.H. Johnson and J.A. Blair (Eds.), *New Essays in Informal Logic* (pp. 1-19). Windsor, ON: Informal Logic.

Koszowy, M. and M. Selinger (2013). Commentary on: Douglas Walton and Thomas F. Gordon's "How to formalize informal logic". In D. Mohammed and M. Lewiński (Eds.), *Virtues of Argumentation. Proceedings of the 10th International Conference of the Ontario Society for the Study of Argumentation (OSSA) 22-26 May 2013* (pp. 1-7), Windsor: Ontario Society for the Study of Argumentation.

Lawrence, J. and C. Reed (2015). Combining argument mining techniques. In: *Working Notes of the 2nd Argumentation Mining Workshop, ACL'2015*, Denver.

Medellin, R., V.L. Hanson and C. Reed (2014). Spoken interaction with broadcast debates. In: S. Parsons, N. Oren, C. Reed and F. Cerutti (Eds.), *Proceedings of the Fifth International Conference on Computational Models of Argument (COMMA 2014)* (pp. 51-58), Pitlochry: IOS Press.

Peldszus, A. and M. Stede (2013). From argument diagrams to argumentation mining in texts: A survey. *International Journal of Cognitive Informatics and Natural Intelligence* 7, 1-31.

Pollock, J.L. (1987). Defeasible reasoning. *Cognitive Science* 11, 481-518.

Rahwan, I. and G.R. Simari (2009). Preface. In: I. Rahwan and G.R. Simari (Eds.), *Argumentation in Artificial Intelligence* (pp. IX–X). Dordrecht: Springer.

Reed, C. (2010). Walton's theory of argument and its impact on computational models. In C. Reed and C.W. Tindale (Eds.), *Dialectics, Dialogue and Argumentation. An Examination of Douglas Walton's Theories of Reasoning* (pp. 73-84), London: College Publications.

Reed, C. and C. Tindale (Eds.) (2010). *Dialectics, Dialogue and Argumentation: An Examination of Douglas Walton's Theories of Reasoning and Argument.* London: College Publications.

Schneider, J. (2014). Automated argumentation mining to the rescue? Envisioning argumentation and decision-making support for debates in open online collaboration communities. In *Proceedings of the First Workshop on Argumentation Mining* (pp. 59-63). Baltimore, Maryland: Association for Computational Linguistics.

Selinger, M. (2014). Towards formal representation and evaluation of arguments. [In: K. Budzynska and M. Koszowy (Eds.), *The Polish School of Argumentation*, special issue] *Argumentation* 28(3), 379-393.

Selinger, M. (2015). A formal model of conductive reasoning. In: B. J. Grassen, D. Godden, G. Mitchell and A. F. Snoeck Henkemans (Eds.), *Proceedings of the 8th International Conference of the International Society for the Study of Argumentation* (pp. 1331-1339). Amsterdam: Sic Sat.

Walton, D. (1989). *Informal Logic: A Handbook for Critical Argumentation*. Cambridge: Cambridge University Press.

Walton, D. (2008). *Informal Logic: A Pragmatic Approach*. Cambridge: Cambridge University Press.

Walton, D. (2011). Argument mining by applying argumentation schemes. *Studies in Logic* 4(1), 38-64.

Walton, D. (2014). A middle way between formal models and natural language legal argumentation. (A talk given at MET-ARG 2014: The 1st International Workshop for the Methodologies of Research in Legal Argumentation at JURIX 2014, Jagiellonian University, Kraków, Poland, 10 December 2014.)

Walton, D. and T.F. Gordon (2013). How to formalize informal logic. In D. Mohammed and M. Lewiński (Eds.), *Virtues of Argumentation. Proceedings of the 10th International Conference of the Ontario Society for the Study of Argumentation (OSSA), 22-26 May 2013* (pp. 1-10), Windsor: Ontario Society for the Study of Argumentation.

Walton, D. and T.F. Gordon (2015). Formalizing informal logic. *Informal Logic* 35(4), 508-538.

Yanal, R.J. (1988). *Basic Logic*. St. Paul: West Publishing Company.

Yuan, T., D. Moore, C. Reed, A. Ravenscroft and N. Maudet (2011). Informal logic dialogue games in human-computer dialogue. *Knowledge Engineering Review* 26 (2), 159-174.