

On the notion of strength in argumentation: overcoming the epistemic/practical dichotomy

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Abstract. In this paper we provide an analysis of various argumentation approaches (mainly due to Pollock) which explicitly deal with the notion of strength. While the attribution of a strength value to arguments seems to be necessary in actual practice, the basic meaning of the notion of strength is not clear, nor its role in resolving conflicts among arguments and determining their justification. The main contribution of the paper is to show that justification is not a purely epistemic notion, and a more articulated model of reasoning activity is a possible way to settle many problems emerging in existing approaches.

1 Introduction

While it is possible to define a very abstract argumentation framework without considering the notion of *strength* [2], the attribution of a strength value to arguments seems to be necessary, in actual practice, to compare arguments with conflicting conclusions, stronger arguments being preferred to weaker ones, as a general rule. This need has been recognized by Pollock in [7], subsequently elaborated in detail in [9], and revised in [11]: this paper is mainly focused on an analysis of these works, which gives rise to conclusions of general validity. Two main interpretations of the notion of strength can be identified in the literature:

- in the interpretation adopted by Pollock strength is supposed to measure the “amount of evidence” provided by an argument in support of its conclusion: in this case there are no constraints among the strengths of related arguments;
- another approach ascribes to strength a probabilistic semantics [5, 6], which implies enforcing on strength values some constraints deriving from the additivity property.

A related concept introduced by Pollock is the degree of justification of an argument, which expresses “how much do the agent believe the argument” (and its conclusion) taking into account the presence of counter-arguments, as well as their strength. On this concern, there are two possible ways to assign degrees of justification: it can simply be decided for each argument whether it is “undefeated” or “defeated”, or the “on sum” degree of justification can be computed

as a continuous value. We will refer to these alternatives as ‘crisp’ and ‘soft’ approach, respectively. In both cases, it is assumed that the notion of strength as “amount of evidence” is sufficient to determine the degree of justification of an argument in presence of counter-arguments. In this paper we will analyze the notions of strength and degree of justification in the context of Pollock’s works, showing that this implicit assumption is not unquestionable and that the overall conceptual foundations of his theory require some extensions and adjustments.

2 Undercutting defeaters

One of the main contributions of Pollock’s work is the following fundamental distinction [7]:

- a *rebutting defeater* is an argument which prevents the acceptance of another one by denying its conclusion;
- an *undercutting defeater* is an argument which prevents the acceptance of another one by invalidating the use of one of its prima facie reasons.

Rebutting defeaters arise when, due to the presence of prima facie reasons and/or unreliable premises, the inferential process produces arguments with contradictory conclusions. Most argumentation theories consider rebutting defeaters only. Undercutting defeaters prevent the acceptability of an argument without denying its conclusion. A typical example is as follows: if an object appears red to my eyes, I feel authorized to believe that it is actually red. However, if I learn that the object is illuminated by red light, I feel no more authorized to believe that it is red, though I have no reasons to believe that it is not. Undercutting defeaters have been analyzed by Pollock [9], who has claimed that rebutting and undercutting defeaters are sufficient to capture all kinds of defeasible reasoning. We agree that undercutting defeaters play a substantial role in practical reasoning and should be present in an adequately expressive argumentation system.

It has to be noted that the term “undercutting defeater” has been used by other authors with a substantially different meaning. For instance, in [1, 3] an undercutting defeater is one which contradicts a premise of another argument, while a rebutting defeater is one which contradicts its conclusion. Clearly both these cases correspond to rebutting defeaters according to Pollock’s classification, while Pollock’s notion of undercut, which does not involve contradiction, is lacking in these approaches.

While undercutting defeaters are a major contribution, their introduction gives rise to some subtleties and complications in the notion of strength, which have escaped Pollock’s analysis and are the main topic of this contribution.

3 Strength and undercutting defeaters

As any other argument, an undercutting defeater has a strength, however it is not definitely clear which role (if any) this strength should have in defeat status computation. In this respect, there are (at least) two different approaches:

- the strength of an undercutting defeater is simply ignored, as in [9]: if an argument α undercuts an argument β then β is not accepted, independently of the strength of α .
- a comparison between the strengths of the conflicting arguments is made: α prevents β to be accepted only if it has a greater strength.

As for the first approach, it may be questioned whether a very weak undercutting argument should be able to suppress a line of reasoning in any case. In order to “decrease the power” of undercutting arguments, we may adopt the second approach. However, as pointed out in [11], there are cases where the undercutting argument is weaker than the attacked one, but maintaining belief in the latter is counterintuitive. The difficulty is related to a discontinuity of the relation between justification and strength, which the soft approach in [11] attempts to smooth: as far as the role of strength of undercutting defeater is concerned, the approach presented in [11] can be seen as a refinement of the crisp approach enforcing strength comparison. Basically, the motivation which underlies the proposal is the following: if both an undercutting and a rebutting defeater are present for a given argument, there are cases where both defeaters are singularly weaker than the attacked argument, but maintaining belief in the attacked argument seems counterintuitive.

In the soft approach, the problem is avoided by summing the strengths of the strongest undercutting and rebutting defeaters, thus allowing them to carry a sort of “conjunct” defeat. On the other hand, if the undercutting argument is too weak, even its accrual with the strongest among rebutting defeaters is not sufficient to defeat the attacked argument.

In our opinion, the accrual of rebut and undercut proposed in [11] seems more an expedient to adjust some cases, rather than a real solution. Counterintuitive examples similar to those proposed by Pollock, can be built in situations where undercut only is concerned: in these cases the accrual with rebut can not help. Instead, what the above example suggests is that the strength of an undercutting argument can not be compared with the strength of the argument it attacks. In a sense, this comparison corresponds to assimilate rebutting and undercutting defeaters as far as strength is concerned, while they are kept clearly distinct when tracing the conceptual framework of argumentation.

Moreover, mixing undercut and rebut yields counterintuitive results, as in the following example. Consider an autonomous robot which is endowed with a set of sensors featuring different reliability. Each sensor is associated with a prima facie reason stating that the real world situation corresponds to the perceived one: the strength of each reason of this kind is related to the reliability of the corresponding sensor, so that if data coming from different sensors give rise to contradictory conclusions, those supported by more reliable sensors prevail. Accidental events may also affect sensor reliability: for instance if the robot crashes into a wall, sensors may be damaged: this can be represented by an argument whose premise is a crash and whose conclusion is an undercutting defeater of the prima facie reasons mentioned above. Note that the effects of the crash can not, in general, be related with the original reliability of the sensors, indeed it may

be the case that the most reliable sensors (under normal operating conditions) are the most sensitive to crash damages. Let us now suppose that the robot has an argument supporting that he has just had a crash. This argument undercuts any argument where the use of sensorial data is involved: according to Pollock proposal, the strength of the undercutting argument should be subtracted to the strength of each argument whose initial premises are based on sensorial data. Clearly the surviving arguments, if any, are those whose strength was higher, namely those supported by most reliable sensors, but this is not generally acceptable: as explained above, it might even be the case that exactly the opposite situation holds.

4 Epistemic and practical reasoning revisited

In [10], Pollock clearly distinguishes between epistemic reasoning (concerning what to believe) and practical reasoning (concerning what to do). This classification deserves further developments: in particular, we believe that the various problems and subtle difficulties analyzed in previous sections share a common root: an oversimplification in modeling the overall reasoning activity of an intelligent autonomous agent. A more articulated model is needed in order to avoid conceptual ambiguities and overlappings inherent to the excessively simplified scheme.

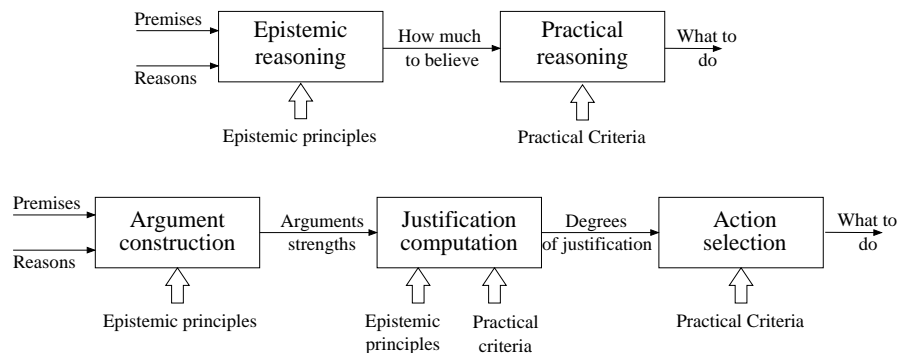


Fig. 1. Two vs. three-level models of reasoning

As a first step, we propose here to distinguish three levels of reasoning activity (see Figure 1), namely argument construction, justification computation, and action selection. The first level concerns the construction of arguments, the computation of their strength, and the identification of conflicts, namely the defeat relation among them. This level is mainly epistemic in nature, in the sense that it can be based on universal context-independent principles, such as the weakest link principle [7]. Practical aspects may however affect this level too, since

the process of construction of arguments may be driven by agent interests [8], which in turn are related with agent goals. The second level deals with conflict resolution: taking in input the result of previous phase (constructed arguments, their strength, and the defeat relation) it computes a justification status for each argument. The justification status may be crisp (the so called defeat status) or soft (the so called degree of justification): in both cases it represents the belief status of the agent, i.e. what to believe (in the crisp approach) or how much to believe (in the soft approach). Differently from Pollock, we suggest that the computation of the justification status of the arguments is not a purely epistemic notion. In fact, establishing a belief status can not depend on universal principles only, but also on “subjective” practical criteria, such as the ‘attitude’ of the agent (e.g. cautious vs. optimistic). The output of the second level is basically a set of conclusions labeled with a justification status, based on the strength of the relevant arguments and counterarguments, and on context-dependent practical components. This information is used at the third level of reasoning in order to decide what to do, according to practical criteria which take into account the goals of the agent, their importance and urgency, and so on. This is a practical level, which, at the current state of the art, is left outside argumentation theory.

The advantages of the proposed model can be made evident by showing how the difficulties of Pollock’s proposals find a natural settlement in the three-level model.

5 The false objective of the “right” approach

We have argued above against any kind of strength comparison between an undercutting argument and the attacked one. This suggests that the most correct position, from a purely epistemic point of view, is the crisp approach, in which undercutting defeaters are able to defeat the attacked argument independently of their strength: the presence of an undercutting argument suggests that an exceptional condition holds, where a reason can not be exploited as usual. If your belief in such a condition is justified, with any strength, then the attacked argument can not survive. This is related to the fundamental difference between rebut and undercut. Rebut is based on a mutual attack between a conclusion and its negation: this reciprocity justifies strength comparison between conflicting arguments. On the other hand, undercut is an unidirectional attack directed against the applicability of a reason: it does not admit reply and, consequently, can not be based on strength comparison. However, one intuitively feels that, also in this case, the strength should be somehow be taken into account: having a very weak undercutting argument suppressing an otherwise robust line of reasoning may sound improper. This is probably the reason why Pollock has subsequently modified his proposal. However this is a practical, rather than epistemic, consideration: in order not to be too cautious, one may prefer to overlook undercutting arguments, when they are not really strong. This might be modeled, for example, by a parameter, say γ_0 , rather than modifying the epistemic

properties of the reasoning mechanism. The higher γ_0 , the lesser attention is paid to undercutting arguments.

The consideration above confirms that the degree of justification is a hybrid notion, therefore its computation should be made at the intermediate level of reasoning activity. The choice of the specific approach is not a general context-independent question, rather it should be parametrized in order to take into account practical issues. The different approaches proposed by Pollock are, in a sense, equally acceptable and the search for the epistemically “right” approach appears to be a false objective. In fact, if the matter could be settled from a purely epistemic point of view, then the ‘maximally skeptical’ approach should be adopted, i.e. the one which does not force the agent to believe anything if there is an equally strong doubt on it. However, a further analysis of the proposed approaches reveals that they can not be totally ordered on the basis of their degree of skepticism. A paradigmatic example is the management of cycles in the defeat relationship among arguments: if the involved arguments have the same strength, then the “right” approach should consider all of them as not justified. In the case of a soft approach, all of the arguments should therefore be assigned a null degree of justification. However, the soft approach fails in managing the so called presumptive defeat [11]. Let us consider Figure 2(a), assuming that α , β and γ have the same strength. Neither α nor β should be justified, and, since accepting β prevents γ to be justified, according to a skeptical approach we should not accept γ (basically, for the same reason why we do not accept α). However, as shown above, the soft approach assigns a null degree of justification to both α and β , and this yields γ to have a degree of justification equal to its own strength [11]. This example is handled appropriately by the crisp approach, whose most sophisticated version refers to the evaluation of all the possible *status assignments*. In short, a status assignment consists in a two-valued labeling of a maximal subset of the arguments, such that each argument is labeled ‘in’ iff all its defeaters are labeled ‘out’, and it is labeled ‘out’ iff one of its defeaters is labeled ‘in’. An argument is considered as justified iff it is ‘in’ in all possible status assignments. In the case of Figure 2(a), there are two status assignments, namely $\langle L(\alpha) = \text{IN}, L(\beta) = \text{OUT}, L(\gamma) = \text{IN} \rangle$ and $\langle L(\alpha) = \text{OUT}, L(\beta) = \text{IN}, L(\gamma) = \text{OUT} \rangle$, therefore γ is not justified. Having discarded the soft approach, it would be tempting to conclude that the crisp approach is the right one. However, if we consider the example in Figure 2(b), it can be easily shown that it has only one crisp status assignment, namely $\langle L(\delta) = \text{IN}, L(\alpha) = \text{OUT}, L(\beta) = \text{IN}, L(\gamma) = \text{OUT} \rangle$, while according to the soft approach all the arguments have null degree of justification. So, in this case, we have the reverse situation: the soft approach gets the ‘maximally skeptical’ answer, while the crisp one fails.

The simple examples considered above are related to the specific problem of presumptive defeat, which is a debated question by itself [11]. However the impossibility of finding the ‘right maximally skeptical’ approach is not just a consequence of the technical difficulties of these (or similar) peculiar examples, but rather arises from a more general and deeper motivation. In fact, being more

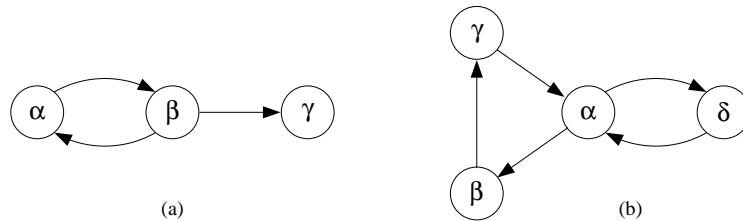


Fig. 2. Two problematic defeat graphs

skeptical about an argument α inherently entails limiting its ability to defeat other arguments and therefore results in being more credulous about all the arguments which are attacked by α . As a consequence, it is inherently impossible to identify the maximally skeptical way to assign degrees of justification.

In order to dispute this observation, one should envisage an approach where any decrease of the degree of justification of an argument does not affect its defeating capability. However, to be coherent with the “maximal skepticism” requirement, such an approach would, by necessity, suppress any argument having a defeater with higher strength, since any such defeater should preserve, in any case, its original defeating capability. As a consequence, an argument having stronger defeaters could not be reinstated, even if its defeaters are defeated. A similar maximally skeptical approach is represented by the acceptability classes proposed in [4]. Suppressing reinstatement, however, deprives argumentation theory of one of its fundamental components for representation of actual common-sense defeasible reasoning. From another perspective, this suggests that only arguments and their strengths are purely epistemic notions: this is coherent with our proposal of a three-level model, which we consider a promising direction for further investigation. Among the future developments of our preliminary proposal, we mention the analysis of the relationships between the two main interpretations of the notion of strength and the two types of belief quantification (credal and pignistic) proposed in [12].

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