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When is argumentation deductive?

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ABSTRACT
This paper discusses and compares various answers to the question when argumentation is deductive. This includes an answer to the questions when argumentation is defeasible and whether defeasible argumentation is a subclass of deductive argumentation or whether it is a distinct form of argumentation. It is concluded that deductive and defeasible argumentation as conceived by Philosophers like Pollock and Rescher and as formalised in the *ASPIC*$^+$ framework and systems like Defeasible Logic Programming, are semantically different categories. For this reason, purely syntactic base logic approaches to formal argumentation are unsuitable for characterising this distinction.

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1. Introduction

In May 2013 I had an email exchange with Philippe Besnard, continued in September that year, on his paper with Amgoud and Besnard (2013) and its relevance for the *ASPIC*$^+$ framework (Modgil & Prakken, 2013, 2014; Prakken, 2010). At some point in our discussion I mentioned that *ASPIC*$^+$ is meant to capture both deductive and defeasible argumentation. Philippe then asked me 'What do you exactly mean by deductive argumentation?' I answered as follows.

> Informally I mean any form of argumentation where all fallibility of an argument is in the premises. Or in other words, any form of argumentation in which one cannot rationally accept all premises but not the conclusion of an argument. So in deductive argumentation an argument can only be attacked on its premises.
>
> Formally I can think of two ways to define deductive argumentation.
>
> Semantically: any form of argumentation where the premises of an argument entail their conclusion in the usual, truth-preserving sense, so (given a model-theoretic semantics of the underlying logical language in terms of truth) where the conclusion is true in all models of the premises.
>
> More abstractly: any form of argumentation where the conclusion of an argument is a consequence of its premises according to some chosen Tarskian abstract logic over the underlying logical language.

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Philippe replied that he agreed with these statements except for two of them. First, he found the semantic definition less convincing since 'it depends on what models are defined to be'. He initially also disagreed with the second sentence of my informal definition but when I rephrased it as '…argumentation in which it is rationally impossible to accept all premises of an argument but not its conclusion …' he agreed with that, too, at least if correctly interpreted his reply 'Thanks Henry!' as such. In any case, earlier he had written 'It looks like we agree on the meaning of deductive argumentation'. Note also that the informal definition of deductive argumentation to which Philippe agreed seems to fits well with general definitions of deductive reasoning that can be found in introductions to logic, in which deductive inferences are equated with deductively *valid* inferences. For example, Copi and Cohen (1990, p. 46) write

> A deductive argument is valid when its premises, if true, do provide conclusive grounds for the truth of its conclusion. In a deductive argument (. . . . · ·) premisses and conclusion are so related that it is absolutely impossible for the premises to be true unless the conclusion is true also.

Or, more recently and more concisely:

> An argument with premises and conclusion *C* is deductively valid just in case it is impossible for the premises to be true while the conclusion is false (Starr, 2021, p. 381).

So it seems that the question what is deductive argumentation is a special case of the question what is deductively valid reasoning (but see Section 6 below for some subtleties).

So why come back to this issue now? One reason is that Tony Hunter, one of the long-time collaborators of Philippe Besnard, has in various publications associated John Pollock work on formal argumentation (Pollock, 1987, 1992, 1995) with deductive argumentation. For example, Hunter and Woltran (2013) write 'Pollock was perhaps the first proponent of deductive arguments'. This is surprising, since Pollock was always clear that he did not model deductive but defeasible reasoning. Accordingly, the main aim of this paper is to discuss and clarify the various ways in which the terms 'defeasible' and 'deductive' are used in the literature on formal argumentation.

In doing so, I will first summarise Pollock's approach to formal argumentation and the way it influenced the *ASPIC*$^+$ framework for argumentation. I will then describe Hunter's so-called base-logic approach to argumentation, which he uses to model defeasible reasoning as a form of deductive argumentation. Subsequently I will use my summaries to argue that the base logic approach is unsuitable for modelling defeasible argumentation as modelled by Pollock and in *ASPIC*$^+$. I will then explore an alternative way of looking at the matter by combining my above reply to Philippe Besnard with Besnard and Hunter (2018)'s description of deductive argumentation, which differs from Hunter's base logic approach. This will yield an answer to the question in the title of this paper; an important part of the answer is that the distinction between deductive and defeasible argumentation is essentially a semantic one.

2. Pollock and *ASPIC*$^+$ on deductive and defeasible argumentation

Here are some of Pollock's quotes on the nature of argumentation:

> Defeasible reasoning is, *a fortiori*, reasoning. Reasoning proceeds by constructing arguments, where *reasons* provide the atomic links in arguments. *Conclusive reasons* logically entail their conclusions. Defeasibility arises from the fact that not all reasons are conclusive. Those that are not are *prima facie reasons*. Prima facie reasons create a presumption in favour of their conclusion, but it is defeasible. Pollock (1995, p. 85)

Pollock thus depicts arguments as inference graphs, where the nodes are statements and the links are applications of 'reasons'. He thus regarded reasons as inference rules, but he did not identify inference rules with deductive inference rules alone. Pollock strongly emphasised the importance of *prima facie* or *defeasible* reasons in argumentation.

> It is logically impossible to reason successfully about the world around us using only deductive reasoning. All interesting reasoning outside mathematics involves defeasible steps. Pollock (1995, p. 41)

> … we cannot get around in the world just reasoning deductively from our prior beliefs together with new perceptual input. This is obvious when we look at the varieties of reasoning we actually employ. We tend to trust perception, assuming that things are the way they appear to us, even though we know that sometimes they are not. And we tend to assume that facts we have learned perceptually will remain true, as least for a while, when we are no longer perceiving them, but of course, they might not. And, importantly, we combine our individual observations inductively to form beliefs about both statistical and exceptionless generalisations. None of this reasoning is deductively valid. Pollock (2009, p. 173)

To the best of my knowledge, Pollock has never attempted to give a formal definition of the distinction between deductive and defeasible reasons. Instead he simply assumed that reasons, that is, inference rules, can be classified as either deductive or defeasible. Almost all examples of deductive reasons he gave were valid propositional or first-order inferences while his collection of defeasible reasons captured stereotypical forms of presumptive reasoning, largely based on his earlier work in epistemology.

Pollock based an important design decision on his distinction between deductive and defeasible reasons. In his formalism only applications of defeasible reasons can be attacked, and there are two kinds of attacks: *rebutting* defeaters attack the conclusion of a defeasible inference by favouring a conflicting conclusion, while *undercutting* defeaters attack the defeasible inference itself, without favouring a conflicting conclusion. The concept of undercutting can be illustrated with Pollock's own favourite example: if the object looks red, that is a reason for concluding, defeasibly, that the object is red; but the presence of red illumination interrupts the reason relation without suggesting any conflicting conclusion. Note that this use of the term undercutter is different from the use in the work of Besnard, Hunter and others on classical argumentation, in which it denotes attack on the premises of an argument. In Pollock's system an undercutting attack instead claims that there is an exception to a defeasible rule.

Pollock's formal work on argumentation heavily influenced the design of the $ASPIC^+$ framework, which also distinguishes between deductive (or 'strict') and defeasible inference rules and which handles rebutting and undercutting attack in the same way as Pollock, except that, unlike in Pollock's approach, in $ASPIC^+$ undercutting attacks need not be at least as preferred as their target to succeed as defeat.

ASPIC$^+$ adds to Pollock a category of attackable ('ordinary') premises, which yields a third kind of premise or 'undermining' attack. I conjecture that it is easy to show that *ASPIC*$^+$ instantiations without preferences and without attackable premises are equivalent to Pollock's formalism.

3. The base logic approach

How can Hunter describe Pollock's work as being on deductive argumentation while Pollock himself clearly described his work as being on not just deductive but also defeasible argumentation? For this we have to look at how Hunter defines deductive arguments.

> 'A deductive argument (...) is a tuple $\langle \Phi, \alpha \rangle$ where Φ is a set of premises, and α is a claim such that for a consequence relation $\vdash_i$, $\Phi \vdash_i \alpha$ holds.' Hunter and Woltran (2013)

Hunter (2018) phrases this slightly differently by saying that $\Psi \vdash_i \alpha$ holds for a *base logic*, which he describes as 'a logic that specifies the logical language for the knowledge, and the consequence (or entailment) relation for deriving inferences from the knowledge'. Hunter thus regards an argument with premises Φ and conclusion α as deductive if Φ implies α according to some base logic. Note that he does not impose properties on the base logic for an argument to be deductive. He does consider the constraints on arguments that their premises are jointly consistent (in the base logic) and are subset-minimal in implying their conclusion. Since these constraints are for present purposes not essential, I will ignore them in the remainder of this paper.

Another key idea of Hunter's use of base logics is that notions of conflicts between arguments are defined in terms of 'logical contradiction between the claim of the counterargument and the premises or claim of the attacked argument'. Here it is crucial that logical contradiction is also defined in terms of the consequence notion $\vdash_i$ of the adopted base logic.

Hunter introduced his ideas on base logics in Hunter (2010). Among other things, he showed that definitions of argument construction in terms of two kinds of inference rules (like the deductive and and defeasible ones of *ASPIC*$^+$ or Defeasible logic Programming Garcia & Simari, 2004) can be reconstructed as a base logic. In his 2010 paper Hunter does not formally define conflict notions between arguments in terms of base logics but he does note that this is another intended use of base logics. He starts his paper with

> Proposals for logic-based argumentation rely on an underlying logic, which we call a base logic, for generating logical arguments and for defining the counterargument relationships (using inference of conflict or existence of inconsistency).

The same ideas are adopted by Amgoud and Besnard (2013) except that they do not recognise any base logic as deductive but only those with a consequence notion that satisfies the conditions of a Tarskian abstract logic.

Definition 3.1 (Abstract Logic): An abstract logic is a pair $(\mathcal{L}, Cn)$, where $\mathcal{L}$ is a language and the consequence operator Cn is a function from $2^{\mathcal{L}}$ to $2^{\mathcal{L}}$ satisfying the following conditions for all $X \subseteq \mathcal{L}$:

(1) $X \subseteq Cn(X)$
(2) $Cn(Cn(X)) = Cn(X)$
(3) $Cn(X) = \bigcup_{Y \subseteq_f X} Cn(Y)$
(4) $Cn(\{p\}) = \mathcal{L}$ for some $p \in \mathcal{L}$
(5) $Cn(\emptyset) \neq \mathcal{L}$

Here $Y \subseteq_f X$ means that Y is a finite subset of X. A set $X \subseteq \mathcal{L}$ is defined as *consistent* if $Cn(X) \neq \mathcal{L}$, and as inconsistent otherwise.

It is this 'more abstract' formal definition of deduction that I alluded to in my reply to Philippe Besnard.

Following Hunter's base-logic approach, Amgoud & Besnard then define arguments and various kinds of attack relations in terms of the notions of consequence and consistency of a Tarskian abstract logic.

4. Deductive argumentation according to the base logic approach

Summarising the base-logic account of deductive argumentation as I understand it, it regards a formal model of argumentation as being for deductive argumentation if (1) arguments are (at least) valid inferences according to the consequence notion of some base logic; and (2) conflict notions between arguments are also defined in terms of such a consequence notion.

Clearly, according to this definition the work of Besnard and Hunter on classical-logic argumentation (starting with Besnard & Hunter, 2001) counts as models of deductive argumentation, just as Amgoud and Besnard (2013)'s generalisation of this work to Tarskian abstract logics. However, the formalisms of Pollock and $ASPIC^+$ do not. Although, as Hunter (2010) showed, their notions of an argument can be reconstructed in terms of a base logic, their notions of conflicts between arguments cannot. To see this[1], consider the following example of a murder investigation in which two witnesses John and Mary, respectively testified that the killer was Bill (John), and that he was not Bill (Mary). Let us regard this information as given and certain and let us then apply a defeasible reason corresponding to the witness testimony argument scheme (that witness W testifies that P is a defeasible reason for believing P) to both facts. Applying this reason to John's testimony (J) yields an argument K for the conclusion that Bill was the killer while applying the same reason to Mary's testimony (M) yields an argument K' for the conclusion that Bill was not the killer. In both Pollock's system and $ASPIC^+$ these two arguments rebut each other since they have logically contradictory conclusions and since both of these conclusions were derived with a defeasible inference rule. This situation is visualised in Figure 1, in which the vertical arrows are defasible inferences and the horizontal arrows are attack relations. So far so good. However, if we apply (Hunter, 2010)'s base logic ideas to Pollock's system and $ASPIC^+$, we see that both systems should regard the information that John testified that the killer was Bill while Mary testified that the killer was not Bill as jointly inconsistent, since from these statements arguments for contradictory conclusions can be constructed. And if argument construction equates inference in the base logic, this means that argument K attacks argument M while argument K' attacks argument J. This situation is visualised

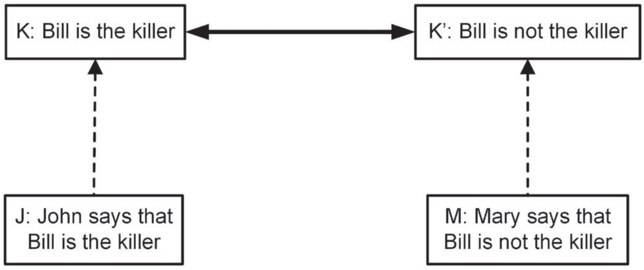

Figure 1. Correct modelling of the example.

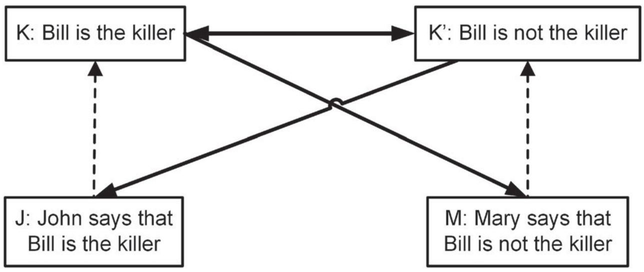

Figure 2. Incorrect modelling of the example.

in Figure 2. This in turn would mean that the sets $\{J, M, K\}$ and $\{J, M, K'\}$ are not admissible since they are not conflict-free. However, this is not what happens in Pollock's system or $ASPIC^+$ since they do not define argument attack in terms of a base logic that equates argument construction in their systems. Moreover, this is as it should be, since it is simply true that as a matter of fact John testified that the killer was Bill while Mary testified that he was not Bill. It happens often in real life that multiple witnesses testify to contradictory statements. So it should be possible to consistently express that this has happened.

It thus turns out that the base logic approach as applied in this way is not suitable for modelling defeasible argumentation as described by Pollock and as modelled in $ASPIC^+$. However, it might be thought that some of the spirit of the base logic approach can be saved by making a distinction between arguments and argumentation. Then we could say that the arguments of Pollock and $ASPIC^+$ are deductive (since they can be constructed according to a base logic) but the kind of argumentation they model is not deductive, since their way of defining and handling conflicts makes the reasoning defeasible. This idea I discuss in the next section.

5. When is an argument deductive?

It is interesting to note that Besnard and Hunter (2018) start their overview of systems of argumentation based on deductive arguments with

> In deductive reasoning, we start with some premises, and we derive a conclusion using one or more inference steps. Each inference step is infallible in the sense that it does not introduce uncertainty.

This definition comes close to my second informal definition in my above email reply to Philippe Besnard, namely, that argumentation is deductive if it is rationally impossible to accept all premises of an argument but not its conclusion. The similarity is that if one accepts all premises of a deductive argument, then there is no reason not to accept its conclusion since the deductive inferences made in the argument cannot introduce any uncertainty.

Note that Besnard and Hunter (2018)'s informal definition differs from the above one in terms of base logics. In fact, what counts as a deductive argument in the base logic approach may well be a non-deductive argument according to this definition. With this definition, Pollock's account of defeasible reasoning should not be called deductive, since clearly his defeasible reasons introduce uncertainty in an argument, as do the defeasible inference rule of *ASPIC*$^+$. Moreover, we now see that the base logic approach to the question 'when is an argument deductive' has inherent limitations since it cannot identify whether an inference introduces uncertainty or not: it treats the deductive and defeasible reasons of Pollock and inference rules of *ASPIC*$^+$ or Defeasible Logic Programming in exactly the same way.

So how can we recognise whether an inference rule is deductive or defeasible? It seems to me that here we cannot escape looking at semantics (something which the base logic approach, being purely syntactic, does not allow). Why is the fact that a witness says P only a defeasible reason for P? This is since it is part of the meaning of the expression 'Witness W says that P' that the witness can be mistaken. The same holds, for instance, for Pollock's perception principle (that an object looks like having property P is a defeasible reason to believe that the object has property P). The same also holds for versions of the statistical syllogism (If P then normally Q, P, so presumably Q). Here the meaning of 'normally' leaves open the possibility that there are cases of P where Q does not hold. So my semantical answer to Philippe Besnard's question what I mean with defeasible argumentation was not so bad at all. What I attempted to say (but did not express clearly enough) was that defeasible argumentation is a form of argumentation in which defeasible arguments are constructed and evaluated and that an argument is defeasible if its conclusion is not semantically entailed by its premises according to the meaning of these premises.

How can we recognise a semantics as being for defeasible inference? This is not so easy to answer. A possible answer is: if its notion of entailment is nonmonotonic. And indeed, there are many nonmonotonic semantics for defeasible reasoning, cf. Kraus et al. (1990) and Beierle (2016), often based on the idea of preferential entailment: in checking whether a conclusion follows from a set of premises we don't look at *all* models of the premises to see if the conclusion is true in all of them but we only look at a *preferred subset* of these models, namely, those models that are as normal as possible given the available information. However, it is unclear how these semantics apply in an argumentation context, since they usually model conflict resolution as part of the semantics while in formal argumentation conflict resolution is instead modelled in the interaction between arguments. To illustrate this difference with an informal example, consider the well-known Tweety example.

Birds typically fly, Penguins typically do not fly, all penguins are birds, Tweety is a penguin.

A semantics of preferential entailment would simply say that this preferentially entails that Tweety cannot fly, while an argumentation system would reach the same conclusion by first allowing the construction of two arguments *Tweety can fly since it's a bird* and *Tweety cannot fly since it's a penguin* and by then preferring the second argument on the grounds that it is based on the more specific information. If, by contrast, the argumentation system would naively use a system of preferential entailment to construct arguments, then only the second argument would be constructed, which would give up the idea of argumentation as a rational way of conflict resolution. So Philippe Besnard's worry in his reply to me about my attempted semantic definition was justified in that it is not obvious how my informal definition can be formalised to recognise whether an argument is deductive or defeasible. Having said so, I do believe that a fully satisfactory answer to the question 'when is an argument deductive?' must involve semantical considerations.

It should be noted that Hunter (2018) studies the incorporation of systems for preferential entailment (in particular Kraus et al., 1990's system P) in his base logic approach. However, he only uses the proof theory of system P (namely, for argument construction) and he does not discuss whether the notions of argument attack that he adds to his use of system P result in an argumentation system that agrees with the semantics of system P. This is unlike, for instance, Dung (1995), who defines the notion of a default-logic argument and a notion of attack between such arguments and then proves a full correspondence between Reiter (1980)'s default logic and his reconstruction. Other work of this kind is Baker and Ginsberg (1989), who developed an argumentation-theoretic proof theory for semantical versions of circumscription, Geffner and Pearl (1992), who did the same for their semantics of so-called conditional entailment, and Bondarenko et al. (1997), who reconstructed several nonmonotonic logics in assumption-based argumentation.

6. Defeasibility and notions of argument conflict

The idea that the difference between deductive and defeasible arguments is a semantic one also has implications for the design of attack relations between arguments. As observed by Hunter (2010), as regards argument *construction* there is no difference between deductive and defeasible arguments: both have premises and both draw inferences from the premises to support the conclusion. However, as regards argument *attack* they are different. As noted by Besnard and Hunter (2018), only defeasible inferences introduce uncertainty; deductive inferences are infallible in that they do not introduce uncertainty. Any fallibility of a deductive argument is in its premises and therefore it seems that the only sensible way to attack a deductive argument is on its premises. By contrast, the fallibility of a defeasible argument may also be in its defeasible inferences, so it makes sense to allow attacks at a defeasible argument on its defeasible inferences, either by way of Pollock's rebutting attack (attacking the conclusion of a defeasible inference) or by way of Pollock's undercutting attack (attacking the defeasible inference itself on the grounds that there is an exception to the rule). However, to apply these ideas in the design of argumentation systems, it is necessary to distinguish between deductive and defeasible inferences in an argument, hence the distinction in Pollock's system, *ASPIC*$^+$ and systems like Defeasible Logic Programming between two kinds of inference rules.

At first sight, once a distinction is made between deductive and defeasible inference rules on the basis of semantical considerations, the definition of attack would seem to be easy: all arguments can be attacked on their premises (except if these are declared to be certain, as are all premises in Pollock's system and the subset of necessary premises in *ASPIC*$^+$) while defeasible arguments can in addition be attacked on their applications of defeasible inference rules. Given these ideas, there is still some room for technically different solutions, for instance, whether conflict only occurs if conclusions and/or premises directly negate each other (as in *ASPIC*$^+$) or whether such conflicts can also occur if a conclusion deductively implies the negation of the other (as in Defeasible Logic Programming). See Garcia et al. (2020) for a comparison between *ASPIC*$^+$ and Defeasible Logic Programming on these and other technical issues.

However, things are more subtle than that. In Prakken (2016) I discussed the relevance of the lottery paradox, a well-known paradox in formal epistemology (Kyburg, 1961) for formal systems of argumentation. I concluded that this paradox suggests that it may sometimes be rational to jointly accept a set of propositions but not all of their deductive consequences. Here is what I wrote.

> Imagine a fair lottery with one million tickets and just one prize. If the principle is accepted that it is rational to accept a proposition if its truth is highly probable, then for each ticket T_i it is rational to accept that T_i will not win while at the same time it is rational to accept that exactly one ticket will win. If we also accept that everything that deductively follows from a set of rationally acceptable propositions, then we have two rationally acceptable propositions that contradict each other: we can join all individual propositions $\neg T_i$ into a big conjunction $\neg T_1 \wedge \cdots \wedge \neg T_{1,000,000}$ with one million conjuncts, which contradicts the certain fact that exactly one ticket will win.
>
> The problem does not only arise in precisely defined probabilistic settings (cf. Poole, 1991). First, non-statistical examples of the lottery paradox can easily be imagined. For example, for each arbitrary part of a complex machine we can rationally accept that it will not malfunction but at the same time we know that some part will at some point in time malfunction. Moreover, the problem arises in any model of 'fallible' rational acceptance. Rational acceptance is usually fallible, either because one starts from uncertain premises or because one applies defeasible inferences. Now whenever a deductive inference is made from at least two 'fallible' pieces of information, the deductive inference can be said to aggregate the degrees of fallibility of the individual elements to which it is applied. This in turn means that the deductive inference may be weaker than either of these elements, so that a successful attack on the deductive inference does not necessarily imply a successful attack on one of the fallible elements to which it was applied.

As a way to formalise these insights, I modified *ASPIC*$^+$ to allow attacks on the conclusions of deductive inferences provided that the strict inference rule was applied to the conclusions of at least two fallible subarguments. How does this square with my above description of deductive inferences in an argument as inferences of which it is irrational to accept all premises while not accepting it conclusion? And how does it square with my above design recommendation not to allow attacks on the conclusion of deductive inferences? I now believe that something I overlooked in my 2016 paper was that, although an argument with a deductive final inference can be weaker than *each* of the subarguments to which the deductive inference is applied, it cannot be weaker than the *aggregated* weakness of all these subarguments. With defeasible inferences this is different: even if applied to infallible subarguments, they can create a fallible argument. In other words, while deductive inferences only propagate existing uncertainty, defeasible inferences add new uncertainty. (An interesting question is how the aggregated uncertainty in a collection of arguments can be formally characterised but that is beyond the scope of the present paper). So when defining deductive inferences in an argument as inferences of which it is irrational to accept all premises while not accepting their conclusion, the terms 'accept' and 'acceptance' have to be read as denoting full acceptance, without leaving any room for uncertainty. It is this sense in which my informal definition of deductive argumentation agrees with the standard philosophical definitions of deductive validity as quoted above in Section 1. Now since arguments often apply deductive inferences to sets of premises or intermediate conclusions that are less than certain, this leaves some room for attacks on the conclusions of deductive inferences. Having said so, an alternative solution may be to modify the *ASPIC*$^+$ notion of undermining attack into Besnard and Hunter (2001)'s *defeaters* or *undercuts*, which attacks do not negate of imply the negation of a particular premise but only negate or imply the negation of some subset of the premises.

7. Conclusion

In this paper I have aimed to meet a challenge posed to me by Philippe Besnard, namely, to explain when argumentation is deductive. The core of my answer was that deductive argumentation is argumentation in which all arguments are deductive. I then answered the question what are deductive arguments in two ways: with Philippe's own answer with Tony Hunter that deductive arguments are arguments in which no inference introduces uncertainty, and by my (arguably equivalent) answer that deductive arguments are arguments of which it is irrational to accept all premisses but not the conclusion. I then argued that to verify whether this is the case, the semantics of the language in which information and over which inference rules are expressed should be taken into account. A purely syntactic base logic approach may have its merits but is not suitable for expressing the philosophers' (Pollock, 1995; Rescher, 1977) distinction between deductive and defeasible arguments, which is essentially a semantic distinction. For similar reasons a purely syntactic base logic approach is not suitable for defining notions of attack on defeasible arguments.

To conclude this paper, I would like to say something about what I have learned from Philippe's work on formal argumentation. First, his work with Tony Hunter (Besnard & Hunter, 2001, 2008) has taught me a lot about how classical-logic argumentation can be formalised. As I was quoted on the book cover:

> This book makes an impressive case for the power and richness of a deductive approach to argumentation. It demonstrates true scholarship, and is a must for logicians, computer scientists, and AI researchers studying argumentation.

Second, his work with Leila Amgoud in Amgoud and Besnard (2013) has taught me how this work on classical argumentation can be generalised into a general account of deductive argumentation. With Sanjay Modgil I have in Modgil and Prakken (2013) tried to incorporate this work in *ASPIC*$^+$.

Finally, Amgoud and Besnard (2013)'s results on embedding deductive argumentation in Dung (1995)'s theory of abstract argumentation frameworks have made me even more aware of the limitations of a fully deductive approach to argumentation. Among other things they show for abstract-logic argumentation, under the assumption that a Dung framework contains all arguments that can be logically constructed, that with suitable notions of premise attack the stable extensions of an abstract argumentation framework coincide with maximally consistent subsets of the knowledge base. This result is not only technically significant but, in my opinion, has the important philosophical implication that a truly rich and general formal theory of argumentation should leave room for defeasible arguments in the sense of Pollock. I am not sure if Philippe would agree with this but in our email discussions he at least agreed with me that non-deductive argumentation can be rational.

To end on a personal note, while I have not interacted much with Philippe at a personal level during conferences, in my email discussions during 2013 I was particularly impressed by his intellectual honesty. He gave me a hard time but on good grounds and always with full respect. This is how it should be.

Note

1. The same point was made with a different example in Modgil and Prakken (2013, Section 6.1).

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