

EVALUATING CORROBORATIVE EVIDENCE

Douglas Walton

Department of Philosophy, University of Winnipeg, Canada

Chris Reed

School of Computing, University of Dundee, UK

In this paper, we study something called corroborative evidence. A typical example would be a case of witness testimony evidence. One witness testifies she saw the accused leaving the crime scene, but her testimony, by itself, may not be all that strong as evidence. However, when a second witness testifies independently, saying that he also saw the accused leaving the crime scene, this new evidence corroborates the testimony of the first witness, making it stronger as evidence. Corroborative evidence does not always have to be testimonial. It can sometimes be circumstantial, as in the case where I check to see whether my watch is keeping the right time by asking a friend what her watch says. I may think my watch is right, but this may be corroborated by my friend saying that her watch has the same time. Of course, both watches may be wrong, making the point that corroborative evidence is fallible.

In this paper we use two tools to study how to evaluate this kind of evidence.¹ One is the argument diagramming system Araucaria (Reed and Rowe, 2005) and the other is the argumentation scheme (Reed and Walton, 2005)². Deploying these tools will lead us to two different methods of evaluating corroborative evidence.

1. Defining Corroborative Evidence

Corroboration, more broadly, however, might be taken to apply to any case in which one item of evidence boosts up the value of another item of evidence higher than it was before. The following definitions for ‘corroborate’ are given by the Oxford English Dictionary:

5. To strengthen (an opinion, statement, argument, etc.) by concurrent or agreeing statements or evidence; to make more sure or certain; to support, confirm: said a. of a person; b. of the confirming statement. 1706 POPE Let. to Walsh 22 Oct., I am glad to corroborate [these observations] by some great authorities. 1751 JOHNSON Rambler No. 153 {page}2 My narrative has no other tendency than to illustrate and corroborate your own observations. 1791 Gentl. Mag. 32/1 He appears to have taken uncommon pains to corroborate all his assertions by an appeal to original authorities. 1820 W. IRVING Sketch Bk. I. 88 He recollected Rip at once, and corroborated his story in the most satisfactory manner. 1860 TYNDALL Glac. I. vii. 54 This observation corroborates those of Professor Forbes. 1878 HUXLEY Physiogr. 54 The simple explanation..has been corroborated by subsequent investigators.

{dag}6. intr. To concur in testimony. Obs. rare.

1776 G. SEMPLE Building in Water 23 These...nearly corroborate with the Soundings at R.

¹ Many of the issues discussed relate to questions studied in a recent paper on argument evaluation (Goddu, 2003), but we have not has space to comment, in order to fit the length requirements.

² Helpful discussions of how these tools are proving to be important both in artificial intelligence and law are provided in (Reed and Norman, 2003).

That definition #6 is listed as obsolete/rare surprised us, as it that represents how we originally assumed we were using it. However, it became apparent to us, after some reflection on examples, that corroborative evidence, although prominent as an aspect of witness testimony, applies to other kinds of arguments as well, like argument from sign and argument from expert opinion. Suppose we find some contusions on branches at the edge of a trail and conclude that a bear came along the path. Then we find bear tracks visible on the path. This new evidence would be called corroborative.

Wigmore (1913: 751), it seems, takes a different tack, with corroborative evidence functioning as specific new items to boost existing evidence.

“*Corroborative* evidence; *i.e.* for *circumstantial* evidence, strengthening the inference, closing up other possible explanations (No third person was near the parties when the knife was found); *fortestimonial* evidence, supporting it by closing up possibilities of testimonial error (Witness stood close by, was not excited, was disinterested spectator).”

In this way, Wigmore's notion of corroborative evidence is probably best accounted for as linked argumentation.

In this paper, we will begin by adopting a broad approach, like Wigmore's that allows the term corroborative evidence to be applied both to testimonial and circumstantial evidence. We include subspecies of both kinds of evidence fitting under several argument schemes recognized in the literature on argumentation theory.

2. Logical Problems with Evaluating Corroborative Evidence

The example of the clock and gun case³ illustrates the thesis that not all instances of collaborative evidence are of the witness testimony type. It also shows that some cases of mutual collaboration are problematic.

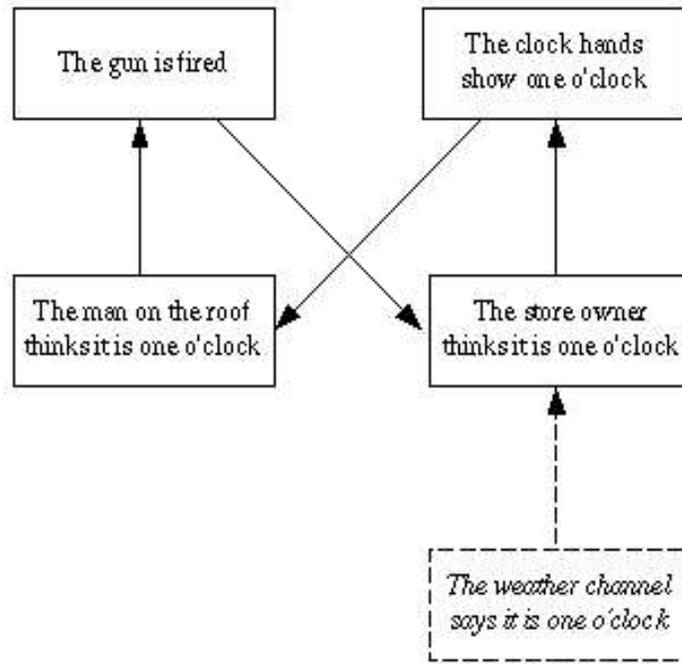
The Clock and Gun Case

An efficiency expert visiting a factory was told that the workers knew when to return to work because a gun was fired at exactly one o'clock by a man standing on the roof. When asked how he knew it was one o'clock, the man on the roof said that he verified the time by looking across the street to the clock on the store. The efficiency expert then asked the store owner how he verifies the accuracy of his clock and the store owner replied that he checks it against the firing of the one o'clock gun.

In the clock and gun case, the firing of the gun indicates that it time to return to work. That accuracy of that indicator is confirmed by collaborating evidence: the reading of the clock on the store, showing the same time. The chain of reasoning in the case is diagrammed in the figure below.

Figure 1: Argument Diagram for the Clock and Gun Case

³ The original version of the clock and gun case can be found in (Walton, 1984, p. 16).



The reasoning in this case looks like it involves arguing in a circle, suggesting the possibility of the *petitio principii* fallacy. But really, if you look at the argument diagram more carefully, the sequences of reasoning exhibits the pattern of an infinity symbol (?). Ignoring the statement in the dotted box at the bottom, the remaining four statements are locked into this infinitely cycling flow. However, when you take the statement in the dotted box into account, there is a noncircular chain of reasoning going from it to the box above it, to the box above that, and thence to the box containing the statement ‘The man on the roof thinks it is one o’clock’. Since we assume that the data in the dotted box has been verified independently of any of the other evidence represented on the diagram, once this implicit premise has been inserted and taken into account, the infinity-like circularity pattern in the diagram is no longer worrisome. The evidence provided by the weather channel is now corroborating the time criterion used by the man on the roof. Hence the apparent circularity is no longer a problem.

Or consider the following argument that might represent evidence in a typical legal case of evidence in criminal law.

Example of a Convergent Argument

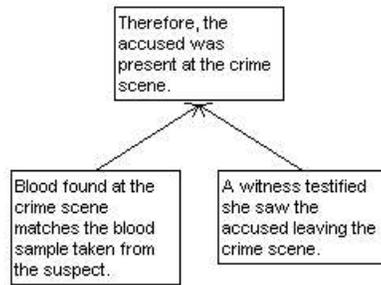
Blood found at the crime scene matches the blood sample taken from the suspect.

A witness testified she saw the accused leaving the crime scene.

Therefore, there is evidence that the accused was present at the crime scene.

As shown in the diagram in figure 1 below, this argument is classified as convergent.

Figure 2: Example of an Argument Diagram with Two Kinds of Evidence



In this convergent argument, each premise provides an independent reason to accept the conclusion. Each of the two premises shown at the bottom represents an independent line of evidence supporting the conclusion shown at the top of the diagram. Of course, the evidence in such a case would typically be expanded by drawing a larger diagram. The premise on the left could be part of argument from expert opinion based on the testimony of a forensic expert. The argument on the right could be fitted into the argument scheme for appeal to witness testimony, and by providing further details of the testimony.

Still the simple case represented in figure 2 presents a problem. The expert testimony evidence might be very strong, and thus might corroborate the witness testimony, making it appear much more credible to the jury. But should this effect be discounted as committing the fallacy of double counting? Looking at the diagram in figure 1 again, each premise independently supports the conclusion. Each offers a certain amount of probative weight as evidence for that conclusion. But if we are also claiming that one premise offers probative weight supporting the other, isn't that counting the weight of this premise twice? Wouldn't that be illogical?

3. Corroboration in Arguments from Expert Opinion

As suggest in section 1, we allow many kinds of examples of arguments with different schemes that might be included under the category of corroborative evidence. Let's begin with the scheme and critical questions for argument from expert opinion, also called appeal to expert opinion (Walton, 1997).

Appeal to Expert Opinion (Walton, 1997, p. 210)

Major Premise: Source *E* is an expert in subject domain *S* containing proposition *A*.

Minor Premise: *E* asserts that proposition *A* (in domain *S*) is true (false).

Conclusion: *A* may plausibly be taken to be true (false).

The six basic critical questions are stated in (Walton, 1997, p. 223).

1. *Expertise Question:* How credible is *E* as an expert source?

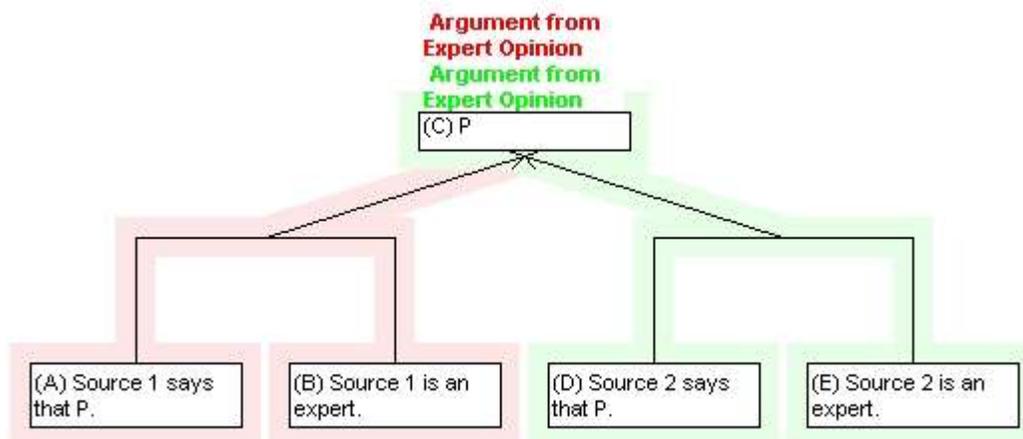
2. *Field Question*: Is *E* an expert in the field that *A* is in?
3. *Opinion Question*: What did *E* assert that implies *A*?
4. *Trustworthiness Question*: Is *E* personally reliable as a source?
5. *Consistency Question*: Is *A* consistent with what other experts assert?
6. *Backup Evidence Question*: Is *A*'s assertion based on evidence?

The critical questions are used to evaluate the argument by probing into its potentially weak points. If an independent appeal to expert opinion agrees with an initial appeal to expert opinion, the potentially weak point CQ5 is strengthened. The new argument corroborates the old one by refuting any potential counter-arguments that might stem from inconsistency with what other experts assert.

To generalize from these two cases, what seems to happen is that corroboration by an independent argument that forms a convergent structure with the original one works because a critical question is headed off at the pass. But of course, this solution takes us to the more general problem implicit in the analysis of all schemes. Should the potential gaps in the argument be expressed as additional premises of the scheme or as critical questions matching the scheme? This general problem won't seem to go away, for as Bart Verheij (2003) pointed out, once the schemes are formalized, the balance between critical questions and premises will be standardized better. Still, even now we can get a general picture of how corroboration works. It fills gaps by anticipating objections, thus making the original argument more plausible than it was before. Often the boost in plausibility of the new argument is slight, but can be increased by adding in still more corroborative evidence from a series of successive arguments.

To try to diagram corroboration in a case of appeal to expert opinion, we begin with the basic situation of the convergent argument in which there are two independent arguments from expert opinion.

Figure 3: Corroborative Expert Opinion Evidence



This is fine, so far. We have argument 1 on the left and argument 2 on the right. The basic structure is that of a convergent argument. Thus under the old rule, we take the stronger argument of the pair, and judge the plausibility of the conclusion *C* by that

method of plausibility evaluation. But how is it that argument 2 could boost up the plausibility that should be assigned to C, even if it is no stronger than argument 1?

The boost effect occurs where there are (1) two arguments directed to the same conclusion, (2) the first argument supports the conclusion with some degree of plausibility, (3) the second argument also supports the conclusion with some degree of plausibility, and (4) when the complete effect of the second argument is factored in, the outcome is that the degree of plausibility with which first argument supports the conclusion is increased from its previous value. Factor (4) is the value of the “boost”, or increase in the old degree of plausibility given by the first argument.

Now we turn to the problem of avoiding double counting while still accounting for the boost effect. In figure 4 we consider the kind of case where source 1 says that proposition P is true, and this assertion can be taken as probatively strong. Independently, source 2 asserts the same proposition, and this assertion can also be taken as probatively strong. So far so good, it is a typical case of two linked arguments, each one of which is an argument from expert opinion, and the two together form a convergent argument supporting the proposition P. But next, it is natural to also consider the hypothesis that when source 2 says that P, that proposition can be taken as corroborative evidence supporting the proposition that source 1 says that P is probatively strong. Indeed, as shown in figure 4, the proposition that source 2 says that P, if probatively strong, would make the proposition that source 1 says that P probatively very strong.⁰

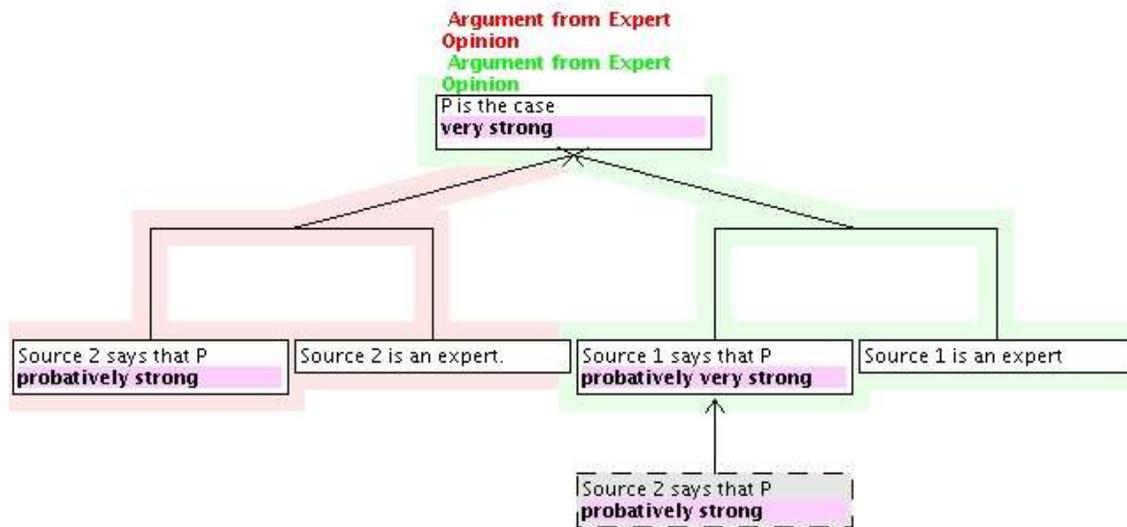


Figure 4: Plausibility and Corroboration

In figure 4, the proposition that source 2 says that P appears twice. First it appears in the link to argument from expert opinion on the left. Then it appears as an implicit premise supporting the proposition that source 1 says that P in the linked argument from expert

⁰ At any rate, it would make it stronger, and let's say that in the kind of case we are considering, depending on how we are rating argument strength by some standard, it would make it very strong.

opinion on the right. This seems to be a form of double counting. We already have source 2 independently saying the same thing as source 1, and each of these arguments corroborates the other, meaning that it presents new evidence that boosts up the conclusion derived from the other one to make it stronger. But then the problem is that once we start considering the critical questions, we see that consistency with what other experts assert, once taken into account, boosts up the argument in a different way. Indeed, in such a case we could say that each of the arguments provides an implicit premise that answers the consistency critical question affirmatively, thus boosting up the other argument. It is a kind of mutual boost effect.

To try to explain how such a mutual effect works, we need to adopt the method of seeing corroboration as providing an anticipatory response to critical questions matching a scheme. This method fits OED definition #5 above. It offers a broad definition of 'corroboration', which could certainly encompass the giving of anticipatory answers to critical questions (or at least those critical questions of the type for which burden of proof is shifted). But then, how can we model the critical questions as part of the evaluation carried out using an argument diagram?

There are two ways the secondary argument could be seen as corroborating the initial one by increasing its plausibility value. The method we have already assumed is to see the new argument boosting up the plausibility value of one or more of the premises of the old one. But there is a second hypothesis. It is that the new argument proactively rebuts a possible attack on the old argument by answering a critical question. This method could be modeled on a diagram by inserting an implicit premise saying that what source 1 says is consistent with what other experts say. Then argument 2 would support that implicit premise, boosting up support for C. But is the consistency with what other experts say and additional premise, or should it be seen only as a critical question? We get into the recurring issue here of whether critical questions can be modeled as implicit premises.

One approach is to say that some critical questions can be seen as presumptions of the original argument while others need to be seen as exceptions to it (Walton and Gordon (2005)). On this approach, if an issue in a dialogue has been raised about a premise in an argument, acceptability depends on the proof standard associated with the issue. Two special kinds of premises are distinguished, presumptions and exceptions. Presumptions not at issue are taken to be acceptable, while exceptions not at issue are presumed not to be acceptable. A presumption, on this account, is like an implicit premise that is assumed to be true, while an exception is like a premise that is assumed to be false until new information might come in that shows it to be true. On this analysis, the critical questions for the argument from expert opinion are of two different kinds. The expertise question, field question, opinion question and backup evidence question are assumed to be true. When you put an argument from expert opinion forward, you presume the source is credible, or has some knowledge, you presume that the expert is an expert in the field of the claim made, you presume that the claim made can be extracted from what the expert said, and you presume the expert's assertion was based on some evidence in the field of knowledge. Asking any of these critical questions makes the argument default until an appropriate answer is given. The trustworthiness and consistency critical questions are different, however. They are exceptions. To show the expert is not personally reliable, for example that she is biased,

some evidence of bias has to be given. To show that the expert's claim is not consistent with what other experts say, some evidence of such an inconsistency must be given. Just asking either of these critical questions is not enough, without some backup, to make the original argument default.

How can we explain the boost effect, in the kind of case shown in figure 4 above, on this analysis, when the opinion of the second expert corroborates that previously put forward by the first expert? There was a presumption that other experts don't disagree. What happens when one other expert agrees? This new development offers some evidence against an exception arising. It doesn't mean that the third expert consulted will also agree. She might not. But the more experts we get agreeing to the original claim, the more plausible it is that the claim is consistent with what the other experts assert. Thus argument 2 tends to rebut the counter-arguments that the claim is inconsistent with what other experts say. Hence it makes the original argument slightly more plausible, creating a boost effect, and thereby corroborating it.

How should corroboration be diagrammed, on this approach? In diagramming an argument, once the distinction has been drawn between presumptions and exceptions, critical questions matching a scheme can be inserted as implicit premises. An exception to argument 1 could be inserted as a missing premise stating the negative proposition that other experts do not disagree. Suppose that source 2 says that P, and that what this source says can be taken as probatively strong. This evidence boost up the value of the implicit premise that other experts do not disagree, and this effect, let's say, has a boost effect on the plausibility of the conclusion, making to very strong.

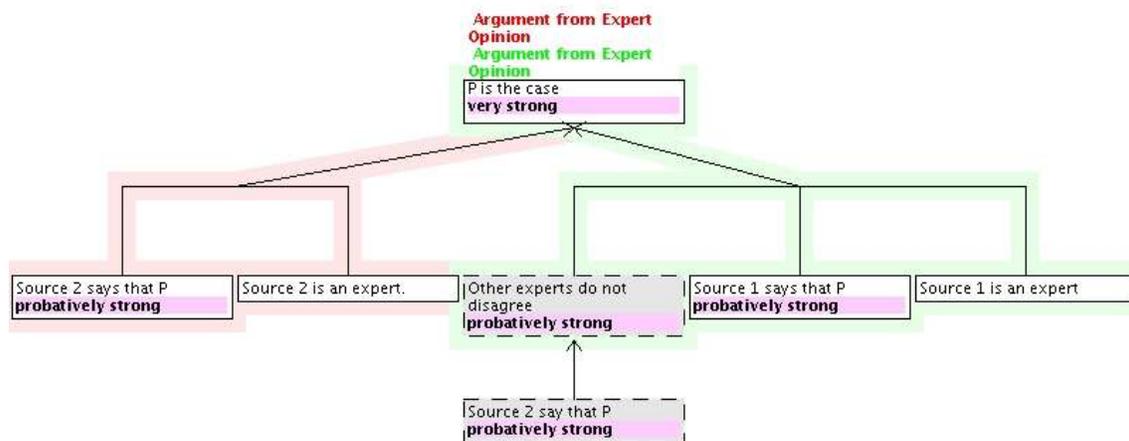


Figure 5. Diagramming Scheme-based Boosting Up

Let's assume that initially, there was no evidence so far on whether the argument was supported or undermined by evidence about what additional experts say. What happens when such evidence becomes available and is factored in? This missing premise is boosted up, because an exception is defeated or undermined by the new evidence. The exception would arise if there is evidence that other experts disagree. When this assumption is defeated by the new evidence telling us that, so far as we now know, other experts do not disagree, the outcome is to boost up the value of the ultimate conclusion.

We are not convinced that this is the ultimate solution to the problem posed by corroboration of expert testimony of one source by another, but it gives us a way of moving ahead with a solution to the problem by suggesting how the new evidence might fit in by affecting the evaluation of a missing premise of the original argument.

4. Corroborative Witness Testimony

Let's now go back to corroboration in witness testimony. Here is the argumentation scheme for appeal to witness testimony as presented in chapter one of *Argumentation Methods for Artificial Intelligence in Law* (Walton, 2005, p. 13).

Scheme for Appeal to Witness Testimony

Position to Know Premise: Witness *W* is in a position to know whether *A* is true or not.

Truth Telling Premise: Witness *W* is telling the truth (as *W* knows it).

Statement Premise: Witness *W* states that *A* is true (false).

Warrant: If witness *W* is in a position to know whether *A* is true or not, and *W* is telling the truth (as *W* knows it), and *W* states that *A* is true (false), then *A* is true (false).

Conclusion: Therefore (defeasibly) *A* is true (false).

Five Critical Questions Matching the Appeal to Witness Testimony

CQ1: Is what the witness said internally consistent?

CQ2: Is what the witness said consistent with the known facts of the case (based on evidence apart from what the witness testified to)?

CQ3: Is what the witness said consistent with what other witnesses have (independently) testified to?

CQ4: Is there some kind of bias that can be attributed to the account given by the witness?

CQ5: How plausible is the statement *A* asserted by the witness?

How could corroboration for convergent arguments be defined in relation to arguments fitting this scheme? For example, suppose witness 1 says *P* and witness 2 independently also says *P*. The old rule was that in this convergent argument, we just take the stronger of the two arguments and go with that. The new approach violates the old rule. The new approach says that by corroborating the testimony of witness 1, the testimony of witness 2 boosts up the plausibility value of the testimony of witness 1.

There are two ways the secondary argument could be seen as corroborating the initial one by increasing its plausibility value. One is that the new argument boosts up the plausibility value of one or more of the premises of the old one. But there is a second hypothesis. It is that the new argument refutes (or undermines) CQ3 as a possible attack on the old argument. What this means is that the new argument gives a positive answer to CQ3 by affirming that what the witness said is consistent with what other witnesses have (independently) testified to. It presents an instance of this consistency, and the more instances it presents, by offering independent testimony from witness 3, witness 4, and so on, the more plausible the initial argument will be. So this is quite a nice hypothesis, in that it enables us to explain how incremental additional independent testimony sequentially boosts up the plausibility value of the initial argument.

Now we can go back to appeal to witness testimony, and analyze corroboration in the same way. We have one appeal to witness testimony, argument 1, and then a second one, argument 2, that corroborates the first one because witness 2 says the same thing as witness 1. CQ 3 for the witness testimony scheme is classified as an exception. If another witness disagreed with what witness 1 said, that would be an exception, and would make the appeal to witness testimony less plausible. But as it happens, what witness 2 says agrees with what witness 1 says. That undermines the exception, or goes against it. Thus it corroborates the original appeal to witness testimony.

The problem remains of how the critical questions that correspond to presumptions, as opposed to exceptions, affect corroboration. They are even more straightforward to evaluate. Positive evidence makes the presumption more plausible, which might affect the original argument by making its plausibility value greater. Negative evidence will detract from the plausibility of the premise, thereby possibly affecting the plausibility of the original argument.

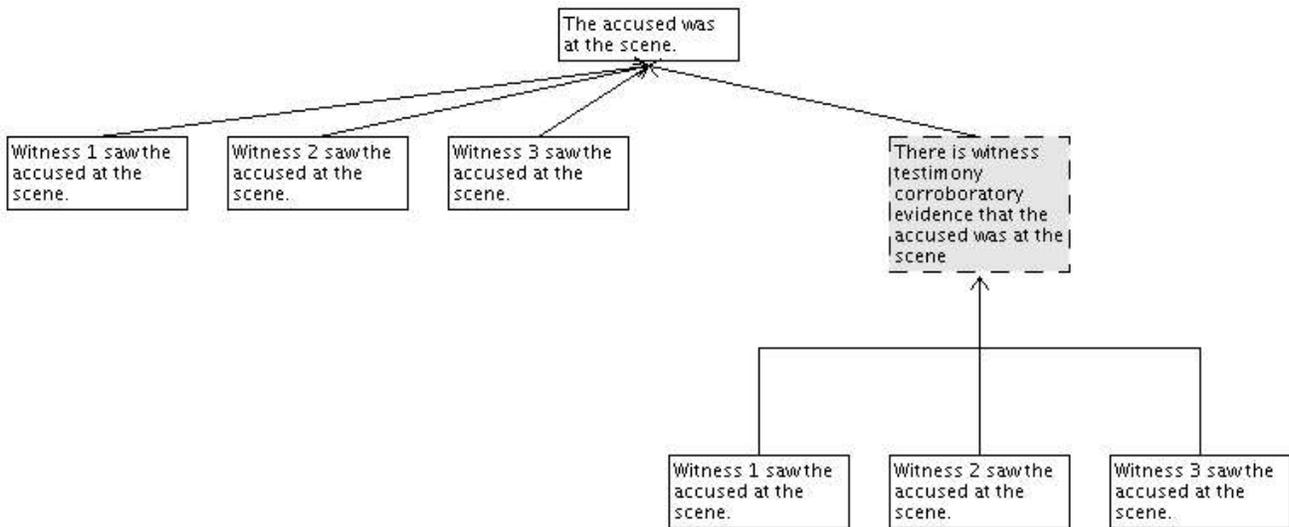
There are several advantages of this approach. One is that provides a way of evaluating cases of corroboration so that we can draw a clear distinction between the ordinary case of the convergent argument, where each premise is independent of the others, and the case of a corroborative pair of arguments. Another is that we can model the argument evaluation to show the plausibility boost occurs in a case of corroboration. Another is that we can do this by evaluating the nodes and arrows on the diagram, along with argumentation schemes and classifying critical questions as presumptions or exceptions. We don't need to bring in other dialectical notions.

This solution is still very sketchy, and needs some examples diagrammed, and many aspects worked out, but it provides a strong candidate approach. On this new approach, we use the old argumentation schemes, like appeal to expert opinion and appeal to witness testimony, and corroboration is evaluated as an upgrade due to bolstering of an implicit premise. The key is to model critical questions as premises that are either presumptions or exceptions. The corroboration of argument 1 by argument 2 is explained as follows. Argument 2 increases the plausibility of a premise (possibly an implicit premise) in argument 1, thus making for an upgrade (possibly slight) in the plausibility value of argument 1. We can also have negative corroboration, or undermining of one argument by another, where some new evidence lessens the plausibility of previous evidence.

5. Another Solution: An Argument Scheme for Corroborative Evidence

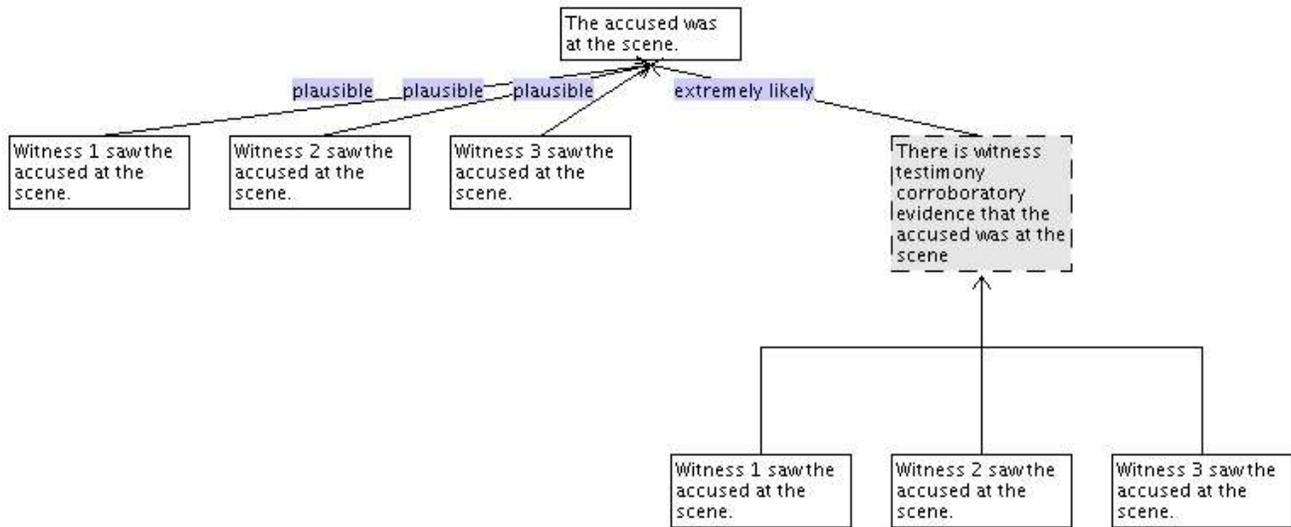
Dealing with corroboration specifically in the context of multiple witness testimony motivates the exploration of an alternative account that has some merits. How is it that such corroboration is working? Each premise in the witness testimony is lending some fixed degree of support to the conclusion. But in virtue of their all being witness testimony, they *in addition* provide corroborative support. Perhaps then, we might analyze corroboration as a separate line of support as in figure 6.

Figure 6: Corroboration in Multiple Witness Testimony



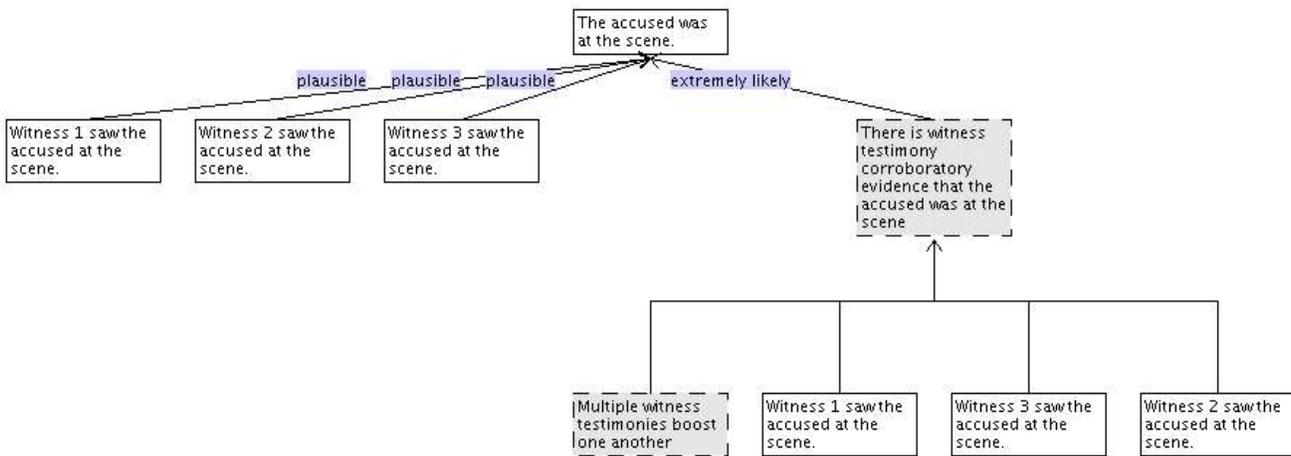
Each piece of testimony evidence might alone contribute a relatively small weight of evidence to the conclusion. But when taken together, another line of support is provided by their combination. That line of support may convey much greater support than any one on their own. Of course, in order for that second line of support to be constructed, it requires all of the testimonies to be taken together, that is, to be drawn together in a linked argument. To emphasize the way in which the evaluation of the argument is working, one might annotate the figure above as in figure 7.

Figure 7: Corroboration in Multiple Witness Testimony with Values



This analysis begs the question of what sort of argument the corroborative argument is, and how the premises can be drawn together in the appropriate way. It is almost as if there is an implicit premise, expressing that multiple witness testimonies together convey a boosted degree of evidence, as shown in figure 8.

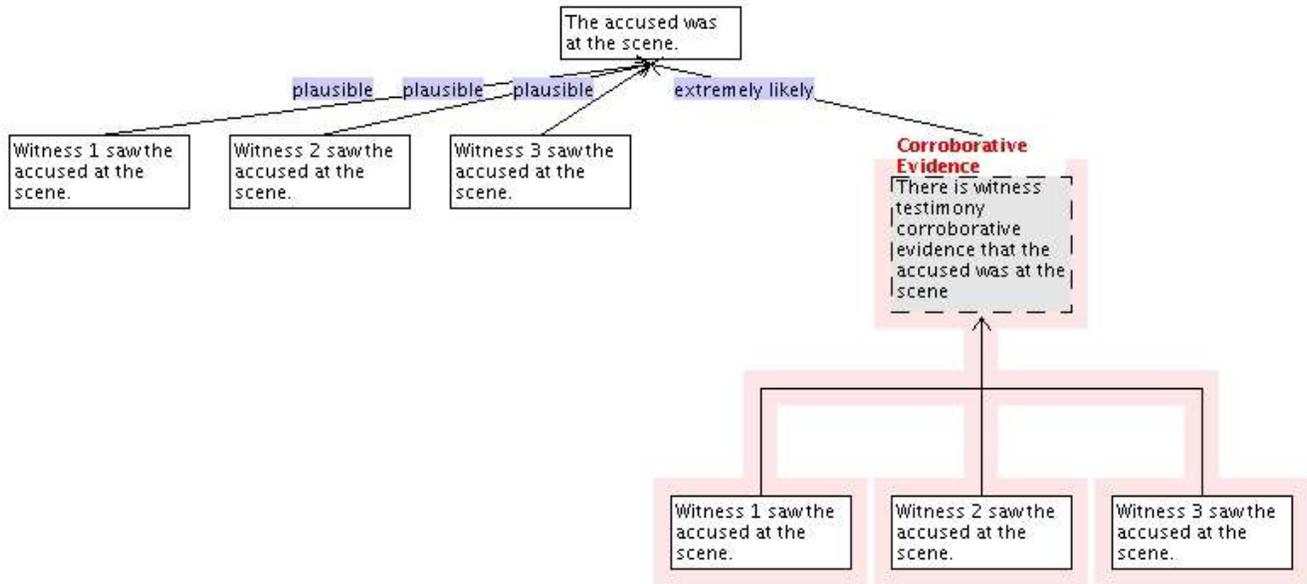
Figure 8: Multiple Witness Testimonies Boosting Evidence



But, this form of reasoning is a stereotypical pattern, so rather than simply adding in a new implicit premise, perhaps a more consistent approach is to employ an argumentation scheme that encapsulates the notion of corroborative evidence, as shown in figure 9.

Figure 9: Argument Scheme for Witness Testimony Corroborative Evidence

The scheme for corroborative evidence runs thus:



Argument Scheme for Corroborative Evidence

Premise P1: There is an item of evidence E1 for claim C

...

Premise Pn: There is an item of evidence En for claim C

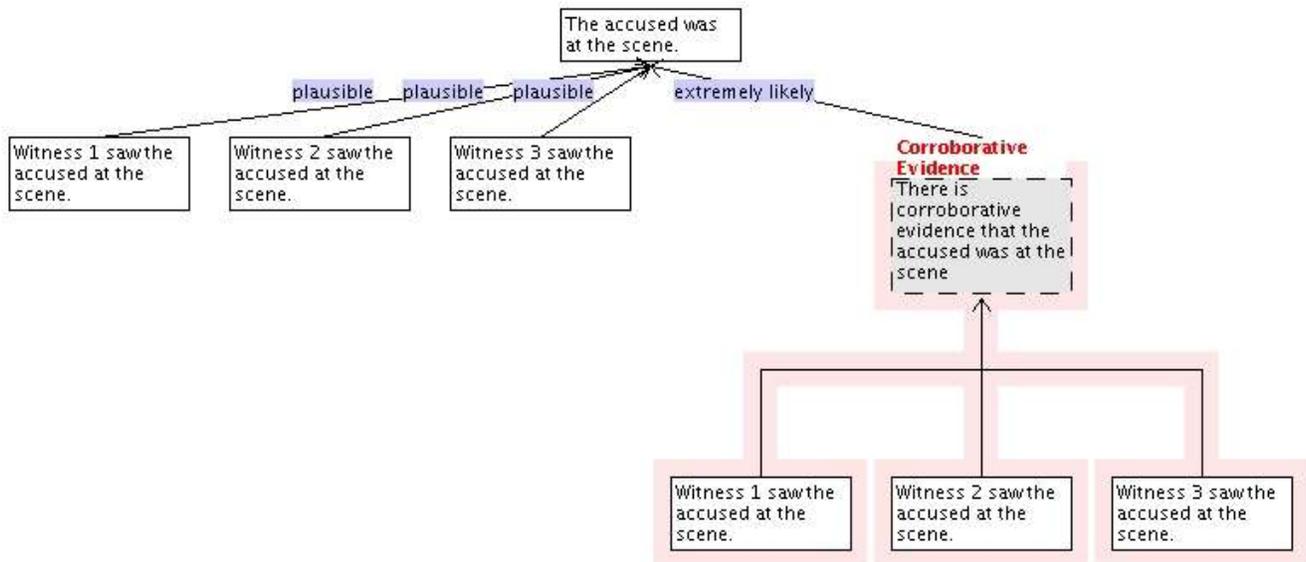
Premise P0: All of the items of evidence E1 ... En corroborate

Conclusion C1: There is corroborative evidence for claim C

Of course, this scheme can be entirely general, and apply to any sort of evidence, not just witness testimony, so we should modify our analysis to simplify the implicit conclusion. This is shown in figure 10.

Figure 10: Corroborative Evidence with Implicit Conclusion Simplified

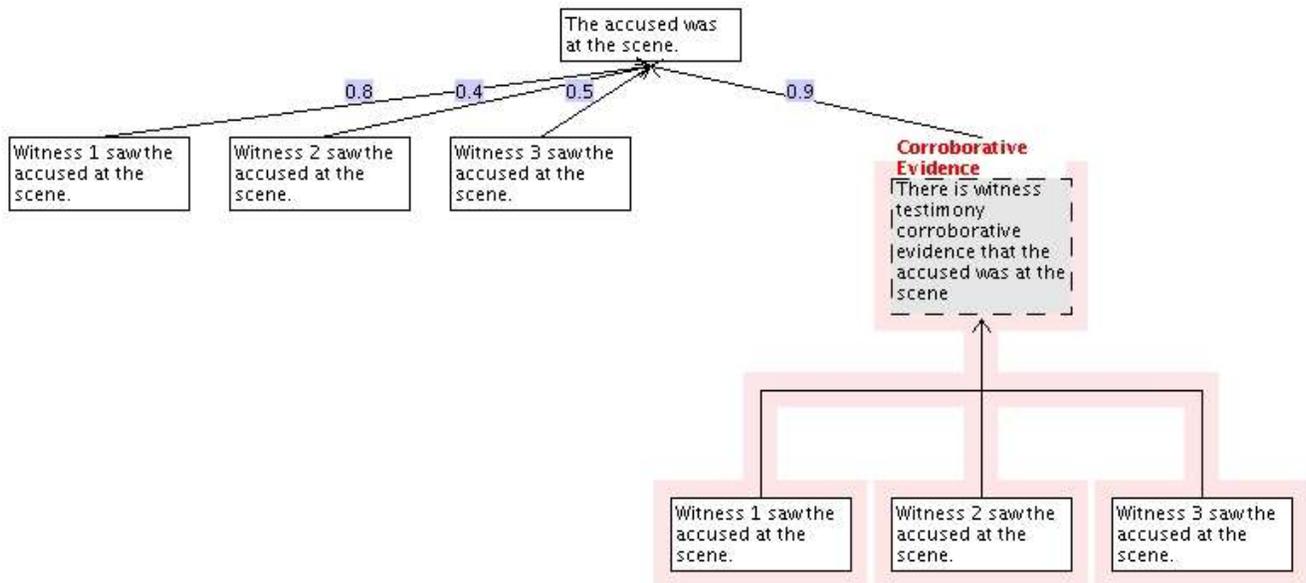
The significant boost test is in this way equivalent to the asking of a critical question associated with the Corroborative Evidence scheme:



Critical Question CQ1: Do the items of evidence really corroborate?

Finally, the degree to which the corroborative evidence supports the conclusion is not dependent upon the degree to which the individual items of evidence support the conclusion, because the degree to which they support the conclusion may be different from the degree to which they contribute to the scheme. Though numerical evaluations are fraught with difficulties, we might repeat our analysis using probabilistic values to highlight this independence. If, say, witness 1 is known to be reliable, whereas witness 2 is of poor character, and witness 3 has poor eyesight, then we might assign their testimonies 0.8, 0.4 and 0.5 respectively. Though the testimonies of witnesses 2 and 3 are somewhat unreliable, they nevertheless boost and are boosted by the testimony of witness 1. Taken together, we may say that the strength of the combined evidence is greater – say 0.9. This is shown in figure 11.

Figure 11: Witness Testimony with Numerical Probability Values



6. Conclusions

We have arrived at two different solutions to the problem of how to evaluate corroborative evidence. As a historical note, each of us developed one of these solutions independently of the other. However we won't say which author advocated which theory. Each of us advocates his own theory, but each of us is also quite happy to be proved wrong. We will leave it up to the audience to judge which theory is better, or perhaps in the end that judgment will need to be made by further investigations. We think each solution is workable, but it may turn out that one is easier to work with, is more elegant, or has better consequences than the other.

According to the first method, the corroborating argument supports one of the premises of the original argument. In doing so, the corroborating argument can boost up the plausibility value of the conclusion of the original argument by supporting that premise, which in turn contributes to the strength of the original argument. We also looked at the variation on this method in which the corroborating argument proactively rebuts a possible attack on the original argument by answering a critical question. This solution, however, can become a little complicated because it takes us into the issue of whether and how critical questions can be modeled as implicit premises in an argumentation scheme.

The second method postulates a new argumentation scheme for corroborative evidence. The nice thing about this method is that the new scheme can apply to cases of circumstantial corroborative evidence as well as testimonial. We have shown how this method can be applied very easily using an argument diagram, showing how there is a significant boost and the plausibility value once the corroborative evidence is factored in.

Each method has its pros and cons. We think that either method will work, and will provide a significant advance for evaluating corroborative evidence of the kind we defined at the beginning of the paper.

References

Goddu, G. C. (2003) Against the “Ordinary Summing” Test for Convergence, *Informal Logic* 23 (3), 215-236.

Reed, C.A. & Norman, T.J. (2003). *Argumentation Machines*. Dordrecht, Holland: Kluwer.

Reed, C. & Rowe, G. (2005). Araucaria, Version 3. Available free at <http://www.computing.dundee.ac.uk/staff/creed/araucaria/>.

Reed, C. & Walton, D. (2005). Towards a Formal and Implemented Model of Argumentation Schemes in Agent Communication. *Autonomous Agents and Multi-Agent Systems*, 11: 173-188.

Verheij, B. (2003). Dialectical Argumentation with Argumentation Schemes: An Approach to Legal Logic. *Artificial Intelligence and Law*, 11, 167-195.

Walton, D. (1984). *Logical Dialogue-Games and Fallacies*, University Press of America, Lanham, Maryland. Available free at <http://io.uwinnipeg.ca/~walton/books/LDG84bk.pdf>

Walton, D. (1997). *Appeal to Expert Opinion*, Penn State University Press, University Park, Pa.

Walton, D. (2005). *Argumentation Methods for Artificial Intelligence in Law*, Berlin, Springer (Lecture Notes in Artificial Intelligence Series), 2005.

Walton, D. and Gordon, T. F. (2005). Critical Questions in Computational Models of Legal Argument. IAAIL Workshop Series, *International Workshop on Argumentation in Artificial Intelligence and Law*, ed. Paul E. Dunne and Trevor Bench-Capon, Nijmegen, Wolf Legal Publishers, 2005, 103-111. Available on web page of D. Walton.

Wigmore, J. H. (1913) *The Principles of Judicial Proof as given by Logic, Psychology and General Experience and illustrated in Judicial Trials*, Little, Brown and Company: Boston.