THE THREE BASES FOR THE ENTHYMEME: A DIALOGICAL THEORY

Abstract

In traditional logic, an enthymeme is said to be an argument, or chain of argumentation, with one or more missing (implicit) premises or conclusions. In this paper a new theory of enthymemes, based on recent developments in argumentation technology including argumentation schemes, argument visualization tools and formal dialogue systems, is put forward. The dialogical theory hypothesizes three bases for the enthymeme in a formal dialogue system CBVK: (1) the participants' commitment sets, (2) sets of argumentation schemes (especially including presumptive schemes) shared by both participants, and (3) a set of propositions representing common knowledge shared by both participants. The formal dialogue system CBVK is the backbone of the theory of enthymemes into which these three components are built. Three examples of enthymemes of a kind commonly found in everyday conversational argumentation are used to show how the theory applies.

0. Introduction

There has been an enormous literature on the topic of enthymeme, as the reader can see by clicking on the Scholar icon in Google and inserting the term 'enthymeme' in the search box. This literature spans several fields, including logic and rhetoric. Although there is much writing on the nature and importance of enthymemes, and their function in argumentation, very little appears to be known about how they actually work. We are very far from developing an automated system of analyzing enthymemes that can fill in the implicit premises or conclusions that should be inserted for purposes of logical analysis of an argument, but that were not explicitly stated in the given text of discourse. However, some recent interdisciplinary work between the fields of argumentation theory and artificial intelligence has made a few small steps toward this ultimate goal. It will be argued here that combining some resources under development in these two fields is the best program of research for making further progress.

This paper presents a new theory based on three preceding papers on enthymemes. The first paper (Walton, 2001) showed how enthymemes are often based on implicit premises that can be classified as falling under the heading of common knowledge. This paper did not develop a general solution to the problem of enthymemes, but did analyze several examples of them found in ordinary conversational argumentation, showing that implicit premises based on common knowledge are commonly found in argumentation. The second paper (Walton and Reed, 2005) showed how argumentation schemes, representing forms of commonly used defeasible types of arguments, can be applied to an argument found in a text of discourse, and used to reveal implicit premises needed to make the argument fit the requirements of the scheme. This method of reconstructing enthymemes was shown to be valuable in revealing needed premises in an argument with implicit premises, even though it was conceded that it did not provide an automated enthymeme system that could be mechanically applied to a given argument in a text of discourse to reveal any implicit premises or conclusions in the given argument. The third paper (Walton and Macagno, 2006) surveyed research on common knowledge in artificial intelligence, combined that with an account of how law deals with evidence based on

common knowledge[1], and showed how these resources help to provide a fuller understanding of how the notion of common knowledge works in argumentation.

This paper develops the results of these previous three papers further by adding a third basis of the enthymeme, in addition to argumentation schemes and common knowledge, arguers' commitment, and provides a general dialectical theory of enthymemes into which all three components are built. Three examples of enthymemes are used to illustrate the three bases of the enthymeme. The structure of the argumentation in each of the examples is displayed for the reader on an argument diagram that shows the missing premises, along with the explicit premises taken from the text of discourse, and that presents an analysis connecting the premises and conclusions in the sequence of argumentation. The problem posed is how to find the bases for the insertion of these missing premises and conclusions into the analysis displayed on the diagram. The argument of the paper is that we have to go beyond the structure of the argument presented on the diagram and look into the dialogical structure of the argumentation, using resources from formal dialogue theory.

1. Previous Work on Enthymemes

According to the analysis of enthymemes that will be put forward in this paper, an enthymeme is defined as an incomplete argument found in a text of discourse.[2] More precisely, some components of the argument can be found as explicit premises or conclusions stated by its proponent, but some other statements need to be filled in as premises or conclusions before it can be determined precisely what the argument is. In many cases, the missing assumption is a premise. But in other cases, it can be a conclusion that needs to be added to the premises before a precise account of the argument can be given. In still other cases, we are confronted in the text of discourse with a chain of arguments in which the conclusion of one argument also functions as a premise in the next argument in the chain. These kinds of cases are more complex, because the missing statement can be a premise as well as a conclusion.

On this definition, an argument has an explicit set of premises $\{P_1, P_2, ..., P_n\}$ and an ultimate conclusion, C, that can, along with an implicit set of statements $\{Q_1, Q_2, ..., Q_n\}$ be added to the explicit set to generate C by a chain of valid[3] inferences. Some instances are very simple, in that all you need to do is add one of the implicit statements to the existing explicit set in order to prove the ultimate conclusion. Other instances are more complex, and involve a chaining of single arguments. In these instances, there is a chaining forward from the explicit premise set of interim conclusions needed to connect up these two sets of statements to the ultimate conclusion C, producing new implicit statements that act as implicit premises or conclusions. This type of argument can be represented as a box and arrow argument diagram, where each statement (premise or

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[1] See (Walton and Macagno, 2005) for a fuller treatment of common knowledge in legal reasoning.
[2] This meaning of the term 'enthymeme' supposedly derives from Aristotle, and has been accepted by nearly everybody who writes on the subject (with some notable exceptions, like Sir William Hamilton), but as Burnyeat (1994) showed, it may be a historical misnomer.
[3] The term 'valid' is used in a broad sense, referring not only to deductively valid arguments, but to inductive and other kinds of defeasible arguments that can be structurally correct by standards other than those for deductive logic.

conclusion) is represented by a text box, and each inference is represented by an arrow, joining a set of boxes representing the premises to a box representing the conclusion. Examples of such argument diagrams are given in section 2.

The classic example is the argument: all men are mortal; therefore Socrates is mortal. As pointed out in many a logic textbook, you need to insert the premise that Socrates is a man in order to make the argument into a valid syllogism. But what are the grounds for inserting this proposition as a premise if it was not explicitly stated by the proponent who put forward the argument about Socrates? The problem (Burke, 1985; Gough and Tindale, 1985; Hitchcock, 1985) is that if a critic is allowed to fill in any proposition needed to make such an inference valid, he or she may be inserting assumptions into the text of discourse that the speaker or audience do not accept, or were not meant by the proponent to be part of his or her argument. There is even the danger of committing the straw man fallacy by attributing an implicit premise or conclusion to a speaker's argument that exaggerates or distorts the argument in order to make it easier to refute (Scriven, 1976, pp. 85-86). An opponent of the given argument may sometimes do this as a tactical move to attack the argument, but such a move would be inappropriate in a critical discussion. Indeed it would violate the rule of the critical discussion that an attack on a viewpoint must represent the viewpoint that has really been advanced by the protagonist (van Eemeren and Grootendorst, 1992, pp. 208-209).

However, in this instance there are two grounds for justifiably inserting the missing premise that Socrates is a man. One is that such an insertion is needed to make the argument convincing. Ennis (1982, pp. 63-66) drew an important distinction between needed and used assumptions. A needed assumption in an argument is a set of missing propositions such that (1) the argument is not structurally correct as it stands, but (2) when the propositions in question are inserted, the argument becomes structurally correct (deductively valid, in the Socrates example). A used assumption in an argument is a proposition that, even though not explicitly stated in the text of discourse, is meant to be part of the argument by the speaker (and is likely to be so taken by the hearer or audience). The difference between these two kinds of implicit assumptions inserted into an argument, according to Ennis (1982, p. 64), is that used assumptions are "unstated reasons", while needed assumptions may not be. Another difference is that finding the needed assumptions is a process that can be carried out mechanically, in some instances at any rate, for example as in the Socrates case, where syllogistic rules or techniques can be used to fill in the missing premise. The other ground for justifiably inserting the missing premise is that it is common knowledge that Socrates is a man. We all know this because Socrates is a very important figure in the history of philosophy, so much so that something is known about him not only by students of philosophy, but by the majority in the general population as a matter of common knowledge.

Govier (1992, p. 120), categorized a proposition as a matter of common knowledge if it states something known by virtually everyone, offering the examples, 'Human beings have hearts' and 'Many millions of civilians have been killed in twentieth-century wars' (p. 120). Freeman (1995, p. 269) categorized a proposition as a matter of common knowledge if many, most, or all people accept it. He added that qualification that popularity is never sufficient to warrant acceptance, because of the danger of committing the fallacy *argumentum ad populum*, or fallacious appeal to popular opinion, instead of

giving proper support for a claim. Govier (p.120) also added the qualification that what is taken to be common knowledge can vary with time, place and context.

Common knowledge has also now become an important subject for investigation in artificial intelligence because building machines to carry out practical tasks often requires programming the machine with some knowledge about the everyday circumstances of the situation in which the machine will have to function and carry out tasks. The open mind common sense system (OMCS)[4] included the following statements (Singh, Lin, Mueller, Lim, Perkins and Zhu, 2002, p. 3) under the category of common knowledge.

People generally sleep at night.
If you hold a knife by its blade then it may cut you.
People pay taxi drivers to drive them places.

These statements are defeasible generalizations that can be expected to hold generally, but can be defeated in specific cases by exceptions to the rule, only some of which can be anticipated in advance. To cite the most familiar example in computing, it is a common knowledge generalization that birds fly, but this generalization is defeated in the special situation in which the bird is a penguin.

Common knowledge can be represented in computing by what is called a frame, a data structure for representing a stereotyped situation, like going to a child's birthday party (Minsky, 1974, p. 2). The power of this theory lies in its inclusion of expectations and other kinds of presumptions (p. 3). Thus a frame can be a source of common knowledge used to fill in gaps, for example, in an argument with premises that were not explicitly stated. According to Minsky (p. 103), a traditional logical approach that represents reasoning based on such implicit assumptions, like syllogistic theory or classical deductive logic, will not work, because it is not flexible enough to represent everyday conversational reasoning. At least it will not work very well, and a system of defeasible reasoning that allows for exceptions and defaults, will work much better.

The kind of common knowledge that is very important in artificial intelligence and cognitive science is based on ordinary ways of doing things familiar to all of us in everyday life. According to Schank and Abelson (1977), this kind of common knowledge is based on what they call a *script,* a body of knowledge shared by language users concerning what typically happens in certain kinds of stereotypical situations, and which enables a language user to fill in gaps in inferences not explicitly stated in a text of discourse. Schank and Abelson used the restaurant story as an example. In this story, we are told explicitly that John went to a restaurant, the hostess seated John and gave him a menu, and John ordered lobster. Later, we're told, John left a tip, and left the restaurant. Given this story as an explicit text of discourse, we can infer some other implicit statements that fill in gaps in the story. Another example (Singh, Lin, Mueller, Lim, Perkins and Zhu, 2002, p. 3) is the utterance, "Bob had a cold. He went to the doctor". You could fill in missing assumptions that the cold made Bob feel uncomfortable, and he went to the doctor to seek help in relief for his discomfort. Such inferences, according to Schank and Abelson are based on common knowledge of a script, for example a story that connects together the normal sequence of events when one enters a restaurant and has something to eat, or goes to the doctor to seek help. This kind of common knowledge

is not, properly speaking in the philosophical sense of the term, knowledge. Rather, it represents plausible assumptions that can be filled in to supplement the account explicitly given of a coherent story representing some common event or sequence of actions that the parties filling in the missing assumptions are familiar with.[5]

According to Jackson and Jacobs (1980, p. 263), in order for rules of conversation to allow participants to engage in collaborative argumentation, there is a need to base many implicit assumptions on commonly shared knowledge. The basic idea is that in a critical discussion using reasonable argumentation the two parties cannot be allowed to dispute everything or they would never reach a resolution of a conflict of opinions in the dispute. They need to work within the limitation of forbearing from disputing statements that are not controversial in light of the central issue of the dispute. These might be assumptions like, 'Snow is white', or 'Los Angeles is in California'. Because such a statement is acceptable as common knowledge, it does not have to be proved in the normal course of the argumentation. This account suggests that common knowledge as used in a type of argumentation like a critical discussion is based on common acceptance of assumptions that are not worth challenging because no party to the dispute has any interest in challenging them. Challenging such a proposition would merely be a waste of time, as it would not prove or disprove anything in the dispute, or help to move it forward towards its goal of resolving the central conflict of opinions at issue. It has often been emphasized in pragma-dialectical studies that resolution of a conflict of opinions by rational argumentation depends on common starting points, or assumptions that both parties in the discussion share, and agree at the opening stage not to dispute during the later argumentation stage of the main issue to be resolved (van Eemeren and Grootendorst, 1992). These observations suggest the usefulness of pursuing the study of enthymemes in a dialectical framework in which the purpose of using an argument in a context of dialogue like that of a critical discussion is taken into account.

The possibility remains however that we might think that we could deal with enthymemes by just using a deductive logic, like that of the syllogism, to fill in missing premises or conclusions in an incomplete argument. This possibility has been argued against by van Eemeren and Grootendorst (1984, p. 127) using the familiar example of the argument that John is English therefore John is brave. This argument may seem to assume as an implicit premise the universal generalization that all English people are brave, making it into a deductive syllogistic type of argument. But is this interpretation of the argument very plausible? According to van Eemeren and Grootendorst (p. 127), it is not, because a more plausible interpretation of the implicit premise is the defeasible generalization that English people generally tend to be brave, subject to exceptions. This example is reminiscent of the defeasible generalization from artificial intelligence cited above: if you hold a knife by its blade then it may cut you. Such defeasible generalizations are not very well analyzed as being absolute universal generalizations of the kind associated with the universal quantifier in classical deductive logic. But the study of defeasible generalizations based on common knowledge surely moves enthymemes towards a dialectical analysis, for whether a defeasible generalization is defeated in the particular circumstances of a given case cannot be anticipated in advance.

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[5] There is another way of defining common knowledge that is widely known in game theory, economics and logic explained in the *Stanford Encyclopedia of Philosophy* (http://plato.stanford.edu/entries/common-knowledge), but it does not appear to be especially useful for the study of enthymemes.

Thus taking into account dynamic features of how a sequence of argumentation proceeds in a dialogue should be a necessary part of the analysis.

There is an additional reason for moving in this direction that concerns the drawing of implicit premises and conclusions by conversational implicature (Grice, 1975), as noted by van Eemeren and Grootendorst (1984, p. 120). One of the most famous cases is the one where a driver asked the person on the sidewalk where he could get some gas (Grice, 1975, p. 70). The person on the sidewalk replied, there is a gas station around the corner. It is suggested by conversational implicature that the person on the sidewalk thinks that the gas station is open, but he does not explicitly say this. Gricean implicature does not draw conclusions by deductive reasoning, but by a kind of contextual suggestion, often implied by innuendo. These kinds of implicit premises and conclusions are very common in everyday argumentation. They cannot be analyzed very well using techniques of deductive logic like syllogistic reasoning, because they depend heavily on the communicative context in which the given argument was used.

2. Examples with Box and Arrow Diagrams

The first example is an argument that was found in a web site called "Animal Freedom" (http://www.animalfreedom .org/english/opinion/argument/ignoring.html).

The Free Animals Example

Animals in captivity are freer than in nature because there are no natural predators to kill them.

The explicit conclusion is the statement that animals in captivity are freer than in nature. The explicit premise stated is that there are no natural predators to kill animals that are in captivity. This explicit premise would seem to be based on common knowledge, but the conclusion is, one might expect, subject to controversy. It could not plausibly be said to be classified as common knowledge. The first missing premise is the statement that there are natural predators to kill animals that are in nature. A second missing premise is the statement that if animals are in a place where there are no natural predators to kill them, they are freer than if they are in a place where there are natural predators to kill them. This second implicit premise takes the form of a conditional, but it could also be described as a kind of generalization. The first missing premise can correctly be classified under the heading of common knowledge, but the second missing premise is controversial. It seems to be based on the special position of the arguer, the position that goes against the usual arguments of animal rights activists. It seems to be based on a persuasive definition of the word 'free' that would very likely be disputed by those who are opposed to the argument, especially those who advocate the usual kinds of positions about animal rights. Whatever we are to say about the basis of this second premise, it is clear that we cannot say that it is based on common knowledge. It is controversial, and even seems to go against common knowledge, or against what would normally be taken to be the conventional wisdom about freedom of animals. On this conventional wisdom animals in the wild are freer than those who are held in captivity.

The argument diagram in figure 1 can help the reader to visualize the structure of the argumentation in the free animals example.
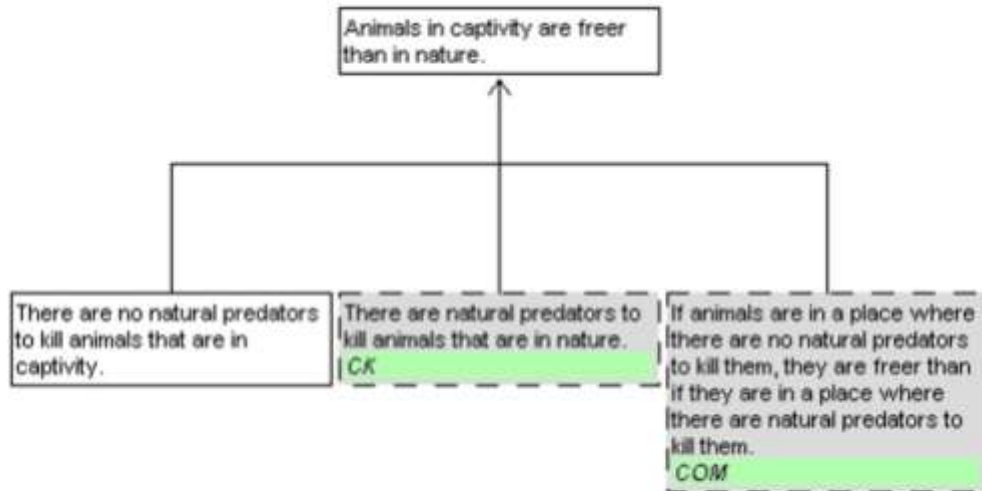
Figure 1: Argument Diagram of the Free Animals Example

In figure 1, the two premises on the right are enclosed in darkened boxes, with a broken line around the border of the box. These markers are meant to indicate that each of these statements is an implicit premise that is part of an enthymeme. The two implicit premises have been labeled as based on common knowledge (CK) and the arguer's commitment (COM). Figure 1 was constructed using the software tool available to help with argument diagramming called *Araucaria* (Reed and Rowe, 2003). It aids a user when constructing a diagram of the structure of an argument using a simple point-and-click interface, which may be then saved in a portable format called AML, or Argument Markup Language, based on XML (Reed and Rowe, 2002). The user inserts the text to be analyzed as a text document into *Arauacaria*. She can then use the cursor to highlight each explicit premise or conclusion in the argument. Next she can insert implicit premises or conclusions. Next, the user can then draw in arrows from each premise or set of premises to each conclusion it supports, and perhaps also use that conclusion as a premise in a next argument. Finally she can produce an argument diagram connecting all the premises and conclusions in one large diagram that appears on the screen and can be exported or printed.

The following example, originally from (Acock, 1985, p. 102), was analyzed in (Walton, 2001, p. 103).

The Dough Example

It is impossible to look through these old cookbooks without being struck by the quantity of dough which was crammed into the human system. Bread, rolls, biscuits, cakes and pastry are accorded the lion's share of their space (*Eating in America: A History*, by Waverly Root and Richard de Rochemont, p. 136).

The explicit conclusion expressed in the first statement can be paraphrased as saying that at some unspecified time in the past, "dough", or flour-based food, was eaten by a lot of people. The explicit premise is that bread, rolls, biscuits, cakes and pastry, were accorded the lion's share of the space in the cookbooks at that time. In addition to these two

explicit statements, two unstated premises can be added as implicit assumptions (Walton, 2001, p. 103).

Bread, rolls etc., are made (mainly) of dough.

Anything that was accorded the lion's share of the space [in a cook book of that time] was a kind of food that that was eaten by a lot of people.

The first premise fits under the general classification of an implicit assumption based on common knowledge. The second assumption is hard to classify. The comments made on it in (Walton 2001, pp. 103-104) are worth quoting.

There could have been some reason why a particular type of food was accorded the lion's share of space in a cookbook, even though that type of food was not eaten by a lot of people. But as a guess, or rule of thumb, you would probably be justified in assuming, in the absence of any indications or information to the contrary, that a cookbook would tend to give more space to recipes for foods that were eaten by a lot of people at the time. Why? Well, cookbooks tend to respond to popular demand by featuring dishes that are eaten by a lot of people, at any given time, because the authors generally want the book to be used, and to sell as many copies as possible. However, that assumption could fail in some cases. For example, suppose the cookbook was trying to reform or change tastes in a particular direction. Or suppose it was funded by a food producer who was trying to promote a certain type of food. Then there would be other reasons why a particular type of food might get the lion's share of attention in the recipes featured. So [this premise] is an assumption that probably holds true in the general run of cases, if there is no special information that suggests otherwise in the given case. But it is not a universal generalization in the absolute or 'for all x' type, of the kind we are so familiar with in deductive logic.

This premise could be roughly said to be based on a kind of common knowledge, but it is not the usual kind of common knowledge as cited in the previous example. The implicit assumption in this case could be better said to be based on what is called a common sense statement about the way things generally work in everyday practices. It makes sense to say that a cookbook would tend to give more space to recipes for foods that were eaten by a lot of people. We know this because we also know that cookbooks tend to respond to popular demand by featuring dishes that would be eaten by a lot of people. In turn we know this because we know that the authors of cookbooks want to respond to popular tastes in order to sell as many copies as possible. Thus the statement that anything that was accorded the lion's share of the space [in a cook book of that time] was a kind of food that that was eaten by a lot of people is plausible because it can be backed up by several supporting reasons that describe common ways of doing things that we all know about as a matter of common sense.

Another interesting aspect of this example is that when an argument diagram is constructed to show the sequence of argumentation leading from the explicit and implicit premises to the conclusion, it becomes apparent that a third implicit assumption needs to be inserted in order to derive the conclusion. All three implicit assumptions are shown in the argument diagram in figure 2 below.
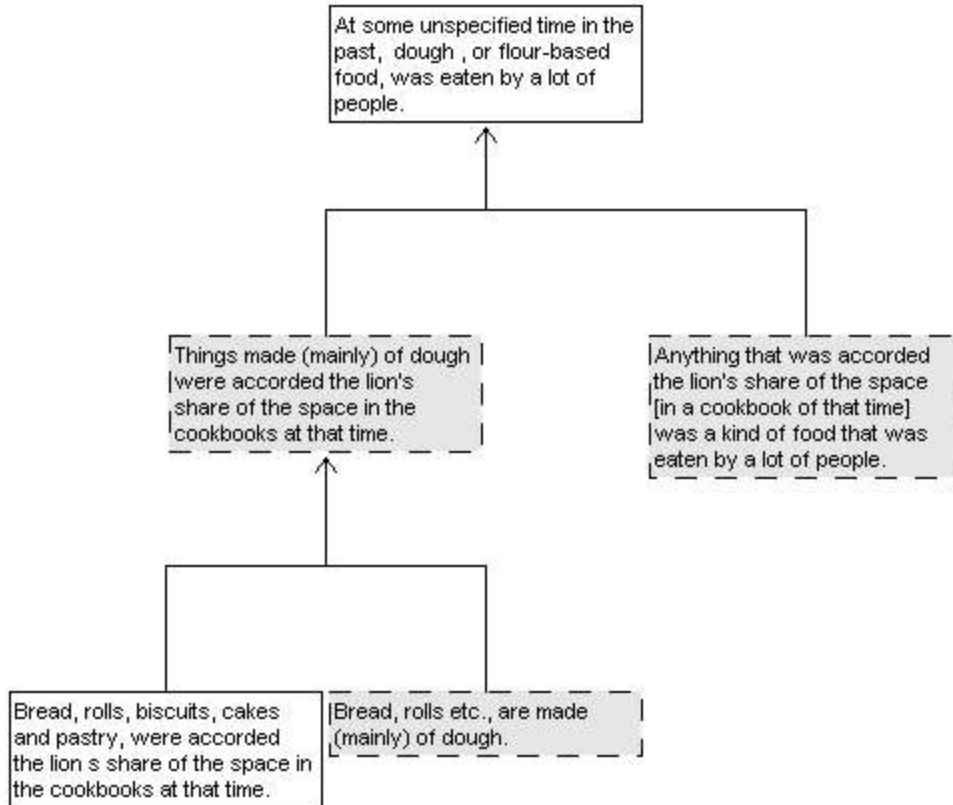
Figure 2: Argument Diagram of the Dough Example

Looking at the lower left part of figure 2, it can be seen that the linked argument at the bottom requires an intervening conclusion in order to enable it to function with the next linked argument to drive the ultimate conclusion. This intervening conclusion is the statement that things made mainly of dough were accorded the lion's share of the space in the cookbooks at that time. This missing conclusion also acts as a missing premise in the second link to argument shown above the first one. This missing assumption is not based on either common knowledge or the arguer's commitment. It is simply a needed assumption that functions both as a conclusion and as a premise in the chain of argumentation needed to drive the conclusion from the explicit premises and the other implicit premises in the argument.

The following example is part of a newspaper article from *The New Zealand Herald* (Tony Ratcliffe, 'Professionals Know How to Look After Circus Animals', January 9, 2004) found on Lexis-Nexis (11/13/2006).[6]

The Circus Animals Example

Animal activist groups put forward an emotional and philosophical argument, not a factual one [some text omitted here]. Circus animal owners and handlers are professionals and know first-hand the importance of

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[6] http://web.lexis-nexis.com/universe/document?_m=2aaccc75a1397f6f753c05a1fb5d862

healthy, well-adjusted animals. We are the true experts when it comes to animal welfare. Our animals are members of the family, loved and cared for just like family pets. Performing animals often live longer than other animals in captivity, and generally outlive their cousins in the wild. Independent studies by animal behaviour specialists, such as Dr. Ted Friend, of Texas A&M University, and England's Dr. Marthe Kiley Worthington, have concluded that the care and welfare of circus animals is equal to that of animals in zoos, stables, kennels and farms.

The text of the circus animals example has been quoted directly, except that some lines were deleted at the place indicated. Also, after the text quoted, other arguments were put forward supporting the general conclusion of the text.

The explicit premises and conclusions of the argument in the circus animals case are listed below.

Animal activist groups do not believe that animals should be exhibited in circuses.
Their arguments are not factual.
Circus animal owners and handlers are professionals and know first-hand the importance of healthy, well-adjusted animals.
Circus animal owners and handlers are the true experts when it comes to animal welfare.
Circus animals are members of the family, loved and cared for just like family pets.
Performing animals often live longer than other animals in captivity, and generally outlive their cousins in the wild.
Independent studies by animal behavior specialists, such as Dr. Ted Friend, of Texas A&M University, and England's Dr. Marthe Kiley Worthington, have concluded that the care and welfare of circus animals is equal to that of animals in zoos, stables, kennels and farms.

Two implicit assumptions can be added that function in the role of implicit premises or conclusions in the argument.

Circus animals are healthy and well-adjusted.

Dr. Friend and Dr. Kiley are experts

The first assumption is a conclusion drawn from the two premises (1) that circus animal owners and handlers are professionals and know first-hand the importance of healthy, well-adjusted animals, and (2) that circus animal owners and handlers are the true experts when it comes to animal welfare. These two premises form an argument from expert opinion used to derive the conclusion that circus animals are healthy and well-adjusted. This conclusion is in turn used as a reason to argue against the claim that the arguments of the animal activist groups are not factual. The other missing premise is also part of an argument from expert opinion used to support the same conclusion.

The argument diagram in figure 3 is very helpful to show how all these implicit and explicit statements work together to form the chain of argumentation in the circus animals example. Another feature of *Aracuaria* is illustrated by this example. The user can insert argumentation schemes by selecting them from a menu and applying them to specific arguments in the chain of argumentation displayed on the diagram.

Circus animals are members of the family, loved and cared for just like family pets.

Circus animal owners and handlers are professionals and know first-hand the importance of healthy, well-adjusted animals.

Circus animal owners and handlers are the true experts when it comes to animal welfare.

Argument from Expert
Opinion

Argument from Expert
Opinion

Circus animals are healthy and well-adjusted.

Independent studies by animal behavior specialists, such as Dr. Ted Friend, of Texas A&M University, and England's Dr. Marthe Kiley Worthington, have concluded that the care and welfare of circus animals is equal to that of animals in zoos, stables, kennels and farms.

Dr. Friend and Dr. Kiley are experts.

Their arguments are not factual.

Performing animals often live longer than other animals in captivity, and generally outlive their cousins in the wild.

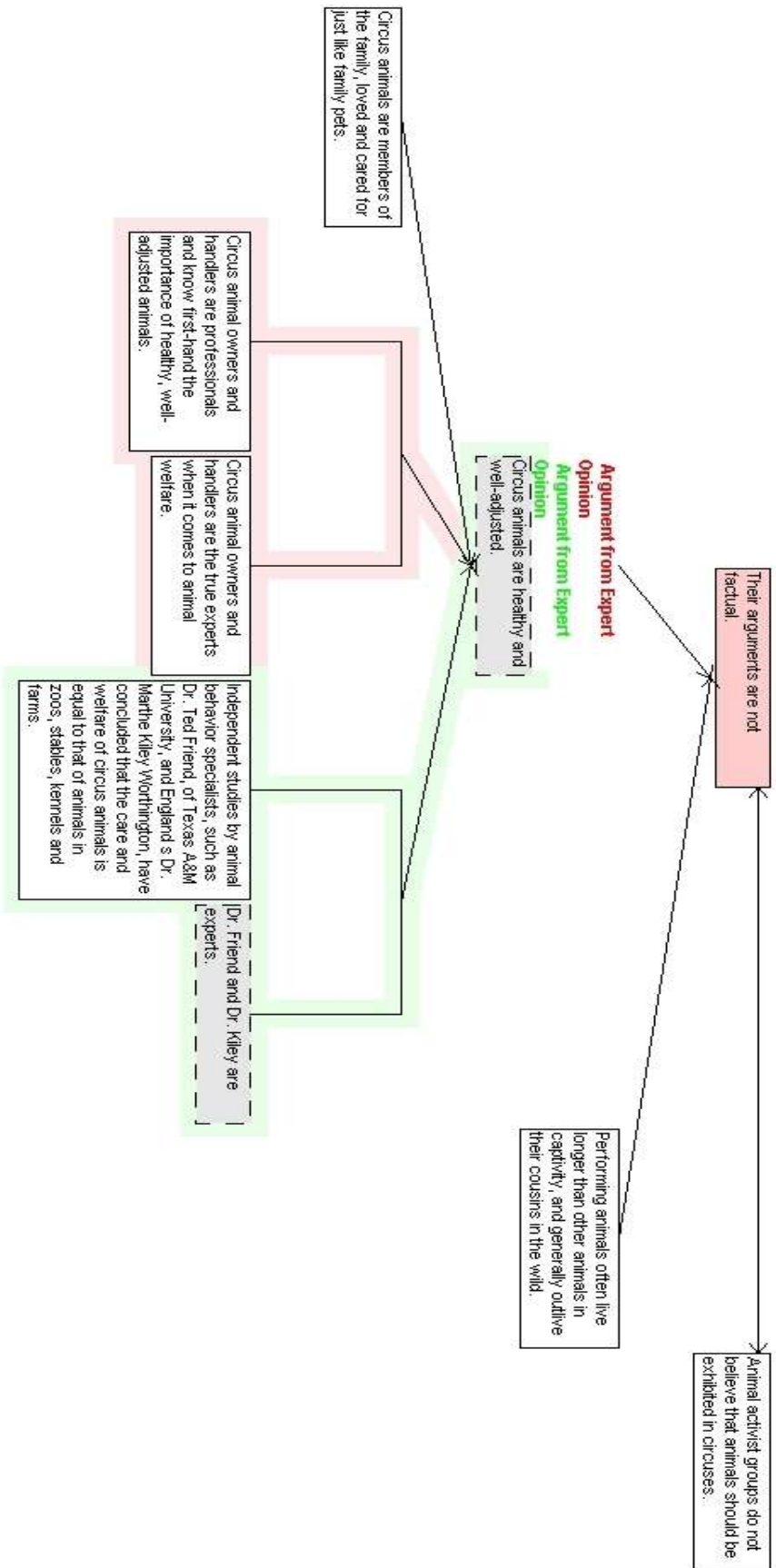Animal activist groups do not believe that animals should be exhibited in circuses.

Figure 3: Argument Diagram of the Circus Animals Example

In figure 3, the statement that the arguments of the animal activist groups are not factual is joined by a double arrow to the statement that the animal activist groups do not believe that animals should be exhibited in circuses. The double arrow represents refutation, a notion similar to that of negation in classical logic. The first statement, that the arguments of animal activist groups are not factual, is enclosed in a darkened box, indicating it is the refutation. Two other statements are also enclosed in darkened boxes, but each of them has a broken line around the border of the box, indicating they are part of an enthymeme. Finally, the reader needs to note that the two linked arguments are marked by a colored border that surrounds them along with a colored label corresponding to each that marks the argumentation scheme for each argument. Both arguments are instances of the argumentation scheme for argument from expert opinion.

Next we need to address the question of where the missing premises came from that were inserted into the argumentation shown on the diagram in figure 3. The proposition that circus animals are healthy and well adjusted functions as the conclusion of the two arguments from expert opinion, but it also functions as a premise in the argument supporting the refutation statement that the arguments of the animal activist groups are not factual. It can be classified as a needed assumption because it enables the argumentation to bridge the gap between the two arguments below it based on argument from expert opinion and the refutation above it. But let's look at this missing premise more closely. Is it based on common knowledge? The answer is clearly negative, because the proposition that circus animals are healthy and well adjusted would not be accepted by animal activist groups. Nor would it be generally accepted as a matter of common knowledge. Quite to the contrary, most people would have doubts about the truth of this proposition, and that is the reason why such an array of arguments is put forward to support it in this example. However, it does fit very well with the commitments of the proponent of this argument against the claim of animal activist groups who believe that animals should not be exhibited in circuses. Thus there are two grounds that can be brought forward to support its insertion as a missing premise. One is that it is a needed assumption to connect up the chain of argumentation in order to fill a gap and make that argumentation plausible. The other is that it is a proposition that the proponent of the argument would be committed to. It fits in with his position as someone who is defending the use of performing animals in circuses. Indeed, it is hard to see the point of this proponent's argument as a whole unless we take this needed assumption to be part of it. This example illustrates very well the thesis that in some cases an implicit premise is based not on common knowledge but on the arguer's commitments.

The other missing premise is the statement that Dr. Friend and Dr. Kiley are experts. This statement can be inserted as an implicit assumption because it is a required premise in the argumentation scheme for argument from expert opinion that the other premise clearly seems to be a part of. It is to be expected that there can be other ways of interpreting and analyzing this argument, but the analysis shown on the argument diagram offers a usual way of summarizing a plausible analysis of it that helps to show how the implicit assumptions fit into the chain of argumentation and can be represented in it by argumentation schemes. So analyzed, this example is an interesting one because it

shows how an argumentation scheme can be used to find the missing premise needed to prove the conclusion, which is in turn needed to support the arguer's ultimate conclusion.

These three examples are relatively easy cases of enthymemes to analyze. To cite an example of a hard case consider the following argument attributed to Johnnie Cochran[7] during his defense of O.J. Simpson: "The glove doesn't fit [the defendant], so you must acquit". To fill in the missing premise, you could always adopt the quick strategy of inserting the following conditional: if the glove doesn't fit the defendant, you must acquit him. But why is this conditional accurately applicable to the case? To see why, one has to fill in a lengthy sequence of argumentation linking up the glove as evidence to the ultimate conclusion to be proven by Cochran in the trial, namely the proposition that Simpson is not guilty of murder. This sequence of argumentation requires quite a large number of other propositions that have to be inserted as implicit premises, for example the proposition that the glove was found at the scene of the crime, and the proposition that it was supposedly worn by the murderer. In effect, quite a large mass of evidence that would make up an impressively large argument diagram would have to be fitted together and join up the ultimate conclusion to the premise that the glove doesn't fit.

Another question posed by this kind of example concerns the depth of analysis required to fill in the missing premises and conclusions in an enthymeme. In a case like this, how far is one required to go to fill in all the missing assumptions that join the explicit conclusion to the explicitly given premises? We return to this question in section 5, in connection with a further discussion of the dough example.

3. Dialogue Systems for Revealing Implicit Commitments

In order to define the notion of an enthymeme even more precisely, we also have to take context into account. Basically, every argument is more than merely a set of premises and a conclusion, i.e. a designated set of statements. The conclusion needs to be seen as a claim that is asserted by the proponent of the argument in a context of dialogue. In such a context there is a second party involved, called the respondent. The proponent puts the argument forward in order to remove the doubts of the respondent about the conclusion. The premises offer reasons to the respondent to come to accept the conclusion, even though he did not accept it before, and had doubts about it. In the formal theory of Hamblin (1971, p. 130) a move in a dialogue is defined as a triple $\langle n, p, l \rangle$, where n is the length of the dialogue, defined as the number of moves made, p is a participant, and l is a locution (nowadays called a speech act). An example of a dialogue with three moves takes the following form: $\langle 0, P_0, L_4 \rangle, \langle 1, P_1, L_3 \rangle, \langle 2, P_0, L_2 \rangle$. At move zero, the proponent P_0 begins the dialogue by making a move of type 4. At move 1, the respondent P_1 replies by making a move of type 3. Thus on Hamblin's model, a dialogue is a sequence of argumentation made up of small connected steps of single moves of this sort. The set of moves is finite, and is closed off at some point by a rule. One important type of move is the speech act putting forward of an argument.

In some instances, however, this two-participant model will be insufficient for our purposes. For in some cases of enthymemes, the dialectical context is more complex than being a two party framework. Sometimes the dialogue needs to be seen as a three party

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[7] http://en.wikipedia.org/wiki/Enthymeme

framework in which an argument analyst, supposedly a neutral party, is attempting to reconstruct the argument prior to analyzing, criticizing or evaluating it. This third party examines the text of discourse and makes decisions which statements can or cannot be reasonably inserted as missing premises or conclusions in order to take the incomplete argument and make a fully expressed argument out of it. In order to carry out this task, the argument analyst needs to give reasons to support his or her view that a particular statement can be taken as an implicit premise or conclusion of the argument. These reasons are based on the text of discourse, partly on the explicit wording of the text, and partly on contextual matters pertaining to common knowledge and other matters of that sort.

The dialectical theory put forward here is initially built on the Hamblin model. Each of the two primary parties, the proponent and the respondent, takes turns making moves in a sequence of dialogue. Each move has the form of a speech act, for example, one speech act is that of putting forward an argument. Another speech act is that of asking a question, for example a question that may express doubts about an argument just put forward by the other party. In this model, each party has what is called a commitment set or commitments store, governed by commitment rules that apply to each speech act that is a move in the dialogue (Hamblin, 1970; 1971). For example, when a proponent puts forward an argument, the conclusion is taken to be a claim made by that proponent, and therefore the statement made in the conclusion is automatically inserted into the proponent's commitment set (Mackenzie, 1981). Normally, each statement that is presented by the proponent as a non-explicit premise of the argument is also inserted into her commitment set. The possible exception is represented in the kind of case where the proponent is merely arguing hypothetically, and is not meaning to assert categorically that these premises are commitments of hers. At any rate, as is a standard feature in formal models of dialogue, a system of dialogue has commitment rules that govern how statements are inserted into or retracted from a participant's commitment set as she makes various moves in the dialogue.

Where a statement is explicitly made in a clear way by an arguer, either as an assertion or part of an argument, normally the commitment rule operates in a clear and precise fashion. But there are all kinds of borderline and dubious cases when it comes to dealing with implicit commitments. There can be all kinds of problems, for example when an argument has not been quoted but paraphrased, or where an implicit assumption may be needed to make the argument valid, but where the proponent may not only have not stated that assumption, but may even disagree with it. These kinds of problem cases have been studied in detail in the literature, for example in (Walton and Krabbe, 1995), but very little has been written on relating commitment-based dialectical models to specific problems arising out of examples of enthymemes.

Four formal dialogue systems were constructed in (Walton, 1994) as structures to model the kinds of argumentation used in connection with informal fallacies. The four systems start from a minimal one and proceed successively to stronger versions. The first system, called CB, is similar to the system H of Hamblin (1970) and the system DC of Mackenzie (1981). The general type of dialogue would nowadays be classified as a persuasion dialogue. There are two parties, called the proponent and the respondent. Each has a thesis to be proved as its ultimate conclusion, and it tries to devise strategies to prove this proposition using as premises only propositions that are commitments of the

other party. For its rules of inference CB uses only classical propositional calculus, even though many other defeasible rules of inference of the kind now called argumentation schemes can be added. There is a non-empty set of rules of inference in the game. *Modus ponens* is a rule, but rules that allow infinite repetitions like 'S, therefore $S \vee T$' are not included. Following Mackenzie (1981), a statement T is said to be an immediate consequence of a set of statements $S_0, S_1, ..., S_n$ if and only if 'S_0, S_1, ..., S_n, therefore T' is a substitution instance of an inference rule in the dialogue system. A statement T is said to be a consequence of a set of statements $S_0, S_1, ..., S_n$ if and only if T is derived by a finite number of immediate-consequence steps from immediate consequences of $S_0, S_1, ..., S_n$. CB is a simple dialogue system that does not allow for the more complex kinds of moves, like certain kinds of questions allowed by H, or commitments to challenges of the kind allowed in DC. CB is minimal because it is designed to study how strategies of proof work in persuasion dialogue in simple kinds of cases that involve basic problems of retraction of commitments.

Hamblin (1970; 1971) required that the commitment-store of each player be a set of public statements, for example a set of sentences written on a blackboard in view of all the dialogue participants. The rules for a system CBV are given below. CBV includes all the rules for CB, along with other rules that allow for implicit commitments as well as explicit commitments. CBV is based on the idea that there is a second set called implicit commitments that are not on public view to them to the participants. Each party has a commitment set divided into two subsets. One consists of the explicit commitments a party has gone on record as asserting. This set of propositions is on view to both parties. The other consists of a set that neither party can see, or get access to, unless something happens in the dialogue to reveal them. In CBV, implicit commitments of a party are revealed by being transferred from the implicit side to the explicit side, if the party having an implicit commitment tries to avoid acknowledging it. For example, suppose the party denies it is committed to a particular proposition, but it is somehow revealed that it is among his implicit commitments. In such a case, the party has to resolve the apparent inconsistency by either retracting the implicit commitment or going on record as accepting it as an explicit commitment. Thus the main feature of CBV is its revealing of implicit commitments in arguments. The rules of rules CBV are presented below, as they were given in (Walton, 1984, pp. 252-254).

The Dialogue System CBV

Locution Rules

(i) Statements: Statement-letters, S, T, U, . . . , are permissible locutions, and truth-functional compounds of statement-letters.
(ii) Withdrawals: 'No commitment S' is the locution for withdrawal (retraction) of a statement.

(iii) Questions: The question 'S?' asks 'Is it the case that S is true?'

(iv) Challenges: The challenge 'Why S?' requests some statement that can serve as a basis in proof for S.

Commitment Rules

(i) After a participant makes a statement, S, it is included in his commitment store.

(ii) After the withdrawal of S, the statement S is deleted from the speaker's commitment store.

(iii) 'Why S?' places S in the hearer's commitment store unless it is already there or unless the hearer immediately retracts his commitment to S.

(iv) Every statement that is shown by the speaker to be an immediate consequence of statements that are commitments of the hearer then becomes a commitment of the hearer's and is included in his commitment-store.

(v) No commitment may be withdrawn by the hearer that is shown by the speaker to be an immediate consequence of statements that are previous commitments of the hearer.

(vi) If a participant states 'No commitment S' and S is on the implicit side of his commitment store, then S is immediately transferred to the explicit side of his commitment store.

Dialogue Rules

(Rl) Each participant takes his turn to move by advancing one locution at each turn. A no-commitment locution, however, may accompany a why-locution as one turn.

(R2) A question 'S?' must be followed by (i) a statement S, (ii) a statement 'Not-S', or (iii) 'No commitment S'.

(R3) 'Why S?' must be followed by (i) 'No commitment S' or (ii) some statement T, where S is a consequence of T.

Strategic Rules

(i) Both participants agree in advance that the dialogue will terminate after some finite number of moves.

(ii) The first participant to show that his own thesis is an immediate consequence of a set of commitments of the other participant wins the game.

(iii) If nobody wins as in (ii) by the agreed termination point, the dialogue is declared a draw.

As a typical successful CBV dialogue continues, more propositions tend to come over from the implicit side to the explicit side in the commitments sets of both parties. A main

part of the interest of such a dialogue is how it reveals the implicit commitments of the arguers on both sides of the persuasion dialogue. Even CBV, however, will prove to be too simple for our needs. We have to add some other components.

In many cases of enthymemes, the structure of the immediate inference in the argument is not one of the deductive or inductive reasoning, like *modus ponens* or statistical syllogism. Instead, it is a presumptive type of argumentation scheme, like argument from expert opinion, argument from commitment or argument from analogy for instance. In the circus animals example, the argumentation scheme central to linking the parts of the argument together was that of argument from expert opinion. How this argumentation scheme was used twice in the reasoning in the circus animals example was shown in figure 3. As shown in figure 3, the argumentation scheme for argument from expert opinion was displayed in Araucaria on the argument diagram representing the chain of reasoning. This scheme is selected from the Walton scheme set using the menu shown in the screen shot in figure 4.
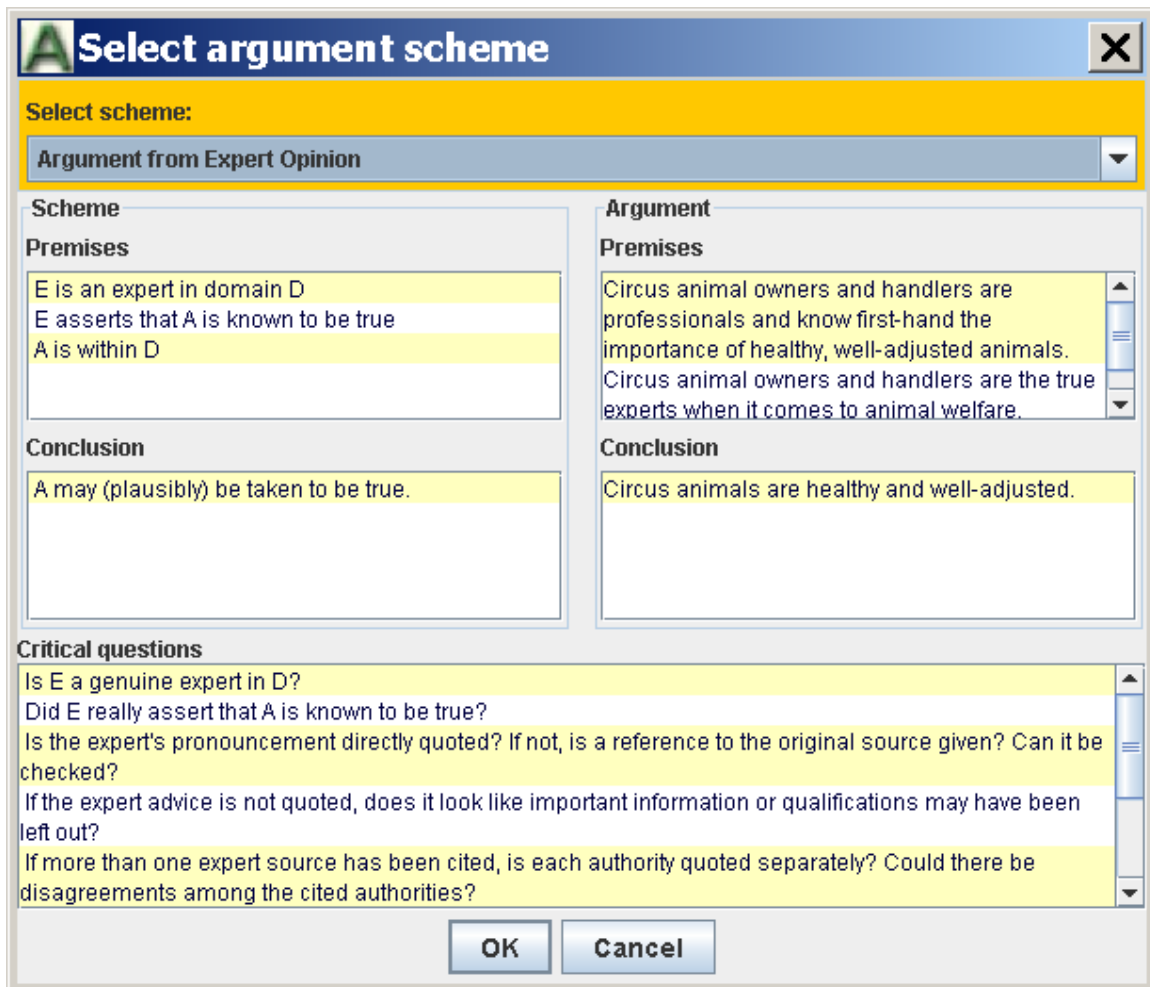

Figure 4: Screen Shot of the Expert Opinion Scheme from Araucaria

The scheme is shown on the left, while part of the example it has been applied to is shown on the right. The critical questions matching the scheme are displayed in the

bottom box. The Walton scheme set contains twenty-six presumptive argumentation schemes that are neither deductive nor inductive in nature, kinds of enthymematic arguments where a missing premise or conclusion can be identified. Once an immediate consequence has been located in an argument, often parts of it that are implicit can be identified by applying one of these argumentation schemes. Deductive logics, like syllogistic theory, have proved to be somewhat useful in helping students to locate missing assumptions in enthymemes. However, such a tool becomes immensely more helpful once presumptive argumentation schemes of the kinds included in the Walton scheme set are employed along with deductive and inductive schemes.

So far everything that has been described occurs at a primary level in which the two parties, the proponent and the respondent, take turns putting forward arguments or making other moves directed to each other. In some cases, analysis at this level will enable us to offer a dialectical theory of enthymemes, because there are cases where the respondent to an argument needs to identify implicit assumptions in it before he can respond to it appropriately. However there are other cases where it is the function of a third party to clarify arguments by bringing out implicit premises or conclusions in them. In these cases, we must move to secondary level, or metadialogue level (Krabbe, 2003) in which a third party critically analyzes the argumentation put forward by the other two parties at the primary level. This third party uses the evidence of the text of discourse of the dialogue known at the point where the dialogue has proceeded so far. It is important that there be a specific text of discourse that has been tracked and recorded. In law, this third party is the trier, the judge or the jury that decides the outcome of the trial. In everyday conversational argumentation, this third party may be an argument analyst of the kind found in a critical thinking course, or applied logic course, where real examples of arguments are being analyzed and evaluated in a university classroom. In order to analyze a given argument, here she first of all has to identify the argument, meaning that she has to identify its premises and conclusion. This task, of course, takes us right into the problem of enthymemes, because typical real arguments of the kind studied in such an environment tend to have premises and conclusions that may not be explicitly stated, but that need to be taken into account in order to give a fair analysis and evaluation of the argument.

In addition to the usual accoutrements of formal dialogue systems, including speech acts, commitment stores, commitment rules, and other kinds of rules governing the moves that can be made by one party, and how these moves must be responded to by the other party, another component needs to be added. It is a database representing the common knowledge shared by both parties. At the opening stage of the dialogue, both parties must not only agree to abide by the dialogue rules. Both parties must also have a commitment set, and each party must have a specific statement identified as his or her global conclusion or thesis to be argued for or against during the whole sequence of the dialogue. This pair of global conclusions makes up the issue of the dialogue. In addition, both parties may agree to take on as commitments a set of statements that neither of them is inclined to dispute. These commitments represent statements that are not directly related to the issue under dispute and that represent background assumptions of a kind that can be broadly classified under the heading of common knowledge. The term, knowledge, used in this way, is something of a misnomer, because the statements do not represent knowledge of the kind that might, for example, be restricted to scientific

knowledge, or to propositions that are known to be true beyond reasonable doubt. They are merely propositions that are generally accepted, both by a majority and the wise (*endoxa*), or at any rate would not be likely to be disputed in the context of the particular argumentation under discussion. Such acceptance is a matter of degree, because a proposition that would not normally be disputed in an everyday conversation might be disputed in a philosophical discussion, for example. Thus whether something can rightly be classified as common knowledge or not depends very much on the issue that is being discussed, and the type of dialogue that the participants are engaged in.

In this theory, it is important to make a distinction between commitments based on common knowledge, and those not based on common knowledge. In some cases an arguer may be taken to be committed to a proposition because it is an item of common knowledge, that nobody would be likely to dispute in everyday conversational practices, and that is not directly related to the issue being disputed in any obvious way. For example, if you and I are having a dispute on the abortion issue, it is not likely that either of us would dispute the proposition that snow is white. It could be taken for granted as an implicit commitment of both parties, unless either party gave some reason to seriously dispute it, or lead us to believe that he or she had doubts about it. In contrast however, there will be many other cases where it is clear that a participant can be taken to be committed to a particular proposition, based on how he or she has argued so far in the dialogue, and has strongly advocated a particular position, even where this proposition couldn't reasonably be placed in the category of common knowledge. For example, in a case of an argument about abortion, one party who has adopted a pro life view and argued that abortion is murder, may be committed to the proposition that the fetus should be classified as a person. But this proposition could not reasonably be classified under the heading of common knowledge, and indeed it may be that the opposed party in the abortion dispute would strongly contest its truth. And it may well be, as in this case, that many people in the general population would contest such a proposition, and therefore that it would be inappropriate to categorize it under the heading of common knowledge.

We can summarize the new model of dialogue put forward here briefly as follows. In addition to the apparatus of CBV, including commitment stores of two kinds, there is a special set of propositions designated at the opening stage of the dialogue called the common knowledge database CK. The common knowledge database is shared by both parties to the dialogue, and it represents propositions that neither party would dispute, or has any interest in disputing, and are widely accepted as being true, or at any rate are not widely subject to doubt or disputation. In special instances, specific sources could be cited for common knowledge. For example both parties to the dialogue might agree to include all of the statements made in an encyclopedia in the common knowledge database. We call this extended system CBVK. We also need to add to CBVK the possibility of shifting to higher level of dialogue. In addition to the primary level of dialogue, there also needs to be a meta-dialogue level in which a third party critically analyzes a given argument in CBVK, or other speech act put forth by either of the two parties in the CBVK dialogue at the primary level.

4. How CBVK can be Applied to the Examples

In this section, a brief outline is given explaining how the system works to fill in implicit premises and conclusions in an enthymeme, and then it is shown how the system applies to the three examples. The system can work at either the primary level or the secondary level. The procedure is similar in either level. For purposes of exposition however, we describe how it works at the secondary level where a critic is filling in the missing assumptions in the proponent's argument based on the data given in the text. The critic has a set of argumentation schemes, a common knowledge database applicable to the dialogue, and also a set of propositions representing the commitment store of the proponent. Basically, what the critic does when confronted with an argument is to try to generate the conclusion from the explicit premises using the argumentation schemes to build up a sequence of reasoning recursively by applying the schemes, over and over, to each of the premises, and to each set of premises. If this task is carried out successfully, the game is over because there is no need to search for implicit premises or conclusions. However, supposing the critic finds that it can only carry out this task if it adds in additional needed assumptions. What it needs to do is to see whether these assumptions can either be found in the common knowledge database or in the arguer's commitment set. If so, once again the task is completed. But in this kind of case, the implicit premises or conclusions have been found, and the enthymeme has been reconstructed from the existing argument.

But things are not always this easy. Once the critic finds such missing assumptions representing common knowledge or the arguer's commitment, it still may have to cast around to find still further intervening premises or conclusions that will fill in the chain of reasoning from these premises to the ultimate conclusion using argumentation schemes to apply to immediate commitments. The process is one of beginning with the explicit commitments of the arguer and using argumentation schemes to fill in implicit commitments. This process can be complex in some cases, but simpler than others, as shown by the variety of examples studied in section 2.

The problem here is to determine in a given case when a proponent puts an argument forward, which propositions can reasonably be taken to be commitments of that proponent. The methodology used in CBVK this for the critic to determine whether the missing premise or conclusion is an implicit commitment of the arguer, or whether it can be taken as an assumption of common knowledge. The common knowledge database is domain-dependent, because what is taken to be common knowledge varies widely depending on the context of the dialogue. But it is assumed in rational argumentation in CBVK that the primary participants share some common knowledge of a kind which will not be disputed by them in the present discussion. The next problem is how to judge in a given case whether a particular proposition can be reasonably and fairly attributed to an arguer as representing his or her position in the argument, and is therefore attributable to him or her as an implicit commitment.

How the system works can be illustrated by the three examples. In the case of the free animals example, the critic looks at the explicit premise and the explicit conclusion that are given, as shown in figure 1. The critic then applies the argumentation scheme for *modus ponens* to its common knowledge database and its commitment store to see if there are any propositions in either set that could be plugged in to supplement the existing explicit premise and generate the explicit conclusion. The critic scans through its common knowledge database and sees that there is a proposition in it stating that there

are natural predators to kill animals that are in nature. It then scans around in its commitment store to see if there is any proposition in it that has the form of a conditional: if the animals are in a place where there are no natural predators to kill them, they are freer than if they are in a place where there are natural predators to kill them. The critic then realizes that if these two implicit propositions are put together with the explicit premise that there are no natural predators to kill animals that are in captivity, the three premises together can generate the conclusion that animals in captivity are freer than in nature. This case represents an automatic use of the technology. The critic does not have to do any creative thinking. All it has to do is search around in its common knowledge database and commitment store for propositions that will fit into an argumentation scheme with one or more of the explicit premises in the given argument, and will generate the conclusion.

The dough example is more complex, as can be shown by examining figure 2. Let's start at the bottom of the left side of figure 2. The critic scans around in its common knowledge database and finds the proposition that bread, rolls etc. are made mainly of dough. But how could that premise be applied to get to the ultimate conclusion that at some unspecified time in the past, dough, or flour-based food, was eaten by a lot of people? The critic needs to realize that this pair of premises can only be used to get to the ultimate conclusion by assuming the two other implicit premises inserted in the shaded boxes in the middle level of the diagram in figure 2. On what basis could the critic make this kind of leap? First let's consider the implicit premise on the left stating that things made (mainly) of dough were accorded the lion's share of the space in the cookbooks at that time. The only reason for picking out this proposition is that it can be derived from the previous two propositions shown at the lower left in figure 2, and can then be used to provide a bridge to the ultimate conclusion, assuming that the other implicit premise shown in the middle level of the diagram can be used. But where does this other premise come from? It could come from the critic's common knowledge database. But there is another factor to be considered.

The proposition that anything that was accorded the lion's share of the space [in a cookbook of that time] was a kind of food that was eaten by a lot of people is a common knowledge proposition because it is supported by other common knowledge premises through practical reasoning. This kind of common knowledge is based on a script of the kind cited in section 1 as being applicable to certain kinds of stereotypical situations in artificial intelligence, used to enable a language user to fill in gaps in inferences not explicitly stated in a text. Practical reasoning is a kind of goal-directed means-end reasoning used to link a goal with an action that can be used to carry out the goal (Atkinson, Bench-Capon and McBurney, 2006). It is shown in figure 5 how practical reasoning could be applied to generate the proposition in question as a conclusion from premises of common knowledge. This case shows the creative aspect of filling in missing assumptions in enthymemes in some of the more complex cases.
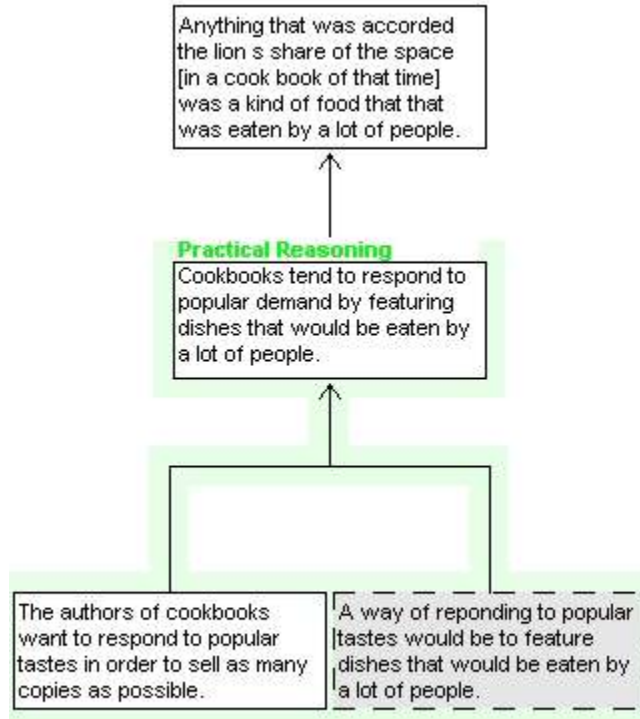
Figure 5: Argument Diagram for Deeper Analysis of the Dough Example

All three propositions in this diagram below the proposition at the top are implicit premises that are additional reasons to support the implicit premise shown in figure 2 stating that anything that was accorded the lion's share of the space [in a cookbook of that time] was a kind of food that was eaten by a lot of people. Thus all of the propositions in figure 2 should be represented in darkened boxes with broken lines around the border of the box, indicating that they are implicit premises. The reason for not presenting the diagram this way is as follows.

When the critic looks around for missing premises or conclusions, it might find the following two propositions in its common knowledge database.

Cookbooks tend to respond to popular demand by featuring dishes that would be eaten by a lot of people.

The authors of cookbooks want to respond to popular tastes in order to sell as many copies as possible.

Now the critic is confronted by the problem of how to get from these two common knowledge propositions to the ultimate conclusion shown at the top of figure 5. The answer is to apply the argumentation scheme for practical reasoning, which would reveal the needed premise that a way of responding to popular tastes would be to feature dishes that would be eaten by a lot of people. Consequently, the critic would insert this needed

premise into the chain of reasoning. Since this proposition also seems to be an item of common knowledge, it fits very well.

We now return to the question posed at the end of section 3. How far is one required to go to fill in all the missing assumptions that join the explicit conclusion to the explicitly given premises? This question applies to the dough example. Figure 5 is a deeper analysis of the dough example that probes more deeply into the supporting reasons behind one of the implicit premises in the argument diagram for that example presented in figure 2. Does that mean that the analysis in figure 2 is inadequate? The answer has to be 'no' because it is quite a common phenomenon that one can often go more and more deeply into analyzing the argumentation in an enthymeme. There are many cases in which one can bring out more and more common knowledge and script-based reasoning representing a deeper analysis of the implicit premises and conclusions in the case. This example illustrates the point very well.

Finally we turn to the circus animals example as displayed in the argument diagram in figure 3. In this example, the critic applies argumentation schemes to try to construct a chain of argument to get from the existing premises to the ultimate conclusion that the arguments of the animal activist groups are not factual. It sees that in order to bridge the gap between that proposition and the propositions represented as explicit premises at the bottom two things are needed. One is that the argumentation scheme for argument from expert opinion has to be applied to the argument on the right at the bottom by inserting the missing premise that Dr. Friend and Dr. Kiley are experts. The other is that to fill the gap between these arguments and the ultimate conclusion an additional proposition needs to be inserted that functions as the conclusion of these arguments and also as an implicit premise in the argument at the next level. This missing assumption is the proposition that circus animals are healthy and well-adjusted. Hence the critic inserts these two implicit assumptions by applying the argumentation scheme for argument from expert opinion twice.

6. Conclusions and Directions for Further Research

In this paper, a theory for analyzing enthymemes has been presented. It can be contended that while it only as theory at this point, and clearly only at an initial stage of invention, it is better than any other method that has so far been put forward in the literature. Although the method is interesting in its own right because it could be practically useful, what is perhaps even more important is that it is based on a theory that has been clearly articulated, and that is made up from components of argumentation technology that are well known and that have been already studied and explored thoroughly. This dialectical theory of enthymemes has four components: (1) sets of locution rules, dialogue rules and commitment rules of the kind set out above for CBVK, (2) a set of propositions agreed upon by the participants at the opening stage of a dialogue called the common knowledge database in CBVK, (3) a set of propositions for each participant in the dialogue representing the explicit and implicit commitments that of that participant as the dialogue proceeds through the argumentation stage and these commitments change, and (4) a set of argumentation schemes representing a wide variety of typical types of arguments used in everyday conversational argumentation, including defeasible schemes as well as deductive and inductive ones of the kind we tend to be

familiar with in logic. CBVK has the first three of these components, but lacks the last one. However such a fourth component could be easily provided by adding a set of argumentation schemes to the inference rules already there.

How the components of the new dialectical theory interrelate on the two levels in general is shown in figure 6. There is a primary level of dialogue in CBVK in which the two participants normally take part in asking questions, putting forward arguments, and so forth. But then there will be intervals where the one party needs to make a decision about what can be taken to be the implicit assumptions in an argument put forward by the other party that contained missing premises, or perhaps an unstated conclusion.
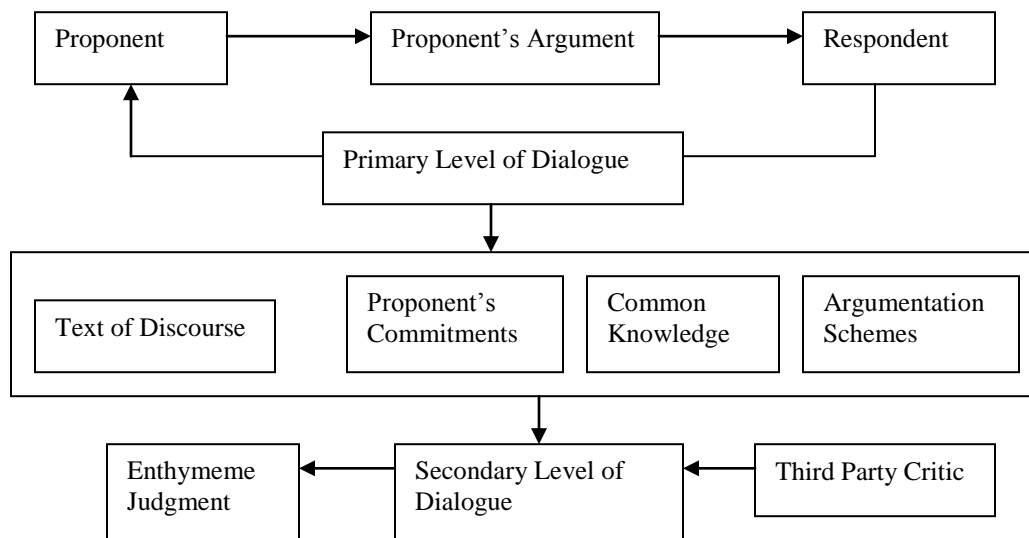
Figure 6: Interrelated Components of the Theory on Two Levels

The theory of enthymemes presented above is based on argument diagramming and argumentation schemes, tools that have been developed in the field of argumentation studies. As well, it is based on a theoretical framework now widely adopted in both artificial intelligence and argumentation studies, namely that of formal dialogue systems. To extend the theory, two additional tools are needed, an inference engine and a search engine. The inference engine starts with the existing explicit premises and then applies argumentation schemes to them, continually generating inferences and until a chain of reasoning is laid out that leads from them to the ultimate conclusion to be proved. In the case of an enthymeme, the engine will fail to do this. What it has to do next and is to look around for missing assumptions that will enable the task to be carried out. To look around, it has to search into the common knowledge database and the arguer's commitment store. These searches could be quite large however. Especially the common knowledge database could be very large. A more efficient way to proceed would be for the search engine to apply the argumentation schemes to pinpoint which premises or conclusions are needed as implicit assumptions that can generate the ultimate conclusion when joined to the explicit premises. But how can this task be carried out?

There are two kinds of agents that could carry out such a task. A non-autonomous agent could mechanically go through the set of explicit premises and apply each of the argumentation schemes in turn to each premise or pair of premises to determine what additional premise might be needed to complete the set that would generate the required conclusion. An autonomous agent could do this in the way a normal human critic would, but it could be problematic to carry out this task in an automated fashion. Thus the project is to see how much of the task can be automated by using existing inference engines and search engines.

The problem here is to determine in a given case when a proponent puts an argument forward, which propositions can reasonably be taken to be commitments of that proponent. The methodology used in CBVK this for the critic to determine whether the missing premise or conclusion is an implicit commitment of the arguer, or whether it can be taken as an assumption of common knowledge. The common knowledge database is domain-dependent, because what is taken to be common knowledge varies widely depending on the context of the dialogue. But it is assumed in rational argumentation in CBVK that the primary participants share some common knowledge of a kind which will not be disputed by them in the present discussion.

The problem studied in the paper was how to judge in a given case whether a particular proposition can be reasonably and fairly attributed to an arguer as representing his or her position in the argument, and therefore attributable to him/her as an implicit commitment. Commitment sets are already widely known as a device in the argumentation literature and dialogue theory (Walton and Krabbe, 1995). As shown in section 3, the basic means whereby a proposition can be designated as an arguer's commitment has already been formulated. Whether or not a proposition is an arguers commitment depends on the type of dialogue, previous moves (speech acts) made by that arguer in the dialogue, and how the commitment rules apply to the particular move at issue made at some point during the sequence of moves made in the argumentation stage of the dialogue. In the kind of case typically encountered in any university class on logic or argumentation, the argument is part of a wider text of discourse in which it is embedded. The third party argument critic who has the job of filling in missing premises or conclusions has access to this text, and it is printed or recorded in some permanent form so that others can inspect it as well. Or the problem of enthymemes can also be confronted when one participant taking part in such argumentation has to interpret the argument put forward by the other party when that argument was based on implicit premises. In this kind of case only two parties are involved. One is the participant who put forward the argument while the other is the participant who has the problem of criticizing it, or otherwise responding to it, even though some part of it was not explicitly stated. The specific problem is how some argument technology can be used to scan over this text, focus on a specific argument, and pick out the implicit premises or conclusions in that argument. As applied to a case of an argument used in a persuasion dialogue, the methodology of choice could be the system CBVK, or some comparable formal system of dialogue with a set of rules for persuasion dialogue. The main thing is that the system should allow for the insertion and retraction of implicit commitments as well as explicit ones.

First, it is assumed that every proposition explicitly asserted by the arguer can be inserted in his commitment store. This means that as the critic scans over the text it will

be continually encountering new arguments and other speech acts and using them to insert propositions in the primary arguer's commitment store. It is this commitment store that determines whether a particular proposition can justifiably be said to be the primary arguer's commitment, and may, on that basis, be inserted into his argument as an implicit premise or conclusion. But an important problem is how we judge more problematic cases. For example, let's assume that participant *P* has explicitly asserted proposition *A*, but proposition *B* follows from proposition *A* in virtue of an argumentation scheme that both participants in the dialogue accept as valid. Is it reasonable for the third party critic of the argument, or for the other participant in the primary dialogue for that matter, to insert proposition *B* into *P*'s commitment set? Or suppose *P* has gone on record as being explicitly committed to proposition *A*, but then later retracted proposition *B*, which logically follows from proposition *A* by means of an argumentation scheme. Is it reasonable for the third party critic of the argument, or the other participant in the primary dialogue, to retain proposition *A* in *P*'s commitment store? These are questions that are hard to give general answers to, because they vary with the type of dialogue, and in particular with the commitment rules and retraction rules appropriate for that type of dialogue. Such matters have been studied in a general way in (Walton and Krabbe, 1995), but there is no space to make further commentary on them here. The system CBVK is meant to be basic, and does not have elaborate rules for retraction of commitments.

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