Translating Wigmore Diagrams

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Abstract. In the early 20th century, J.H. Wigmore described a new method for analysing and laying out arguments in legal cases. His proposal was the first system of argument diagramming, and it is still in use in jurisprudence today. Wigmore diagrams offer a rich ontology of argumentation concepts which in some respects are close to ideas in other, more modern systems of argument analysis and argument diagramming – whilst in other areas, is much richer and more specific than alternatives. The features of Wigmore analyses might reasonably be expected to contribute to modern, computational approaches to argument, both in the legal domain and more broadly. This paper explores some of the key issues in representing Wigmore analyses and translating between them and other systems of analysis such as those founded upon Toulmin models and scheme-based models.

Keywords. Argument Diagramming. Argument Interchange. Argumentation Schemes. Legal Argument. Wigmore Diagrams.

Introduction

Analysing argumentation with diagrams has long been a technique developed for pedagogy in argument and critical thinking [1], and has also played an important role in developing both logical and argumentation theoretic accounts of the structure of monological and dialogical argument [2]. More recently, it has become the subject of widespread investigation in the AI and computer science community [3], [4], [5].

Recently [6] analyzed the issues involved in translating between Toulmin diagrams and 'standard' argument diagrams (the latter so called because they represent the most common approach in argumentation theory and critical thinking), with a view to arriving at a general language for representation of argument. Analysis of Toulmin and standard argument diagrams is facilitated by the use of *Araucaria* [4], a software package which (in its version 3.0 form) allows text to be marked up and diagrammed using either method.

Araucaria has recently been extended to version 3.1, which now allows Wigmore diagrams to be created from marked-up text. Araucaria allows translation between Wigmore diagrams and both standard and Toulmin diagrams. Implementing this translation has given rise to a number of interesting issues which this paper explores.

1. Wigmore diagrams

Wigmore [7] introduced a method of portraying legal arguments in diagrammatic form. Wigmore diagrams are superficially similar to standard diagrams, in that they use a type of ‘box and arrow’ structure: a given statement is supported by one or more other statements, and in turn can form part of the support of another statement above it. There are no divergent arguments (i.e. arguments where one statement can be used to support two or more other statements). Though more recent authors (most prominently, Schum [8]) have developed and refined Wigmore's charting mechanism, the original remains not only a landmark in evidential charting, but also a tool in practical use by legal professionals around the world.

Wigmore has, however, constrained the types of support allowed by classifying the various types of statement and inference according to their roles in a court case, and the resulting diagrams are intricate and complex, made up from over 30 separate diagrammatic components and conventions. Each statement in a Wigmore diagram is referred to as *evidence* of one type or another. Some evidence nodes can be *affirmatory* (i.e supporting another statement) or *negatory* (i.e. arguing against another statement). Support arrows in the diagram are referred to as *forces*, and can have varying degrees, ranging from ‘no effect’ to very strong positive or negative force upon the statement to which it leads.

We will not give a complete catalogue of the various types of evidence and forces that Wigmore uses in his diagrams, since we are concerned more with the general categories of evidence and force and how these translate into other diagram types. Therefore, we begin with a summary of these categories.

1.1. Types of evidence

The various evidence nodes in a Wigmore diagram fall into several broad categories. First, evidence can be classified by the party that offers it. In a typical court case, there are two sides to the argument: the prosecution and the defense.

From another viewpoint, evidence can be *testimonial*, *circumstantial*, *explanatory* or *corroborative*. Testimonial evidence is evidence that is stated by the witness as a fact, usually because they observed or knew something directly. Thus a witness M may testify that the defendant had the knife because M saw the defendant holding it.

Circumstantial evidence is evidence that requires some inference. For example, the police may testify that they found the knife at the scene of the crime where the defendant was known to have been at the time, therefore the defendant must have used the knife to commit the crime.

Explanatory evidence is evidence that is put forward to counter or lessen the impact of testimonial or circumstantial evidence. For example, for the testimonial evidence given above, the witness may have been too excited to see who was holding the knife, or in the circumstantial case, there could have been a third party who dropped the knife at the scene of the crime.

Corroborative evidence is evidence that supports testimonial or circumstantial evidence. For example, in the testimonial case, the witness may state that they were not excited at the time and clearly saw the defendant holding the knife. In the circumstantial case, the police may testify that no footprints other than those of the plaintiff and defendant were seen so no third party could have dropped the knife.

All four of these types of evidence can be offered by either side in the case. In addition, testimonial and circumstantial evidence can be either affirmatory or negatory (explanatory and corroborative evidence only exist in one form). Adding up all the possibilities gives a total of 12 different types of evidence (e.g. negatory testimonial evidence offered by the defendant is one particular type of evidence, while affirmatory testimonial evidence offered by the defendant is another, and so on).

1.2.Types of force

The support arrows linking one bit of evidence to another can have a number of symbolic modifiers attached to them. The main categories in which we are interested here are *affirmatory* and *negatory* force (i.e. the inference either supports or detracts from the conclusion). These force categories are applied only between a statement and its supporting testimonial and circumstantial evidence. The force provided by explanatory and corroborative evidence can vary only by degree.

Each evidence node in the diagram can have up to three groups of other evidence nodes influencing it. The testimonial and circumstantial nodes are grouped below the supported node; the explanatory nodes are grouped to the left, and the corroborative nodes are grouped to the right. Each *group* of nodes may be given a *net probative value* (in Wigmore's words); that is, the net effect of all the evidence in the group can be considered and assigned a single symbol on the support arrow indicating its net effect on the conclusion. The assignment of grades and degrees of force on the support arrows is largely subjective and must be decided by the person constructing the chart.

1.3.Example

An example adapted from [7] is shown in Figure 1.

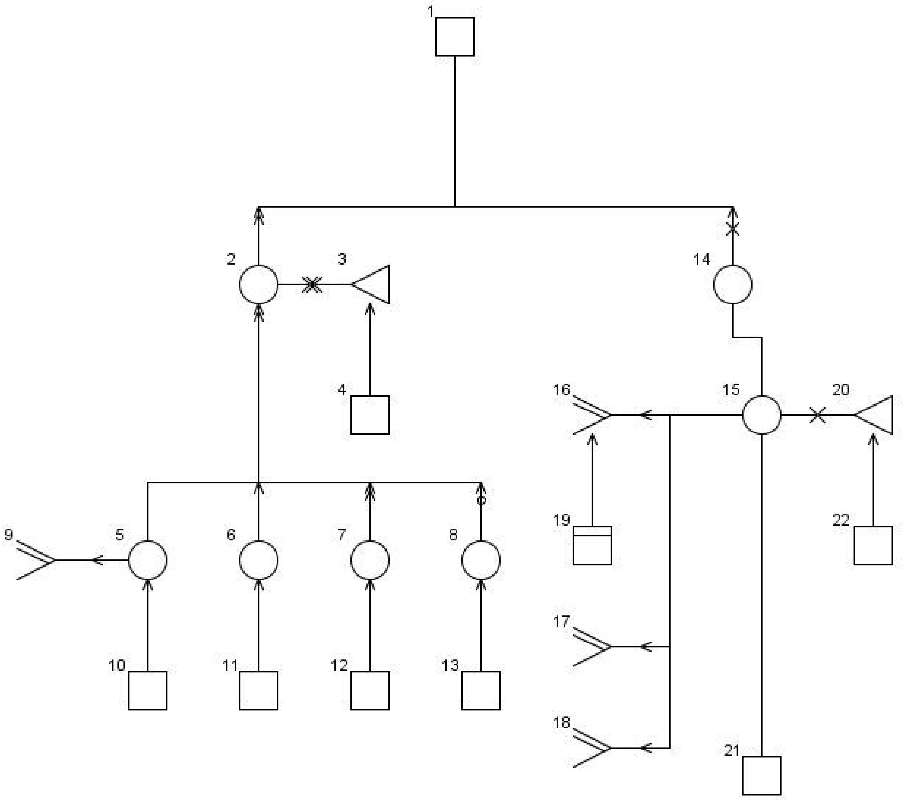

Figure 1. A sample Wigmore diagram, generated by Araucaria

In Figure 1, node 1 is the conclusion which the prosecution is attempting to prove. In the diagram, square nodes are testimonial evidence, circular nodes are circumstantial evidence, nodes with > symbols (such as nodes 9, 16, etc) are explanatory and closed triangular nodes (such as nodes 3 and 20) are corroborative evidence.

Nodes with a double line near the top (9, 16, 17, 18 and 19 in Figure 1) are defendant's evidence; all other nodes are prosecution's evidence. In this diagram, therefore, the prosecution is putting forward most of the evidence and the defense is providing explanatory evidence to counter the prosecution's argument at nodes 5 and 15.

The various symbols on the support arrows indicate the degrees of support. A single arrow indicates the direction of support, so that node 19 supports node 16, for example. A double arrow, such as from nodes 2 and 7, indicates strong support. The arrow on the edge between nodes 16 and 15 indicates that node 16 detracts from the support to node 15, which is to be expected since node 16 is explanatory and attempts to lessen the effect of node 15. The X on the edge between nodes 15 and 20 indicates that the corroborative node 20 supports node 15.

The small circle on the edge leading out of node 8 indicates a negatory force, so that node 8 detracts from the support to node 2. The double arrow just below node 2 indicates the net probative value of nodes 5, 6, 7 and 8.

2. Translating Wigmore diagrams

2.1.Desiderata

Our experience with translation between Toulmin diagrams and their "standard treatment" counterparts [6] has yielded desiderata for the process:

1. Translation should be deterministic, always providing the same output for any given input
2. Translation should be "symmetrical", i.e. translation from A to B should be 1:1 and onto, as should backtranslation from B to A, so that backtranslation from translation is always equivalent to identity
3. Translation should make maximal use of a common interlingua where possible
4. Where (3) cannot be met, theory specific analysands should be included by extending the interlingua

In the context of Araucaria [4], the interlingua is the Argument Markup Language, AML, a standard XML-based language which may be used to represent arguments. Here we explore the translation of Wigmore diagram types into standard notation, and from standard it is further possible to derive a Toulmin diagram interpretation. There are two main considerations in translating Wigmore diagrams: evidence nodes and support forces (the arrows between nodes). We take them in turn.

2.2.Translating Wigmore evidence nodes

2.2.1.Type of Evidence

A testimonial or circumstantial evidence node may have up to three supporting groups of nodes: other testimonial or circumstantial evidence, explanatory evidence and corroborative evidence. Each of these three groups of nodes are represented in the diagram by a set of nodes that have support edges converging on a single edge which then supports the parent node.

There is a superficial diagrammatic resemblance between the Wigmore notation for a group of supporting nodes and the linked argument structure in the standard diagram. It is tempting, therefore, to infer an equivalence between these two structures. However, we believe this correspondence is illusory. The linked argument in a standard diagram implies that all the premises making up the linked group of nodes are required for the connection between these nodes and the node they support. Common examples of linked arguments are found in argumentation schemes: the argument from expert opinion, for example, requires both that the expert have appropriate domain knowledge, and that the proposition they are advocating lies within that domain. In a

Wigmore diagram, however, *all* nodes of a given type that support another node are grouped together, regardless of whether some of these nodes form linked arguments and others stand alone as support for the parent node.

A Wigmore diagram also strongly reinforces pictographically the tripartite grouping of all evidence. One possible way of representing a Wigmore analysis is therefore to introduce virtual "aggregation" nodes in the argument that aggregate all the corroborative evidence supporting a node, all the explanatory evidence supporting a node, and all the other (i.e. testimonial or circumstantial) evidence supporting a node. These intermediate nodes might then be further supported in their turn by convergent arguments from the various premises. An analysis such as Figure 2a, for example, might be rendered at a deep level by the representation in Figure 2b, with C1, Ev1 and Ex1 aggregating the corroborative, testimonial and explanatory evidence for claim 1, respectively.

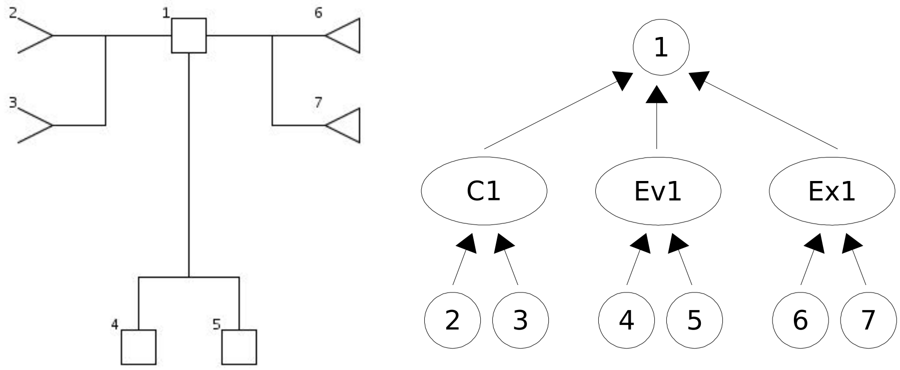

Figure 2. A sample Wigmore diagram (a) and possible deep structure representation (b)

In this way, the ontological status of nodes in the Wigmore analysis (i.e. whether they are corroborative, explanatory or testimonial/circumstantial) is captured by structural features in the AML deep representation. Unfortunately, this misrepresents the arguments in an important way. The role of "corroborating" evidence is, as the terminology suggests, one of working with elements of testimonial and circumstantial evidence to support a claim. In this respect, it is most similar to traditional linked argumentation – but the linkage crosses the groupings in Figure 2b – so, for example, it might be that 2 and 4 form a linked argument, and 3 and 5 form a linked argument. The analysis in Figure 2b not only makes such relationships opaque, it absolutely proscribes the representation of such relationships.

The problem is compounded in that an analysis performed in the Wigmore style provides no mechanism for determining which premises of a claim are linked and which are not. Thus we have no choice but to represent all the nodes supporting another node in a Wigmore diagram as single, unlinked nodes in a standard diagram. Similarly, there is no distinction in a standard diagram between the concepts of explanatory, corroborative, testimonial or circumstantial evidence, so all nodes from all these groups must be treated equally when drawn in a standard diagram.

We can use similar considerations to translate in the reverse direction: from standard to Wigmore. A standard diagram does not contain any information on the type of evidence represented by a node, so we really have no choice but to represent all standard nodes, linked or convergent, as one node type in Wigmore. For convenience, Araucaria interprets all standard nodes as testimonial affirmatory nodes (represented by a plain square) in Wigmore.

The reader may be wondering how these rules conform to our desire to use the AML structure to represent all arguments as standard and then translate to other diagram types. If Wigmore diagrams contain properties not representable in standard, how do we store these properties in AML, thereby ensuring that our second desideratum is met? The answer is that no interchange format will be able, a priori, to cater for all possible representational and operational schemes that involve argument [5]. Instead, AML is designed to support extensibility through a simple "role" mechanism that allows new ontological categories to be catered for in the representation, without the representation having to revise existing analyses. Specifically, individual propositions within an analysis can be marked as taking on a particular role in a particular class. So, for example, in the Toulmin class, a proposition might be marked as a "warrant" - a concept that only makes sense in the context of Toulmin analyses. Of course, if these extensions are not only numerous but also individually significant, then the benefits of an interchange language such as AML are eroded. The exponentially expensive problem of translation between the different classes returns. AML takes a pragmatic solution, providing as much generic capability as possible, and supporting extensions that are intended to be small scale. If particular software systems aim to make use of these extensions in translation then they are not prohibited from doing so.

In the Wigmore case, the four basic types each represent different roles: corroborative, explanatory, testimonial and circumstantial.

2.2.2.Ownership of Evidence

A further complication arises in that Wigmore diagrams distinguish explicitly between evidence offered by prosecution and that offered by defence (the extra top-most bar indicates diagrammatically the latter). Though neither Araucaria nor AML pretend to be able to handle either dialogue or a record of dialogue, they nevertheless both support identification of "owners" in standard analyses – i.e. the identity of the individual, group of viewpoint of which a given proposition is claimed. This is useful for analysing arguments in which, for example, a counter-argument to the author's position is presented and countered. The same machinery can be put to use for distinguishing between prosecution and defence arguments, inasmuch as Wigmore analyses allow the specification of just exactly those two owners and no others. This is an example of desideratum (3) driving representational re-use.

2.2.3.Evidence sense

Wigmore explicitly distinguishes between evidence that is *affirmatory* and evidence that is *negatory*. Unfortunately, Wigmore's presentation leaves it unclear as to exactly what is meant by negatory evidence (and there are few examples of it in his writings). There are three possible interpretations:

1. Evidence can only be defined as negatory with respect to other evidence (implicit or explicit) that is affirmatory. So for example, the claim that "the murderer was in the garden" might be classified as negatory with respect to another claim that "the murderer was in the house".
2. There is something intrinsic to negatory evidence which means that a human can inspect a claim and determine whether or not it is negatory. Such a determination could conceivably be related to burden of proof (so, e.g., a claim such as "there is no evidence that the murderer was in the house" as affirmatory).
3. Negatory means virtually nothing at all, making only a rhetorical distinction rather than a truth functional one (so that, e.g., "the murderer was not in the house" is negatory whilst "the murderer was in the garden" is not).

Option (1) is at the heart of most concepts of negation and contrariness: in propositional accounts, ~p derives its interpretation from the meaning of p; in Araucaria-style analyses, a refutation links a claim and counterclaim; in the Toulmin diagram [9], a rebuttal works to cancel the data-claim connection. Yet there is no indication that this was what Wigmore intended, and the few examples suggest that evidence can be negatory quite independently of other claims that are available. Option (2) would require highly contentious linguistic and philosophical assumptions, but in any case, is computationally intractable and therefore of limited interest here. Option (3) though perhaps one of the most disappointing from a formal point of view seems to resonate most closely with Wigmore's account. There is social psychological evidence that positively presented evidence may be looked upon more favourably than negatively presented evidence [10]. Perhaps therefore, it is this linguistic or rhetorical effect that Wigmore is tackling with his "negatory" class (given that juratorial presentation is a constant motivation for Wigmore). For a representation scheme, this requires nothing more than a single additional role tag for the evidence "sense" indicating whether a piece of evidence is affirmatory or negatory. We return to the problem of "negatoriness" in the context of the relations between propositions, below.

2.3.Translating Wigmore support forces

2.3.1.Premise support

The categories of support forces in a Wigmore diagram offer interesting scope for finding corresponding structures in a standard diagram. Looking back at Figure 1, we see that there are various symbols such as arrowheads, double arrowheads, Xs, double Xs, little circles and so on that are drawn on the support edges. These symbols all indicate either the degree or force with which that edge implies support for the node to which it leads, or whether the force is affirmatory (supports the conclusion) or negatory (detracts from the conclusion).

The degree of support has a natural correspondence in the ‘evaluation’ feature of a standard diagram (which has been equated with the qualifier in a Toulmin diagram [6]). We can therefore use the Wigmore description of the force as an evaluation label in a standard diagram. For example, the single arrowhead on the support edge from node 4 to node 3 in Figure 1 indicates ‘provisional’ support, while the double arrowhead on the edge leading out of node 7 indicates ‘strong’ support. Other symbols have similar meanings: a complete list can be found in [7]. One oddity is the “detracts” force, which could be equated with negatory support. Wigmore, however, does not do so, and therefore neither does Araucaria's interpretation of Wigmore analysis – even though that leaves diagrams in which “support” arrows are, somewhat counterintuitively, labelled with “detracts”.

2.3.2.Evidence Set Support

An important complication is that Wigmore analyses permit a very slightly finer-grained analysis of these evaluative components. For each premise, an evaluation is possible – in Figure 1, for example, premises 5, 6, 7 and 8 can each have independent evaluations. In addition, however, the set of testimonial evidence (composed of premises 5, 6, 7 and 8) can also itself have an evaluation that is separate again. Recall from the previous section that the ontological categories into which evidence is divided are simply being marked as “role” tags on the evidence nodes themselves in AML, with the result that there are no nodes in the deep representation corresponding to the set of testimonial evidence. There is, therefore, no edge in that deep representation to which an evaluation can be attached. Where then does such evaluation belong? The solution is to recognise that these evaluations are intimately tied to the claim to which they lead – i.e. the evaluation on a set of testimonial evidence is not attached to any particular member of the set, but rather to the claim that the set putatively supports. For each of the three sets that a given claim can have (corroborative, explanatory, testimonial/circumstantial), a new role tag is provided that takes the evaluative force marked for that edge. This role tag is attached to the claim.

2.3.3.Negatory Support

The presence of a small circle on an edge in a Wigmore diagram (such as that on the edge leading from node 8) indicates *negatory* force, which means that the node argues *against* its parent. This clearly suggests some relation to the *refutation* in the standard model (or the *rebuttal* in Toulmin). When translating the Toulmin rebuttal into a standard analysis, the closest match is to introduce an “added negation”, so that in essence a rebuttal is the contrary of an implicit warrant [6]. In the Wigmore case, it may seem that we have a more straightforward situation, since Wigmore does not consider the subtle nuances of the Toulmin datum-warrant-rebuttal model. If a node supports another node with negatory force, then in Wigmore, the implication is that the first node counters or refutes the statement being made in the second node. Thus it may seem that we could simply map any node with negatory force on another into a refutation in the standard model, as suggested in Figure 3.

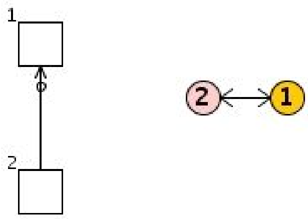

Figure 3. Simplistic negatory/refutational translation from Wigmore (a) to Standard (b)

The problem here is that the standard model (with its heritage in a propositional account) only allows a maximum of one refutation for any given node (i.e. refutation is a relationship between a proposition and its contrary, between *p* and not-*p*). In Wigmore, however, any number of nodes may support another node with negatory force. More importantly, Wigmore's use of negatory force seems to be functioning in a different way, typically functioning not as straightforward refutation, but rather much more like the rebuttal in a Toulmin diagram. The challenge can be addressed by exploiting this similarity with the Toulmin case: by introducing an 'added negation' which is refuted directly by the node with negatory force. This added negation node in turn supports (positively) the node supported directly in the Wigmore diagram. In fact, the simplest way of understanding the translation is not by comparing it with the standard treatment at all, but rather, by considering its translation to a Toulmin diagram (which then, of course, yields a standard analysis by existing translation mechanisms). Figure 4 demonstrates the idea using an example from [11]:

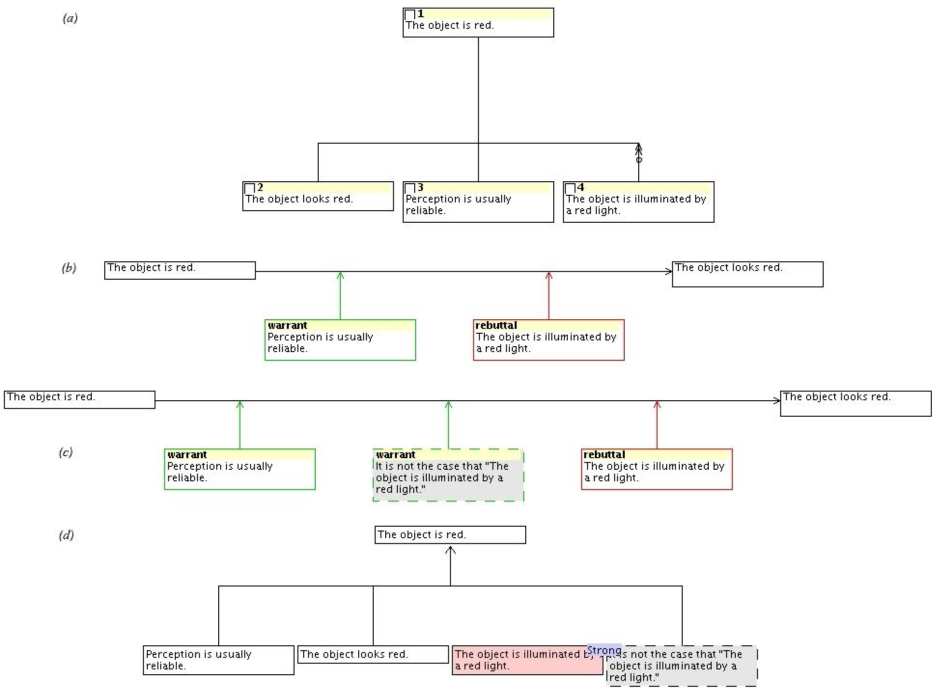

Figure 4. Pollock's example (a) analysed as a Wigmore diagram; (b) its translation into a Toulmin diagram; (c) the Toulmin diagram showing its implicit "added negation"; and (d) the translation to a standard analysis (NB. Qualifiers have been omitted to improve clarity)

2.4.Example

Drawing together all of these aspects of the translation, Araucaria implements a scheme by which the Wigmore diagram shown in Figure 1 yields the following in a standard treatment analysis:

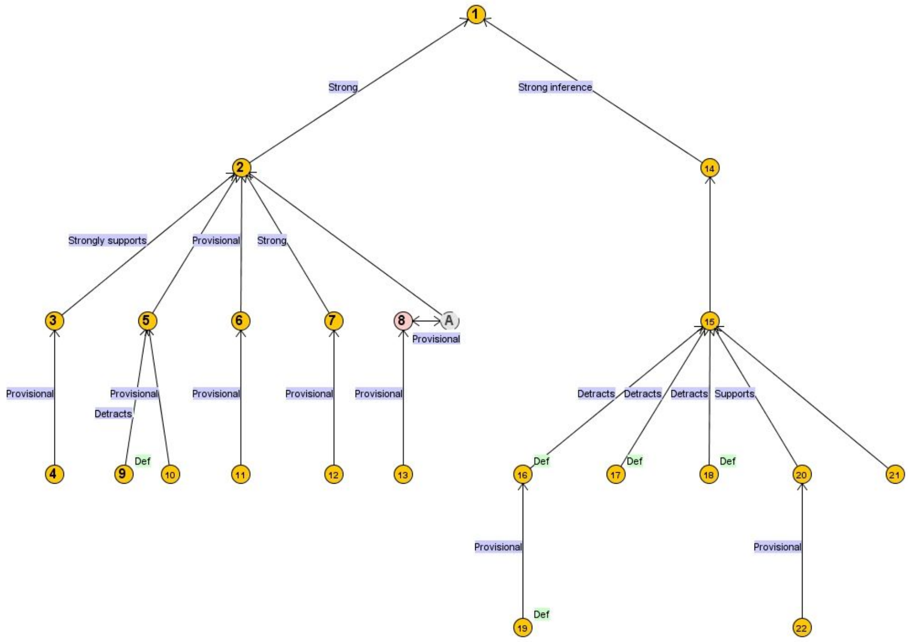

Figure 5. The standard diagram translation produced by Araucaria from the Wigmore diagram in Figure 1

It can be seen that all numbered nodes are translated directly as convergent arguments in standard. Where the Wigmore analysis has a force indicated, the translation here shows that force textually. Where the Wigmore analysis explicitly marks a node as being part of the defence's argument, it is marked “Def” in Figure 5 (anything not marked Def is assumed to be a part of Prosecution's argument). Node 8, which supported node 2 with negatory force, has an added negation node A inserted. Node 8 becomes the refutation of A, and A in turn supports node 2. Finally, any information not displayed (such as the arrangement of claims into corroborative, testimonial and explanatory groups) is latent in the deep AML representation. In this way, both the Wigmore analysis of Figure 1, and this standard version in Figure 5 can be recovered from the AML representation.

3. Conclusions

As with any inter-translation between theories with different backgrounds, goals, and working methods, there is a limit to what can be achieved in automation. The Araucaria research programme has taken a pragmatic approach, building on points of theoretical correspondence and aiming to develop a system that is at the same time usable for adherents of a particular theory of analysis, and also intuitive in its conversion of materials from one theory to another. In adding Wigmore analysis to the set of techniques supported by Araucaria, the project has encountered interesting challenges in both code and theory, but the result is, at the very least, a tool that supports analysis using the Wigmore style, which is in itself unique. This fact means that professional users of such analytical techniques (primarily in the judiciary) have the option of using a software tool to speed their analyses, and, as a further benefit, academic study of argumentation can in some situations have access to those analyses.

Because of the support for translation, the work also means that the large online database of analysed argumentation can be presented in Wigmore style, and can be further extended by analyses natively produced using Wigmore concepts. The translation mechanism meets the full list of desiderata laid out in section 2.1. Finally, from an academic point of view, the exercise has demonstrated the extensibility of AML, which augurs well for future developments in supporting argument interchange between diverse user groups, different disciplines, and various implemented systems.

References

[1] Walton, D. (2006) *Fundamentals of Critical Argumentation*, Cambridge University Press.

[2] Walton, D. and Reed, C. (2003) "Diagramming, Argumentation Schemes and Critical Questions" in F.H. van Eemeren, J.A. Blair, C.A. Willard & A.F. Snoek Henkemans (eds) *Anyone Who Has a View: Theoretical Contributions to the Study of Argumentation*, Kluwer, Dordrecht, pp195-211.

[3] Kirschner, P.A., Buckingham Shum, S.J. and Carr, C.S. (2003) *Visualizing Argumentation*, Springer.

[4] Reed, C. and Rowe, G.W.A. (2004) "Araucaria: Software for Argument Analysis, Diagramming and Representation", *International Journal of AI Tools*, **14 (3-4)**, pp961-980.

[5] Willmott, S., Vreeswijk, G., South, M., Chesnevar, C., McGinnis, J., Rahwan, I., Reed, C. and Simari, G. (2006, to appear) "Towards an Argument Interchange Format for Multiagent Systems" in Maudet, N., Parsons, S. & Rahwan, I. (eds) *Proceedings of the 3rd International Workshop on Argumentation in Multi-Agent Systems (ArgMAS 2006)*, Springer.

[6] Reed, C. and Rowe, G.W.A. (2005) "Translating Toulmin Diagrams: Theory Neutrality in Argument Representation", *Argumentation* **19 (3)**, pp267-286.

[7] Wigmore, J.H. (1931) *The Principles of Judicial Proof* (2nd Edition) Little, Brown & Co.

[8] Schum, D., *Evidential Foundations of Probabilistic Reasoning*, John Wiley & Sons, Toronto, 1994.

[9] Toulmin, S.E. (1958) *The Uses of Argument*, Cambridge University Press.

[10] McGuire, W.J. (1969) *The nature of attitudes and attitude change*, in: G. Lindzey, E. Aronson (Eds.), The Handbook of Social Psychology, vol. 3, 2nd ed., Addison-Wesley, Reading, MA, pp. 136-314.

[11] Pollock, J.L. (1995) *Cognitive Carpentry: How to Build a Person*, MIT Press.