Intelligent Evaluation of Evidence in Wigmore Diagrams

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ABSTRACT

In this paper, we characterize a Wigmore Diagram as an information-flow network. A fuzzy approach to weighing the strength of the evidence as defined in a Wigmore Diagram is defined and compared to the well-known probabilistic approach.

Keywords  
Wigmore Diagrams, Evidence, Networks, Argumentation, Fuzzy Logic

"It is quite possible that Wigmore's method will come into its own in the computer age" (W. Twining, Theories of Evidence: Bentham and Wigmore, 1985, p.135)

INTRODUCTION

This paper has its roots in the interests of one of us in integrating the areas of discrete logical systems and network reasoning [Gabbay 2010]. That paper is an attempt to show how to unify Logic at least in all the areas that attempt to model human reasoning and behavior. The first step is the integration with the formal abstract theory of Argumentation, it being the closest to Formal Logic.

This leads naturally to a study of some of the diagramming methods developed for argumentation. Of special interest are Wigmore diagrams developed for the purpose of organising evidence in Law.

The paper is organized as follows. Section 2 defines the background and concepts of Wigmore diagrams. Section 3 examines related diagramming methods in view of their logical model. Section 4 describes a computational logical model for weighing the evidence in Wigmore diagrams. Section 5 contains our conclusions.

2. WIGMORE DIAGRAMS

2.1 History and Background

In 1904 Wigmore (John Henry Wigmore, 1863-1943, Dean of the Northwestern University Law School) published his most famous work usually known as 'Wigmore on Evidence' or just 'Wigmore', an encyclopedic survey of the development of the law of evidence [Wigmore 1904].

In later works [Wigmore 1913, 1913a, 1931, 1937] Wigmore developed a mapping system for legal argumentation: Wigmore Diagrams (denoted WD in the following). The interpretation and use of such diagrams is the object of this paper.

A WD is a symbolic means for mapping arguments from observable evidence using the method of "divide and conquer" and multi-stage inference. It is not known to what extent WDs are in actual use by legal practitioners. But there is anecdotal evidence (no pun intended) that it is still in use today, about 100 years after the invention by Wigmore. In Israel several trial lawyers are using the method [Kannai 2010].

The approach is still extensively studied by researchers in logic and law, see: [Twining 1984], [Twining 1986], [Schum 1987], [Tillers and Schum 1988], [Tillers and Schum 1989], [Tillers and Schum 1990], [Anderson and Twining 1991], [Kadane and Schum 1996], [Schum 2001], [Twining and Hampsher-Monk 2003], [Anderson et al. 2005], [Rowe and Reed 2006] and [Gordon 2007]. Most of this work deals with practical aspects of the use of WD. It has also been used as a teaching tool by Twining and Anderson [Twining 1984, p.31].

The purpose of a WD is to structure arguments and reasoning chains starting with evidence and reaching facts-in-issue. Wigmore calls this the "ultimate probandum", (i.e. what has to be proved in court) of a case. It facilitates the assessment of the probative strength of the arguments (see section 4).

Mathematically, a WD is a Bipartite, Directed Acyclic Graph (DAG) with labeled edges. The vertices represent propositions, and the labels represent "fuzzy" force qualifiers (e.g. provisional, strong, doubtful, weak, none, see [Zadeh 1983]).

2.2 Definition of Wigmore Diagrams

The Wigmorean Charting Approach consists of two parts: A list of numbered propositions (the key-list) and a diagram. The numbered evidence nodes can be testimonial, circumstantial, explanatory or corroborative, they can be affirmative or negatory (sic, [Wigmore 1937, p.863]), and they can indicate which side offered the evidence, prosecution or defense. Furthermore, some types of evidence nodes and connecting arrows can have degrees of force.

Figure 1 shows some of the basic symbols used in WD.
Figure 1

<table>
<thead>
<tr>
<th>Defense</th>
<th>Prosecution</th>
</tr>
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<tbody>
<tr>
<td>1. Testimonial</td>
<td>□</td>
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<tr>
<td>2. Circumstantial</td>
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<tr>
<td>3. Explanatory</td>
<td>▷</td>
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<tr>
<td>4. Corroborative</td>
<td>△</td>
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</table>

The following is a partial example of a WD as given in [Wigmore 1913, p.87].

The numbered list of propositions (the key-list) is:

17. Some assertion of a witness w
18. w has a bias
19. w’s relation to the defendant is as a discharged employee
   19a. Discharged employees are apt to have an emotion of hostility
20. w showed strong demeanor of bias while on stand
21. Another witness testified to 19

A major problem today with Wigmore Diagrams is that Wigmore did not leave many charted examples in his writings. Furthermore, his definitions are incomplete, and open to different interpretations. This has lead researchers to give their own versions in cases of doubt (for example: What is meant by negation? see [Rowe and Reed 2006, p.176]). In the following we shall also make some minor (simplifying) assumptions.

3. RELATED DIAGRAMMING METHODS

It is interesting to notice how many attempts have been made to redefine and simplify WD. This arises of course from the complexity of WD: "few people have been attracted or persuaded by descriptions of the chart method; but, in the experience of the author, most people who have tried to master it have become convinced of its validity and of its practical value in some contexts" [Twining 1985, p.126]. Twining goes on to state: "My own assessment is that the general approach is sound, but in need of refinement". But an additional opinion by a trial lawyer quoted in [Kadane and Schum 1996, p.68] is the following: "Wigmore's charts look like hieroglyphics or perhaps a wiring diagram". The last analogue happens to be a description not so far from our model.

3.1 Argumentation Schemes

3.1.1 Araucaria

Araucaria [Reed and Rowe 2004] is a software tool for analyzing arguments. It aids a user in reconstructing and diagramming an argument. The software also supports argumentation schemes [Walton 2006]. Once arguments have been analyzed they can be saved in a portable format called AML (Argument Markup Language). Araucaria has been designed with the student, instructor, and Logic researcher in mind.

In [Rowe and Reed 2006] an attempt is made to translate Wigmore diagrams into Araucaria structures. This attempt necessitates some serious restrictions: All nodes supporting another node are represented as single unlinked nodes, there is no distinction in an Araucaria diagram between the concepts of explanatory, corroborative, testimonial or circumstantial evidence. For convenience, Araucaria interprets all nodes as testimonial, affirmatory nodes (represented in WD by a plain square). It also means that Araucaria does not distinguish between evidence offered by the prosecution and that offered by the defense.

Another problem arises with negatory nodes: The problem here is that Araucaria only allows a maximum of one refutation for any given node. In Wigmore, however, any number of nodes may support another node with negatory force.
Similar considerations apply to translation in the reverse
direction: from Araucaria to Wigmore: An Araucaria diagram
does not contain any information on the type of evidence
represented by a node, so there really is no choice but to represent
all nodes, linked or convergent, as one node type in a Wigmore
diagram.

Our interest is in the flow of information specifically in
WD. Araucaria diagrams will therefore not be considered below.

3.1.2 Carneades

Carneades is a computational model of argument, based
on the state-of-the-art of argumentation theory in philosophy.
[Gordon 2007] presents a diagramming method for Carneades,
similar to Wigmore charts, and illustrates how to map legal
evidence using this method.

The diagramming software can help a user prepare his
argument, by providing a set of argumentation schemes [Walton
2006] to choose from. For example, one application scenario for a
diagramming tool based on Carneades would be to help juries to
reach a verdict, during their deliberations. In this scenario, the
jury would deliberate about how to order the evidence,
represented as arguments, and the software would visualize the
consequences of various, proposed or chosen orderings [Gordon
2007, p.112].

Carneades can be used to model reasoning with
evidence in legal cases. [Gordon 2007] presents a reconstruction
of Wigmore’s chart of the evidence in the case of Commonwealth
v. Umilian, 1901, Supreme Judicial Court of Massachusetts, 177
Mass. 582 [Wigmore 1913a, p.872]. However, the reconstruction
in Carneades does not look and is not intended to look like a
Wigmore chart in any way. Diagrams in Carneades will therefore
not be considered below.

3.2 Modified Wigmore Diagrams

3.2.1 Twining

[Twining 2006, Appendix 4] shows a Wigmorean
analysis of a famous case: R. v. Bywaters and Thompson [Young
1923]. He uses a much simplified set of just two kinds of symbols
and connecting lines.

3.2.2 Anderson et al.

[Anderson et al. 2005, p.134 - 140] uses eight kinds of
symbols including two kinds of arrows, a vertical kind signifying
"tends to support", and a horizontal kind signifying "tends to
weaken". The authors apply a Wigmorean kind of analysis to a
fictitious case, defined as an exercise for graduate students (p.40).

3.2.3 Kadane and Schum's Approach

[Kadane and Schum 1996] use an adapted form of
Wigmore diagrams to analyze old and new evidence from the
celebrated Sacco and Vanzetti case from 1920.

The nodes are similar to the nodes of the original WD,
but use different geometrical shapes and colours. The "interim
probandum" takes the place of circumstantial evidence in the
original Wigmore symbols.

The edges are all simple nodes without any of the
conventions introduced by Wigmore himself. They are interpreted
as indicating probabilistic linkages between nodes.

There are also separate diagrams with different symbols
(and shapes) relating to evidence generated ex post facto from two
publications also analyzing the case, [Young and Kaiser 1985]
and [Starrs 1986].

Kadane and Schum have adopted a Bayesian view of
inference networks ([Pearl 1988]), which enables them to
combine the probabilities. In the final chapter of their book they
reach the conclusion that Vanzetti probably was not guilty, and
that this may be true also of Sacco.

[Anderson et al. 2005] has an on-line appendix by
Phillip Dawid. The appendix provides an elementary introduction
to statistical thinking, concepts and techniques relevant in legal
contexts, specifically to problems of proof [Dawid 2005].

The next section (section 4) will develop an information
flow model for Wigmore Diagrams. The approach of Kadane
and Schum may also be considered within that model. In that case the
flow corresponds to a flow of probabilities.

4. A FLOW MODEL FOR WDs

At the top of this paper we quoted [Twining 1985] on
the future use of Wigmore's charting method. In a different paper
the major advantages of using this method are explicitly
formulated [Anderson et al. 2005, p.141-2]:

(i) It requires the person doing the analysis to identify and
articulate precisely each proposition that she claims is a necessary
step in the arguments of the case.

(ii) The method requires that the person employing it specify with
precision each step in each argument being advanced.

(iii) It provides a method of marshaling all the relevant and
potentially relevant data in a complex case into a single coherent
and clear structure in the form of an argument.

We agree with the above, but believe that adding a
quantitative feature is important, and practically feasible in today's
computerized world. We shall do this below in two steps. First we
define a network model for WD. Next we develop an algorithm
for estimating the weight of the ultimate probandum (see section
2.1) based upon the network model. A software implementation
will be a future aim.

4.1 Definition of the model
The definition of a model for WDs in terms of information flow is intuitively straightforward, and will now be explained.

(i) Nodes

There are two aspects to assessment of the quality of an argument. One aspect considers the quality of an argument as a function of the quality of its components. The other aspect tests the extent to which the argument can resist refutation. WD does both: The components have associated strength, and a specific line of argumentation in the diagram also includes doubts and objections. In a WD the basic process of reasoning is in the vertical upwards direction, towards the "ultimate probandum". Explanatory (objections) and corroborating information are attached with horizontal arrows. Wigmore himself allowed such attachments both serially (one attached to the other) and in parallel (each one attached separately to a circumstantial node). But from his examples it is clear that there is no difference between the two types of attachment. He attached negative ancillary evidence on the left, and corroborative ancillary evidence on the right. This is of course just a practical convention, of no theoretical significance.

It has been remarked ([Rowe and Reed 2006, p.176]) that negative evidence is not well-defined in Wigmore's writings. Our assumption is that negative evidence for the prosecution simply means affirmative evidence for the defense, and vice versa. This also seems to be the assumption of [Kadane and Schum 1996], where the symbols for negative evidence have been discarded (see section 3.2.3).

Sources of flow are represented in similar ways in different models. We shall compare our model of information flow with two well-known other types of flow: Fluid and electricity. In all three cases we have nodes representing sources.

In the fluid model there would be two kinds of fluid (gas or liquid), one kind for the prosecution's affirmative testimonials and a second, "neutralizing" kind for the defense's affirmative testimonials. Acids and bases come to mind as a physical-chemical analogue. Belief or uncertainty in facts (as defined in Figure 2 above) indicate the strength of such sources (analogous perhaps to the pH of a solution). A circumstantial circle can be a source itself with associated strength. It can also be fed by a testimonial node. It then has the same strength as the node feeding it. Fluid analogues of ancillary corroborative or explanatory testimonials are controllers of the fluid capacity.

In the electricity model the sources have electromotive force (e.g. batteries), and the network contains (partially) loaded capacitors and resistors, analogous to ancillary affirmative and negatory evidence.

There is no need for an exact analogy. At some point the models naturally diverge. The combination of the strength of different items of evidence is different from the analogous concepts in physics (Bernoulli’s law and Kirchhoff’s laws). However, the electrical analogy seems to be a good source of inspiration in finding rules of strength combination, as we shall see below in section 4.2.2. The fluid analogy, which we initially thought would be helpful, turned out to be too superficial.

(ii) Edges

In our model the edges of a Wigmore Diagram are analogous to pipes carrying fluid or cables carrying electrical current. We ignore the force of the edges (see Figure 2 for Wigmore’s own definitions).

(iii) Flow Computation

The object is now to use the model to give some kind of quantitative estimate of the argumentation, based on the evidence. We shall call this the weight of the argumentation scheme (or of the ultimate probandum). Computer Science deals extensively with problems of flow in graphs (see, e.g., [Cormen et al. 2001]), mainly involving numerical computations. As described above in section 3.2.3 [Kadane and Schum 1996] have developed a computational probabilistic model, estimating the probability of the ultimate probandum.

(iv) Subscripts

We are ignoring subscripts. Wigmore himself did not always indicate these subscripts, and they do not contribute to our model in any way.

4.2 A Quantitative Estimate for WD.

4.2.1 Assumptions and Constraints

[Kadane and Schum 1996] uses probability to find a quantitative estimate for the evidence in a given WD. We shall not deal with the philosophical questions that arise in a probabilistic approach (see [Cohen 1977], [Twining 1985], [Kadane and Schum 1996] and [Anderson et al. 2005, chapters 8-9]). We believe there is a need for a different approach, for the following reasons.

1) We want to develop a model that can be of use for legal practitioners in the domain of criminal law in the spirit of the three arguments from [Twining, 1985] stated at the beginning of section 4.

2) Probabilistic considerations in law are of great interest for legal theoreticians and philosophers. Many practitioners use probabilistic concepts in an intuitive way. However, they may arguably not be interested in applying the mathematical rules of probability to their case at hand. They may not feel sure they are on firm ground if they try.

3) Probabilistic models of inference networks are understandable only by persons with a background in mathematical probability and philosophy. This may not be the case with lawyers, who would find concepts like Pascalian probability and Baconian
probability outside their field of expertise (see [Twining 2006, p.125-130], [Cohen 1977]).

4) Our model must be clear and understandable by legal practitioners. Practitioners of law do not usually appreciate numerical estimates, but may possibly accept fuzzy values.

5) Wigmore himself introduced fuzzy weights of individual components, but did not define how they should combine. Arguably he did not think about probabilistic models.

6) Probabilistic computations do not seem appropriate for our information flow model.

In order to develop an algorithm for estimating the weight of the ultimate probandum, several questions must be answered with appropriate justification. These questions and their terminology (“the five Cs”) arise in [Cohen 1977], [Twining 1985, p.180] and [Anderson et al. 2005, p.103-109].

(i) Conjunction

The ultimate probandum is often a conjunction of what can be denoted intermediate probanda (or perhaps subgoals). How should one conjoin the weight of the subgoals to obtain a weight of the ultimate probandum?

(ii) Corroboration

[Cohen 1977, p.94] defines: “At it simplest, testimonial corroboration occurs when two witnesses both testify, independently of each other, to the truth of the same proposition”. How should one evaluate the combined weight of such corroborative evidence? Does the same principle apply to testimonial evidence, circumstantial evidence and a combination of the two?

(iii) Compound Propositions

How should one evaluate the weight of compound propositions?

[Anderson et al. 2005, p.105] brings the following example:

10  X was at Y’s house at 4:30 pm
12  Y died in his home at 4:30 pm as a result of an unlawful act.
    They can be combined to support the proposition:
13  X had the opportunity to commit the act that caused Y’s death.
    This in turn supports:
3    It was X who committed the act that caused Y’s death.

So how does one compute the weight of 13, based on the weights of 10, 12? And what should be the weight of 3.

(iv) Convergence

[Cohen 1977, p.94] says: “two items of circumstantial evidence converge when both facts, independently of the other, support the probability of the same conclusion”.

[Twining 1985, p.182] gives the following examples of converging items of evidence:

"It was U who killed J",
"U had a design to kill J",
"U had a motive to kill J",
"U had consciousness of guilt about J’s disappearance"
"U knew that J was dead when others did not".

How should one evaluate converging evidence?

(v) Catenation

How should one evaluate catenated inferences? Here a chain of inferences lead to a single probandum, rather than a series of independent supports for the same probandum (corroboration and convergence) [Twining 1985, p.182]. It appears that Wigmore did not consider the catenated inferences as being dependent each on its predecessor. As already stated above, Wigmore himself allowed such attachments both serially (one attached to the other) and in parallel (each one attached separately to a circumstantial node). We shall therefore not differentiate between serially catenated inferences and parallel inferences, but assume they are all in parallel.

4.2.2 Computation in Our Model

From the previous section it follows, that we need a set of rules that are simple, intuitive, and give satisfactory answers to the questions raised while discussing ‘the five Cs’.

We define a modification of the basic min-max rule relating to fuzzy values. It is simple and intuitive while articulating a flow model. Keeping in mind that Wigmore himself used four fuzzy values to indicate the strength both of evidence and of the connecting arrows, we postulate the same basic values as Wigmore: doubtful, weak, medium and strong. We also assume a linear ordering: doubtful < weak < medium < strong. We shall show that such rules also supplies answers to ‘the five Cs’.

(i) Conjunction

Assume each of n subgoals (intermediate probanda) has a strength \( s_i \), then the conjunction (i.e. the ultimate probandum) has the strength: \( \min_{1 \leq i \leq n} s_i \).

(ii) Corroboration

We assume the individual propositions are ordered according to descending strength. This is no problem in a computerized system.
Intuitively if doubtful evidence is combined with weak evidence, the result is itself doubtful. So using the classical fuzzy logic definitions for given evidence X and Y, we define:

\[(1) \quad X \oplus Y = \min(X, Y) = Y\]

if \(X \in \{\text{weak, doubtful}\}\) and \(Y \in \{\text{weak, doubtful}\}\)

where \(\oplus\) stands for "combined with" and \(X \geq Y\).

Now, adding weak or doubtful evidence to medium or strong evidence will have only a very minor effect, so we define.

\[(2) \quad X \oplus Y = \max(X, Y) = X\]

if \(X \in \{\text{medium, strong}\}\) and \(Y \in \{\text{weak, doubtful}\}\)

However, adding medium or strong evidence to strong evidence is different. So we define:

\[(3) \quad \text{medium} \oplus \text{medium} = \text{strong}\]

\[(4) \quad \text{strong} \oplus \text{strong} = \text{strong}\]

These two rules can be understood intuitively. Let us first observe that in fuzzy logic a value represents an interval, and then examine the analogy with electrical batteries:

Two medium loaded batteries coupled together can have the same power as one strong battery - this is rule (3). Two batteries strongly but not fully loaded may be coupled and be equivalent to one strong battery - this is rule (4).

The operation \(\oplus\) is associative and simple, also for manual computations.

So, for given evidence X and Y, the rules (1) - (4) may be summarized in the following table of operations:

<table>
<thead>
<tr>
<th>(\oplus)</th>
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</table>

Table 1

The table is symmetric with respect to the major diagonal. As we assume that the evidence is sorted in descending order, the upper part of the table is not relevant.

We propose using the above definition of \(\oplus\) for testimonial evidence, and, separately, for ancillary affirmative evidence and for ancillary negative evidence.

We must now deal with the question of how to combine the ancillary evidence (once computed as defined above) with the testimonial evidence.

Ancillary corroborative evidence will be combined with testimonial evidence according to Table 1. Ancillary negatory evidence will reduce the strength of the combined result as follows:

<table>
<thead>
<tr>
<th>(\oplus)</th>
<th>doubtful</th>
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<td>strong</td>
<td>strong</td>
<td>medium</td>
<td>weak</td>
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</table>

Table 2

Here the left operand (indicated in the row) represents testimonial evidence combined with the corroborative force supporting it, while the right operand (indicated in the column) represents ancillary negatory evidence.

Intuitively this means that ancillary negatory evidence takes the testimonial evidence by one or more degrees, according to the relative strength of the two kinds of evidence.

(iii) Compound Propositions

As explained above in 4.2.1 (v) Wigmore himself considered compound propositions in parallel, so we shall do the same, applying Table 1.

(iv) Convergence

As explained above in 4.2.1 (v) Wigmore himself considered converging propositions in parallel, so we shall do the same, applying Table 1.

(v) Catenation

The situation here is the same as for Compound Propositions and Convergence (iii - iv). As explained above in 4.2.1 (v) Wigmore himself considered catenated propositions in parallel, so we shall do the same, applying Table 1.

4.3 Using the model

Let us quote Wigmore himself on the use of the diagrams:

The logical (or psychological) process -is essentially one of mental juxtaposition of detailed ideas for the purpose of producing
rationally a single final idea. Hence, to the extent that the mind is unable to juxtapose consciously a larger number of ideas, each coherent group of detailed constituent ideas must be reduced successively to a single idea, until the number and kind is such that the mind can consciously juxtapose them with due attention to each. And the use of symbols has no other purpose than to facilitate this process. Hence, each person may contrive his own special ways of using these or other symbols. [Wigmore 1913, p.90].

One can imagine a prosecutor or defender arranging the arguments in a WD while preparing his case. A WD is subjective in the sense that different advocates may structure their arguments from evidence in different manners, even though the WD includes arguments from both prosecution and defence. Should a chain of reasoning be agreed upon, the structure of the argument can still be formulated in different ways by different practitioners. Each such arrangement leads to a certain weight for the ultimate probandum. So the legal practitioner would try different arrangements of the evidence and argumentation, compute the weight of the ultimate probandum for each arrangement, and choose the arrangement with the maximum weight for presentation in court.

Another use of the model would be for a legal practitioner to note that adding another piece of evidence to his argument will increase the weight of the ultimate probandum, and then go out (or send a detective) to find such a piece of evidence.

Similar ideas have been expressed by [Schum 2003, p.30]: The method of Wigmore diagrams is an elegant heuristic device for generating new evidence and, perhaps, new hypotheses.

5. AN EXAMPLE

We shall illustrate our model and algorithm with a classical example from: Quintilian, Imperial Roman Schoolmaster, ca.35 - ca.100 (Institutio Oratoria V 9.9), see [Goodwin 2000, p.14].

The key list is as follows:

1. There is blood on this man's cloak
2. Therefore, he was involved when the victim was stabbed to death
3. Objection: His cloak was stained when he sacrificed a chicken
4. Reply: He didn't sacrifice a chicken
5. Evidence: His neighbour testifies that he's an atheist and never sacrifices
6. Objection: It was stained from nose bleed
7. Reply: He didn't have nosebleed
8. Evidence: A doctor testifies that he examined the nose and found it sound

A Wigmore Diagram (without indications of strength, which Quintilian did not supply) for this list is:

Let us consider the case from the point of view of the prosecutor, and make some assumptions about the force qualifiers (weights) of the nodes. Assuming there really is blood on the man's cloak (the defence does not suggest there isn't) testimonial evidence node 1 (key-list 1) is assigned a weight of "strong".

Both negatory ancillary objections nodes 3 and 6 on the left side (key-lists 3 and 6) are unsupported by testimonial evidence and are therefore assigned "weak". Their combination (according to Table 1) is also "weak".

The corroborative ancillary nodes 4 and 7 on the right side (key-lists 4 and 7) are both supported by testimonial evidence: nodes 5 and 8. The testimonies are evidence by the neighbour (key-list 5) and the doctor (key-list 8). The prosecutor assumes those testimonies are creditable, and assigns each a "strong" force which "flows" and becomes the weight of the nodes 4 and 7 respectively. Their combination (according to Table 1) is "strong".

The weight of the circumstantial node (key-list 2) can now be determined by considering what flows into it, from below, from the right and from the left. First the corroborative and testimonial forces (from below and from the right side) are combined according to Table 1 to produce a weight of "strong". This combines with the weight of "weak" from the left side according to Table 2, resulting in a weight of "strong". This is the output of the entire diagram. In summary, this indicates that the
prosecution’s case is well supported, and forms a “strong” argument.

In order to further illustrate our model, consider the following (somewhat different) scenario. Suppose that the defence assessed the situation in a similar way, and realised that his case was not going to hold up in court. He decided to look for additional evidence, and produced the following:

3a. The remains of a throat-slained chicken was found in the accused's backyard.

3a is circumstantial evidence, denoted by a circle, which is linked to node 3 from below (see Figure 4).

Figure 4

Even though this is circumstantial evidence, it has a considerable effect on the argumentation. Let us assign a “medium” force to node 3a. It flows into the negative ancillary node annotated by 3, which also will have the weight "medium":

Table 1 is now consulted in order to determine the overall negatory force from combining nodes 3 and 6: “medium”.

Since the other parts of the diagram are not changed, the combination of the testimonial and corroborative ancillary forces is again “strong”. Consulting Table 2 now produces a “medium” overall weight of the diagram, as opposed to the earlier “strong” weight.

In summary, looking for and finding evidence 3a, helped the defence to reduce the diagram’s weight and to undermine the prosecution’s case.

The lawyer for the defence does not leave things as they are now. He decides to look for some testimonial evidence to strengthen his case. From the diagram (Figure 7) it is obvious that node 6 is unsupported. So he sends a private detective to the neighbourhood to find some further evidence. Indeed the detective comes up with the following:

6a. A second neighbour testifies that the accused was punched in the nose a few days back and wore the same bloody shirt on the day of the murder.

6a is testimonial evidence, denoted by a square, which is linked to node 6 from below, as seen in Figure 5.

Figure 5

Let us assign 6a with a “medium” force. This force flows into the negative ancillary node annotated by 6. According to Table 1 the overall negatory force resulting from combining the weights of nodes 3 and 6 (both medium), now equals “strong”.

Using Table 2 in order to determine the entire diagram’s force (from the point of view of the defender) now produces only a “weak” force.

Thus by analysing the diagram, the lawyer for the defence has pinpointed the weak points of his defence. By finding further evidence he has seriously weakened the initially strong case of the prosecution.

6. CONCLUSION

A lawyer going through the example in the previous section may well argue that he could easily do the same without any fancy diagrams or computational algorithms. However, one should bear in mind that a real murder case would have a key-list and diagram larger by several orders of magnitude. So in a real case this kind of interactive computer analysis could be very helpful.
This paper is one of the results of ongoing work on the computerization of the Wigmorean approach. The aim of that research is as a first step to make Wigmore’s method user-friendly and computer-supported, but with more ambitious steps to follow in the future.

[Schum and Tillers 1990] already report the development of software for facilitating the use of Wigmore charting. Our aim is much wider. We intend to apply Artificial Intelligence and Automated Inference methods to assist the human charter to marshal the evidence efficiently, to discover contradictions in the evidence and evaluate it.

7. REFERENCES

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