Argumentation Mining from Judicial Decisions: The Attribution Problem and the Need for Legal Discourse Models

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ABSTRACT

This paper discusses an attribution problem that is particularly critical for argumentation mining in judicial decisions, and the development of a legal discourse model as an important component of any solution to that problem. Attribution in this context is the problem of determining who believes a stated proposition to be true. This is a particularly difficult problem for developing natural language processing software that can use linguistic cues to automatically formulate and test hypotheses about who treats or accepts an expressed proposition as (probably) true, or relies upon or uses it as support. The attribution problem for argumentation mining from judicial decisions arises because the author of the decision (the judge) does not always believe the propositional content expressed by every sentence she writes in the decision. For example, a judge might write the sentence *the varicella vaccine can cause neuropathy in humans*, but writing this sentence does not always indicate that the judge herself believes the stated proposition to be true. The sentence might report an allegation of a party in a legal pleading, or the testimony of an expert witness, or the text of a document exhibit, as well as (or in contrast to) a conclusion or finding of fact by the judge herself. This paper argues that solving the attribution problem for argumentation mining requires development of an adequate legal discourse model – that is, a data structure representing the actors in a legal proceeding and the argument-related information that is important for understanding the meaning of a judicial decision. This paper discusses some basic content for such a legal discourse model that would be useful in making attribution determinations, drawing upon vaccine-injury compensation decisions in the United States for examples and to formulate hypotheses. The paper also argues that adequate development of a legal discourse model requires empirical investigation of actual judicial decisions.

Keywords

Argumentation mining, legal document annotation, natural language processing, attribution relation, discourse structure, discourse model, legal factfinding, vaccine-injury compensation.

1. INTRODUCTION

Especially with the development of opinion analysis and information extraction, it is often important to determine which actors believe a stated proposition to be true [12]. Attribution, in the context of argumentation mining, is the descriptive task of determining "Who believes which propositions?" By "believes" here we mean "treats or accepts as (probably) true" or "relies upon or uses as support."

Accurate attribution can be a critical task for argumentation mining, in which the objective is to extract from a document the coherent lines of argumentation. "Argumentation" here refers to a structure containing related, individual arguments as elements, where "arguments" are sets of propositions, one of which (the conclusion) can be reasonably believed to be true if the other propositions (the premises or conditions) are reasonably believed to be true [11]. Determining which person believes which propositions to be true can be important in identifying the argumentation advanced by each party.

Certain uses of argumentation mining, moreover, depend upon determining which arguments are successful or unsuccessful in persuading a particular decision maker. For useful argumentation mining in judicial decisions, it is often critical to distinguish the reasoning of the court from the arguments of the different parties. For example, a judge might write in her decision the sentence *the varicella vaccine can cause neuropathy in humans*, but writing this sentence does not always indicate that the judge herself believes the stated proposition to be true. The sentence might report an allegation of a party in a legal pleading, or the testimony of an expert witness, or the text of a document exhibit, as well as (or in contrast to) a conclusion or finding of fact by the judge herself. To be useful in distinguishing successful from unsuccessful arguments, argumentation mining from judicial decisions requires accurate attribution of stated propositions to the judge or factfinder.

If the problem of attribution in argumentation mining from judicial decisions is determining which actors in the legal proceeding believe a stated proposition to be true, then the additional problem for automating argumentation mining is developing natural language processing software that can use linguistic cues to formulate and test hypotheses about attribution. Put another way, one problem for automated argumentation mining is extracting attribution relations from legal texts, and in particular from judicial decisions. In the remaining sections of this paper, we do the following: (1) we examine the nature of the attribution problem in actual case decisions (Section 2); (2) we introduce the general concept of a legal discourse model (Section

3); and (3) we suggest how to use a legal discourse model to help solve the attribution problem (Section 4). In each section, we discuss relevant prior work. Finally, we discuss some broader implications of this work and suggest future work (Section 5).

2. THE ATTRIBUTION PROBLEM IN JUDICIAL DECISIONS

Attribution is a classic problem area in natural language processing [5, 10, 12, 13]. To take a clear example, if a sentence explicitly attributes a proposition to some source by means of a direct quotation, then this generally implies that the reader can attribute the quotation to that source [10]. However, this generally does not imply that the author of the <u>sentence</u> believes the content of the <u>quotation</u> to be true. Support (if any) for attribution of the quoted proposition to the sentence author often must derive from the context in which the sentence was written, rather than from the semantics of the sentence itself. Thus, attribution in non-quotation situations is generally more complicated [13].

There has been limited work, however, on the attribution problem in respect to argumentation mining from legal documents. [7] reported on a project to annotate sentences in House of Lords judgments for their argumentative roles. Two tasks were to attribute statements to the Law Lord speaking about the case or to someone else (attribution), and to classify sentences as formulating the law objectively vs. assessing the law as favoring a conclusion or not favoring it (comparison). This work extended the work of [16] on attribution in scientific articles. Unlike the case decisions used in our study, the House of Lords judgments studied by [7] treated facts as already settled in the lower courts, and engaged in what we would call policy-based reasoning about issues of law. The work reported here focuses on the problem of attribution in the factfinding portions of judicial decisions that utilize scientific evidence, and therefore it complements the work of both [7] and [16].

For the task of argumentation mining from judicial decisions, we represent **attribution relations** using at least three main elements or predicate arguments, which is consistent with [12]:

(A) The **attribution object**: the propositional content of a sentence that we attribute to some actor, and which states what we infer that the actor believes to be true;

(B) The **attribution subject**: the actor to whom we attribute belief in the propositional content of the sentence; and

(C) The **attribution cue**: the lexical anchor or cue that signals the attribution, and which provides the evidentiary basis for the attribution.

As indicated in these element descriptions, an attribution object is a proposition, an attribution subject is an actor, and an attribution cue is a word or phrase. The attribution cue functions as the linguistic evidence supporting an attribution relation [20].

The task of mining arguments may seem relatively straightforward when a single sentence contains linguistic cues for the values of all three attribution elements. For example, we can find values for all three elements within sentence (1), as it might be found in a judicial decision written by a judge:

(1)   The court agrees with the testimony of the petitioner's expert witness that the varicella vaccine can cause neuropathy in humans.

In this sentence we find indications of the attribution object or attributed propositional content (*the varicella vaccine can cause neuropathy in humans*) and of two attribution subjects to which the content is attributed (*the petitioner's expert witness* and *the court*), as well as the cues for the attribution relation (*the testimony of* for the petitioner's expert, and *agrees with* for the court).[1] However, as we discuss in this paper, it is very often the case that in judicial decisions we cannot find plausible values for all three elements in a single sentence. Most often, we must resort to extra-sentence linguistic cues and presuppositional information to formulate and test hypotheses about attribution relations.

Consider, for example, if the author of sentence (1) had instead written:

(2)   The petitioner's expert witness testified that the varicella vaccine can cause neuropathy in humans.

By Grice's Maxim of Quality, a reader could reasonably infer that the judge as author of sentence (2) believes that this is the content of the expert witness's testimony. The Gricean Maxim of Quality is an interpretive maxim of pragmatics that states that an author of a declarative sentence generally implicates (warrants the inference by readers) that the author does not believe the stated proposition to be false, and does in fact have what the author believes to be adequate evidence for its truth [3, 8]. But the occurrence of the sentence stating that an expert witness testified to a proposition is generally not a sufficient linguistic cue that the judge herself believed that what the witness stated is true. We generally need more, contextual evidence to make the latter attribution.

Even the occurrence of the simple declarative sentence (3) may or may not be a sufficient linguistic cue that the judge as author of the decision believes the stated proposition to be true:

(3)   The varicella vaccine can cause neuropathy in humans.

For example, if sentence (3) occurs in a section of the decision entitled *Expert Testimony*, then it might be just a parsimonious way of expressing the same meaning as sentence (2). If, on the other hand, sentence (3) occurs in a section entitled *Findings of the Court*, this might warrant attributing it to the judge.

Solving the attribution problem for automated argumentation mining, therefore, presents several difficult types of problems. One type of problem is to determine which intra-sentence linguistic expressions can function as attribution cues. For some expressions the answer seems straightforward (e.g., *agrees with*), while for others the answer is more difficult. We will argue in Section 4 that this problem can be adequately dealt with only empirically, probably with the assistance of machine learning. A second type of problem is to determine which extra-sentence but intra-document linguistic evidence can function as attribution cues (e.g., document segmentation). A third type of problem is identifying presuppositional information that is relevant to attribution for argumentation mining, in the sense of being the common ground of the discourse or background information shared among writers and readers [3]. We will propose in Section 4 that some content of a legal discourse model will turn out to be an important component in solving this type of problem, and that

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[1] We follow the convention of using italics to indicate linguistic referents (words, phrases, sentences) [3], as contrasted with indicating real-world or logical referents (such as a person or a proposition).

we will need to extract much of such information empirically from the data.

Before turning to that discussion, however, in the remainder of this section of the paper we have two objectives. First, we will demonstrate, using examples from judicial decisions, that the attribution problem is a significant one. The examples are drawn from vaccine-compensation decisions of the U.S. Court of Federal Claims [1, 2, 18, 19]. In such cases, a petitioner claims entitlement to compensation by proving, among other things, that a vaccination played a causal role in bringing about an alleged injury. When the government as respondent contests a claim, the case is initially decided by a special master, who evaluates the plausibility of the evidence, draws inferences, and makes findings of fact. We provide examples of sentences excerpted from six of those decisions, authored by six different special masters, which illustrate the nature and extent of the attribution problem for argumentation mining. Second, we will use those examples to suggest the wide linguistic variability that we encounter in when trying to address the attribution problem in actual judicial decisions.

2.1 Attribution in the <u>Casey</u> Decision

The decision of Special Master Sweeney in Casey v. Secretary of Health and Human Services, Court of Federal Claims, Office of Special Masters, No. 97-612V (December 12, 2005), provides several illustrations of the attribution problem. Special Master Sweeney decided for the petitioner Shannon Casey in a case alleging that a vaccination with varicella vaccine caused an autoimmune reaction affecting Shannon's central and peripheral nervous systems. The first illustration shows linguistic cues on attribution embedded directly into the sentences that state both the attribution object and subject:

> (4) Dr. Tornatore found the conclusion that the varicella vaccine caused petitioner's encephalomyeloneuritis to be reasonable. [p. 13]

> (5) Therefore, because petitioner has satisfied all three elements laid out by the Federal Circuit in <u>Althen</u>, the special master finds that petitioner has met her burden of showing that, more likely than not, the varicella vaccine she received on June 9, 1995, caused her encephalomyeloneuritis. [p. 27]

Each sentence attributes belief in the proposition "the varicella vaccine caused the petitioner's encephalomyeloneuritis" to a particular agent: the petitioner's expert witness Dr. Tornatore first testified to this effect (4), and the special master as factfinder for the court later concludes that, more likely than not, this is true (5). Moreover, sentence (4) occurs in the section of the decision entitled *Testimony of Petitioner's Expert: Carlo Tornatore, M.D.* (pp. 12-15), while sentence (5) occurs in the later section entitled *Petitioner Has Met Her Burden* (pp. 26-27). We understand, therefore, that sentence (4) is simply the special master's restating of the testimony of the expert (cue: *Dr. Tornatore found the conclusion that ... to be reasonable*), while sentence (5) is the conclusion of the special master (cue: *the special master finds that petitioner has met her burden of showing that, more likely than not*).

A second example from <u>Casey</u> illustrates an important departure from this fundamental pattern. It illustrates an attribution based in part on the party affiliation of a witness. The concluding section of the decision, entitled *Petitioner Has Met Her Burden*, contains the following single sentence as a complete paragraph:

> (6) Second, all three experts, Dr. Tornatore, Dr. Bellanti, and Dr. Leist, agreed that if the varicella vaccination was the cause of petitioner's injuries, petitioner's onset of symptoms occurred within an appropriate time period after vaccination. [p. 26]

The attribution object is the proposition that "if the varicella vaccination was the cause of petitioner's injuries, petitioner's onset of symptoms occurred within an appropriate time period after vaccination." Sentence (6), taken alone, appears to merely report the testimony of three expert witnesses (cue: *all three experts, Dr. Tornatore, Dr. Bellanti, and Dr. Leist, agreed that*). However, when we interpret the meaning of this sentence in context, we understand that it also implies that the special master is making a finding that "if the varicella vaccination was the cause of petitioner's injuries, petitioner's onset of symptoms occurred within an appropriate time period after vaccination," although the sentence contains no explicit attribution cues to this effect. Our reasoning in support of this attribution has several bases.

First, sentence (6) occurs in the document segment stating and discussing findings of fact, although not every sentence within such a section states a finding of fact. Typically such a section both recounts the salient evidence and provides the reasoning and conclusions of the factfinder.

Second, the introductory word *Second* in sentence (6) and the placement of the paragraph indicate that this sentence states a second item in a list of items. This list is headed by a paragraph stating three legal conditions that the petitioner is required to prove under the decision by the U.S. Court of Appeals for the Federal Circuit in Althen v. Secretary of Health and Human Services, 418 F.3d 1274 (2005), and stating that the petitioner has persuaded the special master as to the truth of all three conditions in this case:

> (7) As summarized by the Federal Circuit in <u>Althen</u>, petitioner will prevail only if she proves, more likely than not, "(1) a medical theory causally connecting the vaccination and the injury; (2) a logical sequence of cause and effect showing that the vaccination was the reason for the injury; and (3) a showing of a proximate temporal relationship between vaccination and injury." 418 F.3d at 1278. The special master is convinced that petitioner has made the requisite showing in this case. [p. 26]

Sentence (6) continues this list (out of order) by addressing the third <u>Althen</u> condition in the list in paragraph (7). In addition, as a summary statement at the end of the list, in sentence (5) we find again the explicit statement that all three elements or conditions of the <u>Althen</u> test have been satisfied in the estimation of the special master.

Third, sentence (6) states that Dr. Leist also testified to this effect. We learn elsewhere in the decision that Dr. Leist was the sole expert witness of the respondent (p. 10 of the decision). To an attorney, this implies that the government has conceded the issue of the timing of the onset in this case, and an attorney would infer that this means that the special master as factfinder has no evidentiary basis for finding in the government's favor on this issue.

Therefore, the reasonable implication of sentence (6) is that the special master finds the proposition "if the varicella vaccination was the cause of petitioner's injuries, petitioner's onset of symptoms occurred within an appropriate time period after

vaccination" to be true, even though this is not explicitly stated in sentence (6).

2.2 Attribution in the <u>Cusati</u> Decision

The decision of Special Master Edwards in Cusati v. Secretary of Health and Human Services, Court of Federal Claims, Office of Special Masters, No. 99-0492V (December 5, 2006), provides an illustration of sentences that state a proposition as an allegation, as testimony, and as finding of fact. Special Master Edwards found for the petitioner Alina Cusati in a case alleging that a vaccination with the measles-mumps-rubella (MMR) vaccine caused the intractable seizure disorder and death of the petitioner's son, Eric Fernandez. Consider the following sentences, which all state or imply that "MMR vaccine can cause fever," although the sentences play a variety of roles in the ultimately successful argumentation and factfinding reasoning:

(8) At the outset, Ms. Cusati asserts that Eric's November 5, 1996 MMR immunization generated a fever. [p. 10]

(9) Instead, Dr. Kinsbourne urged that Eric's November 5, 1996 MMR immunization produced naturally viremia, causing characteristic fever, resulting in Eric's initial seizures, leading to Eric's epilepsy and death. [p. 8]

(10) Dr. Kohrman acknowledged that MMR vaccine, like "viremia from any [source]," does "cause fever." [p. 10]

(11) Dr. Kinsbourne and Dr. Kohrman agree that MMR vaccine causes fever. [p. 11]

(12) Ms. Cusati has provided more than preponderant evidence that MMR vaccine causes fever. [p. 12]

Sentence (8) states an allegation in the argument of the petitioner (cue: *Ms. Cusati asserts that*), although the sentence itself occurs in the document in a section entitled *Discussion*, where one might normally expect to find statements of evidence and findings. Sentences (9) and (10) attribute the proposition of causation to two different expert witnesses, and both occur in a major section entitled *The Medical Testimony*, within sub-sections entitled (respectively) *Dr. Kinsbourne* (sentence (9)) and *Dr. Kohrman* (sentence (10). Sentences (11) and (12) occur in the section entitled *Discussion*. Thus, we have examples of a Discussion section containing sentences that state allegations, testimony, and findings of fact.

Although the party affiliations of these two mentioned experts are never explicitly stated in the decision, Dr. Kinsbourne is clearly the expert for the petitioner, based on the following:

(13) Through Dr. Kinsbourne, Ms. Cusati advances a seemingly simple argument. [p. 10]

Moreover, Dr. Kohrman, the only other expert witness discussed in the decision as providing testimony, presented evidence that the special master clearly considered to be in opposition to the testimony of Dr. Kinsbourne (see p. 13 of the decision). Thus, sentence (11) is evidence that the special master treated Dr. Kohrman's testimony on this particular issue as an admission on the part of the respondent (see also the discussion in 2.1 above on the role of party admissions), and furnishes the warrant for the finding in sentence (12). This inference is also supported by the special master's later restating that:

(14) Moreover, Dr. Kohrman implicated Eric's November 5, 1996 MMR immunization as the cause of Eric's fever. [p. 13]

It is worth noting the attribution cue in sentence (12): *Ms. Cusati has provided more than preponderant evidence*. The immediately preceding paragraph in the decision discusses the meaning and policies behind the "preponderance of the evidence standard" that special masters are required by law to use when making findings of fact. Thus, sentence (12) uses the phrase *more than preponderant evidence* to indicate that the special master is making a finding of fact in the petitioner's favor.

2.3 Attribution in the <u>Werderitsh</u> Decision

The decision of Special Master Millman in Werderitsh v. Secretary of the Department of Health and Human Services, Court of Federal Claims, Office of Special Masters, No. 99-319V (May 26, 2006), provides an illustration of sentences that state evidence from published literature, as well as related sentences stating testimony and implying a finding by the factfinder. Special Master Millman found for the petitioner in a case alleging that two vaccinations with hepatitis B vaccine caused the petitioner's multiple sclerosis. Consider the following series of sentences from the decision:

(15) Their data showed no difference in T-cell proliferation or cytokine production between the two groups, thus not favoring a causal link between demyelinating illness and hepatitis B vaccine, although the authors say that their result was not sufficient to exclude the causal link because the sample size, being quite small, limited the power of the study. [p. 26]

(16) Dr. Leist concluded that the lack of producing an elevated T-cell response against hepatitis B surface antigen in those with neurological symptoms was evidence against a causal relationship between hepatitis B vaccine and demyelinating diseases. [pp. 25-26]

(17) Dr. Leist concluded that it is highly improbable that hepatitis B vaccine induces autoreactive T cells that cause demyelination of the vaccinee's nerves. [p. 26]

(18) The article respondent filed as Ex. 1, the Piaggio article, to show that there was no difference in T-cell proliferation or cytokine production among hepatitis B vaccinees who had demyelinating diseases and hepatitis B vaccinees who remained healthy is not dispositive because the authors admit their study was small and its power thereby reduced. [p. 43]

(19) But the authors of that article stated that their conclusions were tempered by the fact that their study was small and its power thereby reduced. [p. 44]

An earlier sentence in the decision provides the identification of the authors of the article:

(20) Respondent filed as Ex. 1, the article Dr. Leist discussed in Ex. G, entitled "Hepatitis B vaccination and central nervous system demyelination: an immunological approach," by E. Piaggio, et al., 24 J Autoimmunity 33-37 (2005). [p. 26]

This series of sentences illustrates that it is sometimes complicated to identify the proposition to use as attribution object, especially for automating the argumentation mining. In addition, a difficult question is what, if anything, to attribute to the special master on the basis of these sentences. The answer is embedded in sentence (18), with the cue being *the article ... is not dispositive*. There are several bases for attributing this to the special master.

First, location within the document is once more indicative of attribution to the special master. Sentences (15) – (17) occur within a section of the decision entitled *Other Submitted Material* (pp. 13-26), whereas sentences (18) and (19) occur in a section entitled *Discussion* (pp. 38-48). However, such location alone is not dispositive of attribution (see sections 2.1 and 2.2 above).

Second, the use of citations also provides cues about attribution. Sentences (15) – (17) are each followed immediately in the text by sentences citing to exhibits in the legal record. This provides some evidence against attribution to the special master as factfinder, who is citing something that is not her own writing. The lack of citations following sentences (18) and (19), therefore, may indicate that we can attribute the propositions stated in those sentences to the special master. (While sentence (18) contains a citation, that citation functions to determine the reference of the noun *article*, rather than to attribute to someone else the proposition "the article is not dispositive.")

Third, we know from the text that the special master ultimately found for the petitioner in this case. Moreover, Dr. Leist was an expert witness for the respondent in the case, and the respondent filed the Piaggio article that Dr. Leist relied upon for his opposing testimony. Thus, it is reasonable to expect that the special master did not adopt Dr. Leist's interpretation of the significance of the Piaggio study for this case.

Fourth, this attribution is consistent with interpreting the word *But* in sentence (19), which occurs in the text about 1.5 pages after sentence (18), as implying that the special master regards the statement of the authors as sufficient rebuttal to Dr. Leist's conclusion.

In sum, given the location of sentence (18) within the *Discussion* section, the lack of citation for the propositional content of the sentence itself, the overall finding of the special master in favor of the petitioner and against Dr. Leist's opinion on causation, and the corroboration of sentence (19), we can infer that we should attribute to the special master the proposition that "the Piaggio article is not dispositive," based on sentence (18).

2.4 Attribution in the <u>Thomas</u> Decision

The decision of Special Master Abell in Thomas v. Secretary of the Department of Health and Human Services, Court of Federal Claims, Office of Special Masters, No. 01-645V (January 23, 2007), provides an illustration of how attribution can play a critical role within the very reasoning of the special master. Special Master Abell found for the government as respondent, and against the petitioners Camilla and Patrick Thomas, in a case alleging that a vaccination with diphtheria-pertussis-tetanus (DPT) vaccine caused their daughter Kenidi to suffer an acute encephalopathy and subsequent death. Consider the following set of sentences:

(21) In the alternative, Dr. Corbier maintains that the DPT vaccine caused in fact Kenidi's neuro-degenerative condition with seizure disorder. [p. 20]

(22) In the opinion of Dr. Wiznitzer, Kenidi's condition "is not really related to the vaccination at all." [p. 25]

(23) Concerning the testimony offered by Dr. Wiznitzer, the Court found it more credible, for the most part, than that proffered by Dr. Corbier. [p. 31]

In contrast to the situation where opposing experts agree (see Section 2.1 above), it is more commonly the case that opposing

experts disagree on one or more propositions that are material to the outcome of the case, as illustrated by sentences (21) (cue: *Dr. Corbier maintains that*) and (22) (cue: *In the opinion of Dr. Wiznitzer*). Sometimes discrepancies are resolved by assessing the substance or merits of the conflicting propositions. Sometimes, however, a major factor in deciding the conflict is the credibility of the witness testifying. Sentence (23) tells us that, other things being equal, this factfinder will discount the testimony of Dr. Corbier when it is in conflict with that of Dr. Wiznitzer, which furnishes evidence against attributing the conclusion of causation in sentence (21) to the special master. So determining the accurate attribution of a proposition to a particular witness can be a factor in determining the attribution of that same proposition to the factfinder.

It is worth noting also that here the attributions to Dr. Corbier in sentence (21) and to Dr. Wiznitzer in sentence (22) are merely a factor in attributing lack of causation to the special master, but not dispositive: the phrase *for the most part* in sentence (23) leaves open the possibility that on some propositions, the factfinder might side with Dr. Corbier over Dr. Wiznitzer.

2.5 Attribution in the <u>Walton</u> Decision

The decision of Special Master Vowell in Walton v. Secretary of the Department of Health and Human Services, Court of Federal Claims, Office of Special Masters, No. 04-503V (April 30, 2007), illustrates that the problem of attribution can be present in many layers of argumentation. Special Master Vowell found for the government as respondent, and against the petitioner Yvonne Walton, in a case alleging that a vaccination with MMR vaccine caused the petitioner's myocarditis. In the following examples, the issue was the timing of any cardiac symptoms experienced by Mrs. Walton subsequent to her vaccination, and in particular whether any such symptoms could have occurred in April 2001 (within a month after the vaccination) or whether they occurred no earlier than June 2001 (more than 2 months after the vaccination). Consider the following series of sentences from a section of the decision entitled *II. The MMR Vaccination and Subsequent Treatment in the U.S.*:

(24) Consistent with her affidavit, Mrs. Walton testified that she began feeling sick, tired, and suffered from headache and a rash, within a few days of the vaccination. [p. 6]

(25) Later in her testimony, she indicated that she began having heart palpitations within a few days of the vaccination. [p. 6]

(26) There was no mention in this medical record of the symptoms of rash, tiredness, and heart palpitations that Mrs. Walton related in her testimony. [p. 7, referring to a medical record from a visit on April 30, 2001]

(27) At the June 6, 2001 visit to Pro Med, her complaints were a tickling or choking sensation in her throat, shortness of breath, and heart palpitations. [p. 8]

Later in the decision, in a section entitled *IV. Resolving Conflicts in the Medical Evidence*, there occurs the sentence:

(28) To be more specific, there is no credible evidence that Mrs. Walton suffered either a rash or cardiac symptoms (racing heart, chest pain, or palpitations) within 60 days of her vaccination. [p. 19]

From sentences (24) and (25) we can attribute to Mrs. Walton the

proposition that she experienced various symptoms within a few days of her vaccination, including heart palpitations. Sentences (26) and (27) cite medical records (documents) submitted for the evidentiary record in the vaccine-compensation proceeding. The troubling discrepancy for the special master was the lack of corroboration in those records for Mrs. Walton's testimony about her symptoms on or before April 30 (sentence (26)). Sentence (28) states the special master's finding that Mrs. Walton had not established that cardiac symptoms had occurred prior to June 2001.

Later we encounter attribution playing a role in the special master's reasoning. In a section entitled *VI. Expert Reports and Opinions*, we find the following discussion of the expert testimony of Dr. Michael, an expert witness for Mrs. Walton:

> (29) He cited dizziness, fever, headache, pain, rash, and a racing heart as the symptoms Mrs. Walton displayed at her medical appointment a month after the vaccination, noting that the symptoms began about two weeks earlier. [p. 25]

> (30) His opinion thus relied in part on symptoms that were not contemporaneously recorded and which conflict with the facts as I have found them. [p. 26]

> (31) Stripped of its reliance on Mrs. Walton's non-contemporaneous accounts of symptoms, his opinion does not logically connect her vaccination with her subsequent illness. [p. 26]

The special master notes the reliance by Dr. Michael on Mrs. Walton's testimony (sentences (29) and (30)) and discounts Dr. Michael's opinion accordingly (sentence (31)). The attribution to Dr. Michael by the special master of the propositions attributed to Mrs. Walton through her testimony counts against our attributing Dr. Michael's conclusions to the special master.

2.6 Attribution in the <u>Meyers</u> Decision

The decision of Special Master Campbell-Smith in Meyers v. Secretary of the Department of Health and Human Services, Court of Federal Claims, Office of Special Masters, No. 04-1771V (May 22, 2006), illustrates the importance of legal rules concerning the burden of proof (both the burden of producing evidence for the record and of persuading the factfinder by a preponderance of the evidence) in determining attribution. Special Master Campbell-Smith found for the government as respondent, and against the petitioner Darla Meyers, in a case alleging that four vaccinations with DPT (or DTaP) vaccine caused her son Matthew Meyers to develop diabetes. Consider the following series of related sentences:

> (32) The petition alleges that Matthew developed diabetes as a result of four DTP vaccinations administered on October 31, 1997, December 12, 1997, February 28, 1998 and February 15, 1999. [p. 2]

> (33) While petitioner need not show that the vaccine was the sole or even predominant cause of the injury, petitioner bears the burden of establishing "that the vaccine was not only a but-for cause of the injury but also a substantial factor in bringing about the injury." [p. 5]

> (34) In support of his opinion that Matthew's DTaP vaccinations caused and significantly aggravated Matthew's diabetes, Dr. Buttram relies heavily on the theories of John B. Classen, M.D. [p. 8]

(35) Moreover, in 2002, the Institute of Medicine Vaccine Safety Committee reviewed much of the information on which Dr. Buttram relies and concluded that the "evidence favors rejection of a causal relationship between multiple immunizations and increased risk for infections and for type I diabetes." [pp. 9-10]

(36) Dr. Buttram's reliance on Dr. Classen's theories and articles that do not satisfy the <u>Daubert</u> standard of evidentiary reliability is misplaced. [pp. 10-11]

(37) By offering Dr. Classen's articles in support of his opinion, Dr. Buttram fails to provide a reputable medical or scientific explanation for his theory that Matthew's four DTaP vaccinations caused and significantly aggravated Matthew's diabetes. [p. 11]

Sentence (32) states the allegation that the DTP vaccinations caused Matthew's diabetes, and sentence (33) affirms that the burden is on the petitioner to bring forth convincing evidence on the issue of causation. Sentence (34) states the petitioner's evidence on causation: the testimony of the petitioner's expert witness, Dr. Buttram, that the vaccinations caused the diabetes, which opinion "relies heavily on the theories of John B. Classen, M.D."

Sentence (35) states that the Institute of Medicine's Vaccine Safety Committee reached a different conclusion on the basis of much of the same information. The special master indicated (in sentence (36)) that she was not persuaded by testimony that relies on any of Dr. Classen's theories or articles "that do not satisfy the <u>Daubert</u> standard of evidentiary reliability." She is referring here to the standards of evidentiary admissibility articulated by the United States Supreme Court in the case of Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993).

Once the work of Dr. Classen has been discredited as a basis for an opinion of causation, the petitioner has no other evidence on which the special master could find in the petitioner's favor (sentence (37)), thus the special master cannot lawfully conclude "that Matthew's four DTaP vaccinations caused and significantly aggravated Matthew's diabetes."

Note that on the basis of sentence (37) we cannot attribute to the special master the negative proposition that the vaccinations did <u>not</u> cause or significantly aggravate Matthew's diabetes. Failure to be persuaded by the evidence offered for a proposition is not equivalent to being persuaded that the proposition is false. On the basis of sentence (37), we can attribute to the special master only the proposition that "Dr. Buttram fails to provide a reputable medical or scientific explanation for his theory." Logically, this is consistent with Matthew's vaccinations being in fact a cause of his diabetes, which might possibly be demonstrated by some other evidence not introduced into this legal record. Moreover, sentence (35), which quotes the Institute of Medicine Committee, cannot reasonably function as evidence for attributing to the special master the content of the quotation (see Section 1.0 above). Sometimes, therefore, accurate attribution within judicial decisions is a function of the legal rules on burden of proof.

3. THE GENERAL CONCEPT OF A LEGAL DISCOURSE MODEL

In Section 4 we will use a legal discourse model to address the attribution problem in judicial decisions, but first we discuss in this section the general concept of a legal discourse model. A **discourse structure** is a representation of the linguistic features

of a discourse occurring in a text, above the semantic level of n-grams and single sentences [20]. Such structures may involve the typing of sentences by discourse role and discourse relations among sentences, as well as classification of types of discourse structures (such as topic structures, functional structures, or coherence structures [20]). **Discourse relations** include relations among sentences used to form arguments [5]. [9] studied discourse relations for annotating "argument compounds" in technical documents (e.g., product manuals), although the typology of argumentation developed for those documents might not be optimal for typing arguments in judicial decisions.

In general, a **discourse model** is a data structure that a reader can use to understand the meaning and discourse-relevant features of the sentences in a document [3]. A discourse model includes not only information about named actors gleaned from the document itself, but also presuppositional information about possible actors and their properties, actions, and relations. This presuppositional information is the common ground of background information that is shared among writers and readers [3]. When attribution problems arise in normal discourse, the discourse model can assist the reader in making sense of the sentences of the author.

A **legal discourse model (LDM)** is a discourse model that is useful when interpreting the static legal text as a product of a dynamic process of discourse [4]. An LDM is a data structure that is shared at least by attorneys and judges, as well as by other interested participants, such that the author of a judicial decision can presuppose that an attorney reading the decision will be familiar with these actors, and with their properties, actions, and relations, or that it is fair to assume that the attorney will become familiar with them as the need arises. For example, the presuppositional information that a "petitioner" is the person who files the petition for compensation and the "special master" is the person who decides the facts is known (or can be known) by the reader prior to reading the particular vaccine decision, but whether the petitioner has been vaccinated and whether the petitioner is injured are issues to be decided on the basis of the evidence produced in that particular case.

In general, a legal discourse model is a data structure that has at least the following possible elements, insofar as they are relevant to understanding the meaning of sentences within judicial decisions:

(i) the **actors** referred to in the decision (both **named entities** and **types of actors**, the latter usually defined in terms of their **roles**); and

(ii) for each such actor, the **properties**, actor **relations** (including possible **actions**), and other **information** that are relevant for some purpose.

Examples of actors are named entities (e.g., Mrs. Walton, the Institute of Medicine, or the United States Court of Federal Claims) and types of actors identified by their roles in the legal process (e.g., petitioner, witness, or appellate court). Examples of actor relations that are actions are filing a petition, stating testimony under oath, producing a medical record as evidence, and issuing a judgment. Examples of actor relations that are not actions are being a witness for a particular party, considering a witness to be credible, and being persuaded by some testimony.

Some actors and their associated information will be specific to a particular legal case – e.g., Matthew Meyers, who received four DTP vaccinations (Section 2.6 above). Other actors and information, however, will be generic to a particular type of judicial decision, within a particular substantive area of law (e.g.,

petitioners in vaccine compensation cases). Yet other actors and information will be generic to a broader set of cases (e.g., the Court of Federal Claims, which hears not only vaccine compensation decisions, but other types of lawsuits as well). Thus, we anticipate that some of the content of the legal discourse model developed in particular vaccine compensation decisions will be transferrable to other vaccine decisions, and some to judicial decisions in other substantive areas of law.

4. USING A LEGAL DISCOURSE MODEL TO ADDRESS THE ATTRIBUTION PROBLEM

In this section of the paper we focus on the attribution problem in argumentation mining from judicial decisions, as illustrated by the examples taken from the vaccine-compensation cases discussed in Section 2, and we formulate hypotheses about what information contained in a legal discourse model could be useful in solving the attribution problem. That is, we discuss what presuppositional information in a legal discourse model might be useful in determining values (names of actors) for attribution subjects, relative to the attribution objects (propositions) mined from sentences in the decision text. While an attribution is a relationship with three predicate arguments (object, subject, and cue), a legal discourse model is a data structure that lists actors who might be candidates as subjects of attribution relations, together with presuppositional information about those actors. This latter type of information might then be used to infer the attribution relations discussed for the examples in Section 2.

Sentences (4) and (5) from the Casey decision illustrate the use of named individuals entered into an LDM and their categorization. At the point when the reader or automated annotator determines the attribution relations based on sentences (4) and (5), the name *Dr. Tornatore* could have been already entered into the LDM as an expert witness on the basis of this earlier sentence in the decision:

(38) Petitioner testified on her own behalf and presented the testimony of her husband and two expert witnesses: Carlo Tornatore, M.D., and Joseph A. Bellanti, M.D. [p. 10]

Margaret Sweeney could have been entered into the LDM as the special master based on the signature block for the decision:

(39) Margaret M. Sweeney
Special Master [p. 28]

For each presupposed type of actor, an LDM would contain slots for values of certain presuppositional information about features, relations, and actions that could be useful in determining attribution relations. What information can be useful should be determined empirically, by studying the information needed to solve particular types of problems, such as attribution. This section of the paper uses the examples from Section 2 to formulate hypotheses about what types of actors and presuppositional information could be useful in solving the attribution problem involved.

4.1 LDM Elements for the Casey Examples

Sentence (6) illustrates an attribution based in part on the party affiliation of a witness. The propositional object of the attribution is "if the varicella vaccination was the cause of petitioner's injuries, petitioner's onset of symptoms occurred within an appropriate time period after vaccination." Sentence (6) implies that this proposition can be attributed to Dr. Tornatore, Dr.

Bellanti, and Dr. Leist. As we discussed in Section 2.1 above, there are various intra-document bases for also attributing this proposition to Special Master Sweeney. One of those bases is that Dr. Leist was the sole expert witness of the respondent, as stated in the following sentence from the *Casey* decision:

(40) Respondent's sole witness was Thomas P. Leist, M.D., Ph.D. [p. 10]

We reasoned that testimony by a party's witness that is adverse to that party's interests is presumed by the factfinder to be true, absent information sufficient to rebut this presumption. Thus, the presuppositional information needed to infer the attribution to the special master is the party affiliation of a witness, which in this case is supplied for Dr. Leist by sentence (40). In designing an LDM, therefore, it would be useful at least for attribution purposes to include party affiliation as a relation of the actor type "witness." An adequate LDM for the type "witness" in a judicial proceeding in the United States would contain a relation of representation running to a party, and would prompt the search in mining new decisions for the party affiliation of each person identified as a witness.

4.2 LDM Elements for the <u>Cusati</u> Examples

The examples from the <u>Cusati</u> case illustrate the usefulness of having information in the LDM about certain typical actions of types of actors, or relations between types of actors and propositions that function as attribution objects. Sentences (8) – (12) illustrate how different sentences with the same attribution object (the proposition "MMR vaccine can cause fever") can state it as an allegation, as testimony, or as a finding of fact. For sentence (8), the attribution cue *asserts that*, when predicated of Ms. Cusati, implies that this is an allegation, because the LDM would list Ms. Cusati as the petitioner, and the presuppositional information would be that a petitioner is a party who makes the initial allegations contained in the petition.

In contrast to the allegations of a party, sentences (9) – (11) involve the testimony of two witnesses. On the basis of the cue *urged that* in sentence (9) we attribute the attribution object to Dr. Kinsbourne, who would be categorized in the LDM as a witness affiliated with the petitioner (see sentence (13)). Given the cue *acknowledged that* in sentence (10), we also attribute the same proposition to Dr. Kohrman, who would be listed in the LDM as a witness affiliated with the respondent. The LDM would contain any useful information pertaining to the testimony of witnesses, as contrasted with the allegations of parties or the findings of factfinders.

Sentence (12) is the basis for attributing the same proposition to the special master as factfinder, based on the attribution cue *Ms. Cusati has provided more than preponderant evidence that*. The LDM could contain the presuppositional information that a petitioner has the burden of proof on the issue of causation, and that the factfinder is bound to find an issue of fact in favor of a party if the preponderance of the evidence in the legal record weighs in favor of that party on that factual issue. This presuppositional information in the LDM enables us to attribute to Special Master Edwards the proposition "MMR vaccine can cause fever," on the basis of sentence (12).

4.3 LDM Elements for the <u>Werderitsh</u> Examples

The examples from the <u>Werderitsh</u> decision discussed in Section 2.3 illustrate that it would be useful for an LDM to contain presuppositional information about authors of documents submitted as exhibits in legal proceedings. Beyond needing a listing naming the exhibit itself (e.g., *the Piaggio article*, sentence (18)) that can be used as a relation-argument (e.g., for the subject of *filed by respondent*, or of *relied on by Dr. Leist*), the LDM should record the authors of the article as possible attribution subjects. <u>Werderitsh</u> illustrates that it is often useful to include authors of exhibits in the LDM because their conclusions might be viewed as more disinterested than those of the parties or their witnesses.

In the <u>Werderitsh</u> case, sentence (15) implies that the authors of the study (i.e., E. Piaggio, et al.) believed that *their data showed no difference in T-cell proliferation or cytokine production between the two groups*, and that *their result was not sufficient to exclude the causal link because the sample size, being quite small, limited the power of the study*. Whether the study authors actually stated that the results were in fact evidence against causation (although weak evidence), or whether they stopped short of taking any position on causation, is not evident from these sentences.

What is evident is that the respondent argued that the Piaggio article was evidence against causation (sentence (18), cue: *The article respondent filed … to show that*). Moreover, we certainly attribute the proposition to Dr. Leist, based on sentences (16) and (17) (cue: *Dr. Leist concluded that*).

Sentence (18), however, provides evidence that we cannot attribute to Special Master Millman the proposition that the article furnishes evidence against causation. This lack of attribution to the special master is corroborated by the special master's attribution of design limitations to the study authors (sentence (19)). This negative conclusion about the probative value of the Piaggio study results is consistent with the special master's conclusion (elsewhere) that the petitioner had proved her claim of causation.

4.4 LDM Elements for the <u>Thomas</u> Examples

The <u>Thomas</u> examples illustrate that it could be useful to store in an LDM the information about which witnesses the factfinder considers credible. Sentences (21) – (23) illustrate how attribution and credibility can play a critical role within the reasoning itself. The proposition at issue in sentences (21) and (22) is that "the DPT vaccine caused Kenidi's neuro-degenerative condition." We attribute that proposition to Dr. Corbier on the basis of sentence (21), and attribute its negation to Dr. Wiznitzer on the basis of sentence (22). With respect to what Special Master Abell believes, however, sentence (23) indicates that if Dr. Corbier testifies that some proposition is true and Dr. Wiznitzer testifies that the same proposition is false, then, other things being equal, the special master will tend to discount the probative value of Dr. Corbier's testimony, simply because it is the testimony of Dr. Corbier. Put another way, if we encounter a proposition in the <u>Thomas</u> decision and wonder whether to attribute it to the special master, then evidence that Dr. Corbier testified in favor of that proposition and Dr. Wiznitzer testified against that proposition is some evidence that we cannot attribute it to the special master. Because the issue of credibility of a witness is generally relevant to multiple propositions within a decision, it would be useful to store in the LDM the relation that Dr. Corbier is less credible to the special master than is Dr. Wiznitzer.

4.5 LDM Elements for the <u>Walton</u> Examples

The sentences taken from the <u>Walton</u> decision illustrate the usefulness of storing in an LDM a representation of attribution relations (including subjects or actors, and objects or propositions), such that inferences can be made on the basis of

various predicate-arguments of those relations. On the basis of sentence (25) we attribute to Mrs. Walton the proposition that "Mrs. Walton began to have heart palpitations within a few days of her vaccination," which would provide evidence of an early onset of a cardiac condition.

The health-care professional who authored the medical record cited in sentence (26), however, did not record heart palpitations, and the special master considered the lack of mention in that medical record as good evidence running counter to Mrs. Walton's testimony:

> (41) Had Mrs. Walton mentioned any cardiac complaints to either Pro Med or Seton Hospital health care providers or presented with any symptoms of concern on April 30, 2001, I am reasonably confident that one or both of these medical facilities would have documented and explored them. [p. 18]

The first medical record after the vaccination to mention heart symptoms was for a patient visit on June 6 (sentence (27)), more than two months after the vaccination on March 30. So not only can we not attribute the proposition to the special master, we have evidence on which to attribute the negation of that proposition (sentence (28)).

There is, however, evidence for attributing the affirmative proposition to Dr. Michael, an expert witness who relied on the proposition when he testified with an expert opinion on behalf of Mrs. Walton (sentence (29)). Because of this reliance, the special master disagreed with the opinion concluded by Dr. Michael (sentences (30) and (31)). This is a different pattern of argumentation than what we see in the examples from the Thomas decision. In Thomas the special master rejected a proposition because he attributed it to an expert witness whom he did not find to be as credible a witness as another witness. In Walton, by contrast, the special master concluded that the expert witness's opinion was not persuasive in part because the expert relied on a proposition attributed to another witness whom the special master did not find credible. In either situation, however, what would be useful is an LDM that contains the attribution relations involving one actor to help infer attribution relations for another actor.

4.6 LDM Elements for the Meyers Examples

The examples from the Meyers decision illustrate the importance of storing in an LDM certain information about the burdens of proof. For every proposition of importance in a legal case, the legal rules assign to one party the burden of producing evidence for the legal record that is sufficient to support a finding of fact in that party's favor, and to one party (often the same party) the burden of persuading the finder of fact by the standard of evidence (in civil cases, by a preponderance of the evidence). We think it would be useful to store in an LDM, for each attribution object (proposition) that is potentially a critical issue in the case, the party who has the burden of production and the burden of persuasion on that proposition. Although these burdens might be assigned by the legal rules to a particular party at the outset of case (and can be supplied for an LDM as presuppositional default values), additional rules might be triggered in the course of the proceeding, resulting in a "shift" of a burden to another party. What we see from the examples discussed in Section 2.6 is that the information about which party has which burden on which proposition at any point in time might be useful information in attributing a proposition to that party, and ultimately for assisting in determining attributions to the factfinder.

On the basis of sentence (32), we can attribute to the petitioner the proposition that "Matthew developed diabetes as a result of four DTP vaccinations." Sentence (33) explicitly invokes the legal rule that the petitioner bears the burden of proving that the vaccination caused the injury, and the implication is that the factfinder must find against the petitioner on that proposition (that is, we must not attribute that proposition to the factfinder).

5. DISCUSSION AND FUTURE WORK

Based on the examples of attribution problems discussed in Section 2, we have argued in Section 4 that an LDM that is useful from the standpoint of solving attribution problems would include such presuppositional information as: principle types of actors in the legal proceeding; certain types of relations involving those actors, including affiliation with a party, burdens and standards of proof, assessments of credibility, and attribution relations; and certain types of actions typical for those actors, such as testifying, inferring, and making a finding.

Equally as important as suggesting useful content for an LDM, however, is our illustrating an empirical approach to developing a specific legal discourse model for a particular judicial decision, as well as a generic discourse model for judicial decisions in a particular legal area (such as vaccine compensation cases). Our bottom-up, empirical approach is to add actors to a legal discourse model only as needed to solve the attribution problems actually encountered in particular judicial decisions. This parsimonious approach respects the tremendous variability of natural language by not imposing a top-down ontology. Moreover, adding unnecessary elements increases coding costs and the risk of error in coding. Also, by paying close attention to a large number of actual texts, human intuitions become more informed and can better aid the effective automation of sub-tasks. Ultimately, we hope to develop software that can automatically abstract and build an LDM from case decisions.

Because of this emphasis on methodology, we have focused here only on the presuppositional information in the legal discourse model needed to solve the attribution problem within our selected cases, and do not yet propose a general legal ontology. As we expand our sample of decisions and complete an adequate LDM for vaccine cases, a hierarchical ontology will probably emerge that contains many elements transferrable to other legal areas.

In addition, we have focused primarily on the factfinding aspects of vaccine cases, and we leave for future work the mining of policy-based arguments about legal rules. As we include appellate decisions in our sample, then additional actors and pre-suppositional information will be needed. For example, sentence (36) refers indirectly to the U.S. Supreme Court, which decided the lead case referenced in that sentence (Daubert). This reference to an appellate court with jurisdiction over the court of the factfinder raises the important issue of what kinds of jurisdictional and precedential information an LDM needs to contain.

We have not discussed the technical details of a data structure that could store such presuppositional information about actors, because a variety of structures could be used to create an adequate LDM [5]. Instead, we have discussed the minimal types of actors and presuppositional information that we think an adequate LDM should include, rather than the technical specifications for how to represent them.

Finally, work in the near future will include the development of lexical resources for attribution cues and the concepts and relations needed in the LDM, using standard corpus linguistics techniques, such as focusing on collocation, colligation, semantic

preference, and semantic or discourse prosody for search words [4]. We think this is also a fruitful area for machine learning from manually annotated texts, with development and testing of automatic annotators for attribution relations in vaccine cases.

Further into the future, when adapting an LDM to help identify the structure of whole arguments, the thematic, coherence approach of [9] may be useful, or other kinds of discourse structures [20]. An important task will be identifying the linguistic cues for coding discourse relations and argument structures [20].

6. CONCLUSION

The problem of attribution in argumentation mining from a judicial decision is the problem of determining which participants in the legal process treat a given proposition as true. It is a complicated problem to solve for humans trained in the law, and certainly a challenge for automation of argumentation mining. We have indicated through examples the nature and extent of that problem, and how an empirically developed legal discourse model can contribute to solving the problem. This is not yet the problem of determining which propositions are in fact true or plausible, or which events referred to in the text actually occurred [15], nor is it the normative problem of regulating persuasion dialogues [14], but it is an important step along the way.

7. ACKNOWLEDGEMENTS

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