

# Comparing Argument Diagrams

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**Abstract.** Argumentation is central to law. Written and oral argument structures, however, are often difficult to analyze and employ in instruction. Diagrammatic models of argument offer a potential solution to these problems. In this paper we report on the results of an empirical study into the diagnostic utility of argument diagrams in a legal writing context. The focus is on comparing experts' and student-produced argument diagrams and on the extent to which the latter can be used to predict students' performance on subsequent writing tasks. We present the results and draw some tentative conclusions.

**Keywords.** Diagrammatic Argument Models, Argument Analysis, Legal Education

## 1. Introduction

In a recent Legal Writing course, first year law students employed the LASAD program [7] to diagram arguments in preparation for writing a brief on appeal to the U.S. Supreme Court in the case of *United States v. Alvarez*. The U.S. Supreme Court is the highest-level federal court in the U.S. and hears appeals from the nine circuit courts of appeals. The case involved the constitutionality of the federal Stolen Valor Act (SVA), a law that made it a criminal offense if one “falsely represents himself or herself, verbally or in writing, to have been awarded any decoration or medal authorized by Congress for the Armed Forces of the United States,” with an increased penalty if the misrepresentation concerns the Congressional Medal of Honor (CMH). In 2007, at a public meeting of a local Water District Board, Alvarez, a board member, introduced himself and claimed to have to have been wounded in action as a U.S. Marine and to have been awarded the CMH, none of which was true.

The pedagogical assignment was well conceived in that strong arguments could be made for and against the constitutionality of the SVA. Indeed, strong opposing arguments were made in the majority and dissenting opinions of the judges of the 9<sup>th</sup> Circuit Court of Appeals from whose decision that the SVA was unconstitutional the Government appealed. The first year students, untutored in constitutional law, were instructed to base their diagrams on the arguments of either the majority or dissent in the Court of Appeals, depending on which side they had been assigned to represent. Subsequently, the students were assigned to write a brief in support of their side using the diagram as a tool to help plan their written arguments.

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Interestingly, the U.S. Supreme Court recently decided the appeal in the *Alvarez* case, this time generating plurality and concurring opinions in favor of the defendant Alvarez's position that the SVA was unconstitutional and a dissenting opinion for the Government's position defending the SVA.

As a result, an opportunity presents itself to compare diagrams, prepared by the students and by a law professor, of the conflicting arguments of the judges and justices in the Court of Appeals and the Supreme Court, all deciding the same case.

The aim is to inform intuitions about the kinds of information a comparison of realistic argument diagrams can yield about the substance of the arguments, the level of understanding and skills of the student diagrammers, and the prospects for automating such comparisons. Relatively simple, quantitative measures of argument diagrams that relate to content are important in pedagogical contexts, but also in any practical context such as in comparing argument diagrams in web-based civic discussions.

## **2. Computer-supported argument diagramming in legal education**

From a pedagogical viewpoint, the promise of argument diagramming is that it makes explicit some aspects of a legal argument's structure, in particular, the support and opposition relationships of those elements represented. This is especially important in first year legal writing because students are unfamiliar with legal arguments, the structure of which can be quite complex and is often implicit. In legal education, argumentation is often not taught explicitly but by example; students practice making and responding to arguments in Socratic classroom sessions or in moot-court sessions but there is little occasion for observing or reviewing the structure of the unfolding argument. In legal writing courses and materials, students are directed toward recommended step-wise formats for written argumentation as in [11]. But, even in exemplary legal writing such as the judicial opinions discussed here, although the judges demarcate different portions of their arguments with part and subpart numbering, much of the conceptual structure of the argument is apparent only from reading it. This serves the needs of professionals, but does little to help novices, many with suboptimal reading and writing skills, to recognize, or understand, that structure.

Argument diagrams could also help in the design of automated tutoring systems by providing students with feedback about their arguments [9]. While computer understanding of legal arguments represented textually has yet to be demonstrated robustly, computers can interpret certain aspects of arguments represented diagrammatically. For instance, the expert system in the LARGO program's help facility analyzed students' developing argument diagrams and provided feedback on making more complete and correct diagrams [12].

A number of computerized tools have been developed to support diagramming of legal arguments [1,3,5,6,13,15]. Some of these tools have been applied to teach law students skills of legal argumentation and have been the subject of empirical evaluation with inconclusive results regarding whether students actually learned [2,3,12].

In a comprehensive survey of pedagogical uses of argument diagramming in law and other fields, Scheuer et al. [14] found inconsistent support for the belief that argument representation formats can improve students' argumentation behavior and comprehension. To the extent that representations reflect more argument structure, students adopted that structure for their own arguments leading to the construction of

more elaborated arguments. Structuring the students' argumentation process also helped students to produce better arguments.

While work on developing intelligent tutoring systems for legal reasoning continues, a related line examines the use of argument diagrams to diagnose students' argument comprehension and argumentation skills, which could be analyzed to provide a basis for feedback. In [10] we showed that domain experts could grade argument diagrams reliably. In the present work, we explore some automated measurements of argument complexity and representative features of argument diagrams and relate them to a more traditional form of argument (e.g., written essays). This is a first step toward the goal of Lynch's dissertation project to employ machine learning to identify features of argument diagrams associated with better performance on the written arguments planned with the diagrams [8].

### 3. Argument diagramming environment and assignment

The LASAD system is an on-line tool designed to help students prepare argument diagrams in order to plan their briefs and other argumentative writing. It is an entirely web-driven application and stores students' diagrams on a web server. It is written in Java and is compatible with most browsers [7]. LASAD is a revision and generalization of the LARGO program [12].

In our study, students were asked to outline the arguments of the majority and the dissenting judge in the 9<sup>th</sup> Circuit U.S. Court of Appeals and then to diagram their own arguments in the case in preparation for drafting their Supreme Court appellate briefs. As students read the 9<sup>th</sup> Circuit opinion, they were asked to highlight sentences indicating the major legal conclusions, the claims that supported the conclusions or other claims, the citations that supported the claims and conclusions, counterarguments that were considered, and citations, claims and conclusions that were employed to counter the counterarguments. Students were cautioned to paraphrase or quote the highlighted sentences (to avoid plagiarism in their final briefs). A written guide explained how to use the LASAD program to diagram students' own arguments and introduced a set of argument diagram elements (the "argument ontology"). The ontology was chosen in consultation with the instructor as appropriate for first year students' introduction to brief-writing in order to make salient various structural features of the argument: support, opposition, and justification. A more detailed ontology that might involve students in formally representing premises and conclusions in order to apply explicit argument schemes was rejected as pedagogically unrealistic, with too high a likelihood that students would become bogged down in representational issues. For purposes of this assignment, LASAD's element set comprised three types of boxes or nodes and three types of arcs:

- *Conclusion nodes*: represent legal conclusions asserted in the argument.
- *Claim nodes*: represent assertions made by the author in support of (or opposing) a legal conclusion or another claim.
- *Citation nodes*: represent legal authorities (e.g. cases or statutes) cited to support, oppose, or inform the legal claims and conclusions.
- *Supporting arcs (+)*: indicate a supportive relationship with the tail node supporting the head node.
- *Opposing arcs (-)*: indicate an opposing relationship with the tail node opposing the head node.

- *Informational arcs (i)*: represent a factual or topical relationship between two nodes that is neither supporting nor opposing but contains relevant information.

A Citation node has a “Cite” field for recording the statute section or case cite. The “Substance” field is for recording the substance of the citation that is relevant at this point in the argument, for instance, a quotation from the statute or case opinion or a succinct paraphrase. The arcs have a field marked “Reasons” where students should specify the reasons why the information in one node supports, opposes, or informs the content of the other node.

A representative student-produced diagram is shown in figure 1 below. As can be seen in the diagram the student produced a tree-like argument backward chaining from the legal conclusion on the left-hand side of the screen (“The SVA is facially invalid under the First Amendment and was unconstitutionally applied to Alvarez”) to four supporting claims and ultimately to five relevant citations on the right-hand side such as *Schenk v. U.S.* (Citation 17, bottom right) which concludes “the question...is whether the words used...create a clear and present danger...”. Supporting arc 19 (bottom branch) represents Citation node 17 (tail) supporting Claim node 18 (head). The student includes one oppositional arc in the second branch from the top of the diagram, and one informational arc that shows Claim 9 in that branch informing Citation 21 in the topmost branch. Additional text from this diagram appears in figure 2 below.

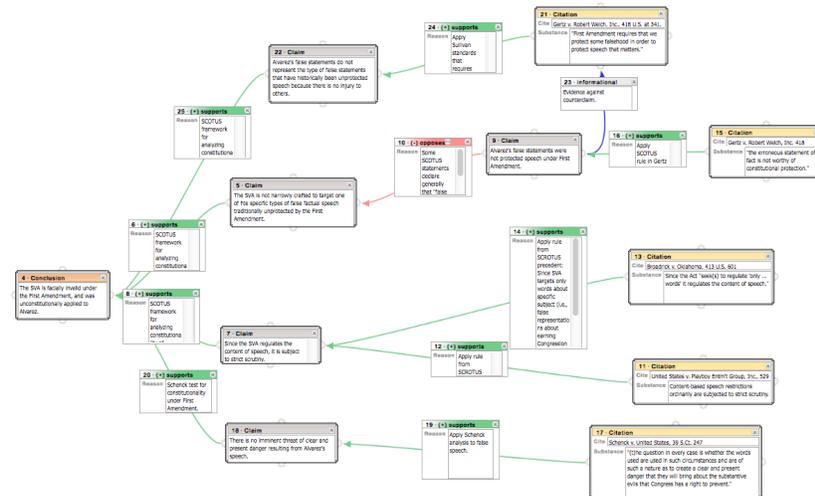


Fig. 1: Sample student-produced argument diagram.

In diagramming their own arguments, students were encouraged to employ a “divide and conquer” strategy: start by considering the main legal conclusion(s) of the side represented and add it to the diagram. Then consider the claims that go into convincing the Court that the legal conclusion is well-founded and add them to the diagram, linked to the main conclusion(s) with “supporting” arcs. Similarly, those claims may be supported by additional component claims that should be added to the diagram. Where the conclusions and claims ultimately needed to be supported with legal authorities, students were instructed to add citation nodes to the diagram

the relevant authorities. Students were invited to cut-and-paste text from the Word files of their 9<sup>th</sup> Circuit argument outlines into the nodes and arcs in their diagrams.

Students were urged to consider possible counterarguments to some of the conclusions and claims in their argument diagrams. Since the 9<sup>th</sup> Circuit opinion included both majority and dissenting opinions, it included many arguments and counterarguments that students could select and adapt. Since the students would not be writing “reply” briefs, in general they should not anticipate all an opponent’s possible arguments. Nevertheless, if a counterargument is sufficiently important that it is likely the court would expect an advocate to have addressed it in his or her brief, the student should do so, and a first step was to include the counterarguments in the diagram.

The guide pointed out that if students did a careful job of diagramming their arguments, the diagrams would contain much of the information they would need to write their textual arguments on the merits in their briefs on behalf of their clients. It pointed out that the often-used format for proving a conclusion of law recommended in [11] included five steps:

1. State your *conclusion*
2. State the primary rule that *supports* the *conclusion*.
3. Prove and explain the rule through *citation* to authority, description of how the authority stands for the rule, discussion of subsidiary rules, analyses of policy, and *counter-analyses*.
4. Apply the rule’s elements to the facts with the aid of subsidiary rules, *supporting authority*, policy considerations, and *counter-analyses*; and
5. If steps 1 through 4 are complicated, sum up by restating your *conclusion*. (emphasis added).

In a class session on January 30, 2012, students received instruction about using LASAD, began an introductory argument diagramming exercise that they were to complete at home, and received the outlining assignment due on February 5. Students were then to begin diagramming their own arguments and submit them by February 16. The written briefs were due on March 16. Of the 48 students in the course a total of 24 consented to the use of their data for research purposes and completed all parts of the assignment and received a grade on the written essay. The essays were graded on a standard A+ - F scale.

After the Supreme Court decision was issued on June 28, 2012, Ashley used LASAD to diagram the U.S. Supreme Court plurality, concurring, and dissenting opinions and the 9<sup>th</sup> Circuit majority and minority opinions in accordance with the above guidelines. Hereafter we will refer to these diagrams as the expert diagrams. The expert diagrams were intended to serve as illustrative examples of high-quality arguments, not as a gold-standard for the assignment. The expert diagrams, like some student diagrams, are too large to be effectively displayed here.

The expert diagrams, like the student’s diagram above, were generated as a mapping from a single legal conclusion node down to citations and some claims without citations. The expert wrote substantially more detailed summaries in his diagram and covered more of the underlying case citations including citations not present in the student diagrams.

For an intuitive sense of the relative complexities of the student’s argument and that of the U.S. Supreme Court’s plurality opinion, an outline of each is shown in figure 2 below. The outlines were generated automatically using a depth-first traversal of the student’s and expert’s diagrams and then manually edited for readability.

**From student-produced diagram:**

(I) conclusion: The SVA is facially invalid under the First Amendment, and was unconstitutionally applied to Alvarez.

- (1) claim: The SVA is not narrowly crafted to target one of the specific types of false factual speech traditionally unprotected by the First Amendment
  - opposed-by*: Some U.S. Supreme Court statements declare generally that false statements of fact not protected
  - (a) claim: Alvarez's false statements not protected speech under 1st Amend.
- (2) claim: Since the SVA regulates the content of speech, it is subject to strict scrutiny.
- (3) claim: There is no imminent threat of clear and present danger resulting from Alvarez's speech.
- (4) claim: Alvarez's false statements do not represent the type of false statements that have historically been unprotected speech because there is no injury to others.

**From expert-produced diagram of U.S. Supreme Court's plurality opinion:**

(I) conclusion: The Stolen Valor Act is unconstitutional under the First Amendment.

- (1) conclusion: The Stolen Valor Act is a content-based suppression of pure speech, speech not falling within any of the few categories of expression where content-based regulation is permissible.
  - (a) claim: A content-based restriction is permitted only if the speech falls within one of the historic and traditional categories of expression.
  - (b) claim: Content-based restrictions on speech are presumed invalid.
  - (c) claim: Alvarez's speech does not fall within one of the recognized categories of expression for which content-based restriction is permitted.
    - opposed-by*: If false statements of fact have First Amendment protection, SVA is constitutional.
    - (1) claim: There is general exception to 1st Amend. for false statements.
  - (d) claim: The SVA is not like other gov't regulations of false speech that have been found permissible.
    - opposed-by*: These regulations show Govt. can regulate false speech.
    - (1) claim: The SVA is like permitted gov't. regulation criminalizing false statements to Gov't officials, perjury, or false representations that one is speaking for the Gov't.
- (2) claim: The SVA by its plain terms applies to a false statement regarding receipt of medals made at any time, in any place, to any person without regard to whether the lie was made for the purpose of material gain. As such, its negative effect on speech is too great.
- (3) claim: The SVA does not survive the "exacting scrutiny" standard.
  - (a) claim: There is a less speech-restrictive means by which the Government could likely protect the integrity of the military awards system...
    - opposed-by*: Exacting scrutiny standard requires compelling gov't interest.
    - (b) claim: The Gov't's interest in preserving the integrity of military honors and the Cong. Medal of Honor is compelling.

Fig. 2: Comparison of outlines of (top three levels of) student's argument diagram and U.S. Supreme Court's Plurality Opinion argument as diagrammed by expert.

#### 4. Comparison Measures

The focus in the present work is on quantitatively comparing student- and professor-generated argument diagrams in terms of a number of measures that would appear to be pedagogically useful in that they relate to the complexity of the arguments represented, and in testing the extent to which those diagram measures of the students' diagrams predict students' final grade performance. The measures that we considered include: (1) size of the graphs and the degree of branching of the argument diagrams; (2) the inclusion of counterarguments in the diagrams; (3) the inclusion of responses to any counterarguments; (4) the amount of text entered in the node and arc fields; and (5) the use of other individual argumentative components such as support and opposition arcs.

The degree of branching in the diagram is an indicator of the legal complexity of an argument. Typically, an argument about a legal issue involves a test or rule whose antecedent comprises intermediate legal concepts linked by logical connectors and whose conclusion determines the result of the issue. The intermediate legal concepts, in turn, are each defined in terms of additional sub-tests or rules involving more sub-concepts and conclusions. This continues until the rules run out and then, in a common law context, arguments by analogy are made to cases that a concept is or is not satisfied. The same basic structure applies whether the argument is for or against the top-level conclusion, although the latter will typically involve showing only that some requisite concepts are not satisfied.

Roughly speaking, for each legal issue, one would expect to see a “root” node in the argument diagram for each conclusion, claim, or sub-claim, for the test or rule associated therewith, and for each component intermediate legal concept on which the argument focused, with branching from the “root” node downward connecting these components. Thus we expect that a well-formed argument diagram should constitute a tree and that the degree of each tree node or the number of child nodes connected to it can be seen as an approximate measure of the conceptual complexity of the legal argument.

Regarding the inclusion of counterarguments and responses in the diagrams, judges are careful both to consider competing arguments of colleagues and to respond to each opposing argument. The responses may show up in at least two ways in an argument diagram: 1) a fraternal supporting link into the same claim node as the opposing link points to, which we term *paired-counterarguments*, or 2) a second opposing link into the claim node from which the first opposing link originates called *chained-counterarguments*. Students would be expected to include at least some of these counterarguments and responses in their argument diagrams.

The arguments and diagrams of the court opinions provide a context for comparing the student argument diagrams in terms of these measures. While the absolute magnitudes of any of these measures may be of limited utility, their magnitudes in the experts’ diagrams provide benchmarks for comparing and assessing the complexity of the students’ diagrams.

#### 4.1. Comparisons

*Size:* The average graph size was not substantially different between the two groups. The expert graphs had an average order of 23.4 (number of nodes) and a size (number of arcs) of 23.2. While the students produced on average 22.6 nodes and 22.2 arcs respectively. The student graphs were subject to wide variation, however. The largest student graph contained 52 nodes and 51 arcs while the smallest contained 5 and 0 respectively. This is reflective of a range of skills and individual motivations on the students’ part.

Interestingly the sizes and orders of the graphs are close for both the expert and the students suggesting that they are all trees. This was the preferred structure for the arguments as discussed above but the system did not compel students to produce them. If we compute the average number of children per non-leaf node, that is, the average number of children a node has provided it has more than 1, then the student and expert diagrams were quite similar with averages of 1.7 and 1.6 respectively.

*Counterarguments:* As noted above the students were instructed to take counterarguments into consideration when drafting their diagrams. They did so but at a

much lower rate than the expert. The student diagrammers included an average of 2.3 opposing links per map versus 5.4 for the expert. This was reflected in the larger presence of counterargument substructures with the expert producing 2.6 chained-counterarguments to the students' 0.7 and 2 paired-counterarguments to the students' 1.3. Both groups used far more supporting arcs than opposing arcs, which reflects the constructive nature of the arguments being reviewed. The Justices take pains to deal with potential counterarguments, and they dwell only on the most critical or obvious.

*Length of text fields:* The expert diagram author wrote more in the text fields with a maximum field length of 21 sentences while the longest field written by a student author was 10. The average number of sentences per field was 1.6 for the expert and 1.05 for the students reflecting the fact that both the students and expert focused on short summary sentences for the bulk of their writing.

Much of the variation seems to be due entirely to the citation nodes where the expert provided a more exhaustive list of citations and more detailed summaries of each cited case. If we average solely over the citation nodes the experts' average sentence length is 2.3 while the students' average is 1. If we discount the citation nodes, the students' average sentence length remains at 0.9 while the experts' average length drops to 1.3 with maxima of 10 and 9 respectively. Clearly both the expert and student diagrammers felt a desire or compulsion to write more about each cited case than in other types of nodes, but the expert went into greater detail on average.

*Other Features:* The expert used one informational arc in his diagrams to compare two sets of opposing citations. The students, by contrast used an average of 2.9 informational arcs per map with one student producing a full 25. This may reflect the students' relative uncertainty regarding the content of the case or the roles of the arcs. The students' lack of experience with the material may have led them to be unsure whether the relevant information was supporting or opposing.

#### 4.2. Grade Prediction

As discussed above the students' final essays were graded on a standard A+ to F scale. The course instructor assigned grades to the essays without reviewing the associated student diagrams. Our task here is to test the extent to which each individual feature of the diagrams predicts students' subsequent essay performance. In this case the predictiveness was tested using a standard Analysis of Variance test for numeric or categorical data [4]. All  $R^2$  values reported are for Multiple- $R^2$  scores [4]. A feature was treated as significantly predictive if it met the standard for statistical significance ( $p < 0.05$ ) or marginally significant if it met the lower standard ( $p < 0.1$ ).

We found that the overall size of the graphs was not consistently predictive of the students' performance. The average number of child-nodes, ignoring leaf nodes, or the degree of branching, however, was marginally predictive ( $F(1,22)=4.144$ ,  $p < 0.055$ ,  $R^2=0.15$ ). We also found that the number of supporting arcs used was a marginally significant positive predictor of the students' score ( $F(1,22)=3.771$   $p < 0.066$ ,  $R^2=0.15$ ) while the number of informational links used was a significant negatively predictor ( $F(1,22)=5.961$ ,  $p < 0.024$ ,  $R^2=0.21$ ). While outliers may affect this result, this latter measure may reflect the authors' relative uncertainty and thus the weakness of their attempts to make a persuasive case.

More importantly, we found that the average length of the fields in sentences was a significant predictor of the students' performance ( $F(1,22)=5.323$ ,  $p < 0.031$ ,  $R^2=0.19$ ). Interestingly, this predictiveness does not hold if we remove the citation nodes from

consideration ( $F(1,22)=1.397$   $p<0.25$ ). If, however we focus solely on the citation nodes we find that it is significantly predictive ( $F(1,22)=6.931$ ,  $p<0.016$ ,  $R^2=0.23$ ). We also found that the number of citation nodes is, in and of itself, predictive ( $F(1,22)=3.017$   $p<0.097$ ,  $R^2=0.12$ ).

## 5. Conclusions & Future Work

In this work, we sought to consider the utility of several simple quantitative measures of argument diagrams in diagnosing substantive aspects of students' work. As noted, such measures for enabling computers to analyze more content-related aspects of the arguments represented diagrammatically are important in pedagogical applications, but also for evaluating, for instance, civic discussions using argument diagrams.

We have presented the results of a small study examining the utility of simple tools for analyzing argument diagrams to distinguish between student-produced and expert-produced argument diagrams and to predict subsequent students' argument performance. Some features, notably the presence of considered and rebutted counterarguments and the length of citation summaries, differed notably between the expert and student diagrams. The number of citation nodes included and their length in sentences predicted the students' performance on the subsequent analysis.

The importance of the number and size of the citation features is consistent with our expectations given the nature of the class and the importance of citing authority. Students who fail diligently to find and prepare citations will hurt their performance. These results led us to inquire about the instructor's grading rubric. Prominent in the description of "A" performance was the following: "Assertions are supported with legal authority/relevant rules and this authority is accurately explained so reader can understand its relevance. Authority is synthesized....Application of the authority/rules uses facts to explain why client's case is similar or dissimilar; counter analysis is considered. In a brief, counter-argument is anticipated and is addressed without raising the other side's argument."

The predictiveness negatively of the informational arcs is also somewhat unsurprising. For first year law students, the structure of legal explanation is presumably still new and a reliance on informational arcs may reflect uncertainty about the content. Given the importance of counterarguments generally, however, we are surprised that particular graph features, such as the number of opposition links or counterarguments, are not predictive. It is also surprising that the degree of branching in students' diagrams is the same as that of the expert's diagrams of the U.S. Supreme Court's argument.

Our goal in conducting this analysis was, in part, to motivate developing tutoring systems for argumentation that use argument diagrams. Such systems typically use *a-priori* rule-sets for providing help, if they provide help at all. In this and Lynch's ongoing thesis work, we seek an empirical methodology for analysis and comparison that will identify more complex diagram characteristics associated with learning and mastery. In future studies we may test more restrictive formalisms and explicit argumentation schemes if they are pedagogically appropriate. We also hope to collect novel expert diagrams. We anticipate that experts, like students, will vary in their diagram structure and hope to identify salient regularities.

We hope to integrate these tools and measures in the ArgumentPeer Project,<sup>2</sup> in which students diagram arguments in order to plan how to write them, and which will generate textual outlines (like figure 2) of the current state of the student's argument on demand. We believe that making and displaying comparisons between a student's current diagram and their peers' work could help students assess their relative progress.

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