CRRAR

Tutorial on Argumentation

Informal Workshop on Argumentation Argument Mining, Nov. 14, 2018

National Institute of Informatics, Room No. 1901-1903, 10-11:00 am.

How to Define *Argument*

- An *inference* is the extraction (drawing out) of a proposition from other propositions using warrants, rules or generalizations.
- *Reasoning* is a chaining of inferences from some propositions to others. Reasoning is best visualized as a directed graph where the nodes represent the propositions and the edges connecting the nodes represent the inferences (Walton, 1990, 403).
- *Argumentation* is defined as a framework in which agents use reasoning in goal-directed dialogue structure (Walton, 1990, 411).
- An *argument* has a conclusion that is pro or con a claim made by one of the agents. It also has premises that are supposed to provide support for (or attack) the conclusion.
- Arguments contain reasoning but are more than merely reasoning. They are pro or con something. An argument is a form of speech act put forward by an agent in a multiagent dialogue.

Dialogue Settings

- Applications of argumentation methods to practical domains, such as medical interviews, or legal argumentation in a trial, increasingly depend on placing the arguments in a dialogue setting in which one can get an idea of how the argumentation is being used for some communicative purpose.
- Formal dialogue systems have been built in argumentation theory, computational argumentation research, to provide frameworks of this kind that take contextual factors into account.
- Dialogue systems regulate such things as the preconditions and effects of speech acts, including their effects on the commitments of the participants, as well as criteria for terminating the dialogue and determining its outcome.
- Good dialogue systems regulate all this by normative rules of procedure in such a way that conflicting viewpoints can be resolved in a way that is both fair and effective.

Stages of Dialogues

- A formal model of dialogue is defined as an ordered 3-tuple {*O*, *A*, *C*} where argumentation is modeled as moving through three stages.
- *O* is the opening stage where the issue to be discussed is formulated.
- *A* is the argumentation stage, where pro-and con arguments are put forward by the two sides.
- *C* is the closing stage where the issue is ideally resolved, or at least where the discussion is terminated.

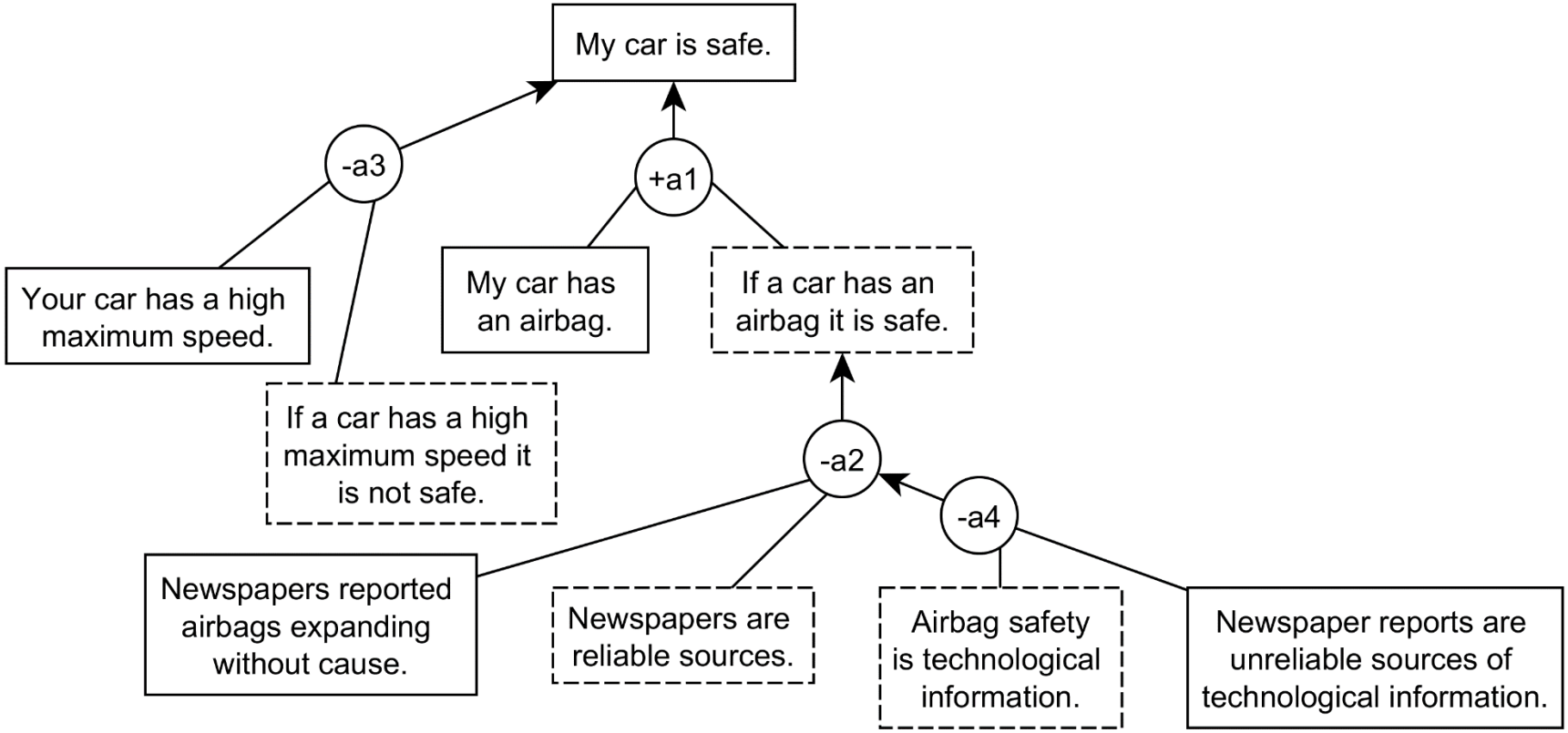
Types of Dialogue

TYPE OF DIALOGUE	INITIAL SITUATION	PARTICIPANT'S GOAL	GOAL OF DIALOGUE
Persuasion	Conflict of Opinions	Persuade Other Party	Resolve Issue
Inquiry	Need to Have Proof	Verify Evidence	Prove Hypothesis
Discovery	Need an Explanation	Find a Hypothesis	Support Hypothesis
Negotiation	Conflict of Interests	Get What You Want	Settle Issue
Information	Need Information	Acquire Information	Exchange Information
Deliberation	Practical Choice	Fit Goals and Actions	Decide What to Do
Eristic	Personal Conflict	Hit Out at Opponent	Reveal Deep Conflict

Prakken Airbag Persuasion Dialogue

- Olga: why is your car safe?
- Paul: since it has an airbag.
- Olga: that is true, but this does not make your car safe.
- Paul: why does that not make my car safe?
- Olga: since the newspapers recently reported on air brakes expanding without cause.
- Paul: yes, that is what the newspapers say but that does not prove anything, since newspaper reports are very unreliable sources of technological information.
- Olga: still your car is not safe, since its maximum speed is very high.
- Paul: okay I was wrong but my car is safe.

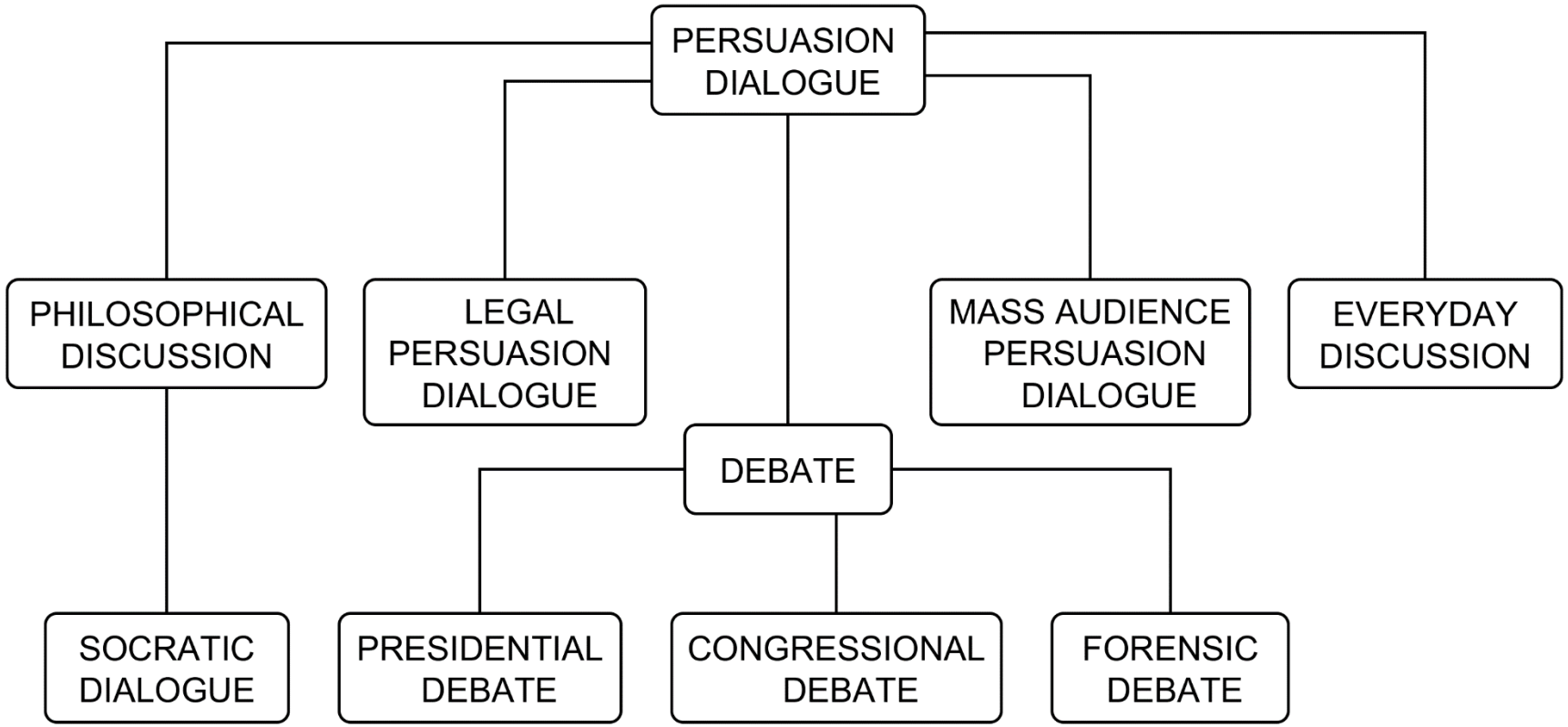
Map Dialogue into Argument Graph



Enthymemes

- Many arguments whether in law or everyday conversational argumentation, have implicit premises or conclusions (Walton and Reed, 2005).
- Consider the example, “Markley lives in California and says the weather is fine there”.
- An implicit premise is that Markley is in a position to know about the weather in California, based on the explicit premise that he lives in California.
- Another implicit premise is the defeasible conditional that if a person lives in a place, he is in a position to know about the weather there.
- The implicit conclusion of the argument is the statement that the weather is fine in California

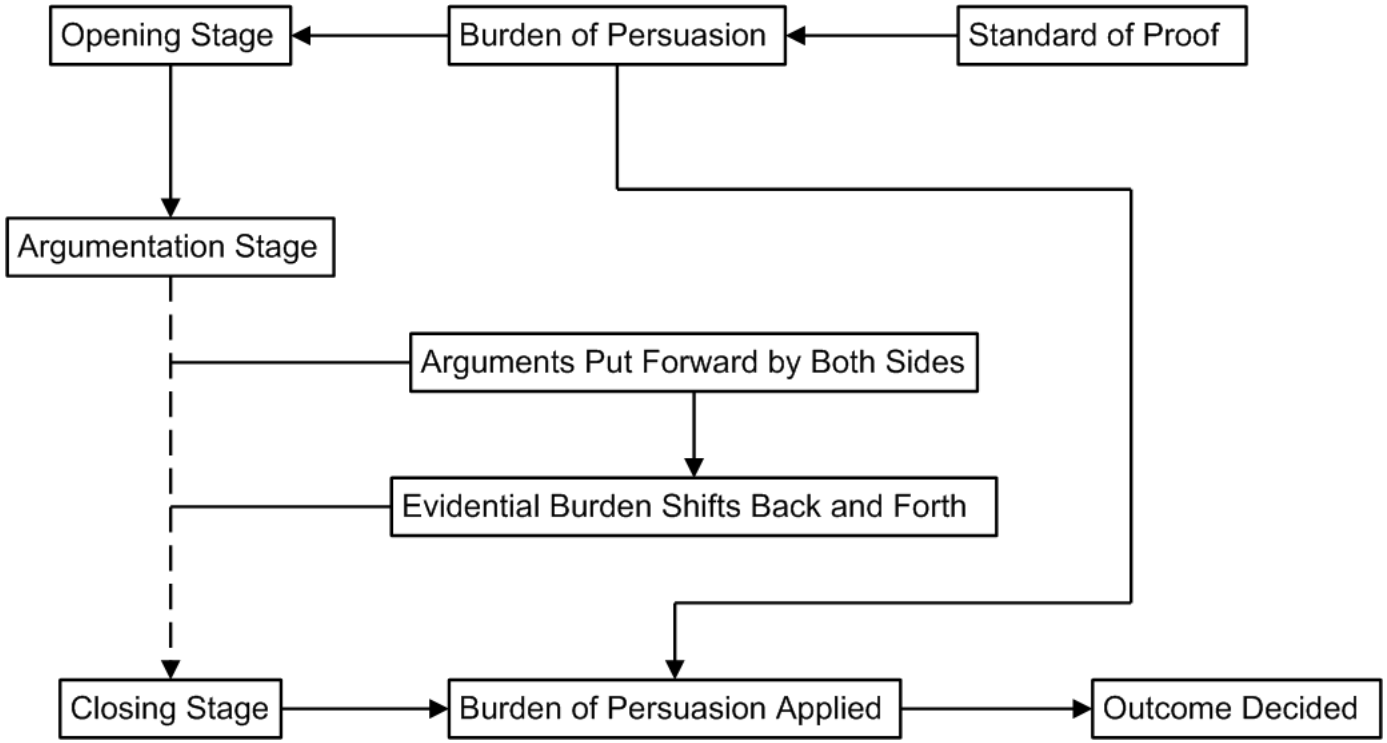
Types of Persuasion Dialogue



Burden of Persuasion in Law

- According to *McCormick on Evidence* (Strong, 1992, p. 425), the term ‘burden of proof’ is ambiguous, covering two different notions commonly called burden of proof.
- The two meanings are commonly distinguished in law by calling one the burden of persuasion and the other the burden of production.
- The latter is sometimes also called the burden of producing evidence.
- The burden of persuasion is described as “the burden of persuading the trier of fact that the alleged fact is true”

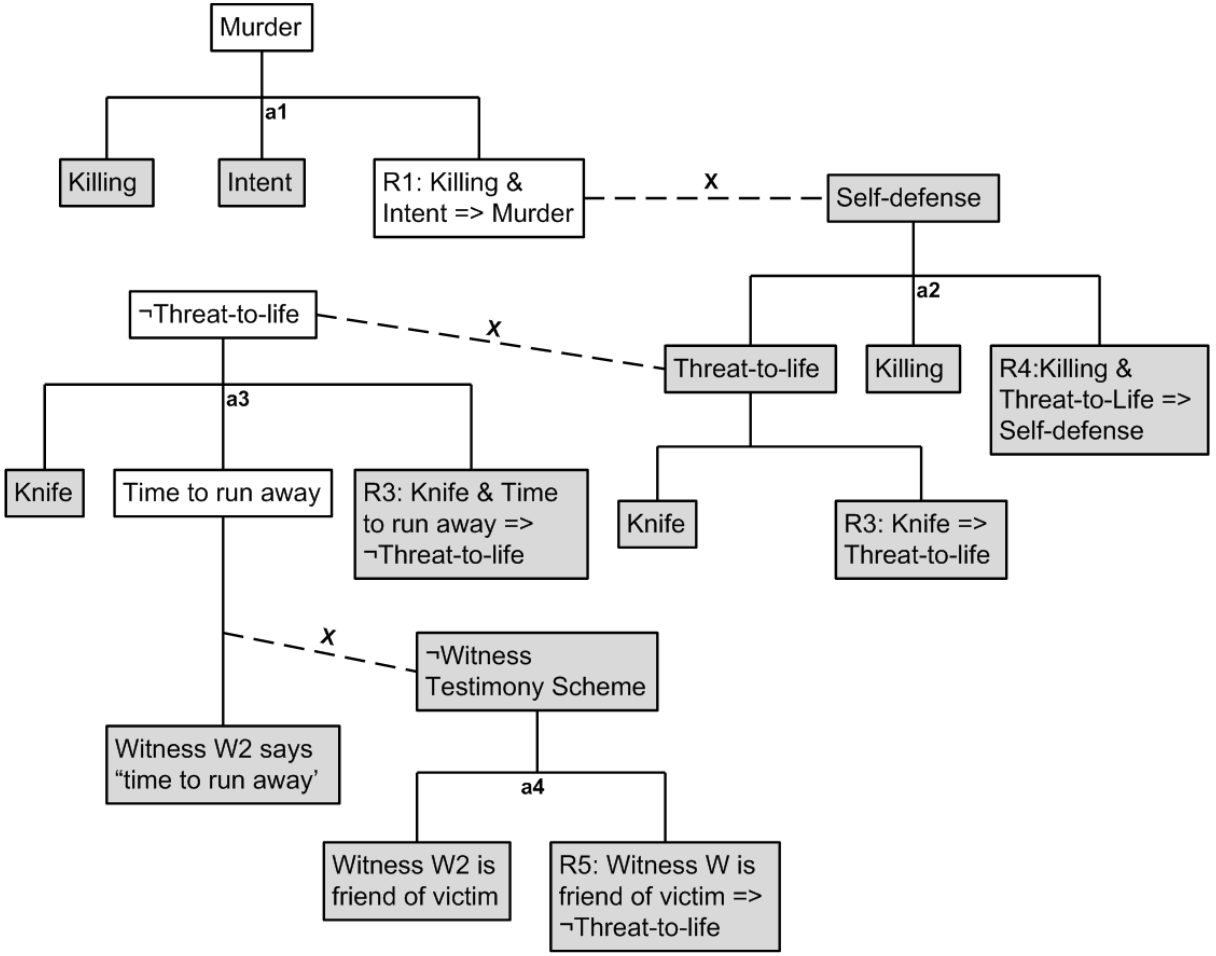
Burdens in Persuasion Dialogue



Shifting of Burden of Proof

- In Dutch law, the prosecution has the burden of persuasion for the elements of killing and intent.
- The burden of production is on the defendant to prove exceptions, such as self-defense.
- Once the defendant has produced evidence that he acted in self-defense, the prosecution has the burden of persuasion that there was not self-defense.

Prakken and Sartor Example, 2009



Argumentation in the Example

- All nodes under the self-defense node are *in*, so the argument for murder is defeated at that point (a2 defeats R1).
- But a4 defeats the witness testimony needed to prove ‘time to run away’ (now *out*).
- Since a3 now fails to prove ‘not-threat-to-life’.
- This shows that R1 is not proved, and that the ultimate claim of ‘murder’ is not proved.

An Evidentialist Model of Knowledge

- This model adopts a viewpoint of bounded procedural rationality to represent the structure of the process whereby argumentation is used to justify or refute the claim that a proposition should have the status of knowledge.
- Two important elements of the model are the requirements (a) that the process uses evidence both for and against the claim and (b) that it is based on defeasible reasoning.
- In the model, a proposition can be classified as knowledge if and only if (1) it has been proved in an investigative procedure called an inquiry, (2) to the proof standard appropriate for the inquiry, (3) based on the evidence marshalled during the inquiry, and (4) using the kind of evidence that is admissible in the inquiry.

Inquiry Dialogue

- The goal of an inquiry is to collect as much evidence as possible, within the timeframe allowed, to prove or disprove a proposition designated at the opening stage.
- At the opening stage a standard of proof needs to be set in place to determine when the inquiry is successful. If there is insufficient evidence one way or the other, the conclusion of the inquiry needs to be that the ultimate proposition to be proved is not yet proved.
- Many scientific inquiries have a high standard of proof.
- The reason is that one of the goals is to avoid retraction at some future point should new evidence come in that casts the ultimate conclusion into doubt.
- Black and Hunter (2007) computationally modeled species of inquiry dialogue where healthcare professionals must corroborate by sharing their specialized knowledge.

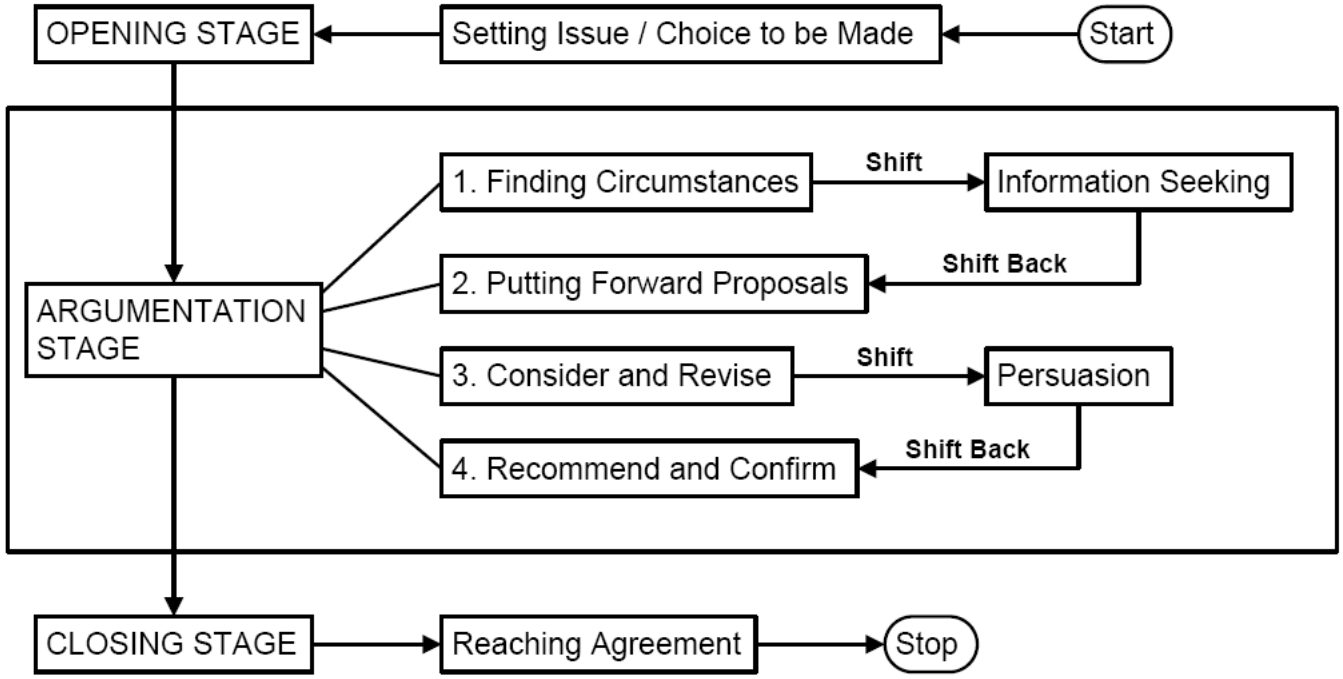
Meaning of “deliberation”

- Although "deliberation" can mean a wide variety of things in natural language (pretty much any activity involving some kind of thought can be called "deliberation"), in recent computer science it has been given a more precise meaning. For example, McBurney et al 2007 (cited as the work built on in this paper) cites three characteristics, which have been widely adopted:
  - it is concerned with actions rather than propositions (and so different from inquiry)
  - there are no initial commitments on either side (and so different from persuasion)
  - it is cooperative rather than adversarial. The object is to achieve consensus, rather than conversion (persuasion) or compromise (negotiation).

McBurney Hitchcock and Parsons (MHP) Model, 2007

1. *Opening Stage*: the collective goal of the dialogue is an issue or 'governing question' that applies to the whole dialogue. The issue is to decide what to do in a given set of circumstances.
2. *Inform Stage*: there is a discussion of goals, any constraints on the actions being considered, and any external facts relevant to the discussion.
3. *Propose Stage*: proposals are put forward by any parties.
4. *Consider Stage*: comments are made on the proposals that have been brought forward, and arguments for and against proposals are considered.
5. *Revise Stage*: the goals, the actions that have been proposed, and the relevant facts may be revised.
6. *Recommend Stage*: participants recommend a particular action which others can accept or reject.
7. *Confirm Stage*: participants together confirm their acceptance of one selected option.
8. *Close Stage*: participants arrive at a good decision on what to do.

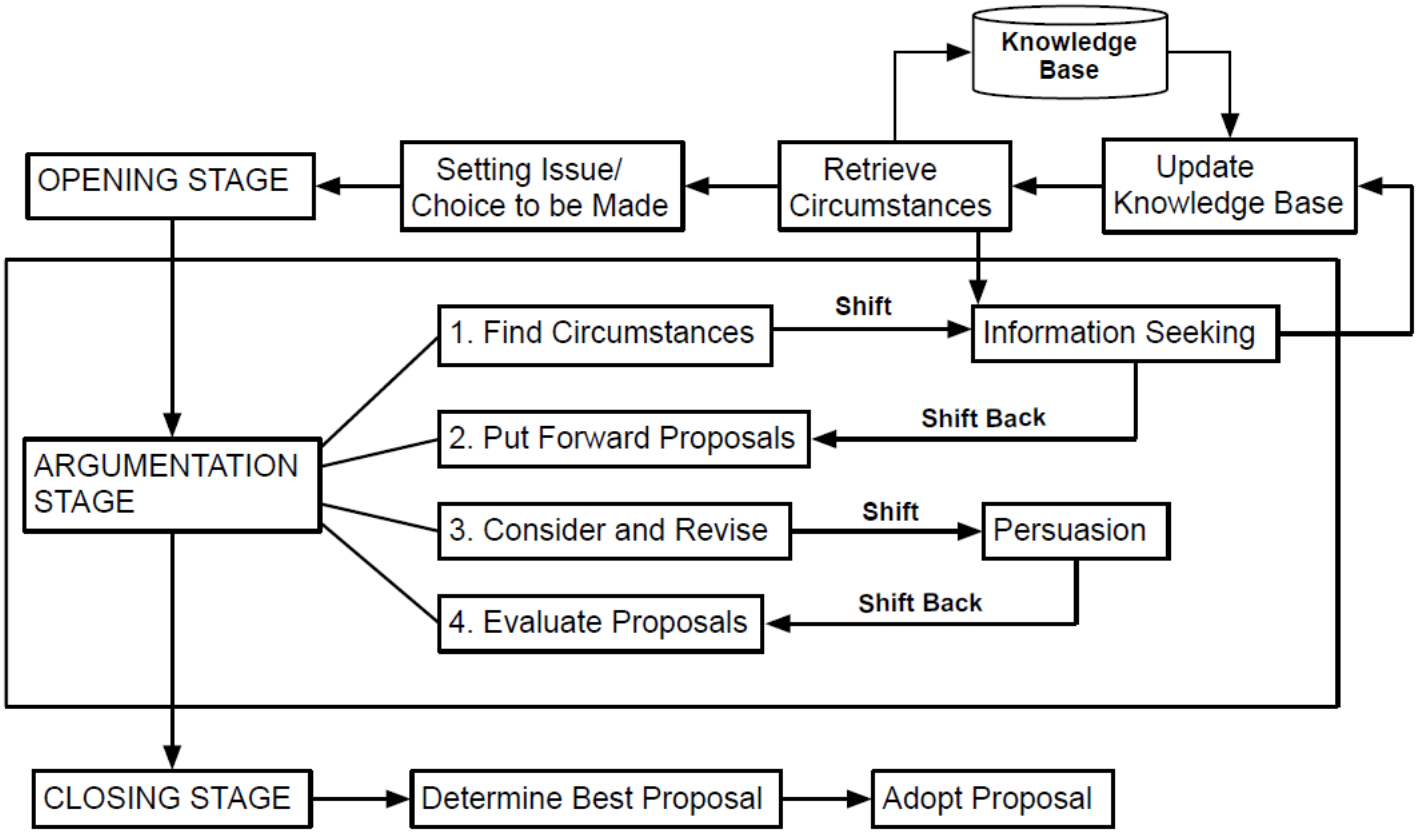
Outline of the MHP Model



Extending the MHP Model

- In realistic cases of deliberation the knowledge bases that the agents have tend to be incomplete, and may need to be updated once new information comes in.
- We propose a new model in which an open knowledge base enables information about changed circumstances to come in.
- During the argumentation stage there is a cyclical flow of argumentation as new knowledge comes that requires reevaluation of proposals.

Revised Model of Deliberation



Compendium of Schemes, 2008

- Included in the 65+ schemes listed in the compendium of schemes in Chapter 9 of (Walton, Reed, and Macagno, 2008) are argument from expert opinion, argument from commitment, argument from precedent, argument from position to know, argument from (positive or negative) consequences, argument from lack of knowledge, practical reasoning (argument from goal to action), argument from cause to effect, inference to the best explanation, argument from analogy, several types of *ad hominem* argument, and the slippery slope argument.

Arg. Scms for Presumptive Reasoning (Walton, 1996) 29 schemes

1. Argument from Analogy 2. Argument from a Verbal Classification 3. Argument from Rule 5. Argument from Exception to a Rule 6. Argument from Precedent 7. Practical Reasoning 8. Lack of Knowledge Arguments 9. Arguments from Consequences 10. Fear and Danger Appeals 11. Arguments from Alternatives and Opposites 12. Pleas for Help and Excuses 13. Composition and Division Arguments 14. Slippery Slope Arguments 15. Arguments from Popular Opinion 16. Argument from Commitment 17. Arguments from Inconsistency 18. Ethotic *Ad Hominem* 19. Circumstantial *Ad Hominem* 20. Argument from Bias 21. *Ad Hominem* Strategies to Rebut a Personal Attack 22. Argument from Cause to Effect 23. Argument from Effect to Cause 24. Argument from Correlation to Cause 25. Argument from Evidence to a Hypothesis 26. Abductive Reasoning 27. Argument from Position to Know 28. Argument from Expert Opinion 29. The Sunk Costs Argument (aka Argument from Waste)

Example of a Scheme

The following argumentation scheme for instrumental practical reasoning is given in Walton, Reed & Macagno (2008), where 'I' represents an autonomous agent.

- MAJOR PREMISE: I have a goal G.
- MINOR PREMISE: Carrying out this action A is a means to realize G.
- CONCLUSION: Therefore, I ought (practically speaking) to carry out this action A.

Critical questions

- CQ1: What other goals do I have that might conflict with G?
- CQ2: What other actions that would also bring about G should be considered?
- CQ3: Among these alternative actions, which is arguably the most efficient?
- CQ4: What grounds are there that it is practically possible for me to bring about A?
- CQ5: What consequences of my bringing about A should be taken into account?

Value-based Variant

- The following argumentation scheme for value-based practical reasoning is from Atkinson, Bench-Capon & McBurney (2005, 2–3).

- In the current circumstances R
- we should perform action A
- to achieve New Circumstances S
- which will realize some goal G
- which will promote some value V.

- Practical reasoning is used in arguments, but also in explanations retroductively to draw conclusions about an agent's goals, motives or intentions, based on reports of what the agent said or did.

Abstract and Structured Models

- In abstract models of argumentation the nodes represent arguments and the edges (ordered pairs of nodes) are attack relations.
- The notion of argument is primitive.
- In structured models of argumentation, arguments have premises and conclusions.
- A set of premises can support or attack a conclusion using pro and con arguments.

An Example of a Problem Case

- This case concerns a man who was convicted of the murder of his wife when she was found dead at the bottom of a set of stairs in their house.
- There was an enormous spattering of blood on her body, in the stairwell and on the wall. She also had serious wounds to the back of her head.
- Much of the evidence in the trial was based on expert testimony by forensic experts.
- However, the experts offered conflicting opinions. When new evidence came in after the trial suggesting the woman had been attacked by an owl and ran inside, the verdict was appealed. In a retrial hearing, key bloodstain evidence presented by one of the experts was shown to be dubious.

Argument Diagrams

- Wigmore (1931) used argument diagrams called “evidence charts” that have the form of a directed graph.
- Each square or circle in a chart represents some presumed evidential fact, and arrows are used to represent inferences.
- One chart represents the arguments on the plaintiff’s side while another represents the evidence on the defense side.
- Twining (1985) and Anderson and Twining (1991) applied a simplified version of this evidence charting technique to build detailed analyses of evidential reasoning in trials.
- Schum (1994) used argument diagrams to model evidential reasoning in such cases as the Sacco and Vanzetti trial.

Combining Schemes with Diagrams

- Araucaria, an early system of computer-assisted argument diagramming developed in 2001 by Chris Reed and Glenn Rowe in the Argumentation Research Group in the University of Dundee, had four features.
- First, it has a a menu of 20 Walton argumentation schemes that the user can apply to an argument diagram he or she is working on.
- Second, it has lists of critical questions matching each scheme.
- Third, it even enabled a user to automatically transfer the given argument diagram the user had drawn to a Wigmore chart diagram.
- Fourth, this them to build a tool for groups to work together to build a diagram, adding new arguments and correcting errors.
- http://araucaria.computing.dundee.ac.uk/doku.php

The Carneades Argumentation System

- The Carneades Argumentation System is a formal and computational model of legal argumentation that bases its output on the input by a user of evidential propositions and arguments linked together into graph structure (Gordon and Walton, 2016).
- The user begins by constructing an argument diagram and inserting premises, conclusions and argumentation schemes into the diagrams at nodes in the graph.
- Once the user has provided this input, the system provides output that enables the user both to evaluate the argument and to extend the argument diagram by inventing new arguments. http://carneades.github.io/

The Problem in the Owl Example

- An expert in forensic neuropathology testified the wounds on the victims head were more characteristic of falling on stairs.
- Another expert witness, a forensic scientist, noted that there were over 10,000 blood drops at the crime scene and stated that their pattern would be inconsistent with a typical beating.
- A professor of biomechanics stated that the injuries were not consistent with being struck, but were with a fall down the stairway.
- A former professor of biomedical engineering, stated that the injuries were not consistent with a fall but were consistent with a beating by a blunt instrument.
- “The experts who testified at trial offered diametrically opposed opinions as to whether there had been an accident or a beating” (State v. Peterson, 2011, 2).

Argument Mining

- Mochales and Moens (2011) developed methods for classifying arguments in legal texts by collecting documents containing judges' legal decisions in cases from the European Court of Human Rights.
- Argumentation schemes were used to help identify arguments.
- Phrases such as 'it follows that', and 'in conclusion', were used to identify conclusions. Phrases such as 'in the view of the factfinder' were used to identify premises of arguments. The task was helped by the fact that the documents they used were divided up into sections where one section was designated as containing summaries of the judges' arguments used to support their conclusions.

Construction of Argument Trees

- A research project outlined in (Ashley, 2014) plans to develop a generalized unstructured information management architecture both to recognize arguments and to construct argument trees from legal cases with the help of annotators.
- Unstructured information is defined as the direct product of human communication, including natural language documents, email, speech, images and video (https://www.oasis-open.org/committees/uima/charter.php).
- It is said to be unstructured in the sense that it lacks an explicit semantics that would enable it to be interpreted as intended by the human author.
- The system will use IBM's Watson QA system as well as a default logic framework based on argumentation schemes for such kinds of arguments as argument from precedent and argument from testimony about causation.

Argument Invention

- This part offers a brief explanation two recently developed AI systems for argument invention.
- First it is shown how the IBM Watson Debater system is being used to help a human arguer to search through a database to find statements that can be used as arguments to support or attack a central claim (called a topic) in a debate.
- Next it is shown how the Carneades Argumentation System (CAS) can also perform the task of automated argument invention, but in a different way, by having the user begin by building an argument graph in a user interface.

A Typical Scheme

- The form of argument specified below represents the argumentation scheme for the argument from expert opinion (Walton, Reed and Macagno, 2008, 310).
-
- Major Premise: Source *E* is an expert in subject domain *S* containing proposition *A*.
- Minor Premise: *E* asserts that proposition *A* is true (false).
- Conclusion: *A* is true (false).
-
- There are also other ways of expressing this scheme. In some of them the major premise is broken down into three separate premises. In other a conditional premise is added.

The Scheme's Critical Questions

- There are six basic critical questions for the scheme for argument from expert opinion (Walton, Reed and Macagno, 2008, 310).

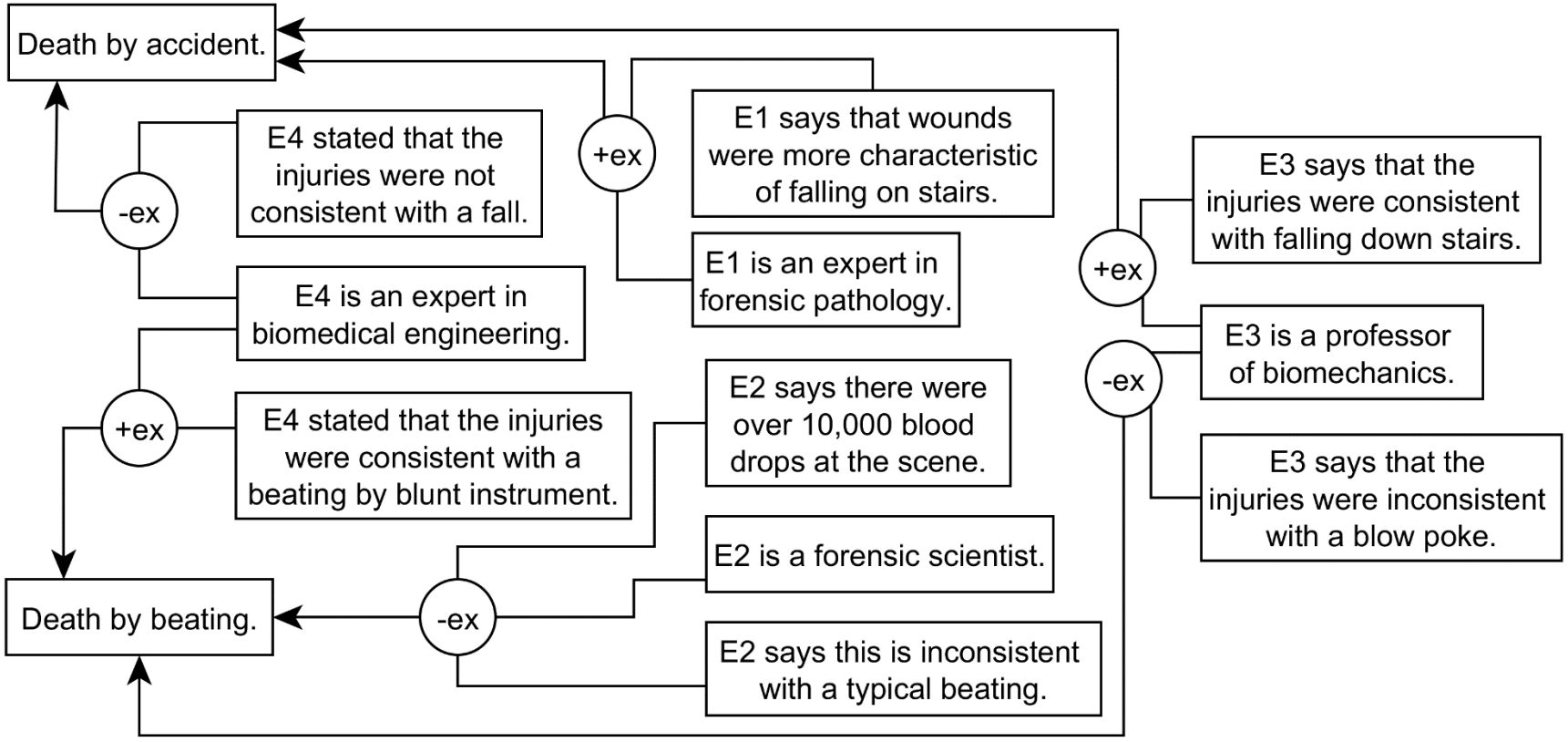
- *Expertise Question*: How credible is *E* as an expert source?
- *Field Question*: Is *E* an expert in the domain *S* that *A* is in?
- *Opinion Question*: What did *E* assert that implies *A*?
- *Trustworthiness Question*: Is *E* personally reliable as a source?
- *Consistency Quest*: Is *A* consistent with other expert opinions?
- *Backup Evidence Question*: Is *E*'s assertion based on evidence?

- If a respondent asks any one of the six critical questions, the argument is suspended until the question has been answered.
- Once the question has been answered, the BoP (burden of proof) in the dialogue shifts back to the other side of the dialogue.

Problems with Expert Opinions

- Typical problem cases ones where the source cited is not really an expert, where the expert is not named.
- In such cases the critical questions (CQ's) can be used help locate the problem and repair the fault.
- The CQ's can be used to identify implicit premises.
- There are also complex cases with conflicting arguments from expert opinion, e.g. in a trial setting.
- As shown later, these cases need to combine schemes and argument diagrams, and include the context of dialogue.
- For example is a problem if the expert presents the argument in a dogmatic manner that it is not open to critical questions.

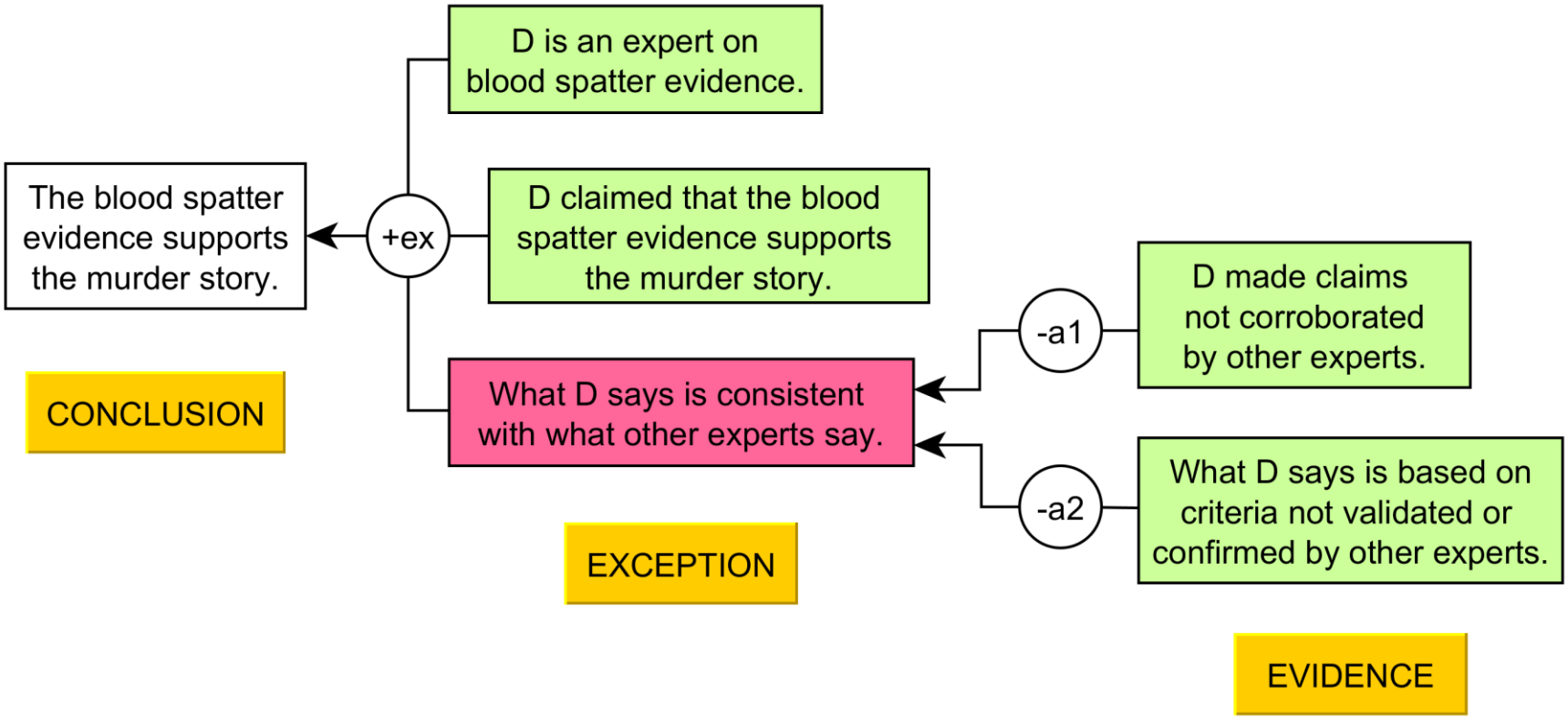
Argument Diagram of the Problem



The Owl Story

- In 2009, T. Lawrence Pollard, one of the Petersons' neighbors, suggested to the police that an owl might have been responsible after he learned of an evidential finding.
- A crime lab had found a wooden sliver from a tree limb and a microscopic owl feather entangled in a clump of Mrs. P's hair.
- A subsequent examination found two more microscopic owl feathers.
- The theory that she had been attacked by an owl was ridiculed by the newspapers

Questionable Blood Spatter Evidence



Cross-examination of D's Testimony

- R, one of Peterson's original attorneys, put forward a plea for a retrial hearing on the basis that the conviction was obtained in violation of the defendant's constitutional rights.
- Rudolf argued that the critical testimony showing how the bloodstains proved that Mr. P had killed his wife came from D.
- When D was cross-examined in the hearing, the answers he gave were unconvincing, often relying on interjecting irrelevant and false information to distract the jury (State v. Peterson, 2011, 12).
- D's testimony as an expert was also discredited because of his previous work in a large number of flawed criminal cases. An audit found that he had falsely represented evidence in thirty-four cases.
- The outcome was that D was finally released after many years, but the murder conviction was not overturned (when I last checked).

Ancient History

- Ancient rhetoricians devised methods to help an arguer skillfully take part in public debates by applying systematic methods (called topics) to enable the finding of new arguments to support or attack a claim (Cicero, 1949; Kennedy, 1963).
- Attempts to refine these rhetorical methods and build on them to try to develop systems of argument invention continued through medieval times, but interest in them lapsed as rhetorical invention began to be seen during the Enlightenment period as a purely humanistic skill not amenable to scientific calculation.
- The popular logic textbook called the *Port-Royal Logic* (Arnauld, 1662) spread what came to be the dominant view that such methodical systems to assist argument invention are neither necessary nor useful (Kienpointner, 1997, 228). On Arnauld's "encyclopedic" view of argument invention, all that is needed is a good memory of the facts (Kienpointner, 1997, 230).

IBM’s Watson Debater Feature

- Watson is built on commercially available 750 Power servers, because IBM aims to market it to corporations in the future.
- The hardware to operate Watson at its minimum system requirements currently costs a relatively modest one million US dollars, but the price is expected to drop in the coming years.
- The new Debater feature lets the machine take a given topic, scan for relevant articles, and automatically find the pros and con arguments based on the context and language of any claims.
- In a demo, Watson took 45 seconds to scour millions of Wikipedia articles and make cases both for and against on the issue of banning violent videogames.

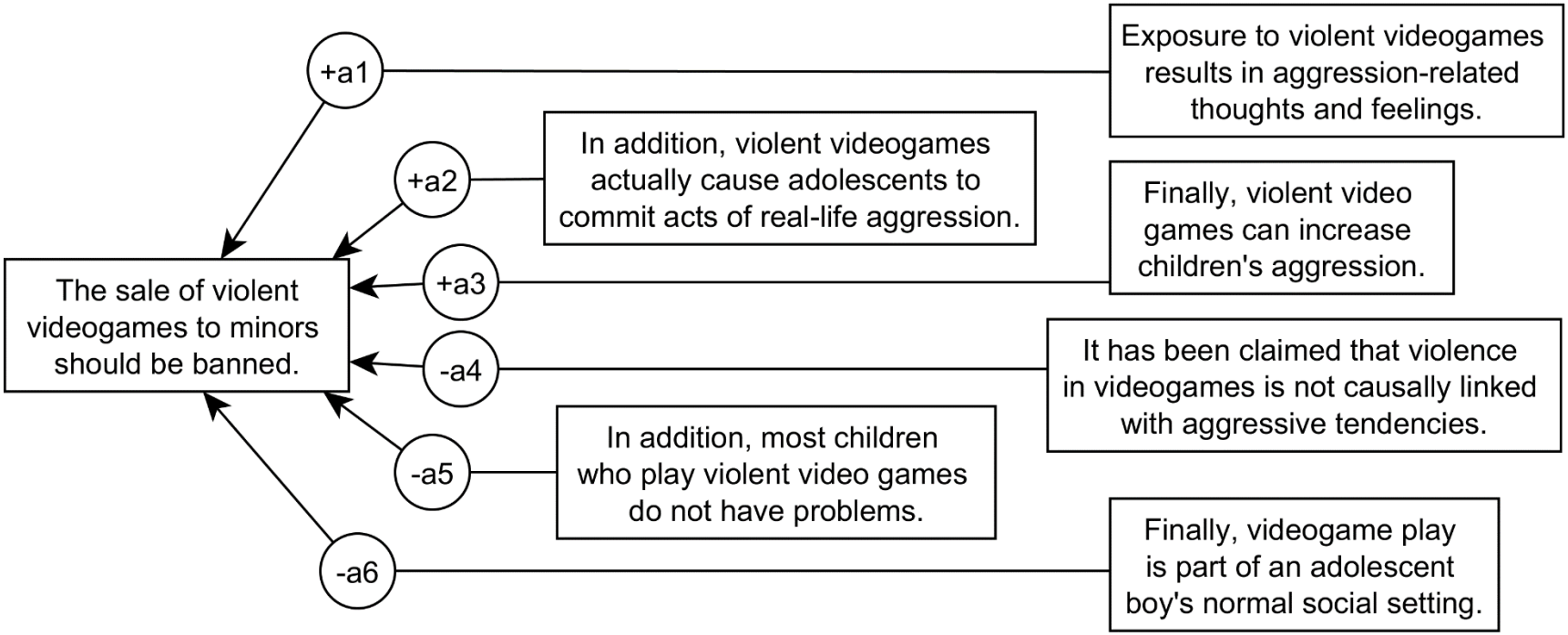
IBM's Demo

- In a canned demo, IBM presented a sample debate topic: "The sale of violent video games to minors should be banned."
- Debater was tasked with presenting pros and cons for a debate on this question.
- Here is what Debater replied:
- Scanned approximately 4 million Wikipedia articles, returning ten most relevant articles. Scanned all 3,000 sentences in top ten articles. Detected sentences which contain candidate claims. Identified borders of candidate claims. Assessed pro and con polarity of candidate claims. Constructed demo speech with top claim predictions. Ready to deliver.
- Debater then presented three relevant pros and cons shown in the next slide.

How Debater Works

- The *topic* is defined as a short phrase that frames the discussion (Levy et al., 2014, 1489).
- The tool IBM has devised helps a human arguer to search for statements that can be used to directly support or attack the given topic.
- The target of such a search is called a context dependent claim (CDC), defined as a general, concise statement that directly supports or contests a topic.
- The tool was developed and tested by having a team of human labelers search for CDC's in a selected collection of Wikipedia articles.

Violent Videogames Example



Sample Topics

Sentiment Analysis

- Sentiment analysis is a technique of natural language processing developed in computational linguistics to extract subjective information from the text.
- It is used to determine the attitude, pro or con (polarity) of the author of a sentence found in a text.
- Sentiment analysis is also used to determine the polarity of a larger body of text, such as a document.
- Categories other than pro and con can also be used, such as neutral, angry, or happy.
- Research in this area has studied examples of detecting polarity in product reviews and movie reviews.

Four Main Techniques

- The four main techniques used in sentiment analysis are keyword spotting, lexical affinity, statistical methods and concept-level techniques.
- Keyword spotting identifies affect words such as ‘superb’ or ‘nasty’.
- Statistical methods use such devices as detecting relationships between the author of the text and the entity which is the subject of the sentiment
- Concept-level techniques detect subtle relationships between concepts using devices such as ontologies from knowledge representation.
- Sentiment analysis uses human coders along with these computational tools for extracting data from a text.

Selecting out Candidates

- A practical problem using Debater was that Wikipedia produced a large number of candidates CDC's initially, but only a small number of them were useful to an arguer who wants to find usable arguments on the pro or the con side of the topic.
- The non-useful ones have to be selected out.
- To cite one example, the statement violent video games can increase children's aggression was selected as a CDC, but the statement violent video games should not be sold to children was also found as a CDC but had to be excluded.
- The reason why it was excluded is that it merely restates the topic, and so would not be useful to the arguer as a CDC.

Finding the Boundaries

- Another illustration of the practical problem of using Debater to identify CDC's concerns the kind of case where a CDC is embedded into a longer Wikipedia sentence.
- In one of the examples (Levy et al., 2014, 1489), the CDC claiming that violence in games hardens children to unethical acts is embedded in a longer sentence which states that two named individuals argue that violence in games hardens children to unethical acts, and goes on to call first-person shooter games murder simulators.
- The task here is finding the boundaries of the text that can be classified as a CDC, so that the non-useful parts of a longer sentence in the natural language text can be excluded.

Seven Engines

- The high-level architecture of the debater system uses seven engines that are currently at different stages of development (Aharoni et al., 2014, 8).
- The *topic analysis engine* is used to identify the main concepts mentioned in a topic and the sentiment towards each of these concepts.
- The *article retrieval engine* searches for Wikipedia articles that have a high probability of containing CDC's. The *CDC detection engine* zooms in within the retrieved articles to detect CDC's.
- The *CDC pro/con engine* automatically judges the polarity of a CDC found, with respect to a given topic.
- The *CDC equivalence engine* attempts to avoid redundancy by determining whether to CDC's or semantically equivalent.
- The *CDC refinement engine* has the task of improving the precision of the generated output, for our example by removing judgments of pro-con polarity that have low confidence.
- Finally, the *text to speech engine* presents the top CDC candidates recommended as arguments for the user to consider pro or con the given topic.

Finding an Argument Fast

- Levy et al. (2014, 1491) see their ultimate goal as that of automatically pinpointing the CDC's in documents quickly so that they can be used right away.
- To carry out this task they use in-house labelers, human agents that understand the natural language discourse and can sift through it to "funnel down" the data to useful statements that directly support or contest the topic of the discussion.
- By solving problems confronted by the labelers' attempts to identify CDC's, the research goal is to improve this selection process and make it more highly automated.
- As the system is used more and more, it will get better and better.
- Comedians hope for an argument finder that is fast enough to help them respond to hecklers.

Debater and Argument Mining

- The purpose of argument mining is to search through a natural language text to identify the arguments in it. What Debater does is to take a database, designate a proposition as a topic, and search through the text to identify arguments in it that support or attack the topic.
- Hence it would seem that the task that Debater performs is very similar to that carried out by the system of argument mining.
- Some might even say that Debater really is a system of argument mining, because it is so heavily based on using tools from computational linguistics to identify arguments in a natural language text.
- Argument mining needs to use the same tools, and also needs to rely on human argument assistants to debug problems in an effort to get more accurate results.

The Carneades Argumentation System

- Another approach to the task of argument construction is that of CAS, a system that models arguments as directed graphs, consisting of two kinds of points (nodes).

- Nodes represented as rectangles in a graph represent propositions that function as premises and conclusions of arguments.

- Rectangular nodes in a graph containing propositions (statements) represent premises or conclusions of arguments.

Proof Standards (original version of (Gordon & Walton, 2009)

- Scintilla of Evidence
  - There is at least one applicable argument
- Preponderance of Evidence
  - The scintilla of evidence standard is satisfied, and
  - the maximum weight assigned to an applicable pro argument is greater than the maximum weight of an applicable con argument.
- Clear and Convincing Evidence
  - The preponderance of evidence standard is satisfied
  - the maximum weight of applicable pro arguments exceeds some threshold α, and
  - the difference between the maximum weight of the applicable pro arguments and the maximum weight of the applicable con arguments exceeds some threshold β.
- Beyond Reasonable Doubt
  - The clear and convincing evidence standard is satisfied and
  - the maximum weight of the applicable con arguments is less than some threshold γ.

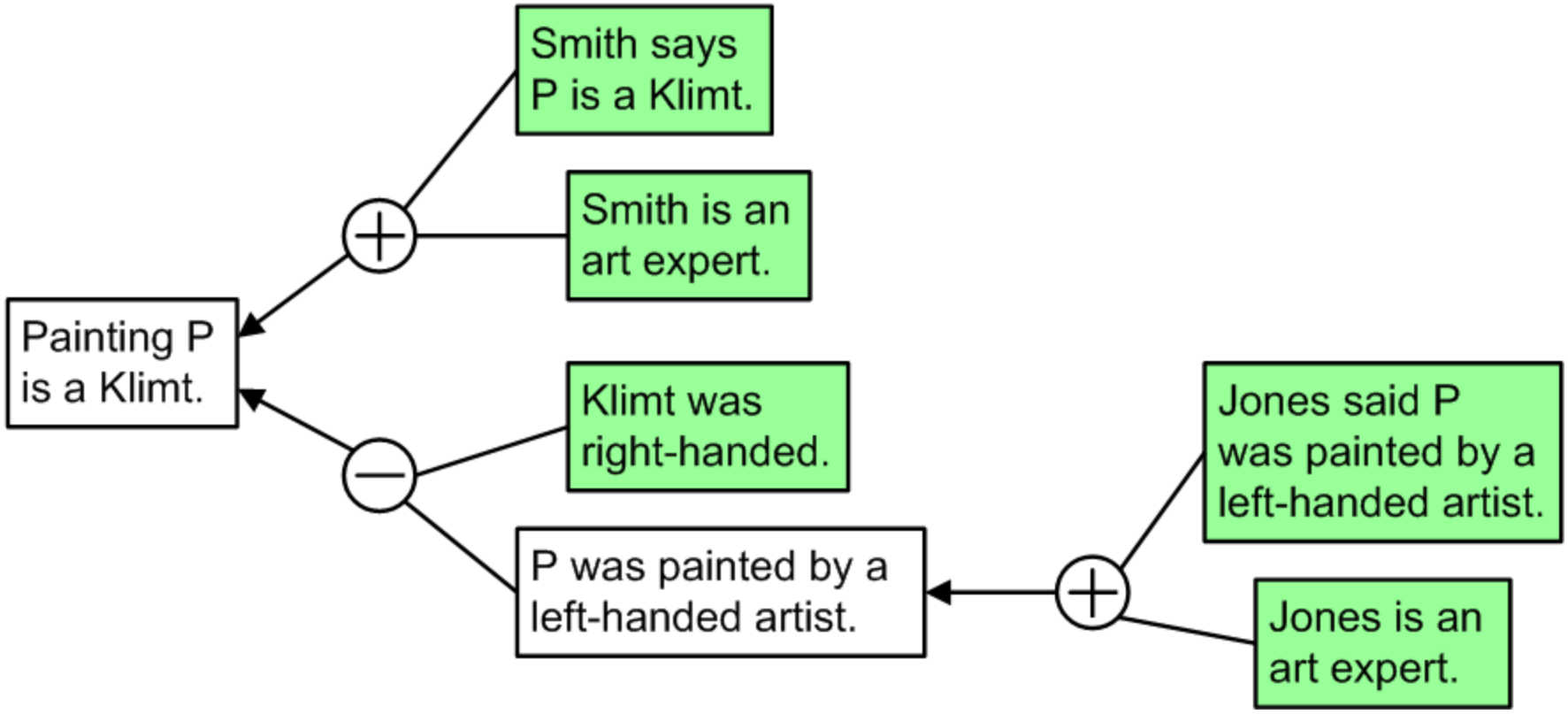
Formal CAS Structure

- An *argument graph* is a bipartite, directed, labeled graph, consisting of statement nodes and argument nodes connected by premise and conclusion edges.
- Formally, an argument graph is a 4-tuple (S, A, P, C), where S is a set of *statement nodes*, A is a set of *argument nodes*, P is a set of *premises*, and C is a set of *conclusions*.
- The 4-tuple does not model a single argument, but rather a set of arguments, a whole argument graph.
- A single argument is a subgraph of the argument graph, where the subgraph is a tree (no cycles) and none of the leaves of the tree are issues but rather assumed to be true or false or rejected or accepted by the audience.

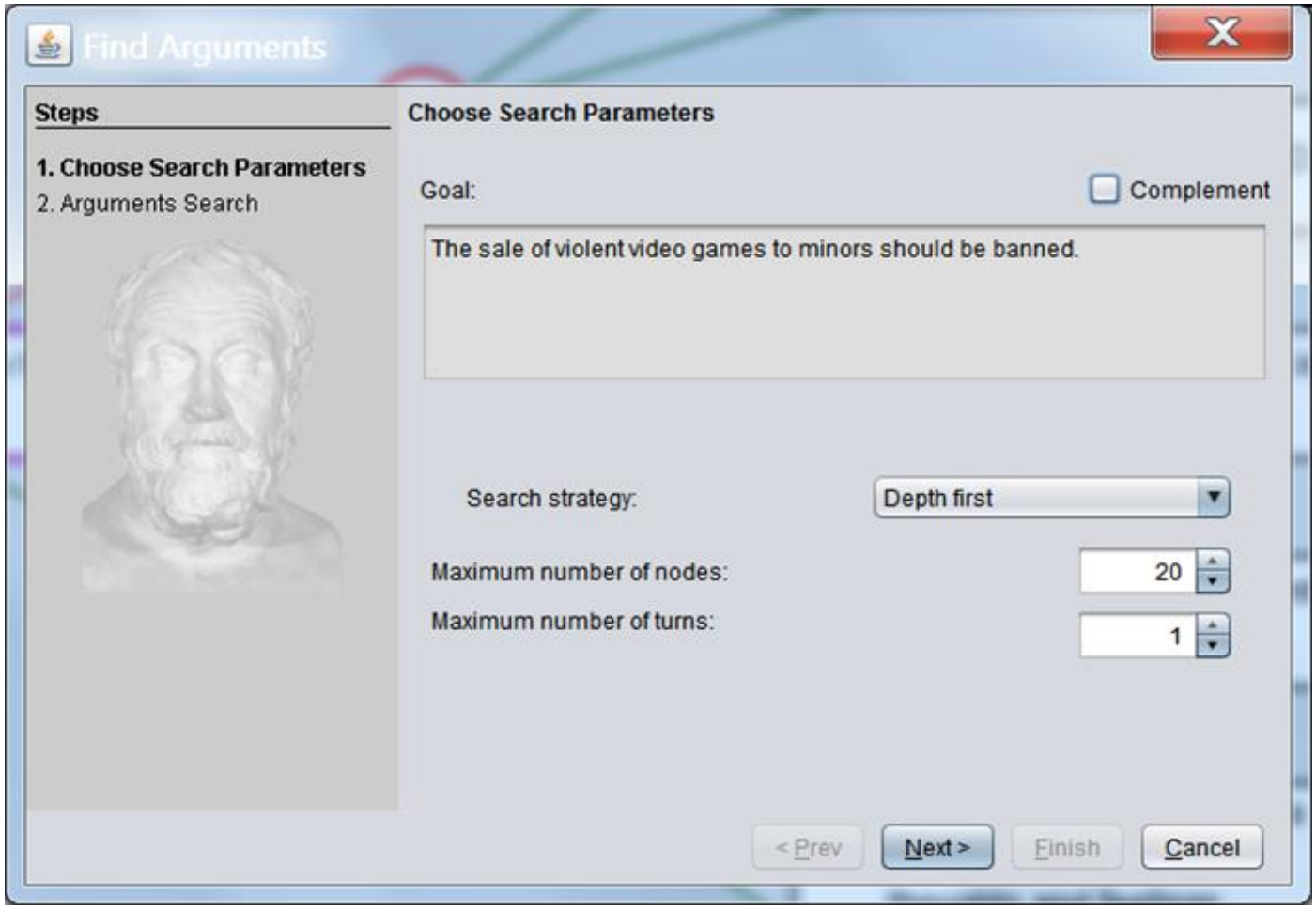
Evaluating Argument Graphs

- In CAS, argument graphs are evaluated by three factors.
- The first is whether or not the audience accepts the premises of the argument or not.
- The second is a knowledge base of argumentation schemes.
- The third is that argument weights (fractions between zero and one) can be assigned to each argument, indicating the strength or weakness of the audience's acceptance.
- A premise that is accepted by the audience is said to be in, and is shown in a green rectangular node in the user interface.
- A premise that is rejected by the audience is said to be out, it is shown in a red rectangular node in the user interface.
- A premise that is neither accepted nor rejected is shown in a rectangular node with a white background.

Typical CAS Argument Graph



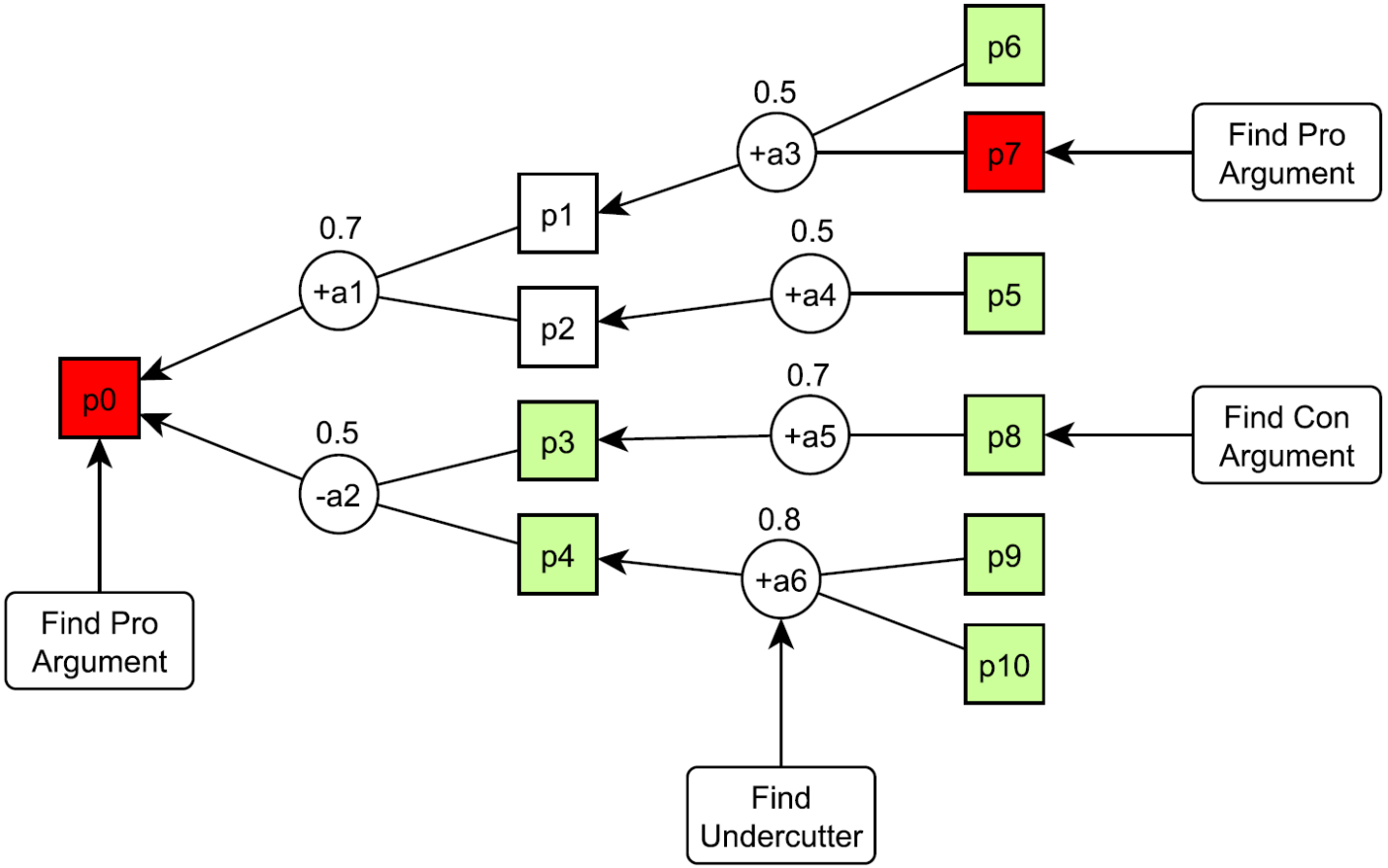
The Find Arguments Assistant

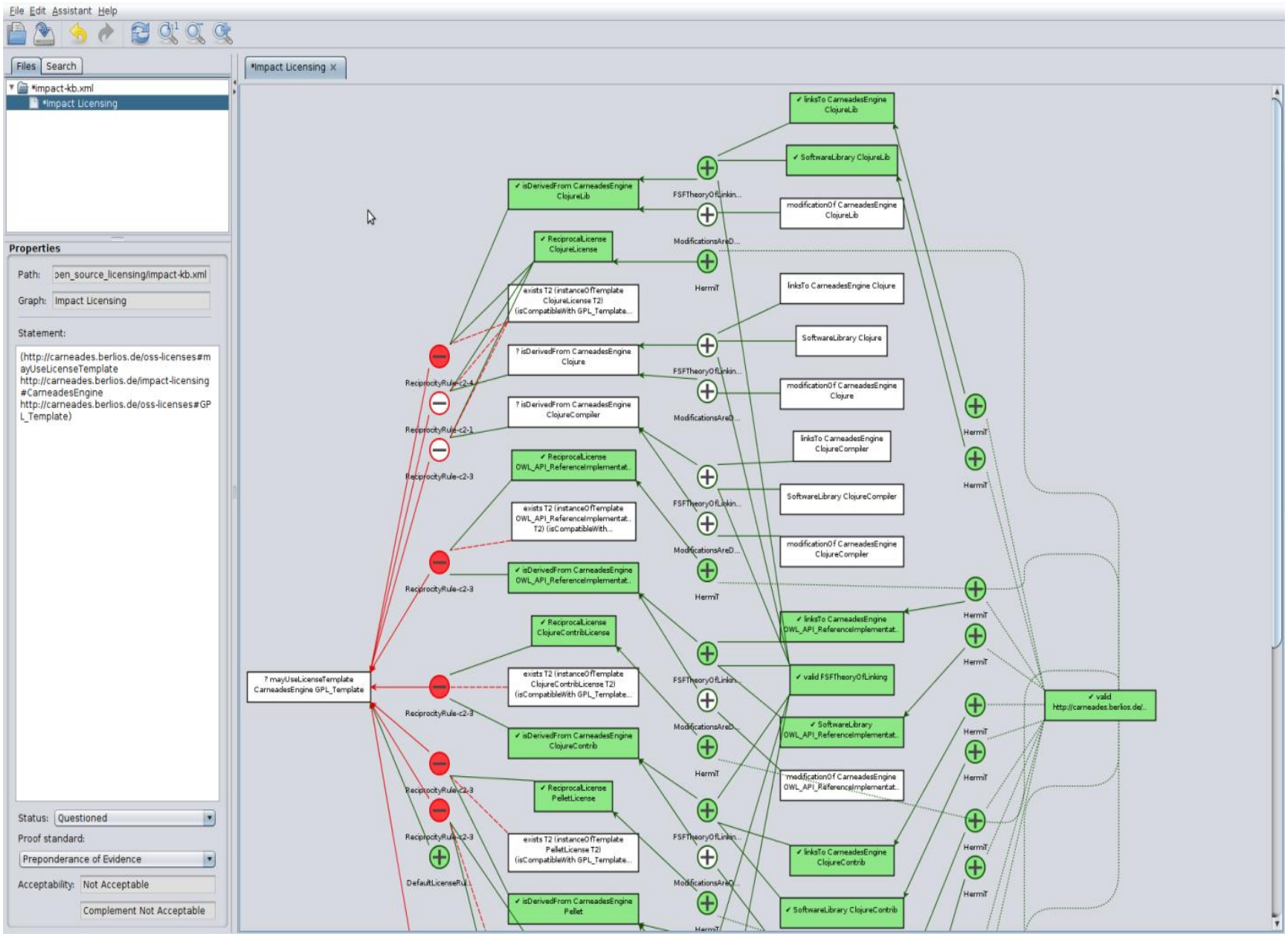


What advice does the CAS argument assistant offer?

- One piece of advice is to search for a new argument that could be used get the audience to come to accept p7 by looking for a pro argument with a weight of **>**0.5 that supports p7.
- A second piece of advice would be to attack one of the premises of a5 or a6.
- A third would be look for arguments that would undercut a5 or a6.
- A fourth would be to look for a different pro argument with a weight of **>**0.5 that would support p0. These four strategies are shown in figure 6.

Advice

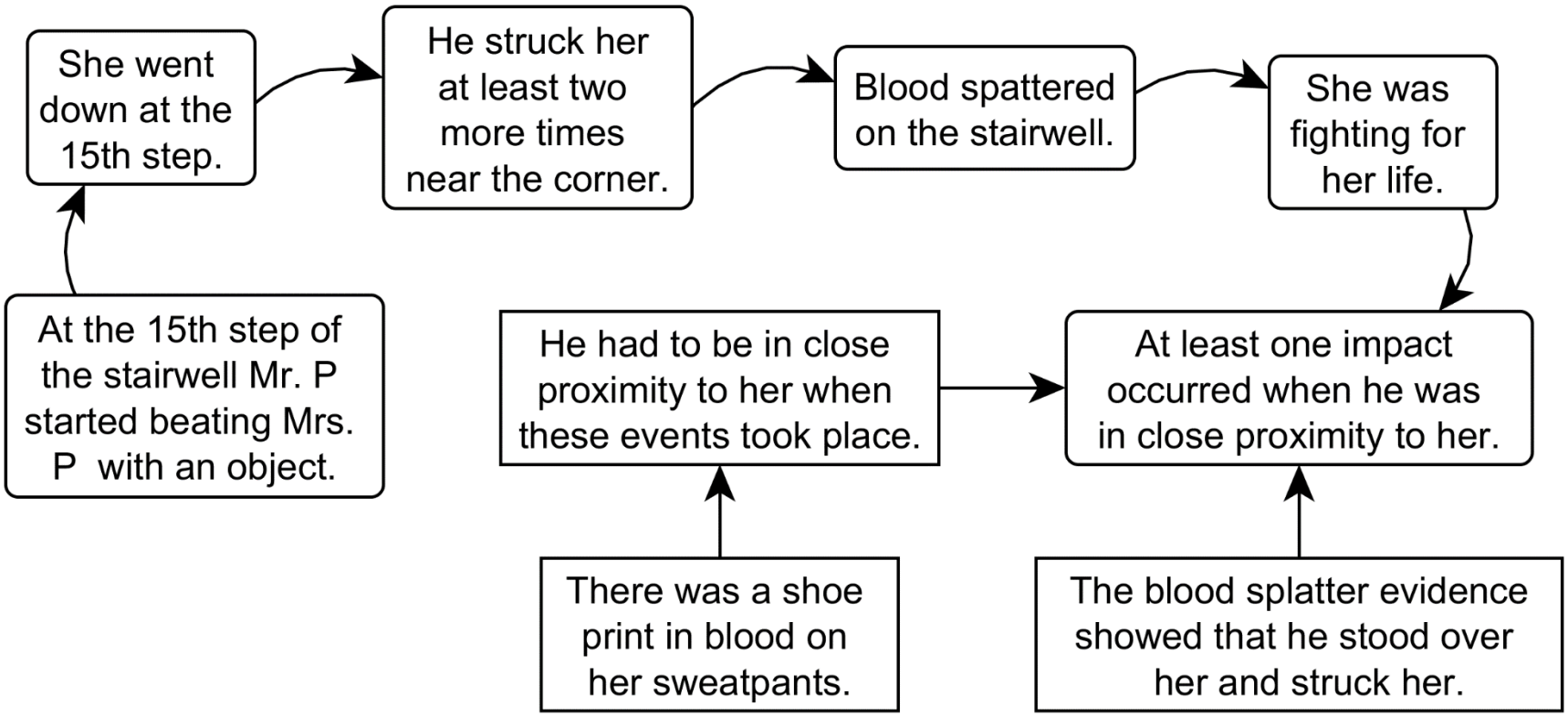

p6
0.5
+a3
p7
Find Pro Argument
p1
0.7
+a1
0.5
+a4
p5
p2
p0
0.7
+a5
p8
Find Con Argument
0.5
-a2
p3
p4
0.8
+a6
p9
p10
Find Pro Argument
Find Undercutter


File Edit Assistant Help
Files
Search
*impact-kb.xml
*Impact Licensing
*Impact Licensing
Properties
Path:
Graph: Impact Licensing
Statement:
(http://carneades.berlios.de/oss-licenses#mayUseLicenseTemplate
http://carneades.berlios.de/impact-licensing#CarneadesEngine
http://carneades.berlios.de/oss-licenses#GPL_Template)
Status: Questioned
Proof standard:
Preponderance of Evidence
Acceptability: Not Acceptable
Complement Not Acceptable
? mayUseLicenseTemplate CarneadesEngine GPL_Template
ReciprocityRule-c2-4
ReciprocityRule-c2-1
ReciprocityRule-c2-3
DefaultLicenseRu...
✓ isDerivedFrom CarneadesEngine ClojureLib
✓ ReciprocalLicense ClojureLicense
exists T2 (instanceOfTemplate ClojureLicense T2) (isCompatibleWith GPL_Template...
? isDerivedFrom CarneadesEngine Clojure
? isDerivedFrom CarneadesEngine ClojureCompiler
✓ ReciprocalLicense OWL_API_ReferenceImplementat..
exists T2 (instanceOfTemplate OWL_API_ReferenceImplementat.. T2) (isCompatibleWith...
✓ isDerivedFrom CarneadesEngine OWL_API_ReferenceImplementat..
✓ ReciprocalLicense ClojureContribLicense
exists T2 (instanceOfTemplate ClojureContribLicense T2) (isCompatibleWith GPL_Template...
✓ isDerivedFrom CarneadesEngine ClojureContrib
✓ ReciprocalLicense PelletLicense
exists T2 (instanceOfTemplate PelletLicense T2) (isCompatibleWith GPL_Template...
✓ isDerivedFrom CarneadesEngine Pellet
FSFTheoryOfLinkin...
ModificationsAreO...
HermiT
✓ linksTo CarneadesEngine ClojureLib
✓ SoftwareLibrary ClojureLib
modificationOf CarneadesEngine ClojureLib
linksTo CarneadesEngine Clojure
SoftwareLibrary Clojure
modificationOf CarneadesEngine Clojure
linksTo CarneadesEngine ClojureCompiler
SoftwareLibrary ClojureCompiler
modificationOf CarneadesEngine ClojureCompiler
✓ linksTo CarneadesEngine OWL_API_ReferenceImplementat..
✓ valid FSFTheoryOfLinking
✓ SoftwareLibrary OWL_API_ReferenceImplementat..
modificationOf CarneadesEngine OWL_API_ReferenceImplementat..
✓ linksTo CarneadesEngine ClojureContrib
✓ SoftwareLibrary ClojureContrib
✓ valid http://carneades.berlios.de/..

Some Points of Comparison

- (1) Both Debater and CAS find a central place in their argument invention procedures for the distinction between pro and con arguments. Both systems essentially view argumentation as a technology for identifying and comparing pro and con arguments in relation to a given issue or topic.
- (2) CAS searches for arguments in a graph made up of statement nodes and argument nodes. Debater searches for claims called CDC's.
- (3) In CAS an argument is defined as a 4-tuple. In Debater, an argument is defined as a pro-or con relation between a claim and the topic.
- (4) CAS has two knowledge bases that it searches through to find arguments. One is a set of propositions representing the commitments accepted by the audience. The other is a set of argumentation schemes. Debater searches through a natural language database such as Wikipedia where claims have to be dug out of the text.
- (5) Debater makes extensive use of tools from computational linguistics to extract CDC's from a natural language text of discourse that is used as its database. CAS assumes as a starting point that the given argument found in the natural language text can be represented as an argument diagram by the user.

Hybrid Diagram for the Murder Story



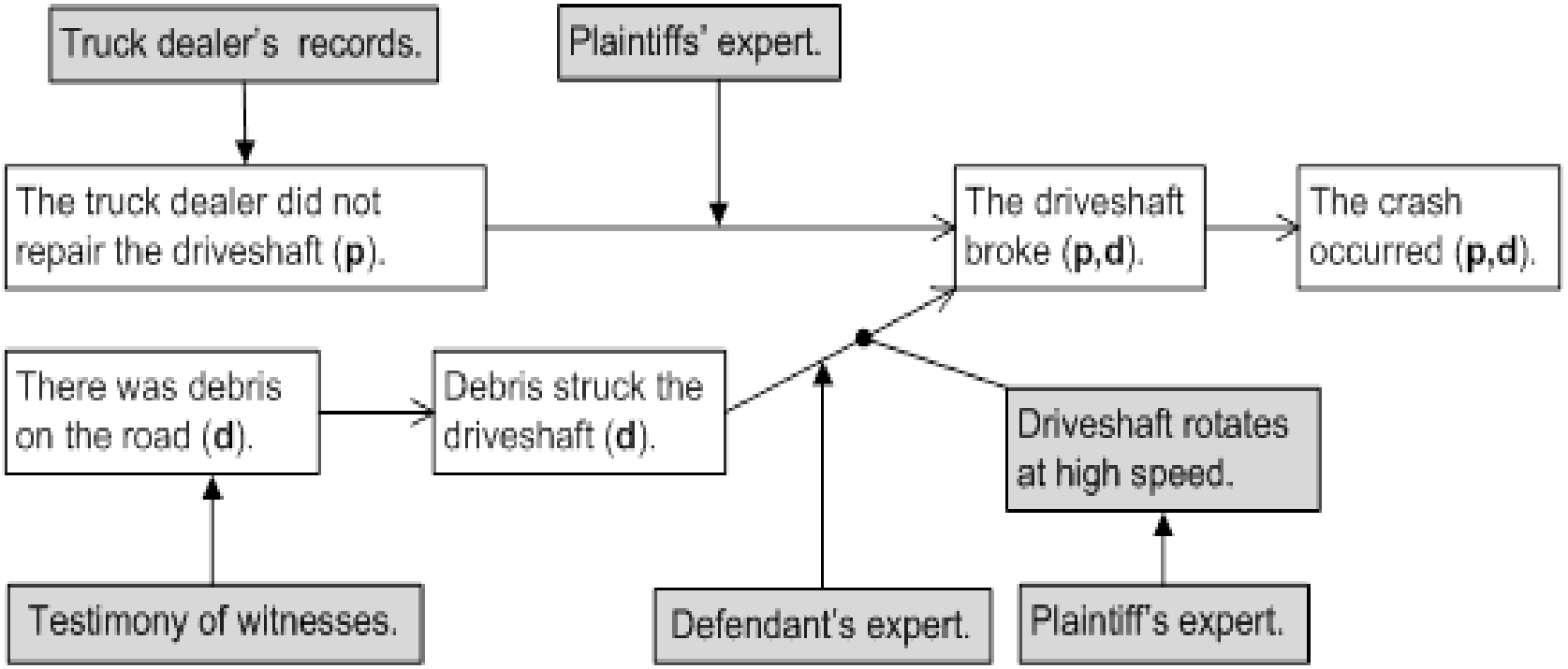
An Example

- In the case of Anderson v. Griffin (a civil case), the driveshaft broke on a tractor-trailer proceeding down an interstate highway disconnecting the brakes.
- At the same time, debris kicked up from the surface of the highway and struck a pickup truck behind the tractor-trailer.
- The pickup truck crashed into the tractor-trailer and the collision injured two people in a car behind the pickup truck.
- These two people, who were injured, sued the truck dealer who was supposed to be responsible for the maintenance of the trailer.

Pro Con Arguments

- The plaintiffs' explanation for the crash was one of negligence. Defendant (the truck dealer) had failed to tighten the middle joint on the driveshaft. This caused the driveshaft to break, setting in motion the accident.
- The explanation was supported by evidence from the truck dealer's record stating that the repairman did not repair that joint, and an expert witness who states that the crash was caused by the fact that defendant did not repair the driveshaft.
- Defendant gave an alternative explanation, claiming that the cable was broken by debris that struck the driveshaft. He supported his claim that there was debris on the road by testimony of witnesses. Defendant therefore added a new testimony by an expert supporting his own explanation, namely a claim that the cable was broken by debris that struck the driveshaft.
- The plaintiffs' expert countered that a piece of road junk would be highly unlikely to strike the driveshaft with enough force to break it, because of the speed at which the driveshaft rotates (27 times a second).

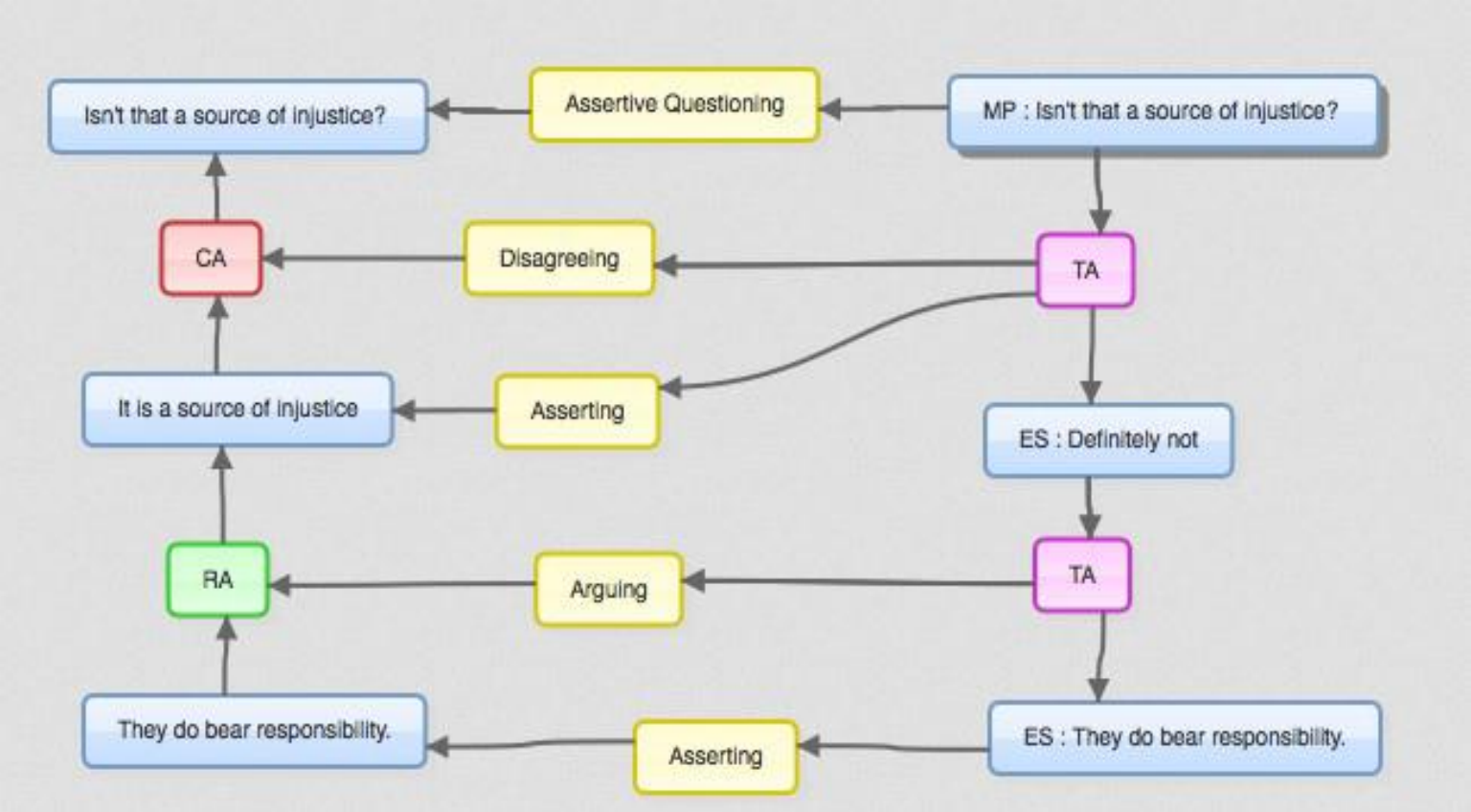
Open arrows denote causal links. Closed arrows denote evidential links. Round arrow denotes an attack of an argument



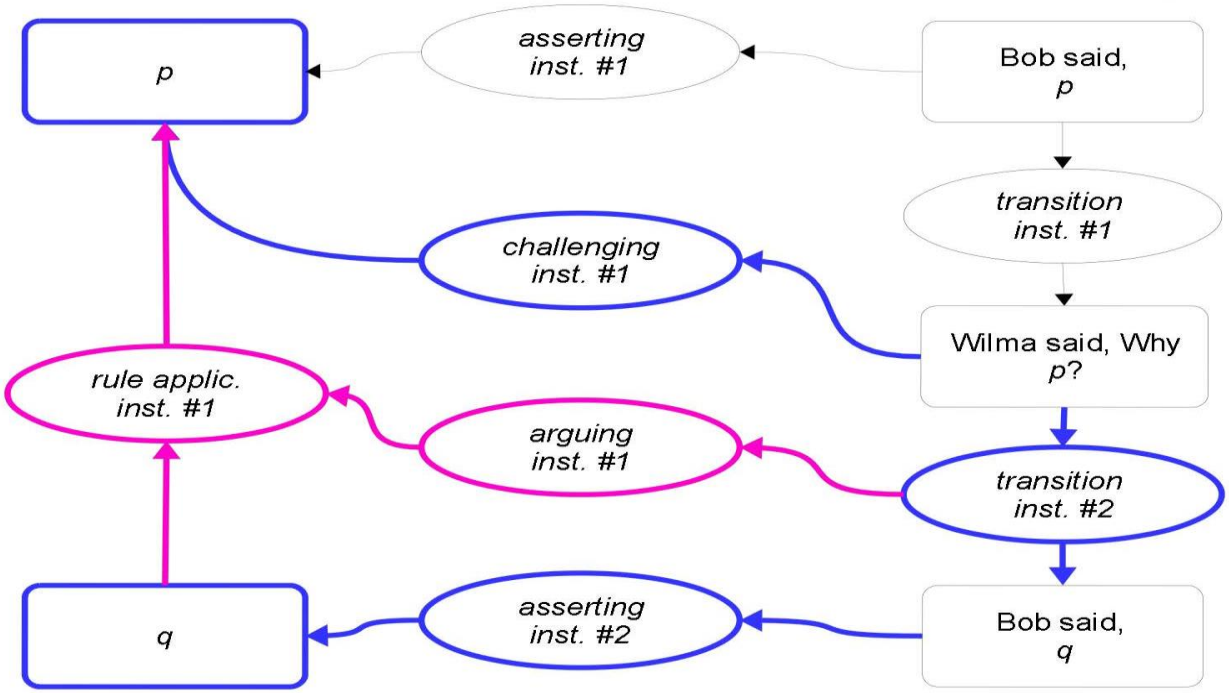
Finding

- Depending on how we would resolve the competing arguments about whether the debris could have caused the driveshaft to break, either the plaintiffs' explanation is slightly better (if we decide to believe the plaintiffs' expert) or the explanations are equally good (if we believe the defendant's expert).
- In the case the jury ruled for the defendant. For some reason, they must have found that the attacking argument based on plaintiffs' expert was not convincing enough and because the two explanations were then equally good, decided that the preponderance of the evidence standard had not been met by the plaintiffs.

OVA+ (http://ova.arg-tech.org/)



ArgTech Dundee-style Graph



References

- Aharoni, E., Alzate, C., Bar-Haim, A., Bilu, Y., Dankin, L., Eiron, I., Hershkovich, D., Hummerl, S., Khapra, M., Lavee, T., Levy, R., Matchen, P., Polnarov, A., Raykar, V., Rinott, R., Saha, A., Zwerdling, N., Konopnicki, D., Gutfreund, D. and Slonim, N. (2014). Claims on Demand - an Initial Demonstration of a System for Automatic Detection and Polarity Identification of Context Dependent Claims in Massive Corpora, *Proceedings of the 25th International Conference on Computational Linguistics (COLING 2014),* Dublin, Ireland, 6-9. Available as of 2014/12/17 at: http://anthology.aclweb.org/C/C14/C14-2002.pdf
- Gordon, T. F. (2010). The Carneades Argumentation Support System, *Dialectics, Dialogue and Argumentation*, C. Reed and C. W. Tindale (eds.). London: College Publications, 145-156.
- Levy, R., Bilu Y., Hershcovich, D., Aharoni, E. and Slonim, M. (2014). Context Dependent Claim Detection, *Proceedings of the 25th International Conference on Computational Linguistics (COLING 2014),* Dublin, Ireland, 1489-1500. Available as of 2014/12/17 at:
- http://www.aclweb.org/anthology/C/C14/C14-1141.pdf
- Prakken, H. and Sartor, G. (2009). A Logical Analysis of Burdens of Proof. *Legal Evidence and Burden of Proof*, ed. Hendrik Kaptein, Henry Prakken and Bart Verheij. Farnham: Ashgate, 223- 253.