Integrating argumentation, narrative and probability in legal evidence (position paper)

Bart Verheij
Artificial Intelligence, University of Groningen
b.verheij@ai.rug.nl

Abstract

Reasoning on the basis of legal evidence has been analysed using three types of approaches: argumentative, narrative and probabilistic. As each type of approach has been defended as a complete account of evidential reasoning, it is natural to assume that there is an integrating perspective. It is here proposed that a logico-probabilistic argumentation theory can integrate argumentative, narrative and probabilistic approaches to legal evidence.

Keywords: legal evidence, argumentation, narrative, probability

1. Approaches to legal evidence

There exist three types of approaches to reasoning with legal evidence: argumentation approaches, narrative approaches and probabilistic approaches (Kaptein et al., 2009; Dawid et al., 2011). Of each type of approach there exist accounts that suggest a complete picture; nothing else seems to be needed. Argumentation approaches focus on arguments for and against what has happened in a criminal case, using reasons grounded in the available evidence. In narrative approaches, plausible stories are constructed as hypotheses about what has happened, and checked and compared on the basis of the evidence. In probabilistic approaches, numeric calculations aim at determining the probability that hypothesized events have happened given the evidence, and at updating probabilities in the light of new evidence.

As these types of approaches are superficially very different, but still have been defended as complete, the question arises whether there exists an overarching integrating perspective. I hold that such a perspective exists, and that a formalization can clarify the relations between argumentation, narrative and probabilistic approaches to reasoning with evidence. In section 2, the three perspectives are discussed in a way that is congruent with the integrating perspective sketched in section 3.

2. Argumentation, narrative and probability

Argumentative approaches (Anderson et al, 2005; Wignore, 1931) are strong in their analysis of complex structures of reasons pro and con. There can be arguments about the justificatory power of a reason (using Toulmin's pro-warrants or Pollock's con-undercutters; cf. Verheij, 2005). Figure 1 shows an argument that the suspect is punishable for a crime because of committing it, grounded in a witness testimony. The argument is attacked because the absence of the witness on the crime scene suggests that he is lying. Formal versions (Prakken 2004; Verheij, 2000) have been proposed, and have proven their analytic value. However, whereas Dung's seminal work (2005) provided a mathematically mature foundation of argumentation, the field now struggles with a confusingly large number of different semantics.

Narrative approaches (Wagenaar et al., 1993) take a synthetic perspective by focusing on the construction of hypothetical stories about what has happened (Figure 2). These stories are then compared in terms of their plausibility and matching with the evidence. In the figure, the different levels of plausibility and of matching have been indicated by lines and arrows of different width. Checking which elements of a story are supported and which not (evidential gaps; Bex, 2011) and determining the consequences of a story in order to for instance test an alibi (story consequences; Bex, 2011) are helpful investigative tools. The emphasis on the existence of different stories helps prevent tunnel vision. However, narrative approaches are more productive in the critical questioning of dubious cases (as in the work of Wagenaar and colleagues) than for decision making: how are plausibility and evidential matching to be determined, and how must they be compared, for instance when (as in

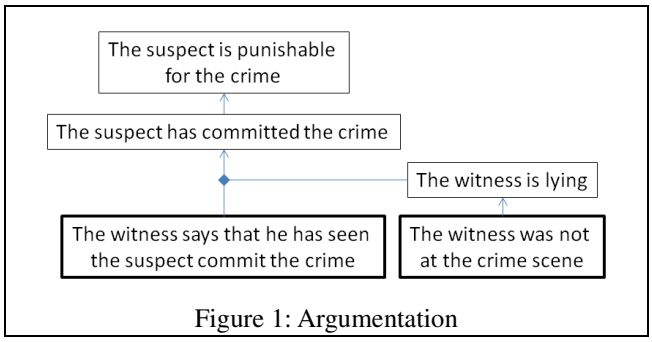

Figure 1: Argumentation

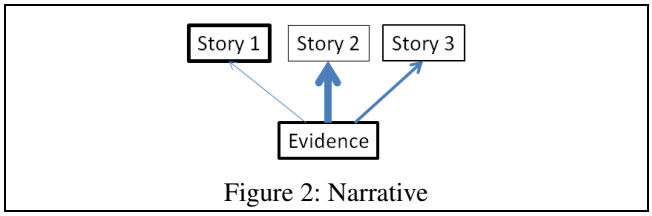

Figure 2: Narrative

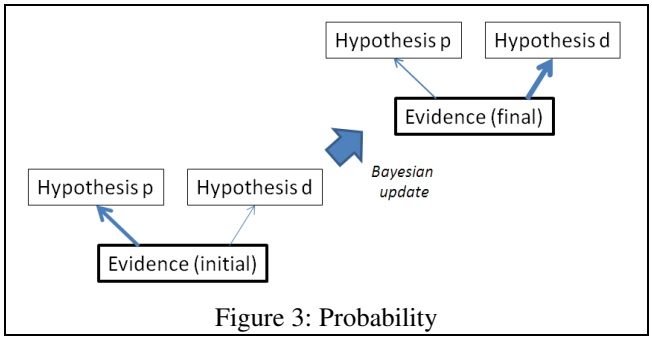

Figure 3: Probability

Figure 3) there is one story with high plausibility but a low match, and another with low plausibility and a high match? Also current formal grounding of narrative approaches is limited, but see Bex (2011) for a formalized hybrid argumentative-narrative approach.

In a probabilistic approach (Figure 3), numeric values are attached to the evidence and its support (expressed e.g. as a conditional probability) for the hypotheses proposed by the plaintiff (p) and defendant (d). Bayesian updating (using likelihood ratios) revises the evidentiary support values when new evidence is added. In the figure, the degree of evidentiary support is suggested by the width of the arrows; initially the evidence provides stronger support for the plaintiff's hypothesis, but finally the situation is reversed. An example of a probabilistic analysis is (Kadane & Schum, 1996). An advantage of probabilistic approaches is that they are well-founded in mathematical theory, but a limitation is that they assume more numbers than are available. It also happens that a probabilistic presentation of evidence leads to errors in court (Buchanan, 2007).

3. Integration by a logico-probabilistic argumentation theory

I claim that a new synthesis of logical and probabilistic techniques is needed, and that an argumentation perspective provides the key to such a synthesis. Therefore, I have initiated the development of a logico-probabilistic argumentation theory (LPAT), building on earlier work in mathematics and intelligent systems applied to legal decision-making. LPAT is a non-trivial synthesis of two seminal foundational theories, namely Kraus-Lehmann-Magidor preferential logic (1990) and Kolmogorov's classic probability axioms. In LPAT, qualitative, rule-based arguments have a quantitative interpretation. The numbers in such a quantitative interpretation can be objective (expressing frequencies) or subjective (expressing values and preferences). Argument strength is defined as a conditional probability. Stories about what can have happened become conclusions of arguments with the available evidence among their premises. So in LPAT there is no formal distinction between 'story conclusions' and other conclusions; stories only tend to consist of several elements. In LPAT, 'holistic' arguments from all premises to a final conclusion are formally connected to Wigmore-style 'analytic' arguments (1931), that consist of structured maps of premises, intermediate positions pro and con, and conclusions.

4. Conclusion

By the mixture of logical and probabilistic techniques, a logico-probabilistic argumentation theory has Bayesian Networks (Taroni et al., 2006; Hepler et al., 2007) as a central competitor. However, whereas Bayesian Networks are successful in data-modeling, additional tools (such as utilities) are required to model decision-making. LPAT addresses this issue by using logical techniques for decision-making and probabilistic techniques for data-modeling. In this way, LPAT may help alleviate the miscommunication between legal decision-makers and forensic data analysts that has leads to infamous judicial errors (Buchanan, 2007; Derksen & Meijsing, 2009).

After a period in which the causal metaphor associated with Bayesian Networks has had priority, it is time for a return to reasons, as formalized by a logico-probabilistic argumentation theory.

Acknowledgements

This position paper could not have been written without the cooperation and discussions with Floris Bex, Henry Prakken and Silja Renooij (cf. the NWO Forensic Science project; http://www.ai.rug.nl/~verheij/nwofs/).

References

Anderson, T.J., Schum, D.A. & Twining, W.L. (2005). *Analysis of Evidence*, second edition. Cambridge: Cambridge University Press.

Bex, F.J. (2011). *Arguments, Stories and Criminal Evidence: A Formal Hybrid Theory*. Dordrecht: Springer.

Buchanan, M. (2007). Conviction by Numbers. *Nature* 445: 254-255.

Dawid, P., Twining, W. & Vasaliki, M. (eds.) (2011). *Evidence, Inference and Enquiry*. Oxford: Oxford University Press/British Academy.

Derksen, T. & Meijsing, M. (2009). The Fabrication of Facts: The Lure of the Incredible Coincidence. In H. Kaptein, H. Prakken & B. Verheij (eds.): *Legal Evidence and Proof: Statistics, Stories, Logic*, 39-70. Farnham: Ashgate.

Dung, P.M. (1995). On the Acceptability of Arguments and its Fundamental Role in Nonmonotonic Reasoning, Logic Programming, and n-Person Games. *Artificial Intelligence* 77: 321-357.

Hepler, A.B., Dawid, A.P. & Leucari, V. (2007). Object-Oriented Graphical Representations of Complex Patterns of Evidence. *Law, Probability & Risk* 6 (1-4): 275-293.

Kadane, J.B. & Schum, D.A. (1996). *A Probabilistic Analysis of the Sacco and Vanzetti Evidence*. New York, NY: Wiley.

Kaptein, H., Prakken, H. & Verheij, B. (eds.) (2009). *Legal Evidence and Proof: Statistics, Stories, Logic (Applied Legal Philosophy Series)*. Farnham: Ashgate.

Kraus, S., Lehmann, D. & Magidor, M. (1990). Nonmonotonic Reasoning, Preferential Models and Cumulative Logics. *Artificial Intelligence* 44: 167-207.

Prakken, H. (2004). Analysing Reasoning About Evidence with Formal Models of Argumentation. *Law, Probability & Risk* 3:33-50.

Taroni, F., Aitken, C., Garbolino, P. & Biedermann, A. (2006). *Bayesian Networks and Probabilistic Inference in Forensic Science*. Chichester: Wiley.

Verheij, B. (2000), Dialectical Argumentation as a Heuristic for Courtroom Decision-Making. In: *Rationality, Information and Progress in Law and Psychology*. Liber Amoricum Hans F. Crombag, 203-226. Maastricht: Metajuridica Publications.

Verheij, B. (2005). *Virtual Arguments. On the Design of Argument Assistants for Lawyers and Other Arguers.* The Hague: T.M.C. Asser Press.

Wagenaar, W.A., Van Koppen, P.J. & Crombag, H.F.M. (1993). *Anchored Narratives: The Psychology of Criminal Evidence*. New York, NY: St. Martin's Press.

Wigmore, J.H. (1931). *The Principles of Judicial Proof or the Process of Proof as Given by Logic, Psychology, and General Experience, and Illustrated in Judicial Trials*, 2nd edition. Boston, MA: Little Brown.