

# **Evidence for a Good Story**

**A Hybrid Theory of Arguments, Stories and Criminal Evidence**

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# Summary

The subject of this thesis is reasoning with evidence to establish the facts in criminal cases. In a legal context, the study of evidence is often equated with the study of the *law of evidence*, for example, the legal rules of evidence that govern which types of evidence are legally valid or admissible. However, a large part of the study of evidence constitutes the study of the *rational process of proof*, which concerns the facts of the case rather than the legal specifics. The reasoning in the process of proof, which is discussed in chapter 2, involves constructing, testing and justifying complex hypotheses about what happened in a case using *evidence* (e.g. witness statements, tangible evidence such as a knife or blood) and *general commonsense knowledge* (e.g. generalizations such as ‘witnesses under oath usually speak the truth’ and general scenarios or story schemes that express usual human behaviour).

The distinction between the study of evidence law and the study of the process of proof was already made in the beginning of the 20<sup>th</sup> century by Wigmore (1931). After Wigmore, the interest in a rational theory of proof decreased and research focused more on the model of adjudication than on factual inference. However, in the past thirty years, a movement that has become known as the “New Evidence Scholarship” has become an important force in research on evidence. A central theme is the logical structuring and analysis of reasoning with evidence, which helps us *make sense of evidence*. In a large case it is important that the reasoning, evidence, hypotheses and background knowledge are made explicit. In this way, sources of doubt in the reasoning can be identified and reasoned about. Furthermore, explicitly identifying and structuring all hypotheses lessens the danger of so-called *tunnel vision*, where the most likely scenario is taken as the leading hypothesis and alternatives are insufficiently considered.

A relatively new development concerning sense-making and (criminal) evidence is the emergence of computer-based support tools for investigators and decision makers. Such a support tool is a computer program that allows for the electronic management of evidence and scenarios in a case. The interest in such *sense-making systems* has recently also grown in AI and Law.<sup>1</sup> Sense-making systems do not contain a knowledge base and do not reason automatically, but instead help the user make sense out of a certain problem by allowing the user to logically structure and visualize his knowledge and reasoning in a case according to some specific underlying logical theory of reasoning. This underlying theory serves multiple aims. One aim is to enforce a standard of rationality by requiring that the user’s reasoning stays within the logical system. Another use of an underlying theory is that the sense-making tool can perform some computations; for example, showing the user which arguments can be accepted and which should be rejected according to the current assumptions.

To summarize, a logical theory of reasoning in the process of proof can aid in collecting, organizing and assessing the evidence and the corresponding hypotheses. Furthermore, such a theory can provide a solid basis for a sense-making system.<sup>2</sup> The theory should be natural, so that users with little or no formal training can use it, rationally well-founded, so that it is in agreement with the prevailing theories of rational reasoning with evidence, and formally specific, to facilitate the design of sense-making software. Furthermore, the theory should ideally encourage a correct and general standard of rational reasoning. Given the current conception of procedural rationality, which says that a belief is rational if it is in agreement with the knowledge that has been considered in a proper procedure, this can be done by defining a proper procedure or heuristic for performing an inquiry concerning evidence in a criminal case. Consequently, the main research questions of the thesis are as follows:

- What form does a logical theory of reasoning in the process of proof have, provided that the theory should be both natural and rationally well-founded?
- What form does a formal procedure and protocol that sets a standard of rationality for reasoning in the process of proof have?

Chapter 3 discusses two main trends in theories for reasoning with criminal evidence: argument-based reasoning and story-based reasoning. Argument-based reasoning, which is advocated by the New Evidence Theorists such as Anderson, Schum and Twining, involves constructing arguments from evidence to a conclu-

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<sup>1</sup> In the multidisciplinary field of AI and Law, insights from general Artificial Intelligence (AI) are applied to topics which are typically studied in law and legal theory.

<sup>2</sup> In *Making Sense of Evidence*, the coordinating research project of this work, a sense-making and visualization tool for Dutch police analysts called AVERS has been developed by van den Braak and colleagues.

sion by performing consecutive reasoning steps using generalizations of the form ‘*e* is evidence for *c*’. For example, we can say that ‘a witness statement that John was in London *is evidence for* the fact that John was in London’. In the argument-based approach, not only arguments for a certain conclusion but also counter-arguments are considered; for example, the inference about Sacco can be attacked by stating that the witness is lying. Argumentative reasoning has been called *atomistic* because the various elements of a criminal case (i.e. pieces of evidence and conclusions) are considered separately and the case is not considered ‘as a whole’. The story-based approach, which has been developed by cognitive psychologists Pennington and Hastie and the legal psychologists Crombag, van Koppen and Wagenaar, involves constructing hypothetical stories based on the evidence about what (might have) happened in a case. In this approach, one performs causal reasoning because the relations between the various events in a story can be expressed as ‘*c* is a cause for *e*’. Alternative stories about what happened before, during and after the crime should be compared according to their internal coherence and the amount of evidential data they cover. The story-based approach has also been called *holistic* (as opposed to atomistic), because the elements in the case (i.e. hypotheses, evidence) are considered as a whole and the individual elements receive less attention.

Both the argument-based and the story-based approach have their own advantages. The argument-based approach, which builds on a significant academic tradition of research on informal and formal argumentation, is well suited for a thorough analysis of the individual pieces of evidence, whilst the empirically tested story-based approach is appreciated for its natural account of crime scenarios and causal reasoning. Both approaches also have their own disadvantages. The atomistic nature of arguments makes them unsuitable for giving an overview of the various hypotheses about what happened in the case and not all aspects of causal reasoning can be found in the argument-based approach. In the story-based approach, the individual evidence does not have a clear place and its credibility and relevance cannot be checked easily.

In sum, a causal, holistic and more story-based approach works best in some cases and in other instances an evidential, atomistic and argumentative approach is the most natural. This depends on the reasoning modelled but also on the purpose of the person analysing a case and the materials available to him. Hence it is concluded that the best way of reasoning in the process of proof is to combine stories and arguments into a *hybrid theory*, which is presented in chapter 4. The basic idea of the hybrid theory is that hypothetical crime stories can be used to causally explain the explananda (facts to be explained) and that these stories can be supported and contradicted by arguments based on evidence or general knowledge. Stories can be used for the quick and creative construction of intelligible hypotheses about what happened in a case and arguments can be used to support these stories with evidence and to reason about the coherence of the stories in greater detail. Thus it is not only possible to reason *with* stories but also *about* stories using arguments. For example, generalizations expressing causal links in a story can be questioned using arguments based on evidence (e.g. ‘This forensic report is evidence for the fact that this bullet did not cause the victim’s death’).

In the hybrid theory, several criteria for the quality of stories are defined. Two such criteria are the extent to which a story is supported or contradicted by arguments based on evidence. Another criterion concerns the number of *evidential gaps* in a story, that is, are there elements in the story for which there is no direct evidence? Finally, there are various criteria that concern the coherence of a story. With coherence I mean the extent to which a story conforms to our expectations about how things happen in the world. For example, a story is insufficiently coherent if obvious parts are missing (e.g. in a theft case it is not specified what was stolen) or if certain events are implausible (e.g. a grown man fleeing from a 2-year-old child). The various criteria for the quality of stories can be phrased as *critical questions* (e.g. ‘How much and which of the available evidence supports the current hypothesis?’, see evidential gaps above).

In chapter 5, a procedure for reasoning in the process of proof is defined. First the hybrid theory is formalized as a combination of formal defeasible argumentation and abductive model-based reasoning. A formal dialogue game is then defined which gives rules for a dialogue in the context of criminal legal evidence. This game takes an adversarial approach in assuming several players who each want to propose, support and defend their own story whilst simultaneously attacking and criticizing the other players’ stories. The game is constrained by a protocol that ensures that all moves are relevant to the discussion. Thus the dialogue game is essentially a model that provides rules for a critical discussion between investigators or judges.

Chapter 6 presents an analysis of an actual case (the Anjumer murder case) using the hybrid theory. This procedural analysis shows how various alternative stories about what happened in a complex case can be constructed, criticized and compared using arguments. It discusses how the various criteria that determine the quality of a story can be used to guide such an analysis and to uncover sources of doubt in the stories.

The hybrid theory’s contribution lies in particular in its full integration of arguments and stories into one theory for reasoning with criminal evidence. I have shown that the combination of evidential arguments and causal stories in inference to the best explanation is a natural but also a rationally well-founded way of reasoning. By retaining the advantages and flexibility of the separate approaches whilst at the same time solving

their problems by integrating them, the hybrid theory properly acknowledges the interaction between arguments and stories.

The current work has also improved on the existing separate accounts of reasoning with stories or arguments. The argument-based work in evidence theory is improved upon because the formal analysis has provided a systematic account of (conditional and non-conditional) generalizations in reasoning with evidence. This formalization of arguments provides a solid logical underpinning for the argument-based component of the hybrid theory and hence for the sense-making system based on this theory. Reasoning with stories has also been elaborated upon in this thesis. Clarity has been provided regarding the rational (as opposed to the psychological) role of stories in reasoning with evidence, namely that they serve as the explanations for the explananda in the process of inference to the best explanation. Furthermore, the ways in which a story's quality can and should be determined and tested have also been expanded, as the criteria that play a role in determining the quality of a story are also extensively discussed and defined. A standard of rationality for the process of proof has been set by defining rules for a critical and relevant discussion about evidence, stories and arguments. Asking the critical questions pertaining to the quality of a story in a properly defined dialogue about proof ensures that the process of proof is a rational process in which we can expect that pitfalls such as confirmation bias or unclear justifications of hypotheses are avoided.

In addition to providing answers for evidence theorists and legal psychologists, this thesis has also made contributions to the multidisciplinary field of AI and Law. The formal hybrid theory is as far as I am aware the first to combine argumentation and reasoning with stories (i.e. causal models) by allowing for the use of arguments to construct and discuss a causal model. In this way, it improves on traditional model-based modelling techniques by allowing for an explicit discussion of the plausibility of the causal model. Furthermore, the dialogue game is one of the first formal dialogue games that model an inquiry dialogue.

The hybrid theory is one of the few logical theories which has conceptual, cognitive as well as computational aims. The results of the tests performed with the system AVERS and the contact with various teams of the Dutch police force and police academy have strengthened the claim that the hybrid theory is close to how actual reasoning in an investigation context is performed. Furthermore, the case study in chapter 6 supports these findings and is at the same time one of the few thorough and large case studies of both a defeasible logic for argumentation and causal model-based techniques.