Story Schemes for Argumentation about the Facts of a Crime

Floris J. Bex[1] and Bart Verheij[2]

[1]Argumentation Research Group, School of Computing, University of Dundee
Dundee DD1 4HN, United Kingdom
florisbex@computing.dundee.ac.uk

[2]Department of Artificial Intelligence, University of Groningen
P.O. Box 407, 9700 AK Groningen, The Netherlands
b.verheij@ai.rug.nl

Abstract

In the literature on reasoning on the basis of evidence, two traditions exist: one argument-based, and one based on narratives. Recently, we have proposed a hybrid perspective in which argumentation and narratives are combined. This formalized hybrid theory has been tested in a sense-making software prototype for criminal investigators and decision makers. In the present paper, we elaborate on the role of commonsense knowledge. We argue that two kinds of knowledge are essential: argumentation schemes and story schemes. We discuss some of the research issues that need to be addressed.

Introduction: complex reasoning with facts and evidence

Reasoning with evidence in a criminal case is a difficult and laborious process. In a large case, investigators, judges and jurors are faced with a mass of unstructured evidence of which they have to make sense. They are expected, often without any prior formal training, to map out complex scenarios about what might have happened in the case and to assess the potential relevance of a vast amount of evidence to each of these hypothetical scenarios. Humans can only process a limited amount of information at once and various cognitive and social biases such as tunnel vision, groupthink and confirmation bias may lead to unwanted situations and mistakes. Such mistakes, which seem almost unavoidable given the difficult nature of the task, can have a large impact on those involved in the case, as evidenced by some (well-publicized) miscarriages of justice in the previous century, such as the US Sacco and Vanzetti case or the British Sally Clark case.

In the theoretical literature on reasoning about the facts of criminal cases, two perspectives are prevalent. The first goes back to Wigmore's work (Wigmore 1931) and has been the basis for much work in the field of legal theory (Anderson et al. 2005). In this argument-based tradition, evidence is treated as giving reasons for and against the facts of the case. In argumentative reasoning, one performs consecutive reasoning steps from the evidence to the facts in issue, using commonsense knowledge to warrant the inference steps. By evaluating the justificatory force of reasons (which depends on the warranting generalizations) and by resolving conflicts between reasons (e.g. by weighing), it is determined which account of the facts can be believed and why.

The second tradition is based on narratives (or stories). Different stories – coherent sequences of events – about what might have happened (e.g. as presented in court or as hypothesized in the investigation) are evaluated and compared. The belief in a story is then determined by looking at how well it fits both the available evidence and our commonsense knowledge. This story-based perspective originates from legal psychologists such as Pennington and Hastie (1993), which has been followed up in the anchored narratives approach by Wagenaar and colleagues (1993), who have used their approach to analyse possible miscarriages of justice.

Recently, Bex and colleagues (Bex 2009c; Bex et al. 2007) have argued for a *hybrid approach*, in which arguments and narratives can be used in conjunction as well as interchangeably. This hybrid approach was shown to be a natural way of modelling the process of proof, the iterative process of constructing, testing and justifying hypotheses in crime investigation and decision- making. The hybrid theory was used as the basis of a sense-making tool, AVERS (van den Braak 2010), which allows the mapping and visualization of one's knowledge about a case using both stories and arguments (cf. Reed et al. 2007, who talk about similar tools in which arguments can be mapped).

When reasoning in the hybrid approach, two forms of commonsense knowledge are used. The first is what we refer to as (inferential) *generalizations*, statements of the form '*a* therefore (presumably) *b*', which in argumentative reasoning allow us to infer conclusions from premises (e.g. Nicole stated Julius shot Peter *therefore* Julius shot Peter). The second form of commonsense knowledge concerns knowledge of general scenarios, clusters of events and their mutual (temporal or causal) relations. Such general scenarios are basis of the particular explanatory stories that explain observations in the case. For example, the observation that 'Peter is dead' can be explained by assuming a particular instance of either a 'murder scenario', 'suicide scenario' or 'accident scenario'.

In this paper, we show that generalizations can be seen as *argumentation schemes* (Walton 1996, Walton et al. 2008), general patterns of argument that act background for particular instantiated arguments, and scenarios can be seen as *story schemes* (Bex 2009a), standard general event-patterns that act as a background for particular instantiated stories. Argumentation schemes, which originate from informal argumentation theory, have been adopted in different types of research in AI and Law (Bex et al. 2003) (including reasoning with evidence) and computational argumentation (Atkinson et al. 2006, Bex et al. 2003, Prakken 2010, Verheij 2003). Story schemes have also been used in AI, for example, as they the basis of natural language understanding systems (Schank and Abelson 1977). Furthermore, the hybrid theory has made a start in showing how stories and story schemes might be used not only to (formally) describe but also to improve complex reasoning processes, such as reasoning with evidence.

Important work remains to be done in order to fully integrate stories and story schemes in computational argumentation. Building on knowledge gained in the formalization of informal argumentation schemes, we want to determine how story schemes can be schematized, classified and formalized so that they can be stored for future reference and further (automatic) reasoning. Thus, story schemes can be further integrated in support tools that can be used to map and analyse complex reasoning.

In sum, this paper is a combination of old and new; it reports on work done by the authors and their collaborators in the last five years and at the same time it tries to look at possible interesting avenues for future research. The rest of this paper is organized as follows. First, we first provide a brief overview of the hybrid approach. Then we elaborate on the idea of schemes for commonsense knowledge, looking at the similarities and differences between argumentation and story schemes. We then elaborate on the formalization of story schemes, emphasizing a number of research issues important for reasoning with legal evidence and complex argumentation in general.

Different approaches to evidential reasoning

The Argumentative Approach

The study of proof was put on centre-stage in the first half of the twentieth century by John Henry Wigmore (1931), who argued for the formulation of principles for reasoning with evidence and proof independent of the rules of law. He set out to develop a charting method that involves reasoning from evidence to the so-called *probanda*, facts to be proven. Wigmore's ideas on proof gained influence much later, when they were elaborated upon by the New Evidence Theorists (Anderson et al. 2005).

Wigmore argued for a basic logic underlying his charts and his views can be seen as a preliminary take on defeasible reasoning with arguments, as was shown by Bex and colleagues (2003), who have modelled Wigmorean argument charts in an argumentation logic. In such logics (see Prakken and Vreeswijk 2002 for an overview), rules of classical logic are augmented with rules for defeasible inference. Arguments are constructed by chaining applications of inferences and thus one ends up with an argument tree akin to a Wigmore chart. Each argument tree has as its premises (leaves) the pieces of evidence and as its ultimate conclusion (root) one of the probanda.

In figure 1, an example of an argument tree is given. The arrows between the premises and (intermediate) conclusions denote (defeasible) inferences. Associated with a defeasible inference is an underlying generalization that acts as a *warrant* (Toulmin 1958). For example, the inference from evidence **NT** to conclusion **1** is justified by the generalization 'witnesses (presumably) speak the truth', which can be rephrased as 'witness *w* testifies that *p*, therefore (presumably) *p*'.
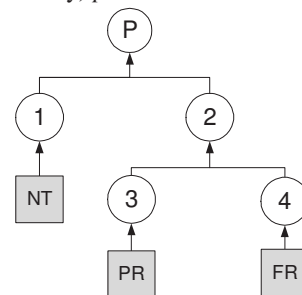
P: Julius shot and killed Peter
1: Julius shot Peter
   NT: Nicole's testimony to 1
2: Peter was killed by Julius shooting him
3: Julius had a gun
   PR: Police report
4: The chemical trace left behind by the bullet that killed Peter is similar to the one left behind a bullet of the type found in Julius' gun
   FR: Forensics expert report

Figure 1: an argument based on evidence

Arguments can also be *attacked*. They can be *rebutted* with an argument for the opposite conclusion and they can

be *undercut* with an argument for why an inference is not allowed (usually because a generalization does not apply in the given circumstances). In the example, an argument for 'Julius did not shoot (and kill) Peter' rebuts the conclusion **P** and an argument for 'Nicole is a liar' undercuts the inference from NT to 1, because it provides an exception to the generalization that 'witnesses speak the truth'. These attacking arguments can also be attacked and thus the status of arguments (e.g. "justified", "overruled") can be determined dialectically.

The Narrative Approach

In the 1980's and 90's, the psychologists Pennington and Hastie (1993) performed a number of tests to determine exactly how (prospective) jurors in the US reasoned with a large amount of evidence in a criminal case. They found that people tend to organize the evidence by building stories about what might have happened. Such stories are essentially networks of events which are causally linked. The idea is that hypothesised stories explain the observations (i.e. the evidence) in the case through abductive inference to the best explanation (IBE). The basic idea of abductive inference is that if we have a general rule *cause* → *effect* and we observe *effect*, we are allowed to infer *cause* as a possible explanation of the effect. This cause which is used to explain the effect can be a single state or event, but it can also be a sequence of events, a story.

Taken by itself the abductive scheme is nothing but the fallacy of affirming the consequent. However, in a setting where alternative abductive explanations are generated and compared, it can still be rational to accept an explanation if no better other explanation is available. Clearly, such reasoning is defeasible, since additional facts might give rise to new explanations. In sum, the idea of abductive inference to the best explanation is that there are different explanations which have to be compared. As an example, consider figure 2, which renders two alternative stories about why Peter died.
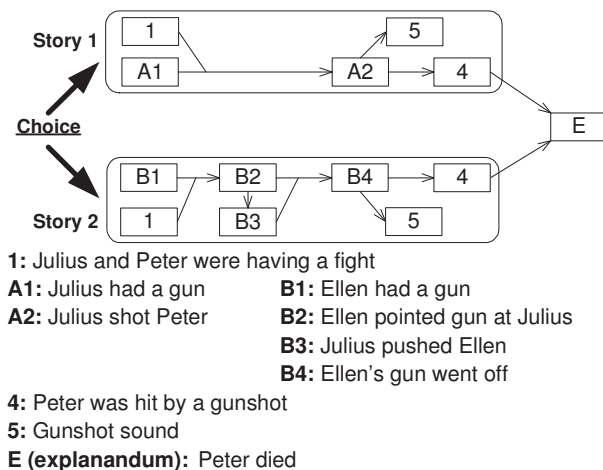

Story 1
Choice
Story 2

1: Julius and Peter were having a fight
A1: Julius had a gun   **B1:** Ellen had a gun
A2: Julius shot Peter   **B2:** Ellen pointed gun at Julius
                              B3: Julius pushed Ellen
                              B4: Ellen's gun went off
4: Peter was hit by a gunshot
5: Gunshot sound
E (explanandum): Peter died

Figure 2: two stories in the narrative approach

In the example case, the observation that Peter died is the explanandum (fact to be explained). In story 1, it is hypothesized that this was caused by Julius shooting Peter, which was itself caused by a fight between Julius and Peter. Story 2 tells an alternative tale: Ellen, Peter's wife, was also present during the fight. She produced a gun, seemingly to protect her husband. Julius felt threatened by this so he pushed Ellen, which made the gun go off, accidentally hitting Peter. Notice that, in addition to the explanandum, the two stories also explain the observation that there was a gunshot.

Naturally, the choice between alternative explanations depends on how much of the observed evidence is explained: the more observations are explained, the better the story conforms to the evidence. Furthermore, the coherence of the hypothetical stories also plays a big role in choosing between them. This coherence depends on whether the story conforms to our general commonsense knowledge and on whether the story conforms to certain case-specific assumptions. For example, the coherence of story 1 partly depends on whether we deem the causal link between (**1**, **A1**) and **A2** to be plausible. In other words, do we find it plausible that someone gets out a gun and shoots someone when he is in a fight? Similarly, with regards to story 2, is it credible that someone like Ellen has a gun? And how likely is a gun to accidentally fire?

Both the argumentative and the narrative approach have their own advantages. The argumentative 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 and the direct inferences that can be drawn from them. The empirically tested narrative approach, on the other hand, is mainly appreciated for its natural account of crime scenarios and causal reasoning (Heuer 1999). Both approaches also have their own disadvantages. The more atomistic nature of arguments makes them unsuitable for giving an overview of the various hypothetical scenarios about what happened in the case and not all aspects of causal reasoning can be found in the argumentative approach. In the narrative approach, the individual evidence does not have a clear place and its credibility and relevance with regards to the facts at issue cannot be checked easily. Furthermore, it is not always clear how one should reason about the coherence of a story and how stories should be compared.

The Hybrid Approach: combing stories and arguments

In his dissertation, Bex (2009) shows that when dealing with the complex reasoning involved in large criminal cases, arguments and stories need to be combined into one *hybrid theory*, where stories are used to causally explain the explananda and arguments based on evidence are used to support and attack these stories and each other. In the hybrid theory, stories such as those in figure 2 are *anchored* in evidence using arguments such as the one in figure 1. Figure 3 shows this anchoring. The main story,

which is a general, slightly summary version of story 1 (figure 2), is anchored in a "ground" of solid evidence through sub-stories, which go into the events in the main story in greater detail.
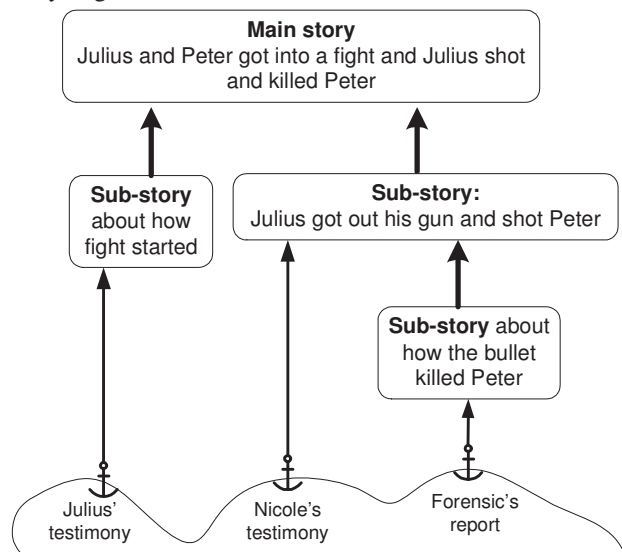

Figure 3: Anchoring stories in evidence in the Hybrid Approach

The hybrid approach solves one of the most important issues with the narrative approach as, for example, described by Wagenaar and colleagues (1993), namely that often the connection between the evidence and the stories is not made clear. In the hybrid approach, stories can be firmly anchored or, in other terms, *evidentially supported*. In the example, the evidence **NT1** from figure 1 supports the event **A2** in story 1. Arguments can be attacked, which may break the "anchor's chain", causing the story to be no longer connected to the ground. If, for example, it turns out Nicole is a liar, then the justificatory force of **NT1** will diminish.

Aside from anchoring stories in evidence, the hybrid approach also makes it possible to reason about the coherence of a story in a dialectical way. For example, we could argue that 'normally, people do not get out guns when they are in a fight', effectively attacking the causal relation between (**1**, **A1**) and **A2** in story 1. This argument can itself be attacked by saying, for example, that 'Julius is an aggressive person who does not react to stress in the same way other people do'.

In the hybrid theory, there are essentially two types of criteria for determining the quality of a story: the extent to which it conforms to the evidence and its coherence. Anchoring is a criterion of the first type and the plausibility of causal relations is a criterion of the second type. Bex (2009) gives these and other criteria as a list *critical questions*, typical sources of doubt when reasoning with the hybrid theory. The questions that concern the extent to which the story conforms to the evidence are as follows:

- *Evidential support* or *anchoring*: How much and which of the available evidence supports the story?
- *Evidential contradiction*: How much and which of the available evidence contradicts the story?
- *Evidential gaps*: How many and which events in the explanation are unsupported by evidential data?

The other three questions concern a story's coherence, the extent to which a story conforms to commonsense knowledge:

- *Plausibility*: How plausible are the events and causal relations in the story?
- *Completeness*: Does the story adhere to plausible story scheme?
- *Consistency*: Are there elements of the story that contradict each other?

Some of these criteria for the quality of stories, particularly the ones pertaining to coherence, will be further discussed below.

One of the lessons learned from the work on the hybrid theory is that stories and arguments are essentially "communicating vessels": when dealing with the complex reasoning involved in large criminal cases, a narrative approach works best for some points of a case, while in other instances an argumentative approach is the most natural. The hybrid approach allows for the flexibility of the separate argumentative and narrative approaches whilst at the same it uses arguments and stories as complementary tools for complex reasoning. An interesting topic for future research is whether stories and arguments can be further integrated. In the hybrid approach, arguments are used to talk about the individual elements of stories (i.e. events, causal relations). How would one use arguments to reason about stories as-a-whole? And can stories only be used in inference to the best explanation, or are there other ways of reasoning for which stories are suitable? These are questions that will have to be further explored; in the rest of this paper, however, we will concentrate on the role of schemes that express commonsense knowledge.

Commonsense knowledge in evidential reasoning: argumentation schemes and story schemes

Evidence is (quite obviously) the most important source of knowledge in evidential reasoning; the knowledge gained from sources of evidence provides the "ground" on which all other reasoning about a case can be built (figure 3). However, evidential reasoning also involves a large amount of *commonsense knowledge* about the world around us. This knowledge is not based on direct evidence, but rather it is stored in what is metaphorically called a *stock of knowledge*, a repository of general commonsense knowledge about the world that is "stocked" in the reasoner's mind (Cohen 1977).

Commonsense knowledge allows us to assume or infer new information in a way that is as reliable as is needed in the context. This type of knowledge, whilst often accepted in a wide community, has varying degrees of reliability and for every general scenario or generalization, there is at least one example of a situation in which it does not hold. The reliability of the commonsense knowledge we use also depends on context. For instance, in the beginning of the investigative phase, it may be useful to accept some slightly implausible scenarios and generalizations in order not to constrain the investigation too much by setting high standards. Later on, in the actual decision-making process, more reliable commonsense knowledge corresponding to a stricter burden of proof ('beyond a reasonable doubt' as opposed to 'possibly') will be used. As such, commonsense knowledge can have exceptions, its use involves the risk of getting it wrong and depends on context.

In the hybrid approach, commonsense knowledge is used in two pivotal ways. First, good and effective reasoning with evidence requires knowledge of pragmatic (not necessarily formal) rules of inference, generalizations which warrant inferences from premises to conclusions. Second, knowledge of relevant scenarios or clusters of events is needed. Generalizations and scenarios can be seen as argumentation schemes and story schemes respectively, schemes that encode general patterns of reasoning. For example, a witness testimony argumentation scheme ('witness *w* testifies that *p*, therefore (presumably) *p*') is a general scheme for particular arguments based on witness statements ('witness Nicole testifies that Julius shot Peter, therefore presumably Julius shot Peter'). Similarly, a "murder" story scheme (motive – murderous action – deadly consequence) is a general scheme for particular murder stories (fight between Julius and Peter – Julius shot Peter – Peter was hit).

In this section, the two types of schemes will be discussed. First, argumentation schemes will be discussed and it will be shown how researchers in AI have used and formally modelled them and then story schemes will be introduced.

Argumentation schemes

The first kind of commonsense knowledge that is needed in our hybrid approach to reasoning with evidence concerns the inferential generalizations underlying reasoning steps. In recent research on informal and computational argumentation theory, these are referred to as *argumentation schemes* (Walton 1996) Argumentation schemes can be thought of as a semi-formal generalization of the rules of inference found in formal logic. Schemes can be abstract or specific. For example, the standard Modus Ponens inference rule can be seen as an abstract argumentation scheme. An example of a specific argumentation scheme is that for Argument from Witness Testimony (Bex et al. 2003):

Witness W is in a position to know whether A is true or not.
Witness W asserts that A is true (false).

Therefore, *A may plausibly be taken to be true (false).*

For example, from the evidence that Nicole, who was there when Peter got shot, asserts it was Julius who shot him it can be inferred that Julius shot Peter.

Prakken (2010, see also Verheij 2003 and Bex 2009c on abstract and contextual inference rules) has argued that in logics for argumentation, a scheme can essentially be modelled in two ways, namely as a conditional premise and as a metalinguistic rule of inference; in the first case, an additional (defeasible) modus ponens inference rule is needed to infer the conclusion from the minor and major (conditional) premise. Verheij (2009) distinguishes three statements which are important here, viz.

- Witnesses can usually be believed
- If witness *w* asserts that *a* is true/false then *a* is true/false
- If witness Nicole asserts that Julius shot Peter then Julius shot Peter.

The first is the ordinary language expression of a scheme, a generalization. The second is a conditional scheme, a rewrite of the first statement which is necessary if we want to use a scheme of the first type in an argumentation logic. The third is an instantiation of the second rule. Now, the relation between the natural-language expression and the formal rule can be rendered as in figure 4.
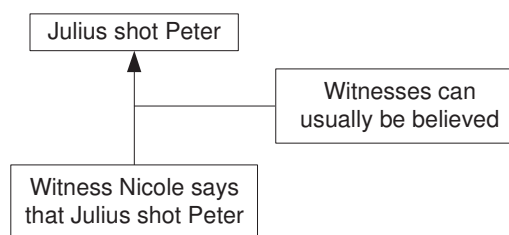

**Figure 4: an argument with its scheme
expressed as a generalization**

Note how the inferential relation in the argument is linked to the scheme as expressed by the generalization (the instantiation-step is not shown in the figure). This picture shows that there is a strong analogy between argumentation schemes and Toulmin's (1958) notion of warrants, as figure 4 bears a strong resemblance Toulmin's argument diagrams.

In addition to the generalization expressed by an argumentation scheme, each scheme also has associated *critical questions*, typical sources of doubt for the generalization. For the Witness Testimony scheme, these can be the following:

1. Did *w* really perceive *a*?
2. Does *w* accurately remember *a*?
3. Does *w* have a reason for lying?
4. Did *w* really assert *a*?
5. Is *a* consistent with what other witnesses say?

These critical questions give pointers on how and where an Argument from Witness Testimony might be attacked. For example, the fifth question points to a possible rebuttal of *a* (i.e. *not a*). But not all critical questions are related to rebuttals. For instance, the fourth question raises doubt about one of the premises of the scheme. Thus, the critical questions fulfil various roles.

In 1996, Walton's focus was not on computational applications of his argumentation schemes. As a result, the use of argumentation schemes cannot always be modelled as single, one-step inferences. For instance, some are small chains of inference steps or small dialogues. The idea to further systematize argumentation schemes has been taken up in the field of computational argumentation. Recently, Walton and colleagues (2008) gave an updated collection of argumentation schemes. Bex and colleagues (2003) have reconstructed Wigmore's evidence charts using argumentation schemes. Verheij (2003) has proposed a systematic specification of argumentation schemes inspired by knowledge engineering technology and Atkinson and colleagues (2006) have modelled arguments based on a particular scheme (that for Practical Reasoning) and its critical questions in an abstract formal argumentation framework.

Argumentation schemes have also been used for more practical applications. Argumentation schemes have been incorporated in the Araucaria argument diagramming tool (Reed and Rowe 2004) and its online variant OVA.[1] Furthermore, Moens and colleagues (2007) have used argumentation schemes for the automatic detection of arguments in legal texts.

Story schemes

In the 1970's, the fields of cognitive science and artificial intelligence also took an active interest in stories. This research mainly focused on developing formal grammars for describing the structure of a typical story (e.g. Rumelhart 1975). These story grammars divide stories into episodes, which consist of a beginning, development and consequences. In later research, (Schank and Abelson 1977), more specific story-patterns called scripts or explanation patterns are given, which help in story understanding. For example, the 'restaurant-script', which contains information about the standard sequence(s) of events that take place when somebody goes to dine in a restaurant, helps us understand a simple story about someone who goes to dine in a restaurant because it fills the gaps, the events which are not explicitly mentioned in the story (e.g. the person reading the menu). Scripts and explanation patterns can also be used to explain an event (Schank 1986), as they connect the event with an explanation that has been used to explain the event before.

Episodes, scripts and explanation patterns can be seen as instances of something which we call *story schemes*, general patterns of events that can serve as a background to

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[1] free to use at http://ova.computing.dundee.ac.uk/

particular stories. Like generalizations and argumentation schemes, story schemes range from abstract to specific. For example, a scheme *beginning – middle – end* is a very abstract scheme for stories. Pennington and Hastie's (1993) episode scheme for intentional actions, a causal pattern of the form *motive → goal → action → consequences*, is more specific. Even more specific schemes mention not only a sequence of events, bit also other information important in a story of that particular type. Take, for example, the story scheme for 'murder':

1. **Anomaly that the scheme explains:** person *y* is dead.
2. **Central action of the scheme:** person *x* kills person *y*.
3. **Other relevant information:** the motive *m*, the time of the killing *t*, the place of the killing *p*, the weapon *w*.
4. **Pattern of actions:** person *x* has a motive *m* to kill person *y* → person *x* kills person *y* (at time *t*) (at place *p*) (with weapon *w*) → person *y* is dead.
5. **More specific kinds of murder:** assassination (e.g. liquidation), felony murder (e.g. robbery murder), killing of one's spouse.

In addition to a pattern of actions, this scheme also contains other information, such as what the central action is and which other, more specific schemes might be applicable.

Story schemes are hierarchical in that specific schemes can be seen as instances of abstract schemes if the elements of the specific story scheme correspond to elements of the more abstract story scheme. For example, a murder is an instance of an intentional action: *motive* from the intentional action scheme corresponds to *person x has a motive m to kill person y* from the murder scheme and the causal link *action → consequence* from the intentional action scheme corresponds to *person x kills person y → person y is dead* from the murder scheme. Because the elements of the scheme are often abstract, it is also possible for a single element of a scheme to correspond to a whole sub-scheme. For example, the motive of an intentional action may be another intentional action with its own motive. More specifically, in a "revenge murder" scheme the motive *m* corresponds to a general murder scheme. Thus, stories that match a scheme higher up in the hierarchy can be composed of sub-stories that correspond to other schemes lower in the hierarchy, as was already shown in figure 3.

An argumentation scheme denotes a single (inferential) relation between two propositions. A story scheme denotes multiple temporal and causal relations between propositions (expressing events or event types). This means that in principle, argumentation schemes and story schemes can be modelled in a similar way. Recall that there are two ways to represent a general argumentation scheme: in ordinary language and more formally, as a schematic conditional (the first and second statement in the previous section). Similarly, the murder scheme can be phrased in ordinary language: 'Sometimes, a person's motive to kill might actually induce him to kill another

person, ending the other person's life'. The variables in story schemes can be instantiated in the same way as as the variables a general argumentation scheme can be instantiated. Hence, a particular story and its corresponding scheme can be rendered in the same way as a particular argument and its corresponding scheme. As an example, see figure 5. Here, the original story is rendered at the bottom; this story matches a sub-scheme of the murder scheme in which the motive m is a fight and the weapon w a gun. Through the hierarchical structure of schemes, this original story corresponds to a story that matches the Murder scheme. The causal relations in the Murder Scheme are expressed in natural language in the same way as the inferential relation in the argument in figure 4 is expressed in natural language.
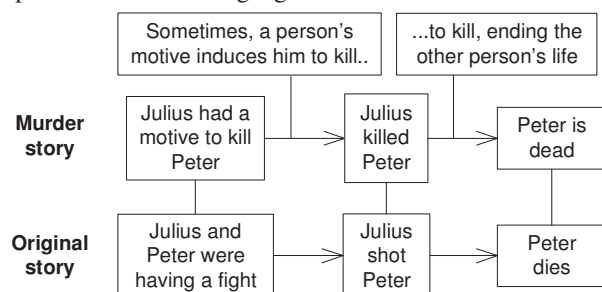

Figure 5: two versions of a story corresponding to a scheme

Story schemes can be used in different ways in reasoning about evidential decision making and crime investigation. In an investigation context, story schemes are important in that they serve as possible templates for hypotheses about what happened and they can guide the search for further evidence. In a murder case, for example, one would look for evidence of the type of weapon used or one could interrogate the suspect on his motives. Furthermore, story schemes can also be used to critically analyse stories: if a story does not match a particular scheme (for example, the motive is missing in a murder story or the causal link between action and supposed consequence is missing) it's quality diminishes (see list of criteria for a story in the section on the hybrid theory).

One issue which might be explored further is that of critical questions for story schemes, which would point to typical sources of doubt for stories that match a particular scheme. Bex and colleagues (2009b) mention a list of such critical questions for the intentional action scheme (e.g. 'is there another motivation which is a deterrent for doing the action?' or 'can the action have the stated consequences?').

Conclusions and future research

In this paper, we have shown how stories and arguments can be used creatively and persuasively in the context of reasoning with evidence in criminal cases. We have argued that argumentation schemes and story schemes form the most relevant forms of commonsense knowledge in the context of reasoning with evidence. Furthermore, in our opinion the multiple theoretical and practical uses of argument schemes in computational argumentation show the potential of such logical schemes for commonsense reasoning.

We think that what has happened for inferential generalizations by the rise of research on argumentation schemes is also a possible direction for stories. In particular, we consider the following issues to be urgent topics of research:

1. *Repositories of argumentation and story schemes.* Which argumentation schemes and story schemes are relevant in reasoning with evidence?
2. *Embedding in software support systems.* Can sets of argumentation and story schemes form the backbone of useful software support systems?
3. *Case studies.* Are real cases usefully analyzable using the hybrid theory? Are they an appropriate source of argumentation and story schemes?
4. *Elaboration of the notion of a story scheme.* What are the properties of story schemes that make them useful in reasoning with evidence? What is the role of abstraction of stories and story hierarchies? How are actual facts to be matched to story schemes in a repository?
5. *Integration of argumentation and stories.* Can argumentation and stories be connected in a more fundamental way than in the hybrid theory? Can the idea of 'communicating vessels' be fleshed out in a genuine integrated approach?

Some ideas about these questions have already been proposed by the current authors and their collaborators. Bex and colleagues (2003) and Walton (2002) mention a number of argumentation schemes which can be used specifically in reasoning with evidence (question 1). Van den Braak (2010) has already shown that a tool which allows for "story-mapping" (cf. argument-mapping, Reed et al. 2007) can be of use in police investigations and police training (question 2).[2] Bex and colleagues (2003) analyse a part of the famous Sacco and Vanzetti case using argumentation schemes and Bex (2009c) devotes a large part of his dissertation on analysing a Dutch murder case using the hybrid theory (question 3). Questions 4 and 5 have also been explored in Bex' dissertation and in Bex (2009a) and Verheij and Bex (2009), respectively. We think these first ideas are a fertile ground on which new research can be built, further exploring the use of stories in computational theories of complex reasoning.

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[2] See also Bex' recent blog post on
http://blog.law.cornell.edu/voxpop/2010/04/16/argument-mapping-and-storytelling-in-criminal-cases/

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