Forensic Statistics and Graphical Models (6)

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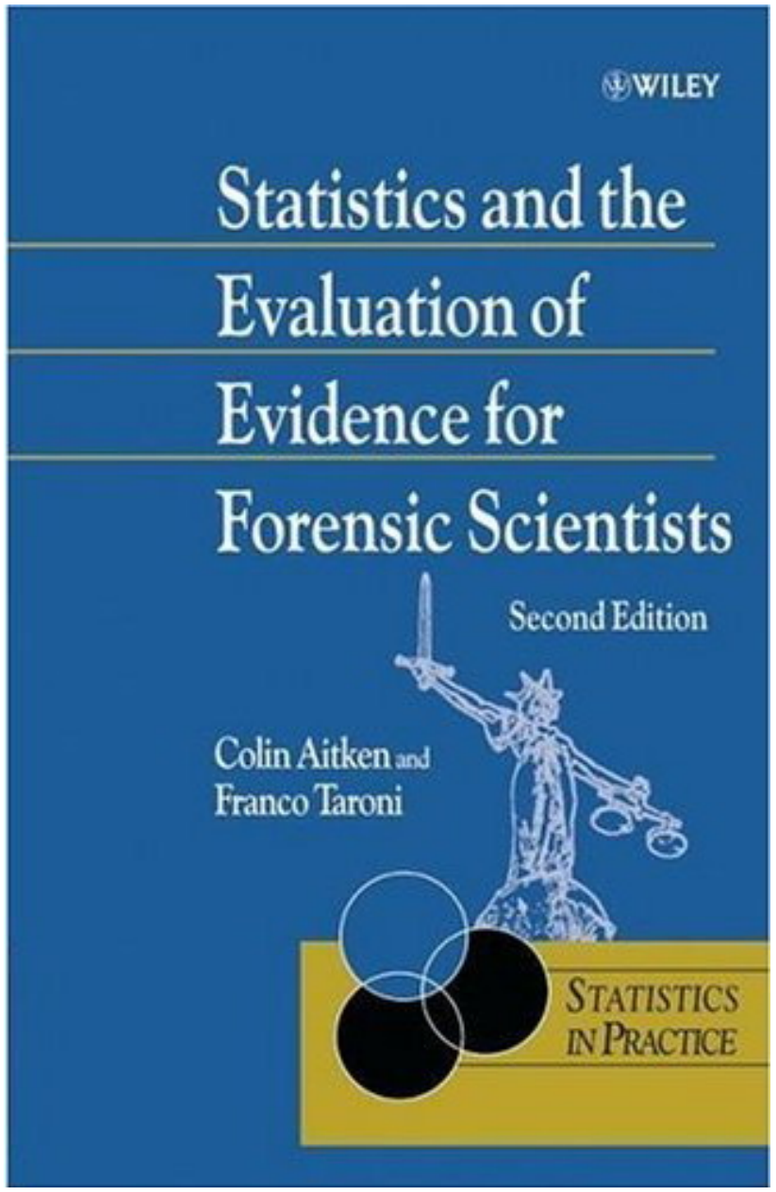
The hierarchy of propositions

Evett (19??)



Propositions

It is widely accepted for the assessment of scientific evidence that the forensic scientist should consider different propositions which commonly represent alternatives proposed by the prosecution and the defence to illustrate their description of the facts under examination. The importance of these has been illustrated in *R. v. Clark*. These alternatives are formalized representations of the framework of circumstances. The forensic scientist evaluates the evidence under these propositions. The formulation of the propositions is a crucial basis for a logical and scientific approach to the evaluation of evidence (Cook *et al.*, 1998b). The framing of the propositions is an important and difficult stage of the evaluation process, which can be specified by three key principles (Evett and Weir, 1998):

- Evaluation is only meaningful when at least one alternative proposition (two or more competing propositions) is addressed, conventionally denoted throughout this book as H_p and H_d.
- Evaluation of scientific evidence (E) considers the probability of the evidence given the propositions that are addressed, $Pr(E \mid H_p)$ and $Pr(E \mid H_d)$.
- Evaluation of scientific evidence is carried out within a framework of circumstances, denoted I. The evaluation is conditioned not only by the competing propositions but also by the structure and content of the framework.

Propositions (continued)

Generally, propositions are considered in pairs. There will be situations where there will be three or more, and comments on these situations are given in Section 8.1.3. This happens quite often with DNA mixtures, for example, where the number of contributors to the mixture is in dispute (Buckleton *et al.*, 1998; Lauritzen and Mortera, 2002). It is generally possible to reduce the number of propositions to two, which will be identified with the respective prosecution and defence positions. Clearly the two propositions must be mutually exclusive. It is tempting to specify that they are exhaustive, but this is not necessary. The simplest way to achieve this is with the addition of the word 'not' into the first proposition, saying, for example: 'Mr C is the man who kicked Mr Z', and 'Mr C is not the man who kicked Mr Z'. However, this gives the court no idea of the way in which the scientist has assessed the evidence with regard to the second proposition. Mr C may not have kicked the victim, but he may have been present at the incident. Analogously, consider the propositions 'Mr B had sexual intercourse with Miss Y' and 'Mr B did not have sexual intercourse with Miss Y'. In fact, if semen has been found on the vaginal swab then it may be inferred that someone has had sexual intercourse with Miss Y and,

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The hierarchy of propositions

- Source level (level I)
- Activity level (level II)
- Crime level (level III)

Level I: source

The assessment of the level I category (the source) depends on analyses and measurements on the recovered and control samples. The value of a trace (or a stain) under source level propositions (such as 'Mr X's pullover is the source of the recovered fibres' and 'Mr X's pullover is not the source of the recovered fibres', so that another item of clothing is the source of the trace) does not need to take account of any more than the analytical information obtaining during examination. The probability of the evidence under the first proposition (numerator) is considered from a careful comparison between two samples (the recovered and the control). The probability of the evidence under the second proposition (denominator) is considered by comparison of the characteristics of the control sample and some kind of population of alternative sources.

Level II: activity

The next level (level II) is related to an activity. This implies that the definitions of the propositions of interest have to include an action. Such propositions could be, for example, 'Mr X assaulted the victim' and 'Mr X did not assault the victim' (some other man assaulted her, and Mr X is not involved in the offence), or 'Mr X sat on the car driver's seat' and 'Mr X never sat on the car driver's seat'. The consequence of this activity (the assault or the sitting on a driver's seat) is the contact (between the two people involved in the assault, or the contact between the driver and the seat of the car) and consequently a transfer of material (fibres in this example). So the scientist needs to consider more detailed information about the case under examination relative to the transfer and persistence of the fibres on the receptor (e.g., the victim's pullover). Circumstances of the case (e.g., the distance between the victim and the criminal, the strength of the contact and the *modus operandi*) are needed to be able to answer relevant questions like 'is this the sort of trace that would be seen if Mr X were the man who assaulted the victim?' or 'is this the sort of trace that would be seen if Mr X were not the man who assaulted the victim?'. The assessment of evidence under level I propositions requires little in the way of circumstantial information. Only I, the background information, is needed. This could be useful in order to define the

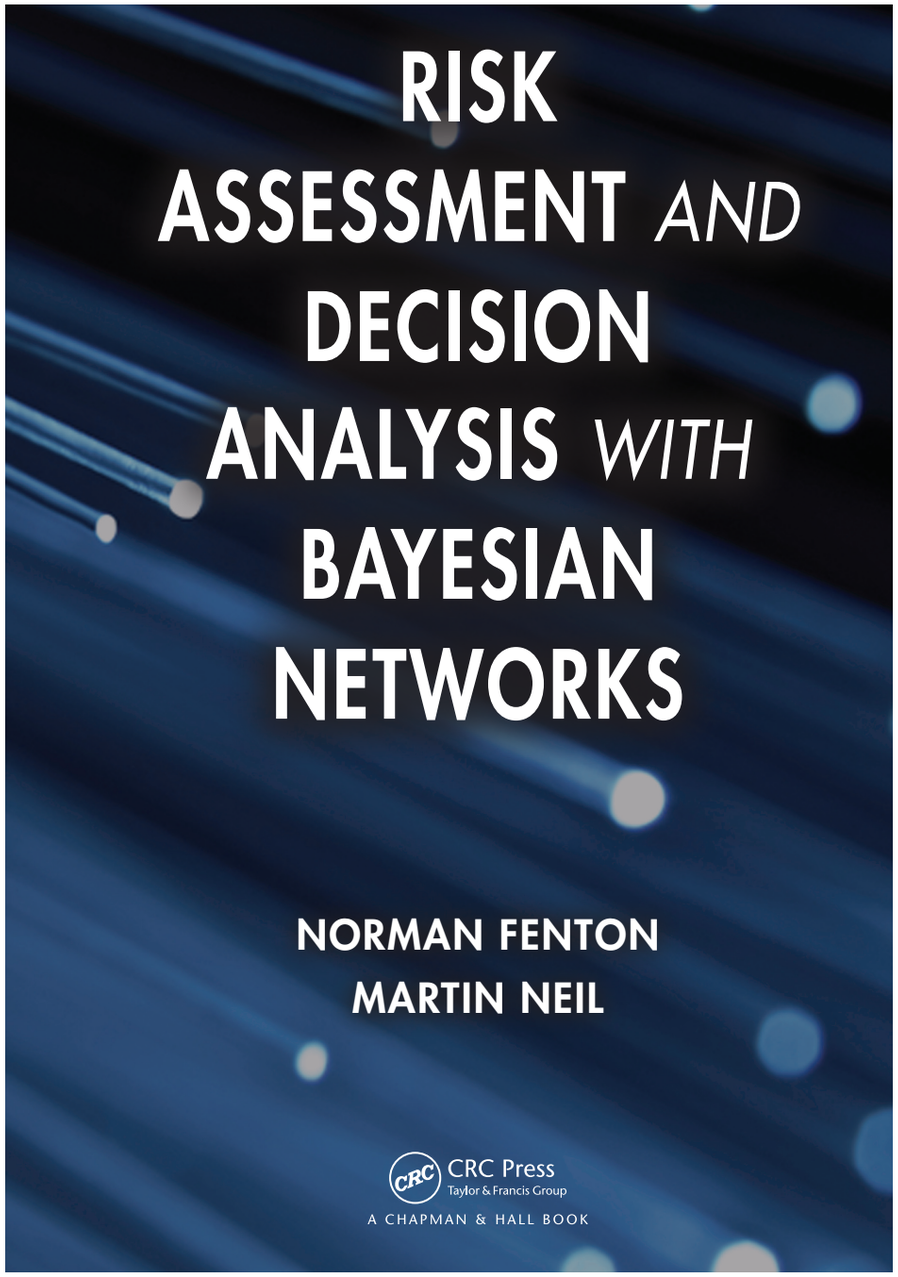
Level III: crime

Level III, the so-called ‘crime level’ or ‘offence level’, is close to the activity level. At level III, the propositions are really those of interest to the jury. Non-scientific information, such as whether or not a crime occurred, or whether or not an eyewitness is reliable, plays an important role in the decision. In routine work, forensic scientists generally use the source level to assess scientific evidence, notably for DNA evidence. Evidence under the activity level propositions requires that an important body of circumstantial information is available to the scientist (see Section 7.2.3). Unfortunately, this is often not the case because of a lack of interaction between the scientists and investigators. There are limitations in the use of a source level evaluation in a criminal investigation compared with an activity level evaluation. The lower the level at which the evidence is assessed, the lower is the relevance of the results in the context of the case discussed in the courts. For ease of simplicity, note that even if the value,

Table 7.1 Examples of the hierarchy of propositions. (Reproduced by permission of The Forensic Science Society)

Level	Generic		Examples
III	Offence	A	Mr A committed the burglary
			Another person committed the burglary
		B	Mr B raped Ms Y
			Some other man raped Ms Y
		C	Mr C assaulted Mr Z
			Mr C had nothing to do with the assault of Mr Z
II	Activity	A	Mr A is the man who smashed window X
			Mr A was not present when window X was smashed
		B	Mr B had sexual intercourse with Ms Y
			Some other man had sexual intercourse with Ms Y
		C	Mr C is the man who kicked Mr Z in the head
			Mr C was not present at the kicking of Mr Z
I	Source	A	The glass fragments came from window X
			They came from some other broken glass object
		B	The semen came from Mr B
			The semen came from some other man
		C	The blood on Mr C's clothing came from Mr Z
			The blood on Mr C's clothing came from an unknown person

Idioms
(argument templates)



Idioms
(argument templates)

13.3 Building Legal Arguments Using Idioms

Despite its elegant simplicity and natural match to intuitive reasoning about evidence, practical legal arguments normally involve multiple pieces of evidence (and other issues) with complex causal dependencies. Fortunately, there are unifying underlying concepts which mean we can build relevant BN models, no matter how large, that are still conceptually simple because they are based on a very small number of special cases of the idioms that were described in Chapter 8.

Evidence Idiom

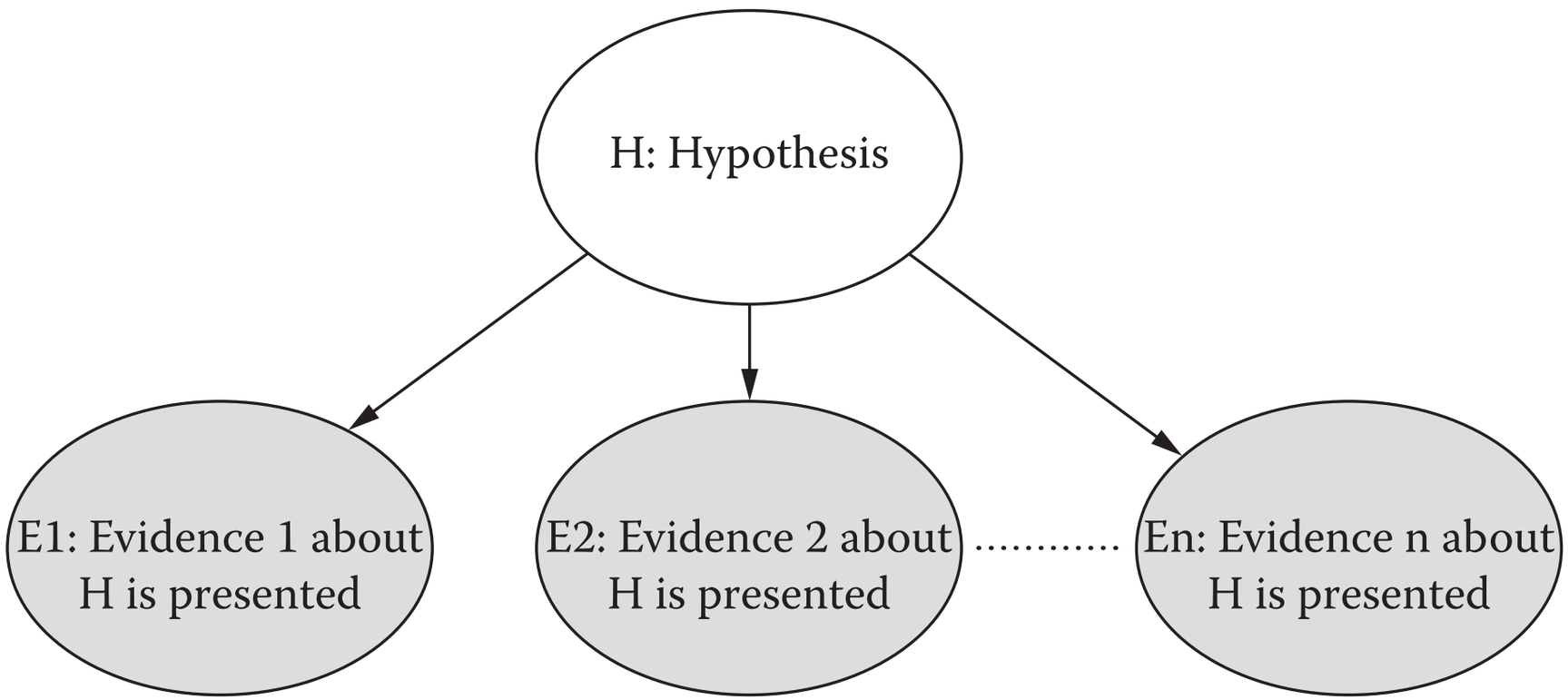


Figure 13.4 Evidence idiom.

Evidence Accuracy Idiom

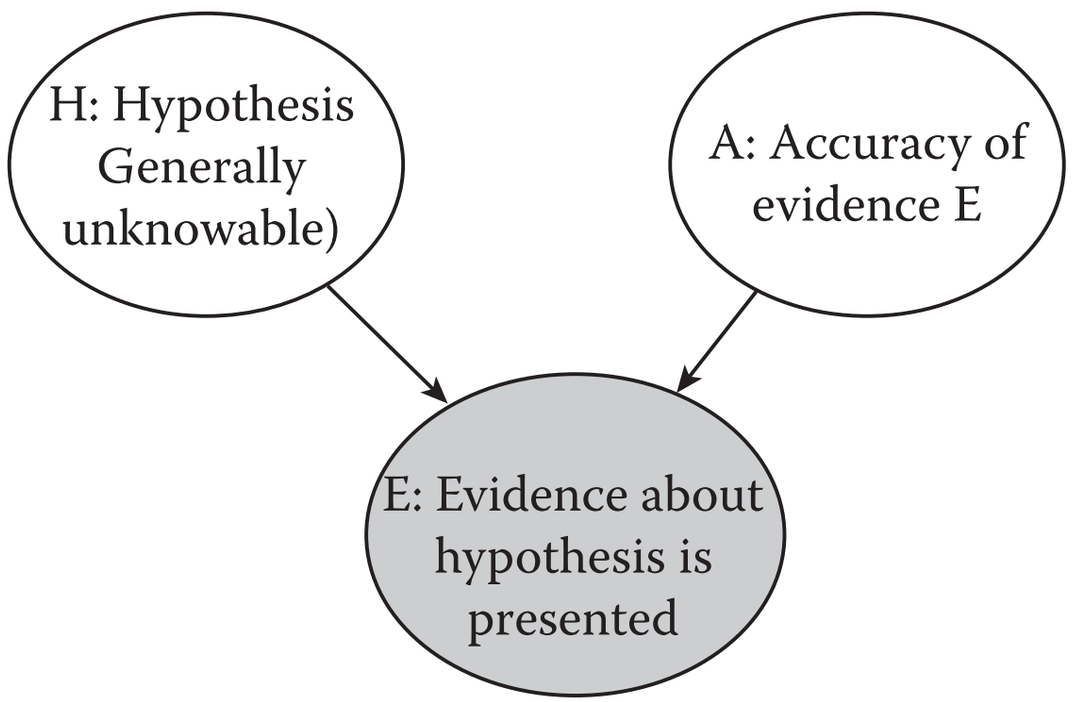
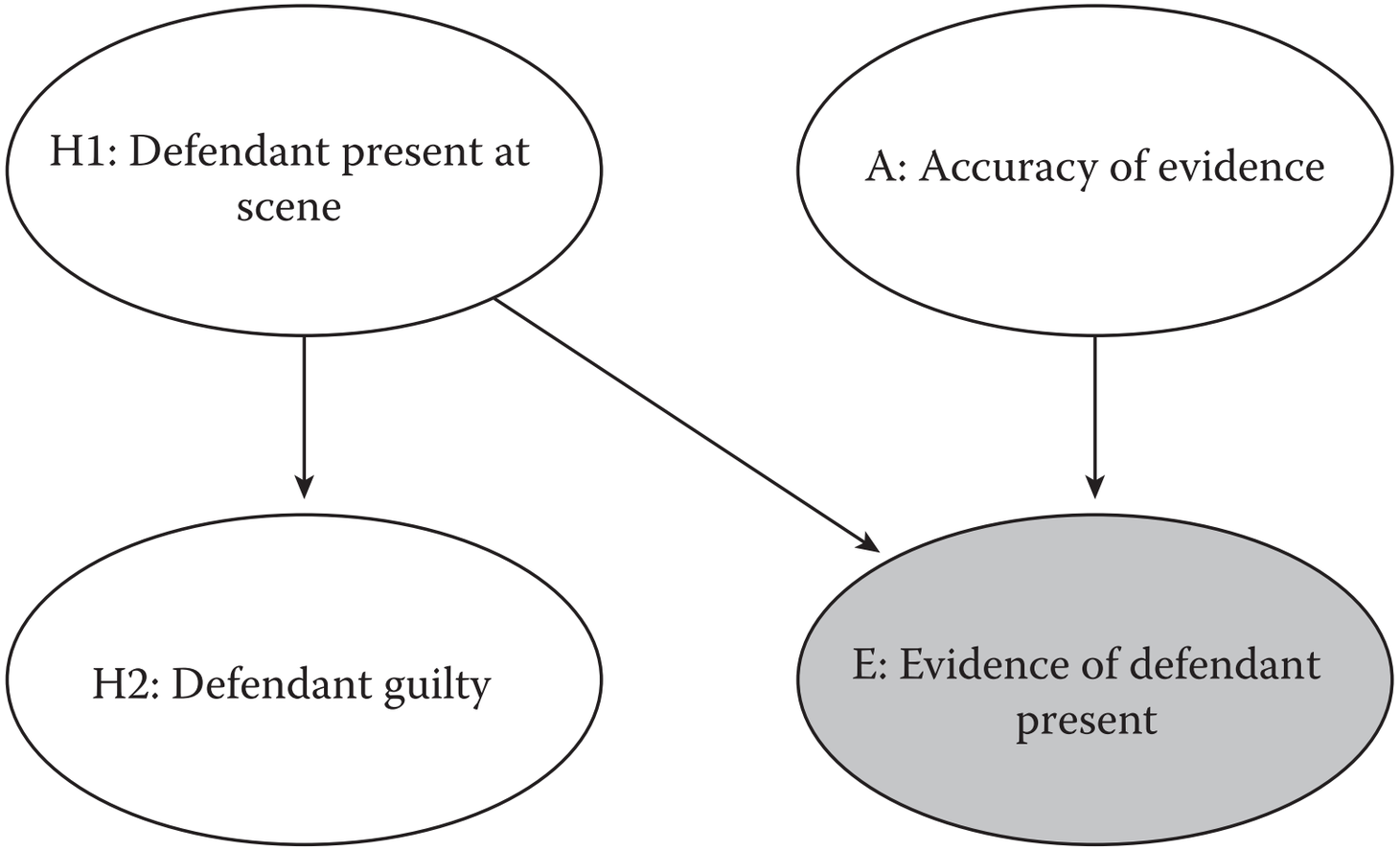


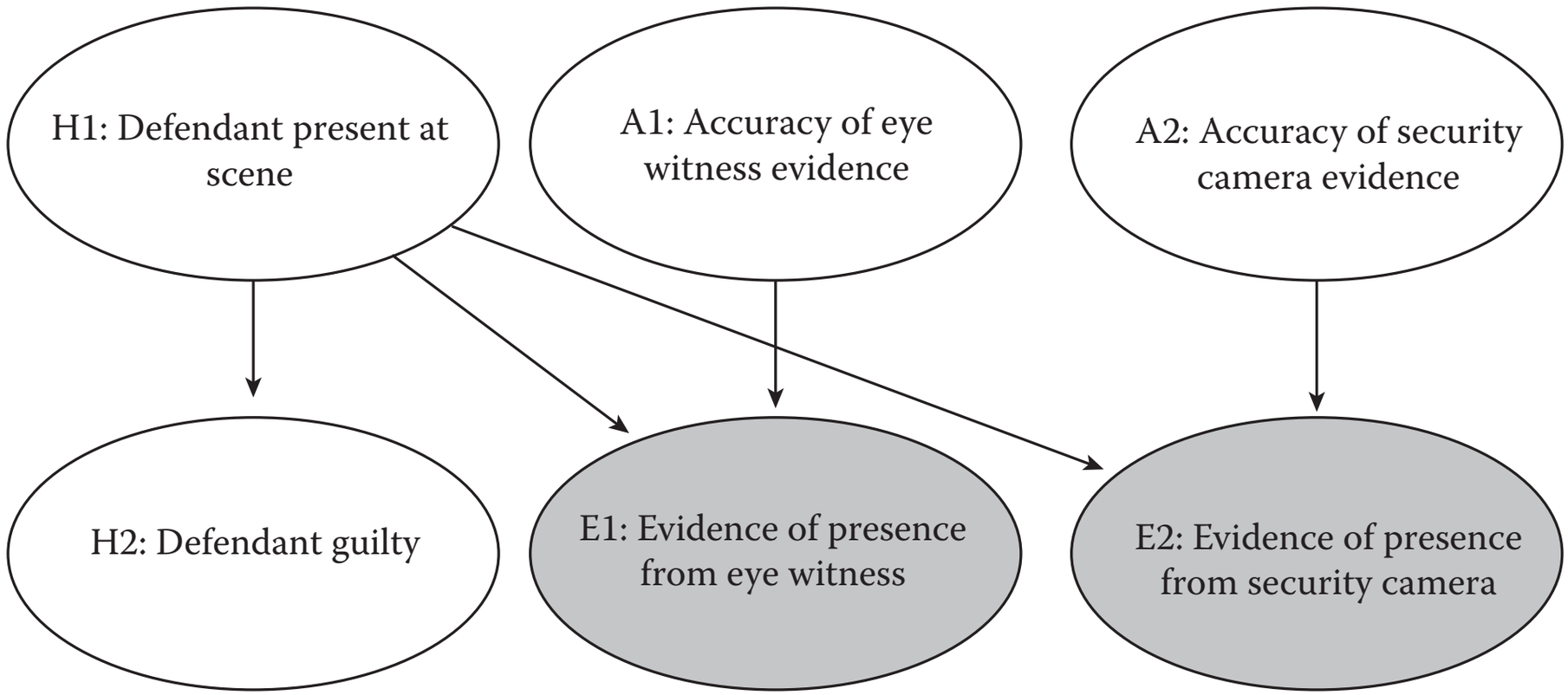
Figure 13.11 General idiom to model evidence taking account of its accuracy.

Opportunity Idiom (1)



(a) Idiom for incorporating “opportunity” (defendant present at scene of crime)

Opportunity Idiom (2)



(b) Multiple types of evidence for opportunity hypothesis

Figure 13.13 Opportunity idioms.

Motive Idiom

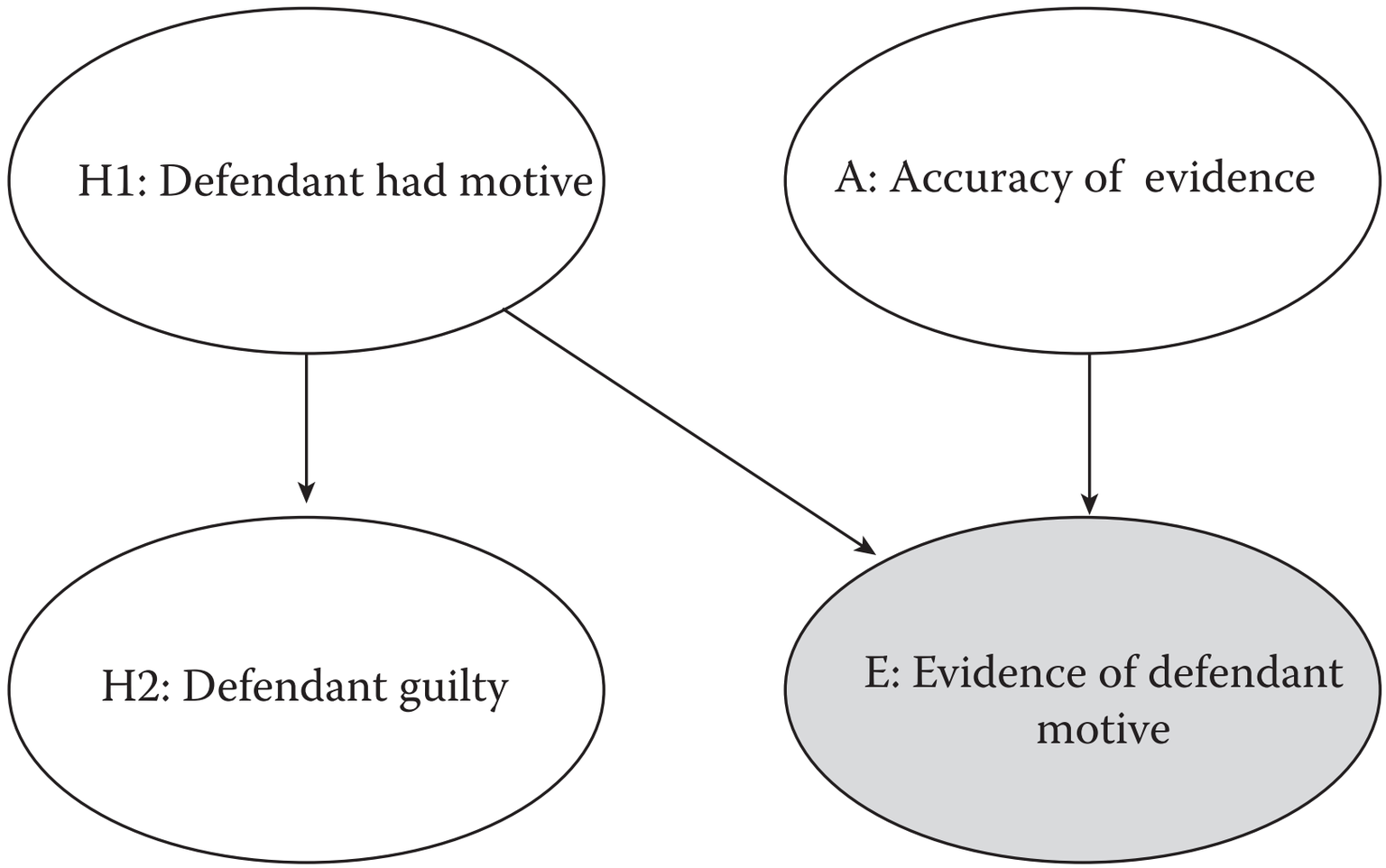


Figure 13.14 Idiom for incorporating motive.

Opportunity and Motive

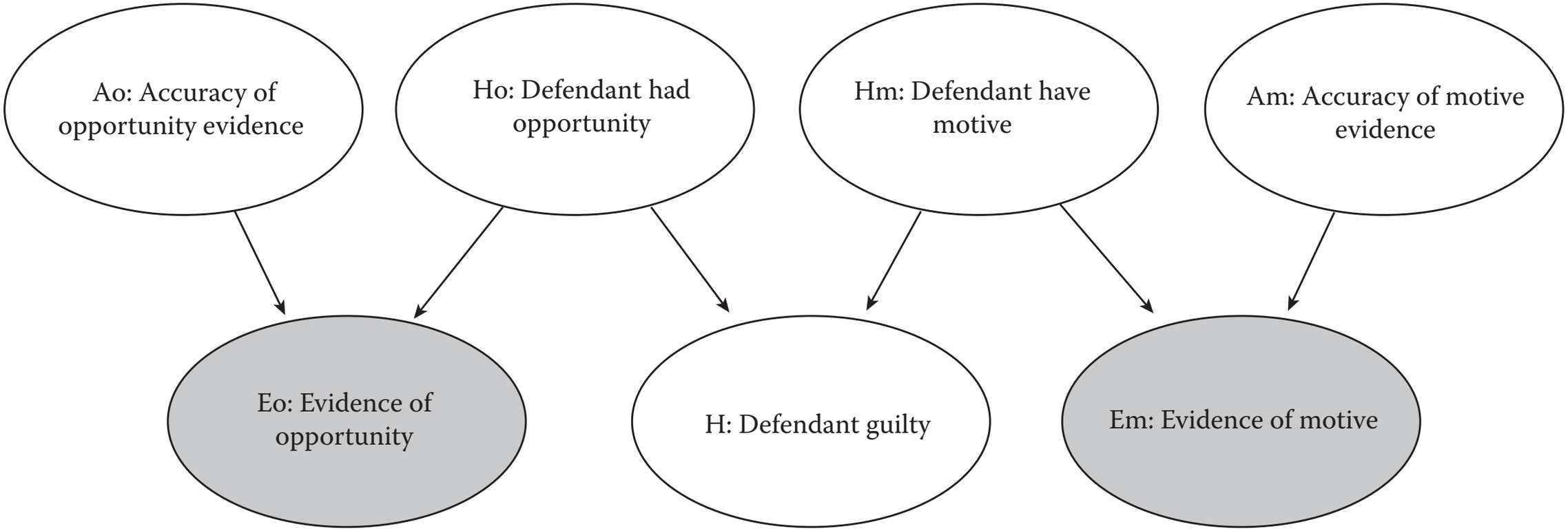


Figure 13.15 Incorporating both opportunity and motive.

Multiple Motives

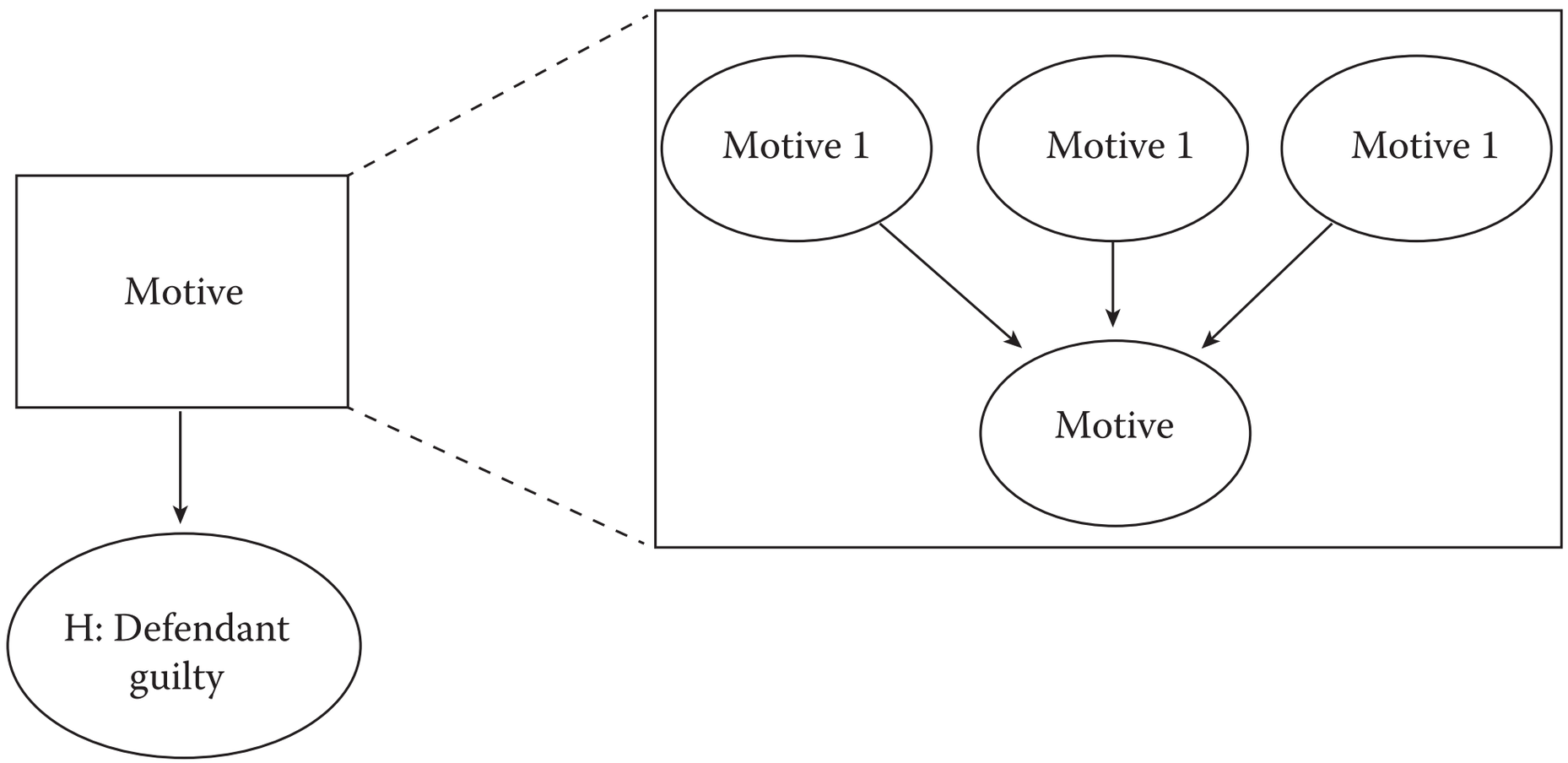
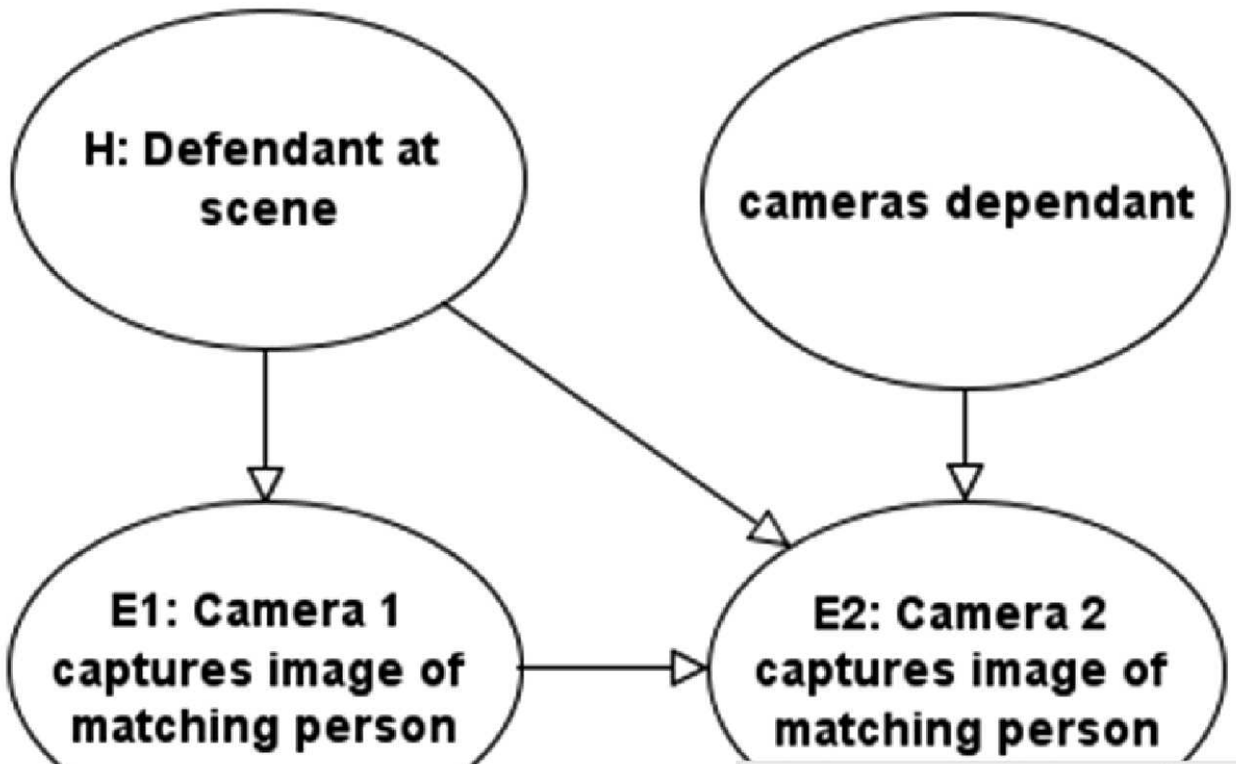


Figure 13.16 Appropriate model for multiple motives (using object-oriented notation).

Dependency Idiom

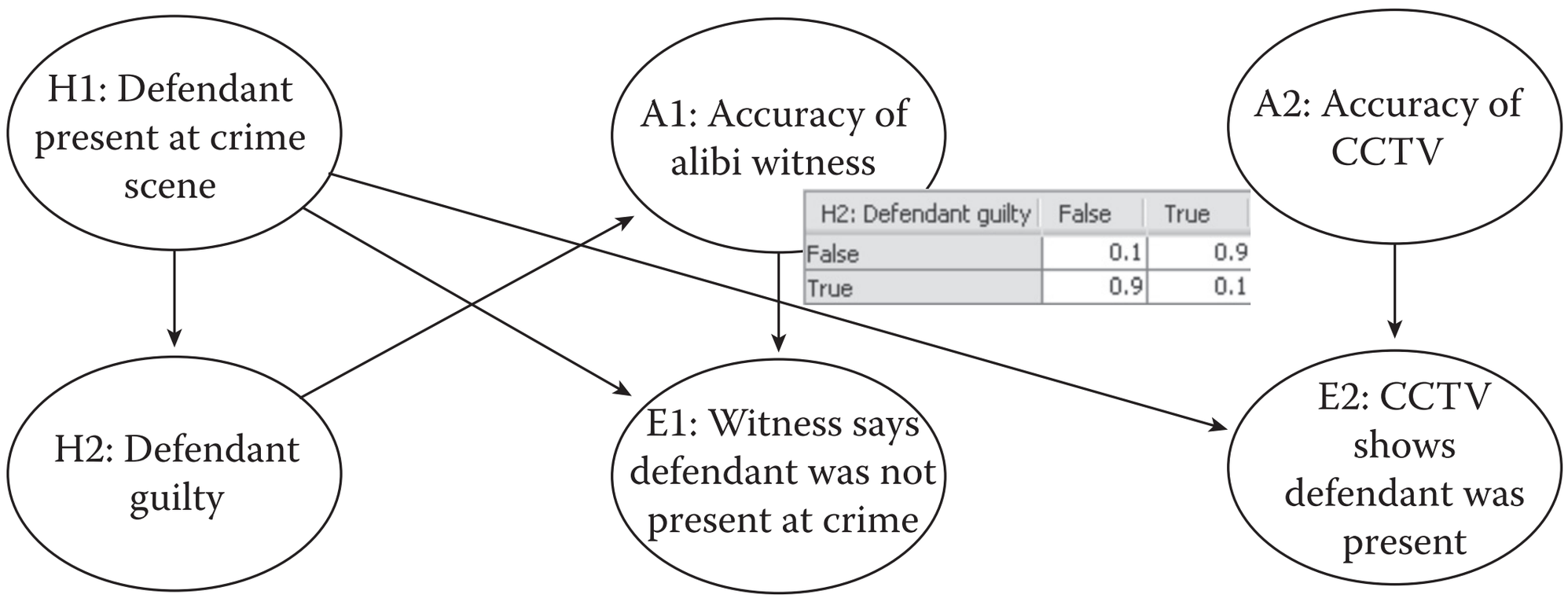


H: Defendant at scene	False	True
False	0.9	0.2
True	0.1	0.8

cameras dependant	Independant				Dependant			
H: Defendant at scene	False		True		False		True	
E1: Camera 1 captures image ...	False	True	False	True	False	True	False	True
False	0.9	0.9	0.2	0.2	1.0	0.0	1.0	0.0
True	0.1	0.1	0.8	0.8	0.0	1.0	0.0	1.0

(a) Idiom instantiation

Alibi Evidence Idiom



H2: Defendant guilty	False	True
False	0.1	0.9
True	0.9	0.1

Figure 13.19 Alibi evidence idiom, with NPT for A1 (accuracy of alibi witness).

Explaining Away Idiom

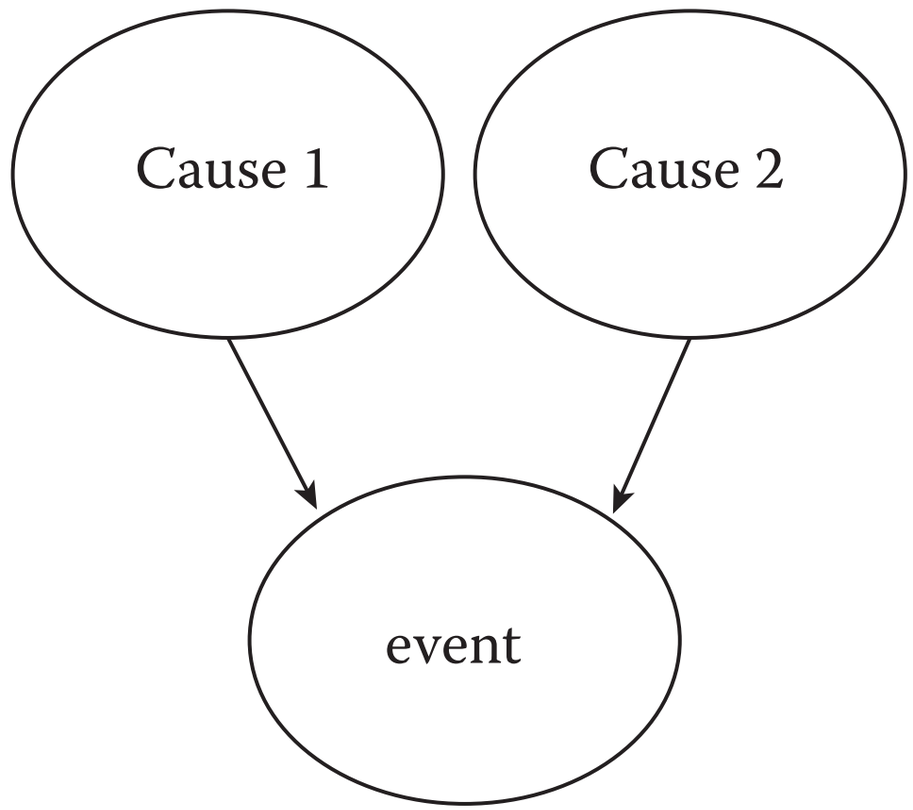


Figure 13.21 Explaining away idiom.