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Evaluating evidence in linked crimes with multiple offenders

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ABSTRACT

In de Zoete et al. (2015) a framework for the evaluation of evidence when an individual is a suspect of two separate offenses (based on Evett et al., 2006) is implemented using a Bayesian network. Here, we extend this to situations with multiple offenders. When we have multiple offenders, new questions arise: (1) Can we distinguish between the offenders, even if we do not know their identity? (2) Do we know that certain pieces of evidence originate from the same person? (3) Do we know the number of offenders? With the aid of a mock case example, we show that such subtle differences between situations can lead to substantially different conclusions in terms of posterior probabilities of a certain suspect being one of the offenders in a particular crime.

We reach our conclusions by constructing appropriate Bayesian networks for each situation. Although we find it undesirable that Bayesian networks are demonstrated in court, they can be very helpful in guiding expert and legal reasoning, identifying pitfalls and assist in preventing them. Bayesian networks can be used as a tool to understand how the different pieces of evidence influence each others evidential value, and the probabilities of the hypotheses of interest.

1. Introduction

In legal casework, it is not uncommon that an individual is a suspect of multiple (similar) offenses. In these situations, the evaluation of the evidence becomes rather complex. Most importantly, when considering the culpability of a suspect for a crime, one needs to consider the evidential value from observations of other, similar, crimes. In Evett et al. [2] a method is suggested to evaluate the evidence when a person is a suspect in two separate offenses. The authors show that, in such a situation, the evidence can be grouped into two categories: (1) evidence which is only relevant for a specific crime, and (2) evidence which is relevant for the connection between crimes. de Zoete et al. [1] extend the analysis of Evett et al. [2] by recognizing another category of evidence: (3) evidence relevant for both the link between crimes and for a specific crime. This occurs when similar pieces of evidence that match characteristics of the suspect are obtained in different crimes. Furthermore, in de Zoete et al. [1] Bayesian networks are introduced as a reasoning tool for crime linkage. Both Evett et al. [2] and de Zoete et al. [1] only consider situations with a single offender.

In this work, the focus lies on evidential reasoning in crime linkage problems with multiple offenders. We identify different types of multiple offender crime linkage situations. For each situation we present a Bayesian network.

The paper is structured as follows. Literature on (multiple offender) crime linkage is discussed in Section 2. In Section 3 different situations, each resulting in a different Bayesian network, are presented. Because crime linkage with multiple offenders becomes rather complex, even with a small number of cases, we use a simple mock case example. For this example, we make simplifying assumptions, for example that all the evidence was left by the offenders. The different situations are distinguishable by (1) whether or not it is possible to distinguish between the offenders and (2) whether or not it is possible to 'group' the evidence. Studying the behaviour of posterior probabilities[1] for the mock example results in general

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[1] In forensic statistics, it is common to work with likelihood ratios. However, likelihood ratios for hypotheses that are collections of multiple sub-hypotheses can only be determined when reasonable priors for these sub-hypotheses are available, something which is often not the case. Nevertheless, for demonstration purposes we will choose priors and work with posterior probabilities.

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lessons for these type of problems. These results are presented in Section 4. In Section 5 we summarize the general lessons following from the mock example. We also identify pitfalls in probabilistic reasoning. We conclude that in forensic casework, these Bayesian networks can be very valuable, not as a tool to compute probabilities that can be reported, but as a tool that can assist in supporting our reasoning and in preventing pitfalls.

2. Literature overview

In this section we review some aspects of linked crimes in the literature. This sketch serves as the background against which we present our probabilistic contributions in the sections to follow. A broad selection on papers regarding crime linkage can be found on the website of Crime Linkage International Network [3].

2.1. Identifying linked crimes

In Grubin et al. [4] it is noted that the most reliable means of establishing a link between offenses is by 'physical' evidence (e.g. DNA profiles/footwear evidence). For example, in de Zoete et al. [1], an example is presented in which the link between cases consists of matching fibre evidence. However, Winter et al. [5] notes that such evidence is often absent. In these situations, non-physical evidence can assist in determining the strength of the link between two crimes. In Woodhams et al. [6], linkage analysis is defined as a process that aims to identify crimes that are likely to have been committed by the same perpetrator. In this, and many other papers [7,8], the authors are interested in the *behavioural* similarity between two crimes as well as the *behavioural* distinctiveness, i.e. whether there are reliable and identifiable differences in the way that one offender commits crimes compared to another offender.

Different methods for different types of crimes have been suggested to assess whether there exists a link between crimes. The focus in these papers often concerns the question whether it is possible to determine whether two crimes share a common offender. For investigative purposes, regarding two crimes as 'linked' could assist in identifying suspects. However, in a criminal trial, one cannot disregard the uncertainty associated with this link. In [9], a statistical approach is introduced that computes Bayes factors that reflect the strength of the evidence that two cases are linked. Bennell and Canter [10] study the predictive value of different features associated with commercial burglaries for determining whether two crimes have (a) common offender(s). These can assist in estimating how likely it is that two burglaries have a common offender given (for example) the distance between the two crime scenes, the stolen property and/or entry behaviours. And, likewise, in Ribaux et al. [11] characteristics from shoe marks, tool marks and/or glove marks observed in different crimes are used to identify possibly linked burglaries. Summarized, Ormerod and Sturman [12] mention that linkage analysis can be pivotal in assessing whether the same individual is responsible for similar offenses.

Apart from the investigative phase of possibly linked crimes, one should also keep in mind that in order to be able to use crime linkage as evidence in court, it has to be deemed admissible. This may differ between legal systems. Labuschagne [13] states that linkage analysis is especially important when there is evidence that suggest culpability for some, but not all offenses. However, in Fawcett and Clark [14], the authors note that the linkage analysis is, at present, unrepresentative evidence that cannot *independently* indicate a defendant's culpability. In other words, linkage analysis 'alone' is insufficient evidence. One needs crime specific evidence to make it legally admissible. The same is recognized in de Zoete et al. [15] in which the differences between a Dutch legal and a probabilistic perspective are discussed. The authors of [15] show that, although it is common to require such crime specific evidence when linking crimes in practice, it is unnecessary from a probabilistic point of view to have crime specific evidence for every case.

In Evett et al. [2], a framework is introduced that can assist in evaluating the evidence when an individual is a suspect in two separate offenses. de Zoete et al. [1] extend this analysis with the aid of Bayesian networks. The emphasis in these papers lies on understanding the combined evidential value and acknowledging the (potentially large) set of alternative explanations. Most notably, it is recognized that the combination of these two can result in situations in which the evaluation of the evidence becomes very complex. With multiple offenders, the set of alternative explanations that should be regarded grows even more rapidly. Furthermore, one should recognize that there are several situations that one can regard when linking crimes with multiple offenders with only subtle differences between them. A different situation can result in a substantially different belief regarding the culpability of the suspect(s), see Section 3.

2.2. Consistency and behaviour of groups in serial crime

A substantial part of the literature on crime linkage focuses on a situation with only one offender per crime[2] . However, Burrell et al. [8] examines the differences in behavioural similarity for different crime linkage situations. The authors did not observe statistical differences between the behavioural similarity for a link between two lone offender offenses and two group offender offenses. In other words, there is little reason to expect substantial differences in the behavioural similarity when dealing with multiple offender crime linkage compared to single offender crime linkage. Furthermore, Burrell et al. [8] investigate the differences in behavioural similarity when one of the crimes was performed by a lone offender and the other by a group (in which the lone offender was present). The authors advise to take some caution when linking such crimes.

Regarding the size of offender groups, Reiss and Farrington [16] and Walsh [17] identified that the majority of multiple offender crimes had two offenders. Co-offender stability, i.e. the tendency to select the same co-offender for two consecutive crimes is discussed in multiple papers. In [18] youth surveys are used to examine this co-offender stability. The authors conclude that, if offenders commit multiple robberies in a short span of time, they are more likely to select from the same *group* of companions. For different types of crimes, there was less chance that offenders would select from the same group of companions. Warr [18] believes that this could be due to some kind of group specialisation. Apart from [18], also Klein and Crawford [19], Reiss [20] and Short [21] note that delinquents commonly have a larger network of co-offenders than would be expected from the size of their offending groups. Contrary to Warr [18], Weerman [22] and McGloin et al. [23] conclude that the same offender composition is unlikely to emerge on more than one occasion. Reiss and Farrington [16] state that co-offending pairs tend to be short lived. Nonetheless, in either situation, an interpretation framework like a Bayesian network can assist in evaluating the evidence.

3. Modeling crime linkage with multiple offenders

In this section we identify different situations when linking multiple offender crimes. The different situations are introduced with the aid of a mock case example. The mock case example is introduced to describe the different situations and examine the influence of this situation on the posterior beliefs of interest. What the evidence actually represents is not important for our mock case example which

[2] It is possible that some researchers did not distinguish between solo or group offender cases which would result in samples that contain a combination of them.