A209 Combination of Evidence in Complex Casework Using Bayesian Networks

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After attending this presentation, attendees will understand the pros and cons of using Bayesian networks for combining evidence in a complex case.

This presentation will impact the forensic science community by evaluating a combination of evidence from a wide range of expertise areas in a transparant and logical way. This will assist forensic experts and, in the future, also law and court officers in correctly weighing the combined evidence in criminal investigations and ensuing court procedures.

In forensic casework, often multiple investigations are performed. Reporting the evidential value of the combined results within a single casework investigation is desirable in many respects. Bayesian networks have been proposed in the literature as a useful tool for combining evidence; however, many challenges are encountered when putting theory into practice in complex casework investigations. Nonetheless, it is concluded that this is the way forward. This presentation illustrates the pros and cons of using Bayesian networks in complex casework investigations using a real case, involving many questions and many types of forensic evidence.

Late in a summer night, two incidents occurred in a rural Dutch area. A motorcade of a car with trailer, an excavator, and a private car are observed by the police. This is a combination that is often used for a hit on an ATM. The excavator is used to break into the ATM, the last private car is used to hinder pursuers (e.g., by throwing spikes on the road). The police pursue and encounter the motorcade. On a side road, the car advances and hits the police car in the flank. A police officer standing outside the police car feels threatened and shoots five times at the vehicle. Subsequently, an injured male is encountered on the driver's seat in this car. An excavator is found abandoned a little further down the road.

A few days afterwards, in the woods close by, the body of a man is found. His head and back are covered with maggots of different sizes and a large part of the soft tissue has gone. On his skull, an injury (impression) is observed. This male is identified shortly afterwards. His DNA matches blood and tissue samples taken from the vehicle and a guardrail next to it. The main question: Was this man (mortally) injured by the police officer during the shooting incident?

Many forensic investigations were made including comparisons of bullets to the police officer's gun, DNA-investigations on many samples, fiber comparison of materials found on the bullets to garments and balaclavas, comparison of paint and glass particles found on the bullets to the car paint and (broken) window glasses. Especially the micro traces (human tissues, glass, paint, fiber) on two bullets found in the vehicle appear to link both the deceased and the injured male to the incident and to each other. GSR investigations on clothing around damages (holes) were made to verify if these damages could be bullet holes. The FT-IR spectrum of a white substance found on one bullet matched the spectrum of bone material. An investigation of the tool marks on the head injury did not provide a definitive answer whether this injury was caused by a bullet. The autopsy and subsequent pathology and toxicology investigations could not determine a cause of death for the deceased due

to the advanced decomposition of the body and the lack of soft tissue. Through hair and fiber investigations a link with the excavator was investigated. In total, 11 expert areas were involved.

The use of Bayesian networks was explored in this case. This presentation shows a network that was made for answering a part of the main question: the manner of death. Some progress was made to combine DNA, glass, paint, fiber, (white) material, bullet trajectory, toolmarks, and pathology evidence. The assumptions made in the structure of the model and the probability tables behind it shall be discussed, as well as the various advantages (explicit derivation of the combined evidential value, transparancy of reasoning and assumptions, sensitivity analysis, information analysis) and disadvantages (many assumptions required, possibly misleading suggestion of exactness, sensitivity to small changes in formulation). This presentation concerns work in progress. No claim is made that the present approach provides the final answer although there appears to be no viable alternative to the Bayesian network modeling and look forward to a fruitful discussion to advance the evaluation of a combination of forensic evidence on a scientific basis.

Evidence Combination, Micro Traces, Bayesian Networks

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