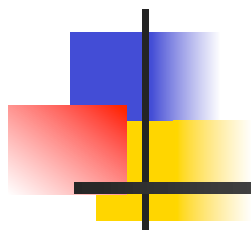


# On how expert witnesses can give useful Bayesian analyses of complex criminal cases



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26 September 2016



# Introduction

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- Restriction to court settings
- Based on my experiences as counter expert to Alkemade
  - **Breda Six** (robbery and murder): “to assess and evaluate” A’s report
  - **Oosterland** (serial arson): “to assess the reliability of A’s method and its application to the case”



# Assumptions

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- Bayesian probability theory is an **adequate model of rational reasoning** about (legal) evidence
- In complex cases **Bayesian networks** are needed



# Foundations of probability estimates

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- Frequentist  $\neq$  objective
  - Selecting and interpreting statistics requires judgement
- Epistemic  $\neq$  subjective
  - Expert opinion can be more than purely subjective



## Expert testimony

Expertise on Bayes does not imply expertise on murders, arson, testimonies, ...

E is expert on D  
E says that P  
P is within D  
Therefore (**presumably**), P is the case

- **Critical questions:**
  - Is E biased?
  - Is P consistent with what other experts say?
  - ...
- And the **premises** have to be established

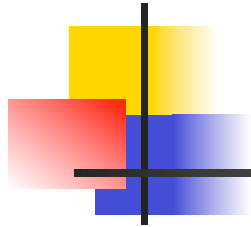


# Breda Six: the blood stain issue

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**Blood stain expert** "with no degree of probability conclusions can be drawn concerning the dryness of blood stain."

**Alkemade** nevertheless estimated probabilities concerning this issue



# Questions to be answered

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- Relevant hypotheses, evidence and intermediate propositions?
- **Dependency** relations between propositions?
- **Probabilities?**
  - Priors?
  - Conditional probabilities?



# Who should answer these questions?

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- Many forensic scientists:
  - **We** determine the **conditional** probabilities (since these can be based on our expertise)
  - **The judge or jury** determines the **prior** probabilities
- Applies to analysis of individual pieces of evidence
- But **not** to analysis of complex cases
  - Who identifies hypotheses, evidence?
  - Who determines dependencies?





# Kinds of experts

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- Experts in statistics and/or probability theory
- Experts in a domain
  - DNA, footprints, vingerprints, blood stains, testimonies, group behaviour, ...
- Expertise in Bayes **does not imply** expertise in a domain!
- Domain experts are often **not comfortable** with large-scale Bayesian analysis!
- And we need **several** domain experts



# Team testimony?

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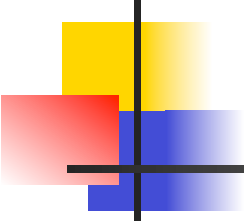
- An expert in Bayesian networks
- A statistician?
- Domain experts on the aspects of a case
- **Problem 1**: does not cover commonsense issues
- **Problem 2**: different teams might generate very different models
- **Problem 3**: can judges, prosecutors or jury members really **make sense** of a BN model?



# Recent Dutch court decisions (1): Breda Six

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"... the reliability of the aforementioned method is ..., given the state-of the art in research, too uncertain to be applied in a complex criminal case such as the present one. "



# Recent Dutch court decisions (2)

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- 'Investigating judge' did not allow new report by A for prosecution in rape and murder case:

"Apparently there is at this moment not a workable hypothesis"

"We do not see how such a broad investigation could lead to a conclusion about guilt or innocence"

# Recent Dutch court decisions (3)

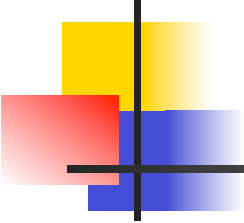
Naive Bayes

- Court disregarded report by Prof. Ton Derksen for defence:

(... the outcome of a Bayesian analysis) "to a large extent depends on the selection and evaluation of the evidence made by Derksen"

"The court does not exclude that this method, provided it is used properly, can be a tool in truth finding, ..."

"... but the final answer to the question whether a charge can be lawfully and convincingly proven, is not a question that is suitable for probabilistic calculations. Answering this question is the task of the judge."



# Generalising my main conclusion

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- A Bayesian expert witness should **refrain** from making modelling decisions on matters that are outside the scope of the expert's expertise
  - And in a full Bayesian modelling of a complex case there are many such decisions
- Generalises to experts on other reasoning methods
  - Logic
  - Argumentation
  - Narrative
  - ...
  - Combinations of reasoning methods