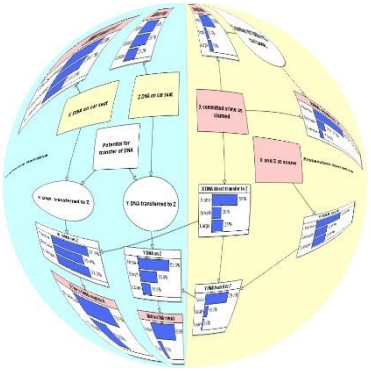


FOS: Probability and Statistics in Forensic Science

Overview of the Programme

1 December 2016

Norman Fenton
Queen Mary University of London and Agena Ltd

Isaac Newton Institute for Mathematical Sciences

Turing Gateway to Mathematics

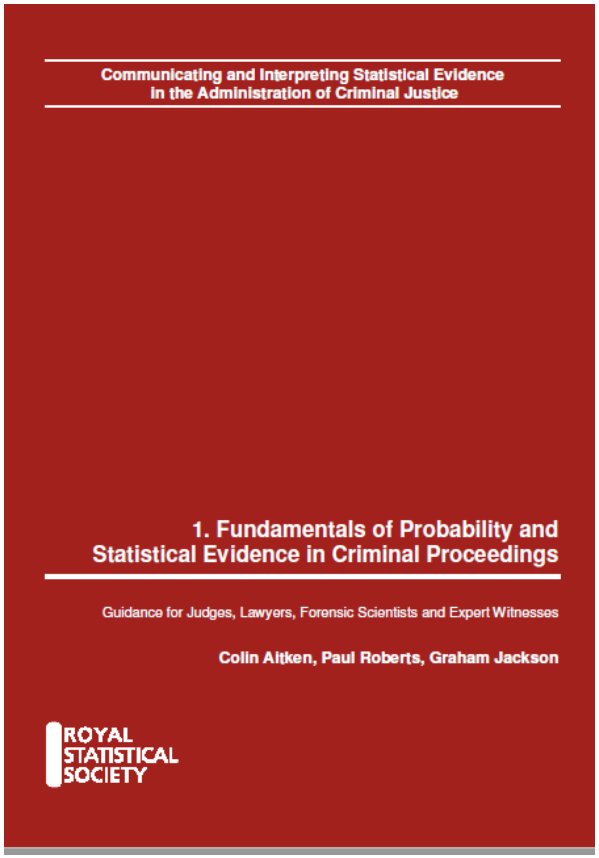
History

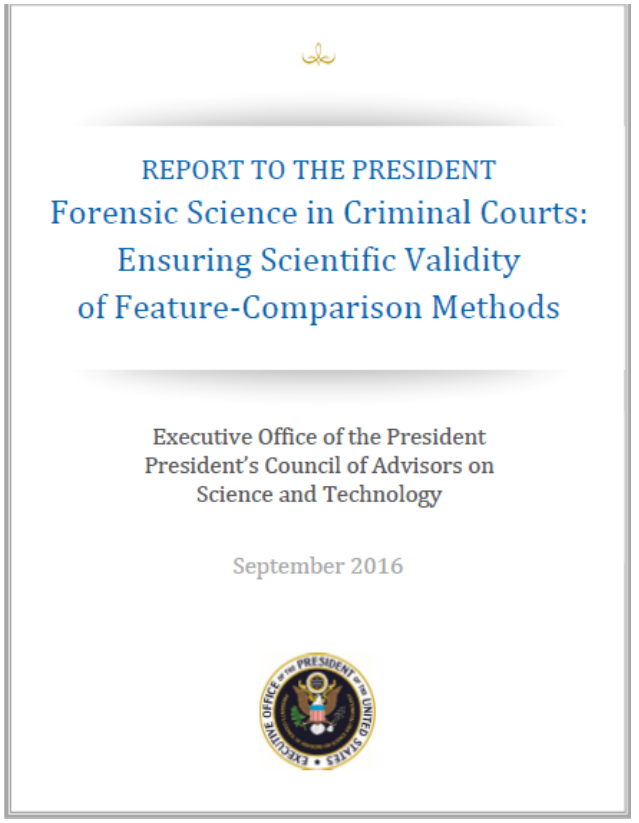
1. **Proposal submitted in 2013 after R v T judgment**
2. **Revised version approved 2014**
3. **Turing Gateway meeting Feb 2016**
4. **Main Programme 21 July – 21 Dec 2016**
   - **Workshop 1: "The nature of questions arising in court that can be addressed via probability and statistical methods", 30/8/16 – 2/9/16**
   - **Workshop 2: "Bayesian Networks and Argumentation in Evidence Analysis", 26/9/16 – 29/9/16**
   - **Workshop 3: "Statistical Modelling of Scientific Evidence", 7/11/16 – 11/11/16**

Key Programme Aims

- **Unlock the potential of Bayes and Bayesian Networks for analysis and presentation of forensic evidence and legal arguments**
- **Address the challenges offered by new DNA methodologies**
- ***Produce a consensual set of public guidelines, specifying conditions under which probabilistic techniques can be used in court without the risk of being challenged on appeal***

To complement/clarify existing guidelines





Our focus is on criminal law

***Contributors*: Frans Alkemade, David Balding, Giulio D'Agostini, Christian Dahlman, Philip Dawid, Jacob de Zoete, Norman Fenton, Joseph Gastwirth, Gerd Gigerenzer, Richard Gill, Therese Graversen, Jane Hutton, Karen Kafadar, David Lagnado, Geoffrey Morrison, Julia Mortera, Leila Schneps, Nadine Smit, William Thompson, Patricia Wiltshire**

Principle 1

Probability is intrinsic in understanding the impact of evidence

- **Law schools and forensic courses should teach basic statistical and probabilistic thinking at least to avoid common fallacies**
- **Statisticians need to understand how legal probability assessments are constrained by the law**
- **Statisticians need to take responsibility for dispelling the so-called paradoxes that 'prove' probability is inconsistent with legal reasoning**

Principle 2

All forensic analysis is subject to potential errors that should be quantified

- **Forensic scientists should attempt to quantify false positive, false negative and other types of error rates**
- **Statisticians should incorporate errors into their models**
- **Legal professionals should expect this information**

Principle 3

Cognitive bias by statisticians, forensic experts or anyone gathering information in a criminal investigation can lead to highly misleading results

- **Forensic scientists should determine minimal amount of contextual information required to make an unbiased but useful analysis.**
- **In 'statistics-led investigation', the court should call upon a qualified statistician, and not, for example, a medical professional simply because the statistics concern medicine.**

Principle 4

Statisticians, forensic scientists and legal professionals may profitably work together

- **Forensic scientists can benefit from working with statisticians when forensic evidence is to be quantified and, in working with legal professionals, they have a responsibility to use language and concepts that are transparent and as clear as possible.**
- **Statisticians must be aware of the assumptions they are making when quantifying forensic evidence, and can benefit from discussing whether those assumptions are realistic or correct with forensic scientists.**
- **Legal professionals will need to master the basics of the probabilistic language, in order to correctly assess the weight of scientific evidence, especially in conjunction with other evidence and present it in a convincing way to judges or juries.**

Principle 5

Much evidence consists of multiple interdependent pieces of information which need to be correctly combined

- **All those involved in evidence analysis at all stages of the criminal law process should be aware of tools such as graphical models that explicitly help the analyst estimate the overall impact of a combination of many dependent pieces of evidence when there are multiple unknown hypotheses (such as source level, activity level and offense level hypotheses).**
- **It may be difficult to introduce the use of such methods directly in court, but they are available options for use by anyone involved in any of the phases of an investigation preceding the trial.**

Principle 6

The Likelihood Ratio is a good tool under simple circumstances, but must be used with great care in complex situations to avoid misleading conclusions

- **When using the LR all reasonable 'alternative' hypotheses should be considered and carefully explained.**

Principle 7

The notion of a "match" is highly loaded and must be used with care

- **Forensic scientists are not necessarily obliged to reduce their presentation of evidence to match/non-match.**
- **Statisticians (and forensic scientists) must take care that the use of the word 'match' is made entirely clear and explicit as to what exactly is matching and how far this goes towards the goal of confirming their hypothesis.**

Principle 8

Any forensic database can be useful, as long as its scope and relevance are well understood

- **Wherever possible (recognizing that commercial organisations may have valuable IP in such work) forensic databases should be 'open source' with publicly available and complete documentation concerning the methodology used in gathering the data**

Principle 9

Software used in forensic analysis should be validated, defensible and documented

- **As results from different software on the same evidence can produce very different results, statisticians should be aware that lawyers can reasonably seize on such differences to discredit both the software and the associated forensic science, and be prepared to fully explain the reasons for the differences.**
- **Software should be accompanied by a document explaining what it does, its methods and assumptions, and information on validation testing. Open-source software will tend to provide such information more readily than privately developed software, but a minimum of information must be presented in order for any software system to be usable in court.**

Principle 10

It is a misconception that science is objective, and subjective assumptions are unscientific

- **Forensic experts need to make explicit all key subjective assumptions being made, along with their justifications and implications. These should be provided in their reports.**
- **Statisticians ditto.**
- **Legal professionals should demand such assumptions if they are not provided by the experts.**

Principle 11

Bayesian reasoning is a valid method for assessing the weight of evidence and combining evidence

- **When using Bayesian reasoning, statisticians should consider ranges of values for prior probabilities and a sensitivity analysis for key outcomes.**
- **Develop methods for determining prior probability in criminal cases.**

Principle 12

Exceptional care is required to communicate statistical analyses of evidence to lay people

- **Statisticians can help expert witnesses and legal professional with a range of methods (e.g. likelihood ratio, use of the verbal scale, graphical models) for presenting probabilistic statements.**
- **Statisticians should disseminate as widely as possible the elements of the principles presented above, using: audio-visual media, particularly short instructional videos with real life examples, collaborations with forensic scientists and lawyers, public lectures, books aimed at the general public, communication with the media, teaching opportunities in schools, universities and law schools.**

Summary

- **FOS has brought together relevant world leading experts from multiple disciplines but with single objective of improving the use of statistics in the law**
- **Already many dozens of new collaborations and breakthroughs, future meetings planned**
- **Evolving guidelines represent excellent opportunity to make a real impact**