CASE STUDY

Newton Gateway to Mathematics

Probability and Statistics in Forensic Science

BACKGROUND

In 2016, the Isaac Newton Institute for Mathematical Sciences (INI) ran a six month Research Programme on Probability and Statistics in Forensic Science. The Programme aimed to try to tackle the problems around the rudimentary and often flawed way that probative value of forensic evidence is presented in Courts. In particular, where probative value is presented in probabilistic and statistical terms there have been numerous instances of misunderstanding leading to miscarriages of justice.

Yet there have been recent significant advances in the range and scale of forensic techniques used to help solve legal cases and emerging mathematical techniques and frameworks have the potential to improve dramatically many aspects of the criminal justice system.

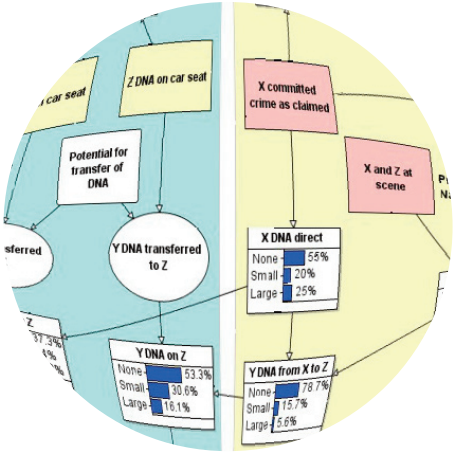
Set against this backdrop, the Gateway arranged a pre-Programme consultation in February 2016, with legal practitioners (Judges, QC's, and Barristers) and academic experts to inform the Programme. This meeting clearly highlighted the need for a consensus as to the uses and limitations of statistics and probability in criminal evidence and how these should be expressed in Court. This was followed later in the year (December 2016) by a full-day Open for Business dissemination event supported by the Criminal Bar Association.

CHALLENGES

The challenges faced by the legal community in this area are significant. As well as the uses and limitations of statistics and probability, maths experts in Court need to communicate in ways that people can understand. The pre-Programme consultation also identified that more independent validation of assumptions and models, including that of software used for DNA analysis, is needed.

The INI Research Programme initially set out to:

- Address the fundamental mathematical, statistical and algorithmic challenges in developing the methods to increase their reliability and ensure their consistency and applicability to real cases.



- Investigate the barriers facing the optimal use of mathematics in the Courtroom which are on three levels: scientific, cultural, and communication (including language and behaviour).
- Produce a consensual set of guidelines specifying conditions under which specific techniques can be used to provide results and reliability estimates that are sufficiently certain to be presented in Court without the risk of being challenged on appeal.

ACTIVITY

The deep engagement with the research community and legal profession afforded by the consultation and the larger dissemination event stimulated some important outputs. The December workshop brought together legal professionals involved in cases where statistics and probability have been used; legal scholars who worked in the area of statistics and the law; mathematicians; statisticians and those from the public sector, including forensic scientists and the Police.

As a result of these activities, a number of promising areas were identified which could help address the challenges around how probative value is presented in probabilistic and statistical terms. Some of these were included in the research carried out in this Research Programme and included the field of Bayesian-based probabilistic frameworks to assist in evaluating forensic evidence and combining this with other types of evidence. Such graphical models have the potential to dramatically improve many aspects of the criminal justice system.

The event provided an update on the latest developments in relevant research and highlighted the use of statistics in law and the role of digital forensics. Various perspectives were presented in the talks which were given by academics, the Metropolitan Police and a Lord Justice of Appeal.

IMPACTS

The workshop provided the opportunity for academia, industry and the public sector to share current questions, practice, and future possibilities regarding statistics and forensic science. It featured presentations and discussions on:

- The development of an agreed set of guidelines and a summary of the core statistical and probabilistic issues which should be assessed when any evidence using estimates is presented.
- Communication and education projects by several organisations, including the Royal Society and the Advocacy Training Council.
- Reviews of mathematical issues in past criminal and civil cases, including common statistical features of appeal cases.
- Exploration of different methodologies, and issues relating to the use and communication of likelihood ratios.

One outcome from the workshop was the development of *Twelve Guiding Principles and Recommendations for Dealing with Quantitative Evidence in Criminal Law*. These include recommendations that are specifically geared towards statisticians, some more towards forensic scientists, and some that are aimed at legal professionals.

The Principles, accompanied by explanations and recommendations are available on the INI website. It is hoped that with further consultation these and other outcomes from the Programme will be disseminated amongst the legal community. This will help people involved in any stage of a criminal investigation to learn how to incorporate scientific results correctly into the body of evidence so as to avoid the errors that have led to so many miscarriages of justice.

"We wanted to ensure that key members of the legal profession were aware of the progress and recommendations we had arrived at with respect to the use of probability and statistics in criminal proceedings. A number of the attendees - including High Court Judges - expressed support for the recommendations and also provided insights that were incorporated into the final version".

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