Call for expressions of interest in establishing a network for multidisciplinary research into quantitative approaches to forensic analysis and inference

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The current document asks for expressions of interest from researchers. The plan is to form a network that will apply for major research funding in one or two years from now (i.e, in 2019 or 2020). I believe that before we can write a successful joint funding application we need to begin working together as a team and understand how we can effectively collaborate on achieving common goals. With that in mind, we plan to hold a number of meetings for network members prior to applying for funding.

Potential funding applications could include:

- Engineering and Physical Sciences Research Council (EPSRC) Interdisciplinary Research Collaboration

- Leverhulme Research Centre

- Leverhulme Research Leadership Awards (for building research teams)

- Leverhulme Visiting Professorships (to fund a 3 to 12 month visits to the UK by eminent researchers from overseas)

- Marie Skłodowska Curie Research and Innovation Staff Exchange Scheme (for collaboration between academia and industry across EU funding scheme member countries)

- Marie Skłodowska Curie Individual Fellowships (for funding postdoctoral research posts)

- Marie Skłodowska Curie Innovate Training Network (for funding doctoral research posts)

- Newton Advanced Fellowships (for collaboration between UK based researchers and researchers from developing countries)

- Isaac Newton Institute for Mathematical Sciences (programme of up to 6 months with up to 20 participants in residence at the Institute, plus workshops attended by larger numbers of participants)

The plan described below reflects my vision. It is subject to improvement and modification depending on the composition of the team that is formed. I am happy to receive suggestions for improvements and modifications.

Please contact me if you are interested in becoming part of the team or want to know more. Being part of the network does not commit you to being part of any particular funding proposal. Please let me know of others who you think would be good candidates to invite to be members of the network.

I will revise this document as more members are added to the team. New members will be asked to provide information parallel to that already supplied by existing members.

Thanks

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Proposed network for multidisciplinary research into quantitative approaches to forensic analysis and inference

Problems

There has been severe criticism of current practice in many branches of forensic science, much of which produces logically-untenable conclusions based on untested non-transparent non-replicable subjective judgement. Criticism has appeared in official reports, e.g., the 2009 National Research Council Report[1] and the 2016 report by President Obama's Council of Advisors on Science and Technology (PCAST),[2] and in October 2017 was even featured on the popular HBO comedic current affairs programme Last Week Tonight with John Oliver.[3]

PCAST stated that:

> neither experience, nor judgment, nor good professional practices (such as certification programs and accreditation programs, standardized protocols, proficiency testing, and codes of ethics) can substitute for actual evidence of foundational validity and reliability. The frequency with which a particular pattern or set of features will be observed in different samples, which is an essential element in drawing conclusions, is not a matter of "judgment." It is an empirical matter for which only empirical evidence is relevant. Similarly, an expert's expression of *confidence* based on personal professional experience or expressions of *consensus* among practitioners about the accuracy of their field is no substitute for error rates estimated from relevant studies. For forensic feature-comparison methods, establishing foundational validity based on empirical evidence is thus a *sine qua non.* Nothing can substitute for it.[4]

Proposed solution

We see the solution to these problems as the adoption of quantitative approaches that include:

- transparent and explicit use of the likelihood ratio framework to quantify strength of evidence;[5]

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[1] National Research Council (2009). *Strengthening forensic science in the United States: A path forward.* Washington: National Academies Press. http://www.nap.edu/catalog.php?record_id=12589

[2] President's Council of Advisors on Science and Technology (2016). *Forensic science in criminal courts: Ensuring scientific validity of feature-comparison methods.* https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/PCAST/pcast_forensic_science_report_final.pdf

[3] http://www.sciencealert.com/john-oliver-has-busted-open-the-misconceptions-behind-forensic-science

[4] PCAST (2016) p 6. Emphasis in original.

[5] As recommended by the European Network of Forensic Science Institutes: Willis S.M., McKenna L., McDermott S., O'Donell G., Barrett A., Rasmusson A., Nordgaard A., Berger C.E.H., Sjerps M.J., Lucena-Molina

- calculation of likelihood ratios based on relevant data, quantitative measurements, and statistical models;

- direct reporting of the likelihood-ratio output of the statistical models; and

- empirical testing of the performance of the forensic analysis system under conditions which reflect those of the case to which it is applied.

As argued in Morrison & Thompson (2017)[6] and Morrison (2018),[7] such quantitative approaches are logically correct, are transparent and replicable, are intrinsically resistant to cognitive bias, and the empirical test results provide a rational basis on which a court can make admissibility decisions. Such quantitative approaches would result in expert testimony that would in principle be able to meet the rigorous applications of admissibility criteria such as those of US Federal Rule of Evidence 702 and the *Daubert* trilogy of Supreme Court rulings,[8] or of England & Wales Criminal Practice Directions 19A[9] (actual admissibility for a given case would be determined by the court).

Impediments to progress

Substantial progress in implementing quantitative approaches has been made in some branches of forensic science, but in many branches of forensic science quantitative approaches have to-date only been adopted by a minority of practitioners. Impediments include cultural resistance within the communities of practitioners, current lack of appropriate data and difficulty in obtaining appropriate data, insufficient research on what properties to measure and how to measure them, insufficient research on appropriate statistical models for calculating likelihood ratios given the types of measurements made, and difficulty in communicating the meaning of likelihood ratios to the courts.

J.J., Zadora G., Aitken C.G.G., Lunt L., Champod C., Biedermann A., Hicks T.N., Taroni F. (2015). *ENFSI guideline for evaluative reporting in forensic science*, European Network of Forensic Science Institutes. http://enfsi.eu/wp-content/uploads/2016/09/m1_guideline.pdf

[6] Morrison G.S., Thompson W.C. (2017). Assessing the admissibility of a new generation of forensic voice comparison testimony, *Columbia Science and Technology Law Review*, 18, 326–434. http://www.stlr.org/cite.cgi?volume=18&article=morrisonThompson

[7] Morrison G.S. (2018). Admissibility of forensic voice comparison testimony in England and Wales. *Criminal Law Review*, (1), 20–33.

[8] Federal Rules of Evidence as amended Apr. 17, 2000, eff. Dec. 1, 2000; Apr. 26, 2011, eff. Dec. 1, 2011. Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579 (1993); General Electric Co. v. Joiner, 522 U.S. 136 (1997); Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999).

[9] Criminal Practice Directions [2015] EWCA Crim 1567

Proposal to promote further progress

In order to promote further progress, we propose the establishment of a network for multidisciplinary research into quantitative approaches to forensic analysis and inference. This will bring together world-renowned and up-and-coming researchers with backgrounds in multiple fields including:

- forensic inference and statistics

- forensic speech science

- forensic analysis of stabbing wounds

- forensic analysis of toolmarks in injury and dismemberment

- forensic analysis of gunshot impact

- blood pattern analysis

- cognitive psychology applied to forensic practice and communication

- evidence law

- TO BE EXPANED

Together, these researchers will provide the critical mass of overlapping and complementary knowledge and skills necessary to make meaningful progress toward solving the problems described above. The multidisciplinary nature of the team will foster research into philosophical, psychological, and legal principles relevant across all branches of forensic science, and the implementation of those principles in multiple branches of forensic science. The multidisciplinary nature of the team will also allow knowledge and skills gained from working in one branch of forensic science to be effectively transferred and adapted for use in other branches, thus breaking down traditional silos. This will include transfer of skills and knowledge related to defining relevant populations and collecting relevant data, statistical modelling tools for quantifying strength of evidence, and protocols and metrics for empirical validation of system performance.

Forensic use of DNA is, perhaps, the most advanced branch of forensic science in terms of adoption of quantitative approaches. Forensic use of DNA is not without its problems, but this branch of forensic science is already well served by researchers around the world, including at a Leverhulme Research Centre for Forensic Science in Dundee, Scotland. To avoid replication, the scope of our proposed research network will therefore exclude DNA. From a statistical perspective, DNA is peculiar in that at the molecular level the data are invariant and discrete, whereas in most branches of forensic science the data are continuous and have within-source variability. We will focus on the many other branches of forensic science which share the

problems associated with the latter type of data and which need greater support in order to complete the transition to quantitative approaches.

The proposed research network will focus on evaluation of evidence for potential presentation in court, i.e., analyses that are intended to meet legal admissibility standards. In principle, the same standards should apply even if, as is often the case, the results of such analyses are not actually presented in court but do contribute to pre-trial decisions such as decisions related to plea deals. The focus of the proposed research network will not be on investigative applications, i.e., applications that are primarily or only intended for use in earlier stages of law-enforcement investigations.

The proposed research network is expected to begin with a geographical nexus in the English Midlands, with researchers from multiple institutions in this region meeting on a regular basis. The research network is also expected to expand to include researchers from other parts of the world, with less frequent physical meetings, but with teleconferencing used to facilitate regular interaction.

Team members

The following individuals have expressed an interest in being members of the network. The current document is preliminary and the inclusion of any individual's name does not imply formal endorsement by their institution.

Dr Geoffrey Stewart Morrison

Associate Professor of Forensic Speech Science, Centre for Forensic Linguistics, Aston University

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Morrison is an interdisciplinary researcher with more than 10 years' experience working in forensic inference and statistics and in forensic speech science. He has published in speech science, forensic science, and law journals. He has been a Subject Editor and Guest Editor for the peer-reviewed journals *Speech Communication* and *Science & Justice*. He was lead author, in collaboration with 18 others, of the first response to the PCAST report that was published in a peer-reviewed journal.[10] His past appointments include Director of the Forensic Voice Comparison Laboratory, School of Electrical Engineering & Telecommunications, University of New South Wales; Scientific Counsel, Office of Legal Affairs, INTERPOL; and Simons

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[10] Morrison G.S., Kaye D.H., Balding D.J., Taylor D., Dawid P., Aitken C.G.G., Gittelson S., Zadora G., Robertson B., Willis S.M., Pope S., Neil M., Martire K.A., Hepler A., Gill R.D., Jamieson A., de Zoete J., Ostrum R.B., Caliebe A. (2017). A comment on the PCAST report: Skip the "match"/"non-match" stage. *Forensic Science International*, 272, e7–e9. http://dx.doi.org/10.1016/j.forsciint.2016.10.018

Foundation Visiting Fellow, Probability and Statistics in Forensic Science Programme, Isaac Newton Institute for Mathematical Sciences. He has collaborated on research and development projects with law enforcement agencies in Australia and Europe, and has forensic casework experience in Australia, Canada, the United Kingdom, and the United States.

Morrison has worked on expanding understanding of the application of the likelihood ratio framework, including the need for careful consideration of what constitutes the relevant population, and the need for transparent communication of choices made. He has also worked on popularising appropriate metrics for validation of forensic analysis systems, and on increasing the understanding that, in order for the results to be meaningful, empirical test data must be sufficiently reflective of the conditions of the case under consideration (he is currently a Guest Editor for a journal special issue on validating forensic voice comparison systems under forensically realistic conditions). His research has explored the performance of different quantitative measurements made on voice recordings and different statistical models applied to the resulting data. Voice recordings in forensic cases are often of poor quality and have substantial mismatch due to differences in speaking style and recording conditions (the latter including background noise, reverberation, transmission through telephone systems, and being saved in compressed formats). This results in very challenging data. Morrison has taken knowledge and skills gained in working in forensic speech science and applied them to research on evaluation of forensic evidence in general, and, in collaboration with others, to forensic data related to paint colour, fingerprints, face images, and glass fragments. He has also published on the admissibility of forensic evidence from a scientific perspective, attempting to assist lawyers to understand relevant scientific concepts, and attempting to assist forensic practitioners to understand how to meet legal admissibility standards.

As a member of the proposed research network Morrison plans to collaborate with other members to continue improving the understanding of the likelihood ratio framework among forensic researchers, forensic practitioners, and lawyers; to collaborate on adapting, developing, and applying statistical models to data in multiple branches of forensic science; and to collaborate on empirical validation of forensic analysis systems in multiple branches of forensic science.

Prof Sarah Hainsworth FREng

Pro-Vice-Chancellor and Executive Dean of the School of Engineering and Applied Science, Aston University

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In addition to being Pro-Vice-Chancellor and Executive Dean of the School of Engineering and Applied Science, Hainsworth is Director of the Forensic Engineering Laboratory at Aston University. She was previously Professor of Materials and Forensic Engineering and Head of the Department of Engineering at the University of Leicester. She conducts quantitative

research on the forces involved in stabbing with knives, broken glass bottles, and other implements, and on characterising tool marks in injury and dismemberment using microscopy and micro-computed tomography. She has published in the *International Journal of Legal Medicine* and in *Forensic Science International*. Along with Prof Sue Black, Prof Guy Rutty, and Dr Grant Thomson, she is editor of the book *Criminal Dismemberment: Forensic and Investigative Analysis*.

Hainsworth also conducts forensic casework analyses, and has provided reports and testified as an expert witness in court. In 2013 she analysed wound marks found on the recently-discovered skeleton of King Richard III, which helped establish the manner of his death. She is a recipient of the American Academy of Forensic Sciences' Andrew H Payne Jr Special Achievement Award in recognition of her contributions to forensic engineering sciences, and is a Fellow of the Royal Academy of Engineering.

As a member of the proposed research network Hainsworth plans to collaborate with other members on developing databases and statistical models for addressing strength of evidence questions within the likelihood ratio framework, such as the probability of observing a particular wound pattern if it were the result of a deliberate attack versus of it were the result of an accident. Her plans include collaborative training of doctoral students.

Dr Patrick Geoghegan

Lecturer in Biomedical Engineering, School of Life and Health Sciences, Aston University

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Geoghegan has a Masters in Aeronautical Engineering and a PhD in Biomedical Engineering. Following his PhD he had a postdoctoral position at The Institute of Environmental Science and Research (ESR) Forensic Service Centre in New Zealand. His forensic research interests include blood pattern analysis (BPA) and cranial gunshot impacts. His work has concentrated on developing quantitative knowledge that can aid crime scene investigation. He has published several papers in the *International Journal of Legal Medicine* and in *Forensic Science International*.

As a member of the proposed research network Geoghegan hopes to contribute his engineering expertise to collaborative work with others, particularly his expertise in high speed imaging and image analysis. He also plans to continue his work on blood stain patterns caused by different weapons. Large datasets need to be constructed so that better statistical models can be developed and more rigorous conclusions reached. This will benefit greatly from collaboration with members of the network who have expertise in statistical modelling for evaluation of forensic evidence.

Dr Robert Nash

Senior Lecturer in Psychology, Department of Psychology, Aston University

http://robert-nash.com/

Nash is a cognitive psychologist whose work focuses on legal and forensic aspects of human memory and cognition. He has published empirical work on topics including false memories, investigative interviewing techniques, eyewitness memory, and false allegations and confessions. Nash is a member of the editorial board of the journal *Psychology, Crime & Law*, a governing board member of the Society for Applied Research in Memory and Cognition, and was an editor of the 2017 book *False and Distorted Memories*, published by Psychology Press.

As a member of the proposed research network Nash plans to collaborate with other members on research related to forensic decision-making, in particular, research on the influence of cognitive bias and how to minimize it. He also plans to collaborate on research aimed at increasing the effectiveness of the communication between forensic practitioners and triers of fact, especially the communication of strength of forensic evidence.

Mr Nik Smith

Manager, Lancashire Forensic Science Academy (LFSA)

http://lfsa.co.uk/

Lancashire Forensic Science Academy (LFSA) is a collaboration between the Police Crime Commission (PCC), Lancashire Constabulary, and the University of Central Lancashire's School of Forensic and Applied Sciences. Its purpose built facilities (based within constabulary headquarters) are designed to create an optimum environment to meet professional development and training needs. Crime scene investigators, forensic science experts, academics, and students benefit from shared expertise whilst working alongside each other to research, investigate and deliver forensic science services in Lancashire.

Smith has been the manager of the LFSA since January 2018. Prior to this, he was a Senior Forensic Practitioner. He joined the Forensic Science Service (FSS) in 1996 working as a DNA analyst on the National DNA Database in Birmingham before transferring to the North West Forensic Science Laboratory in Chorley, where he trained as an assistant forensic scientist within the evidence recovery unit, then as a Reporting Officer (expert witness) in biological evidence and DNA interpretation. He was a scene attending scientist within the major incident team at the Chorley Laboratory, and was the local Lead Scientist for Blood Pattern Analysis (BPA) and was part of a team responsible for BPA quality and training across the country. More recently he was Lead Scientist in the area of Case Assessment and Interpretation (CAI) at Cellmark Forensic Services. He has also spent several years as a Lecturer in Forensic Science at the University of Central Lancashire. Smith has been involved in a large number of complex

and often high profile forensic investigations, and has provided expert evidence on many occasions including at the Central Criminal Court (Old Bailey).

Planned involvement in the network: TBA

Prof Paul Roberts

Professor of Criminal Jurisprudence, Faculty of Social Sciences, University of Nottingham

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Roberts researches in the fields of criminal justice, evidence, criminology and criminal law, with particular emphasis on philosophical, comparative and international perspectives.

As well as being Professor of Criminal Jurisprudence at the University of Nottingham, Roberts is an advisor to the England & Wales Forensic Science Regulator, a member of the Royal Statistical Society's Working Group on Statistics and the Law, a member of Northumbria University's Centre for Forensic Science, and a member of the Board of Foreign Advisors of the Institute of Evidence Law and Forensic Science of China University of Political Science and Law. He has served as a consultant to the Crown Prosecution Service and to the Law Commissions of England & Wales and of Scotland.

He is an editorial board member for *International Commentary on Evidence*; *Criminal Law & Philosophy*; *Law, Probability and Risk*; and *Law and Philosophy*. He was also a founding editorial board member of *The International Journal of Evidence and Proof*, serving as Reviews Editor (1995–2005) and General Editor (2005–2009). His publications include Roberts & Zuckerman, *Criminal Evidence* (OUP, 2/e 2010), and Aitken, Roberts, Jackson, *Fundamentals of Probability and Statistical Evidence in Criminal Proceedings* (Royal Statistical Society, 2010).

Planned involvement in the network: TBA