

1. PhD: Uncertainty quantification and propagation through complex chains of computational models

A PhD scholarship on the interface of Statistics and Computational Modelling, fully funded at UK/EU level, is available for suitably qualified students at the University of Southampton as part of the Centre for Doctoral Training in Next Generational Computational Modelling (<http://www.ngcm.soton.ac.uk>). The project is supervised by Professor David Woods (Southampton) and Dr Veronica Bowman (Defence Science and Technology Laboratory).

This project will explore how predictions can be made, and assessed, through complex chains of computer models. For example, consider predicting casualties from the release of a biological or chemical agent. Modelling such outcomes requires linking predictions of meteorology, atmospheric dispersion, sensor properties and dose response. Each model will be subject to uncertainties including uncertain inputs, uncertain tuning parameters, and uncertain physical mechanisms. Understanding the reliability and accuracy of the overall predictions of casualties requires understanding how the uncertainties from the individual models will propagate and combine.

Naively, simulation studies could be used to understand the uncertainty in predictions. However, typically the models will be too computationally expensive for such studies to be feasible. Furthermore, such studies would ignore some sources of error, such as model inaccuracies. In addition, there is a need to combine the model outputs with any available real data, at any of the stages of the model chain, to help calibrate and validate the predictions. This project will develop the necessary methodology for (i) construction of accurate statistical emulators, or surrogates, of chains of models to reduce computational cost; (ii) data fusion from a variety of models and data sources of different fidelities; and (iii) the necessary algorithms to allow computationally feasible Bayesian inference for multi-model chains.

The research will be motivated by, and demonstrated on, multi-model chains from Dstl which are used for hazard response, hazard management and government procurement programmes. The research will therefore have a clear and tangible application to real world problems.

The University of Southampton's £10 million Centre for Doctoral Training in Next Generation Computational Modelling was launched in November 2013 and is jointly funded by EPSRC, the University of Southampton, and its partners. The NGCM brings together world-class simulation modelling research activities from across the University of Southampton and hosts a 4-year doctoral training programme that is the first of its kind in the UK.

If you wish to discuss any details of the project informally, please contact Professor David Woods, Southampton Statistical Sciences Research Institute, Email: [D.Woods@southampton.ac.uk](mailto:D.Woods@southampton.ac.uk), Tel: +44 (0) 2380 595117.

Details of how to apply are available at <http://www.ngcm.soton.ac.uk/apply.html>

## 2. PhD Studentship in Biostatistics at Southampton

A studentship is available in the statistics group within Mathematical Sciences of the University of Southampton on a specified project entitled "A capture-recapture modelling approach with applications to surveillance using validation information". This project is a joint project with the Animal Health Veterinary Laboratory Agency (AHVLA) who is co-sponsoring the project.

Full funding is available for 3 years and pay home/EU fees in full amount as well as a yearly stipend around on Research Council level (roughly £13,000). The project is on the use of capture-recapture methodology as an assessment tool for the completeness of veterinary surveillance streams in the UK.

### Project details:

One of AHVLA's key aims is to rapidly detect new and emerging diseases. As part of its efforts to fulfill this aim, it performs scanning surveillance through its network of regional laboratories, with results from farm testing and post-mortems recorded in the FarmFile database. Through this database, AHVLA monitors the apparent prevalence of a number of endemic diseases and performs syndromic surveillance through monitoring of diagnosis not reached cases. As part of AHVLA's efforts to improve the completeness and the power of its scanning surveillance to detect new/emerging diseases, it is intending to obtain data on animal infections and disease through additional sources, including industry data (e.g. British Pig Health Scheme) and other data (e.g. fallen stock). However, it is unclear how best to integrate these data sources with FarmFile. Capture recapture models are able to provide estimates of true disease occurrence in a population by integrating data from multiple sources. The objective of this study is to apply capture recapture methods to data from FarmFile and other sources to achieve a more valid and reliable estimate of the number of hidden cases and thus correct prevalence estimates for undercount. The central methodologic idea is to use a regression approach of the ratios of neighboring frequencies which often shows a linear pattern so that a regression model appears suitable. Having the model estimated it is then possible to predict the frequency of zero counts (missing cases). In addition, bringing in additional sources allows a more stable estimation of the frequency of zero counts since the this frequencies has been observed in those parts of the data where the additional source(s) have identified. This can be expected to lead to an improved estimator of zero-counts. The major application area will be the Farmfile database supplemented by other sources such as the British Pug Health Scheme or fallen stock. However, the methodology is also useful in a diverse setting of applications ranging from public health, criminology, social sciences to quantitative linguistics. The proposed project fits excellently into the university highlighted areas of life sciences, health and well-being. Surveillance of population health, disease outbreaks and food-security violated epidemics are of current prime interest to the society. Also, chronic diseases such as cancer are monitored by cancer registers which are prone to undercount which can be determined by means of capture-recapture. The project would support and supplement the ongoing activities in diagnostic methodology and capture-recapture research.

The project would be also linked to existing international collaboration on capture-recapture research to the University of Utrecht (Professor Peter van der Heijden), University Sapienza Rome (Professor Marco Alfo), Cornell University (Professor John Bunge), and the King Mongkut University of Technology North-Bangkok (Professor Sa-  
aat Niwitipong).

The research student will join the research environment of the Southampton Statistical Research Institute (S3RI), comprising various statistics groups at the University of Southampton including Mathematical Statistics, Social Statistics and Medical/Bio-Statistics.

Contacts: for further details and expressions of interest please contact Professor Dankmar Böhning, Deputy Director of S3RI (d.a.bohning@soton.ac.uk), Phone: 023 8059 6712 or Dr Mark Arnold, Head of Biomathematics and Statistics Unit, AHVLA (Mark.Arnold@ahvla.gsi.gov.uk)