

<b>Project title</b>	Tools for Multivariate Bayesian Analysis with Elicited Priors
<b>Principal supervisor</b>	Fadlalla Elfadaly
<b>Second supervisor</b>	Yonas Weldeselassie
<b>Discipline</b>	Statistics
<b>Research area/keywords</b>	Bayesian statistics, elicitation method, prior-posterior analysis
<b>Suitable for</b>	Full time applicants

### **Project background and description**

Novel methods for quantifying expert opinion about new multivariate prior distributions for Bayesian analysis have recently been proposed in the literature. These include the elicitation of multivariate normal prior distributions for generalized linear and piecewise-linear models (Garthwaite et al, 2013; Elfadaly and Garthwaite, 2015); eliciting Connor-Mosimann and copula prior distributions for the parameters of multinomial models (Elfadaly and Garthwaite, 2013, 2017; Wilson, 2018); and eliciting logistic normal prior distributions for multinomial models that contain explanatory covariates (Elfadaly and Garthwaite, 2020). The methods have been implemented in interactive graphical software tools that help an expert to quantify his or her opinion (<http://statistics.open.ac.uk/elicitation>).

However, complete prior-posterior Bayesian statistical analyses that use the new multivariate prior distributions with real datasets are yet to be developed. The current proposed PhD project will investigate and suggest new appropriate methods for producing clear graphical representations and useful descriptive statistics as well as flexible and interactive ways of handling these multivariate prior distributions with the resulting posterior and/or predictive distributions. Prior-data conflict and prior modification based on the available data will also be considered. Software tools will be designed to implement the newly proposed methods, preferably in the form of Shiny R applications, to facilitate and maximise the usability and applicability of the elicited distributions in practice.

The project involves a combination of methodological and computational work. New methods will need to be developed, tested and implemented in software applications. The suitable candidate is expected to have a solid knowledge of statistics from a good degree with a substantial statistical component. The work requires a substantial amount of computing and programming, mainly in R. But previous knowledge of R is not essential.

### **Background reading/references**

- Elfadaly, F. G. and Garthwaite, P. H. (2013). Eliciting Dirichlet and Connor-Mosimann Prior Distributions for Multinomial Models. *TEST*, **22**, 628-646.
- Elfadaly, F. G. and Garthwaite, P. H. (2015). Eliciting Prior Distributions for Extra Parameters in Some Generalized Linear Models. *Statistical Modelling: An International Journal*, **15**, 345-365.

- Elfadaly, F. G. and Garthwaite, P. H. (2017). Eliciting Dirichlet and Gaussian Copula Prior Distributions for Multinomial Models. *Statistics and Computing*, **27**, 449-467.
- Elfadaly, F. G. and Garthwaite, P. H. (2020). On Quantifying Expert Opinion about Multinomial Models that contain Covariates. *Journal of the Royal Statistical Society - Series A*, **183**, 959-981.
- Garthwaite, P. H., Al-Awadhi, S. A., Elfadaly, F. G., and Jenkinson, D. J. (2013). Prior Distribution Elicitation for Generalized Linear and Piecewise-linear Models. *Journal of Applied Statistics*, **40**, 59-75.
- Wilson, K. J. (2018). Specification of Informative Prior Distributions for Multinomial Models using Vine Copulas. *Bayesian Analysis*, **13**, 749-766.