Software for generalized Bayesian Inference

An object-oriented R implementation of generalized iLUCK-models

Gero Walter
Department of Statistics,
Ludwig-Maximilians-University Munich
gero.walter@stat.uni-muenchen.de

Abstract

In the process of practioners adopting novel statistical methods for their analyses, the availability of a software implementation plays a crucial role. In recent years, the statistical environment R [2] is more and more used for every-day analyses in academia and inside corporations. It has also become a de facto standard among statisticians for software implementations of novel methods, which can be easily distributed by means of so-called *packages* via the online repository CRAN (Comprehensive R Archive Network). This poster presents an R implementation of generalized iLUCK-models that is (about to be) released as an R package on CRAN.

Generalized iLUCK-models [3] are a class of imprecise probability models that generalize the framework of Quaeghebeur and de Cooman [1] for imprecise Bayesian inference in canonical exponential families, which includes the Imprecise Dirichlet Model (IDM) under prior information. This framework allows for a powerful inference calculus where ambiguity in the prior information can be represented by a set of priors $\mathcal{M}_\theta$ (often called credal set). The priors in $\mathcal{M}_\theta$ are described by a parameterization in terms of two parameters $y^{(0)}$ and $n^{(0)}$ that (i) provides a unified description of conjugate priors to arbitrary sample distributions that form a canonical exponential family and that (ii) makes an easily tractable inference procedure possible due to the linearity in the update step. By varying the parameter $y^{(0)}$ in a set $\mathcal{Y}^{(0)}$, the set of priors is created. In [4], Quaeghebeur and de Cooman's framework was generalized to a class of models called iLUCK-models to implement this method also in linear regression models, which are omnipresent in statistical analysis. However, iLUCK-models do not use the full expressive power of imprecise probability due to their insensitivity to prior-data conflict. By allowing a variation of the other prior parameter $n^{(0)}$ in some set $\mathcal{N}^{(0)}$, we defined a class of models called generalized iLUCK-models that overcome this deficiency through a flexible weighting of prior and data information.

The presented implementation is programmed as a class system that models the hierarchy between the unified description of conjugate priors and a concrete conjugate prior to a certain sample distribution. A basic framework for the definition, display and updating of generalized iLUCK-models in terms of the unified description is provided, which can be easily extended to give inferences for arbitrary sample distributions. As a reference implementation, the extensions for inference from a scaled normal distribution $\mathrm{N}(\mu, 1)$ are provided.

Keywords. Software, R, generalized Bayesian inference, Imprecise Dirichlet Model (IDM), prior-data conflict.

References

[1] E. Quaeghebeur and G. de Cooman. Imprecise probability models for inference in exponential families. In F.G. Cozman, R. Nau, and T. Seidenfeld, eds., *ISIPTA '05*, p. 287–296, 2005.

[2] R Development Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, 2008. See also: `http://www.R-project.org`, `http://www.cran.R-project.org`

[3] G. Walter and T. Augustin. Imprecision and prior-data conflict in generalized Bayesian inference. *Journal of Statistical Theory and Practice: Special Issue on Imprecision*, 2009. To appear.

[4] G. Walter, T. Augustin, and A. Peters. Linear regression analysis under sets of conjugate priors. In G. de Cooman, J. Vejnarová, and M. Zaffalon, eds., *ISIPTA '07*, p. 445–455, 2007.