Statistical Science
2017, Vol. 32, No. 1, 36–40
DOI: 10.1214/16-STS603
Main article DOI: 10.1214/16-STS576

How Principled and Practical Are Penalised Complexity Priors?

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1. INTRODUCTION

This note discusses the paper "Penalising model component complexity" by Simpson et al. (2017). We acknowledge the highly novel approach to prior construction and commend the authors for setting new all-encompassing principles that will certainly impact Bayesian modelling. We also perceive the potential connection with other branches of the literature. Nonetheless, we remain uncertain as to what extent the principles exposed in the paper can be developed outside specific models, given the lack of precision in the said principles. The very notions of model component, base model and overfitting prior, are for instance much more conceptual than mathematical. We thus fear the advocated concept of penalised complexity may not reach further than extending first-guess priors into larger families, thus failing to establish reference priors on a novel and sound ground.

> "On the other end of the hunt for the holy grail, 'objective' priors are data-dependent and are not uniformly accepted among Bayesians on philosophical grounds."

The most sensitive aspect of Bayesian modelling is undoubtedly the call to a prior distribution. From Fisher onwards (Zabell, 1992), up to this very day (Martin and Liu, 2015, Seaman, Seaman and Stamey, 2012), the concept of prior distribution has been criticised as being alien to the sampling model and critics have pointed out the arbitrariness of some or all aspects of chosen priors. This is most prominent in weakly informative settings when the context is deemed too poor to return an expert opinion, and thus build an informed prior. The whole branch of so-called objective (aka, reference or noninformative) Bayesian statistics (Berger, Bernardo and Sun, 2009) has been constructed to answer and bypass such criticisms, clearly not achieving a complete silencing of such criticisms.

> "Prior selection is the fundamental issue in Bayesian statistics. Priors are the Bayesian's greatest tool, but they are also the greatest point for criticism: the arbitrariness of prior selection procedures and the lack of realistic sensitivity analysis (...) are a serious argument against current Bayesian practice."

In this paper, the authors aim at providing some form of prior robust modelling, rather than noninformative principles that are so delicate to specify, as shown by the literature (Liseo, 2005). It is a highly timely and pertinent paper on the selection and construction of priors. It also shows that the field of "objective" Bayes theory is still central to Bayesian statistics and this constitutes a great argument to encourage more Bayesian researchers to consider this branch of our field. This attempt is most commendable and we hope it will induce others to enlarge and deepen the work in this direction.

The paper starts with a review of prior selection in connection with levels of prior information. The authors then advance some desirable principles for the construction of priors on a collection of models that is restricted to hierarchical additive models with a latent structure. Connections with other approaches abound, from Jeffreys' priors and the asymptotic developments of Bochkina and Green (2014), to the nonlocal priors of Johnson and Rossell (2010), and sparsity priors. (However, this may constitute the more tentative part of the paper.) The applications are the disease mapping model of Besag et al. (1991) and the multivariate probit model.

2. PC PRIORS

> "Most model components can be naturally regarded as a flexible version of a base model."

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