

Quantification of prior impact in terms of prior effective historical and current sample size

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Bayesian methods are becoming increasingly popular in clinical trials due to their flexibility in adaptive designs and their capability of borrowing historical information through elicitation of informative prior distributions. However, prior informativeness is often difficult to quantify and communicate. In this context, the concept of the prior effective sample size (ESS) has proven to be particularly convenient, equating the information provided by a prior to a given sample size.

As prior information can - practically or hypothetically - arise from a certain number of historical samples, the common approach equates the prior ESS to the number of samples in such historical data set. This measure is however independent from the newly observed data, and thus would not capture an actual “loss of information” induced by the prior in case of prior-data conflict. This motivates the work of Reimherr et al (2014) who propose to relate the information of the prior to a number of (virtual) samples from the current data model. We build on their approach to introduce the prior effective current sample size (ECSS), tailored to the application in a Bayesian clinical trial design setting.

We illustrate the utility of the approach by applying it to a two-stage adaptive randomization strategy, which has been the focus of several recent publications. Thereby, the number of patients recruited in the second stage is adjusted depending on the prior effective sample size at an interim analysis. In this setting, we argue that the ECSS is the appropriate data-dependent measure, as the final aim is to save current patients (as opposed to historical patients used to elicit a prior) from randomization. Special emphasis is put on robust mixture priors and power priors which dynamically adapt to prior-data conflict and are common prior choices in such designs. In this context, quantification of “posterior effective sample sizes”, i.e. the sample size induced by the prior conditional on data (after adaptation to prior-data conflict), is often of interest. There is no consensus on how to obtain such data-dependent measure e.g. for mixture priors in the traditional framework to prior effective sample sizes. We argue that the ECSS may help to fill this gap and show that further insights can be provided by estimation of the ECSS of such priors.

We conclude that the ECSS provides valuable insights into the impact of a prior and that it may serve as a useful tool for its communication. An efficient R implementation is being developed.

Reimherr, M., Meng, X.-L., and Nicolae, D. L. (2014). Being an informed bayesian: Assessing prior informativeness and prior likelihood conflict. arXiv preprint arXiv:1406.5958 .