Annals of the Institute of Statistical Mathematics (2021) 73:891–920
https://doi.org/10.1007/s10463-020-00770-3

Asymptotic theory of dependent Bayesian multiple testing procedures under possible model misspecification

Noirrit Kiran Chandra[1] · **Sourabh Bhattacharya**[2]

Received: 13 May 2020 / Revised: 4 September 2020 / Accepted: 29 September 2020 /
Published online: 13 November 2020

Abstract

We study asymptotic properties of Bayesian multiple testing procedures and provide sufficient conditions for strong consistency under general dependence structure. We also consider a novel Bayesian multiple testing procedure and associated error measures that coherently accounts for the dependence structure present in the model. We advocate posterior versions of FDR and FNR as appropriate error rates and show that their asymptotic convergence rates are directly associated with the Kullback–Leibler divergence from the true model. The theories hold regardless of the class of postulated models being misspecified. We illustrate our results in a variable selection problem with autoregressive response variables and compare our procedure with some existing methods through simulation studies. Superior performance of the new procedure compared to the others indicates that proper exploitation of the dependence structure by multiple testing methods is indeed important. Moreover, we obtain encouraging results in a maize dataset, where we select influential marker variables.

Keywords Bayesian multiple testing · Variable selection · False discovery rate · Kullback–Leibler · Misspecified model · Posterior convergence

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10463-020-00770-3) contains supplementary material, which is available to authorized users.

✉ Noirrit Kiran Chandra
noirritchandra@gmail.com

[1] Department of Statistics and Data Science, University of Texas at Austin, 2317 Speedway D9800, Austin, TX 78712-1823, USA

[2] Interdisciplinary Statistical Research Unit, Indian Statistical Institute, 203 B. T. Road, Kolkata, WB 700108, India