Summary

Markov Chain Monte Carlo (MCMC) methods have always been an incredible tool for Bayesian model checking. However, the use of such computer-intensive statistical tool has resulted in several shortcomings when applied to complex models. Critics have argued that complex models hinder MCMC's convergence rate which resulted in long computational time required for posterior approximations. Hence, we propose the use of variational Bayes (VB) approximations for Bayesian inference as an alternative to MCMC. In this paper, we adopt the model checking approach suggested by Dey, Gelfand, Schwartz and Vlachos (1998) and introduce different discrepancy functions for model checking where P-values are computed. By fitting a hierarchical binomial regression model to data generated from known model failures, we demonstrate the capabilities and computational efficiency of the proposed methodology as well as the limitations on the choice of discrepancy function. Finally, we conduct model checks on Bristol Royal data to investigate whether the data can be fitted to the presumed model despite the presence of an outlier. In a nutshell, the paper implements an alternative approximation method for Bayesian inference and focuses on simulation based model check for hierarchical models. As such, it provides great insights for researchers who are interested in studying complex models.

Author's contributions: The VB implementation in Chapter 3 is a novel methodology applied to the simulation based hierarchical model checking approach. I have also ran the simulations in Chapter 4 and applied the proposed methodology onto real life dataset in Chapter 6. The codes are available in the CD-ROM attached to the thesis. All the R-codes were done by me except for the codes on VB approximations which was supplemented by Professor David Nott.