

Is fully exponential Laplace approximation as good as we think in latent variable models?

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Abstract

In statistics, approximating a ratio of two intractable integrals is often needed. The first-order fully exponential Laplace approximation to such a ratio is the ratio of two first-order Laplace approximations and is known to be second-order accurate under mild conditions. Because of the improved error rate, it is commonly used to approximate posterior moments in many applications. It has also been used to approximate the gradient for the estimation of various latent variable models, since it has been presumed that the improved error rate is attained also for these cases.

In this paper, we first generalize the first-order fully exponential Laplace approximation to higher orders. We show that the improved error rate compared to the regular Laplace approximation is still attained. Secondly, we show that the fully exponential Laplace-approximated gradient is the same as the gradient of the Laplace-approximated observed log-likelihood function of the same order, if it is used to approximate the gradient in latent variable models. The implication is that the estimator using the fully exponential Laplace-approximated gradient does not have an improved error rate as previously thought.