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# Old and new auxiliary variable methods for Metropolis-Hastings algorithms for distributions with intractable normalizing constants

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Suppose that we want to simulate from the posterior density for the parameter $\theta$ given data $y$, with prior $p(\theta)$ and likelihood $f_\theta(y) = h_\theta(y)/c_\theta$, where the normalizing constant $c_\theta$ is intractable. Thus the posterior density

$$p(\theta|y) \propto p(\theta)h_\theta(y)/c_\theta$$

is not computable. In an ordinary Metropolis-Hastings algorithm for drawing samples from the posterior distribution the acceptance probability depends on the "unknown" ratio of normalizing constants $c_\theta/c_{\theta'}$. Most methods to date have used various approximations to estimate or eliminate such ratios of normalizing constants. In Møller et al. (Biometrika, 2006, pages 451-458) we present a new Metropolis-Hastings algorithm for drawing samples from the posterior distribution without approximation. It is called the *auxiliary variable method*, since we extend the posterior distribution by introducing a certain auxiliary variable so that the acceptance probability can be computed. The auxiliary variable method is a nice application example of perfect simulation algorithms, and it has e.g. been used for Bayesian analysis of Gibbs models (Markov random fields and Markov point processes). Moreover, the auxiliary variable method has more recently been modified and extended to more efficient MCMC algorithms.