**Gibbs Sampling**

The computation problems of the complicated, complex and intractable multiple integrand become much easier through implementation of the Gibbs sampler. Especially in implementing Bayesian methods, the need to evaluate integrals, occurs at many stages for example in calculating expectations, eliminating nuisance parameters, forming marginal distributions and predictive distributions and so on. The combination of likelihood and prior generally produces a posterior distribution too complex for mathematical summarization, thus there is a need of computational tools to calculate variety of summaries from posterior distributions that are mathematically complex and also often high dimensional. One such method that is straight forward to implement and which has wide application is Gibbs sampling.

Gibbs sampling is an algorithm to generate a sequence of samples from the joint probability distribution of two or more random variables. The purpose of such a sequence is to approximate the joint distribution, or to compute an integral. Gibbs sampling is a special case of the Metropolis-Hastings algorithm, and thus an example of a Markov chain Monte Carlo algorithm. The algorithm is named after the physicist J. W. Gibbs, in reference to an analogy between the sampling algorithm and statistical physics.

Rouchka (1997) defined the properties of Gibbs sampling as:

* Gibbs sampling requires large sets (15 or more sequences) for weakly conserved patterns to reach statistical significance.
* It is a heuristic and not an exhaustive search, so you are not guaranteed to reach an optimal value, but you will not get stuck in local maximums the way EM algorithms do.
* Gibbs sampling allows us to view sub optimal results.
* Fast and sensitive-generally finds an optimal local alignment model for N-sequences in N-linear times.

The goal of Gibbs sampling is to find estimates for the parameters of interest in order to determine how well the observable data fits the model of interest, and also whether or not data independent of the observed data fits the model described by the observed data.

The first requirement of the Gibbs sampler is the observable data. In the general case of Gibbs sampler, the observed data remains constant throughout. It requires a vector parameters of interest that are initially unknown. Gibbs sampling requires an initial starting point for the parameters. Then, one at a time, a value for each parameter of interest is sampled given values for the other parameters and data. Once all of the parameters of interest have been sampled, the nuisance parameters are sampled given the parameters of interest and observed data. At this point, the process is started over. The power of Gibbs sampling is that the joint distribution of the parameters will converge to the joint probability of the parameters given the observed data (Rouchka, 1997).

In Gibbs sampler, a random variate is simulated from conditional univariate distribution. For a k-dimensional density function, we start by specifying an initial arbitrary value and simulate first random variate then, using this simulated variable second random variable is simulated and so on until ‘k’ random variates are generated. This completes first iteration. A sequence of ‘m’ such iterations is used to estimate some characteristics required. Different techniques are used to stimulate a long Gibbs sequence of random variates. We used ‘a one run sequence’ in which, an initial ‘r’ iterations are discarded as ‘Burn-in’ and from next ‘M’ iterations every hth observation is selected to form a sample of size . This technique has an advantage that it has little dependence on the initial value.

Gibbs sampling is applicable when the joint distribution is not known explicitly, but the conditional distribution of each variable is known. The main purpose of the Gibbs sampling algorithm is to generate an instance from the distribution of each variable in turn, conditional on the current values of the other variables. Estimation of parameters from the standard distribution is often given by packages such as SAS (Statistical Analysis System).