



AA608: Astrostatistics

MH-MCMC

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1 Markov Chain Monte Carlo :-

Markov chain Monte Carlo (MCMC) methods comprise a class of algorithms for sampling from a probability distribution. By constructing a Markov chain that has the desired distribution as its equilibrium distribution, one can obtain a sample of the desired distribution by recording states from the chain. The more steps that are included, the more closely the distribution of the sample matches the actual desired distribution. Various algorithms exist for constructing chains, including the Metropolis–Hastings algorithm.

2 Metropolis–Hastings algorithm :-

the Metropolis–Hastings algorithm is a Markov chain Monte Carlo (MCMC) method for obtaining a sequence of random samples from a probability distribution from which direct sampling is difficult. This sequence can be used to approximate the distribution (e.g. to generate a histogram) or to compute an integral (e.g. an expected value). Metropolis–Hastings and other MCMC algorithms are generally used for sampling from multi-dimensional distributions, especially when the number of dimensions is high.

The most commonly used proposal distribution is

$$Pr(x_{trail}|x_{s-1} = normal(x_{trail}; x_{s-1}, \Sigma)$$
$$Pr(x_{trail}|x_{s-1}) = \frac{1}{(2\pi)^N |\Sigma|^{1/2}} \exp \left[-\frac{1}{2} (x_{trail} - x_{s-1})^T \Sigma^{-1} (x_{trail} - x_{s-1}) \right]$$

3 Problem Discussion:-

After code the problem which is given in the python file with necessary comment .It clear that for high and low value of proposal distribution we obtain the different values of acceptance ratio ,omega matter value and scaling factor h values.

3.1 For small values of proposal distribution we have

- Value of omega matter : 0.28521108304391535
- Value of h : 0.7207468780192944
- Value of acceptance ratio : 36.06
- Covariance: 0.0012505907442764955
- Variance Omega : 0.008425537659868225
- Vairance Hubble : 0.004239433276420027

3.2 For small values of proposal distribution

- Value of omega matter : 0.2955543514535766
- Value of h : 0.7024541322256507
- Value of acceptance ratio : 1.46
- Covariance 0.00011760711116542379
- Variance Omega : 0.0002680796043138575
- Vairance Hubble : 0.0009840134508148693