Indian Institute of Technology, Indore

Department of Astronomy, Astrophysics and Space Engineering (DAASE)

AA 608 - Astrostatistics

MH-MCMC Assignment

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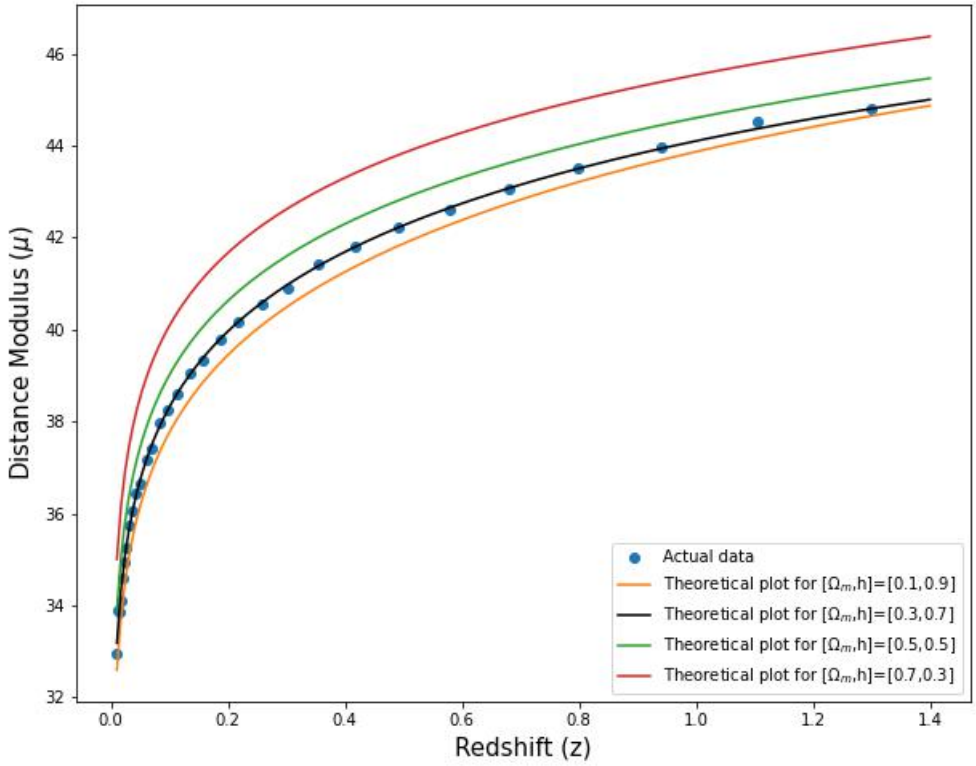
Results and Conclusion

Supernova Ia

1. The actual data and some theoretical plot for various h and Ω_m values are shown as labeled in the plot.
2. From the plot, we infer that the actual data fits with the theoretical plot with values of h = 0.7 and $\Omega_m = 0.3$.
3. So from the sampling we would expect the distribution to converge at the above-mentioned values.



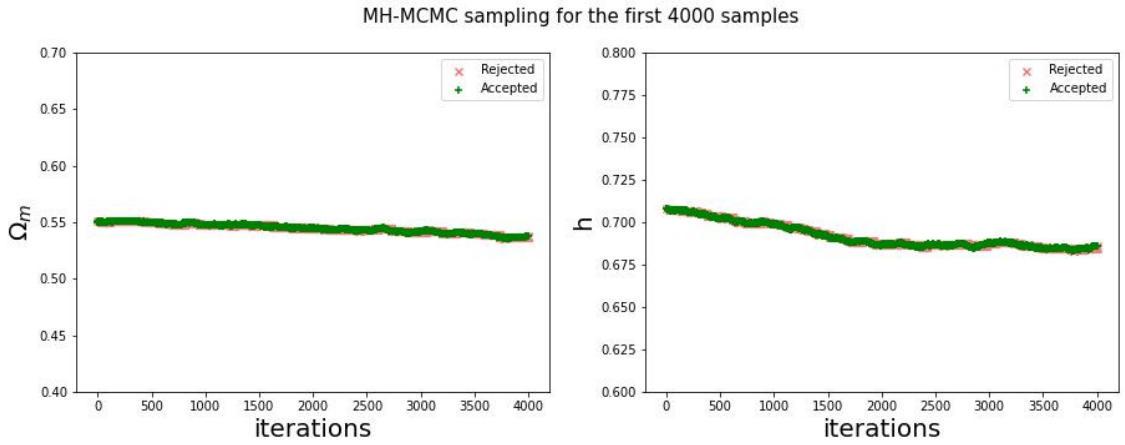
Redshift vs Distance modulus for the actual observed data and theoretical plot

Proposal Distribution

Total Number of samples considered - 20000

1. **Very Small Proposal Distribution**

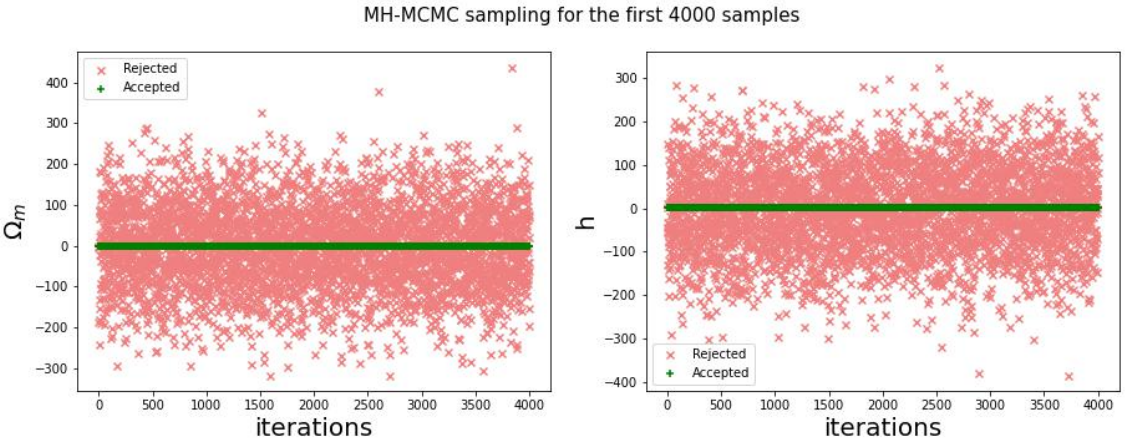
   (a) The plot shown below represents the points that are accepted and rejected.
   (b) We infer that almost all the trial points proposed or drawn from the Gaussian centred at respective previous points are accepted that is the trial points samples distribution but not efficiently.



MH-MCMC sampling for $\sigma = 0.0001$

(c) And we observe that the burn-in occurs only after the first 20% of the samples that is 4000 samples which make it inefficient.
(d) 98.5% of the points are accepted (average acceptance percentage)

2. **Very large Proposal Distribution**

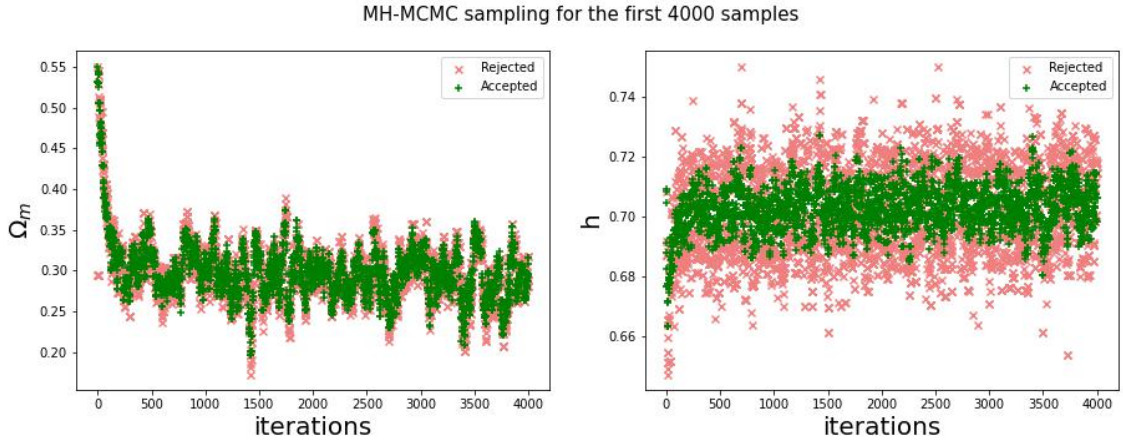


MH-MCMC sampling for $\sigma = 100$

(a) The plot shown below represents the points that are accepted and rejected
(b) We infer that almost all trial points proposed or drawn from the Gaussian centred at respective previous points are rejected that is the trial points completely fails to sample distribution.
(c) 0 sampled points were accepted making the average acceptance percentage 0%.

3. **Reasonable Proposal Distribution**

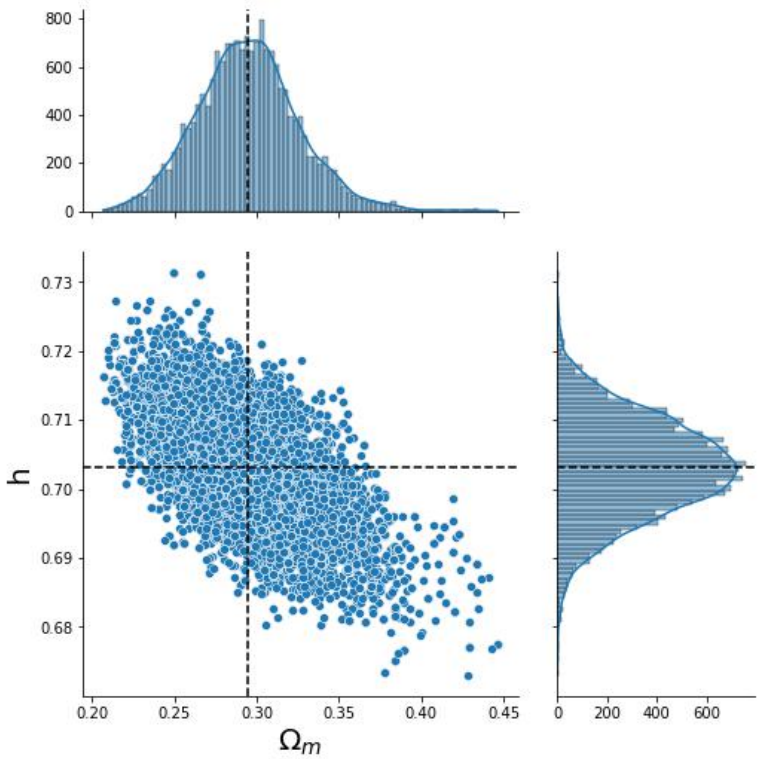
(a) The plot shown below represents the points that are accepted and rejected.
(b) Around 51% of the proposed points are accepted.
(c) We observe that burn-in occurs efficiently, within the first 200 samples.



MH-MCMC sampling for $\sigma = 0.01$

(d) Finally, the parameters converge to an estimated average value of h = 0.7031, $\Omega_m = 0.295$ which is around the values that we desired.

4. **Joint and Marginal Distribution**



(a) The mean of both the distributions of h and Ω_m are referenced in the plot.
(b) Mean of h = 0.7031
(c) Mean of $\Omega_m = 0.295$.

(d) Covariance Matrix: $\begin{bmatrix} 9.7428 \times 10^{-4} & -1.3398 \times 10^{-4} \\ -1.3398 \times 10^{-4} & 4.928 \times 10^{-4} \end{bmatrix}$

(e) The first element of the covariance matrix represents the variance of Ω_m, fourth element represents the variance of h whereas the second and third elements represents the covariance of Ω_m with h and covariance of h with Ω_m, respectively.