Indian Institute of Technology, Indore

Department of Astronomy, Astrophysics and Space Engineering (DAASE)

AA 608 - Astrostatistics

MCMC - Important Sampling

Prepared by: G Akash

Roll No: msc2203121005

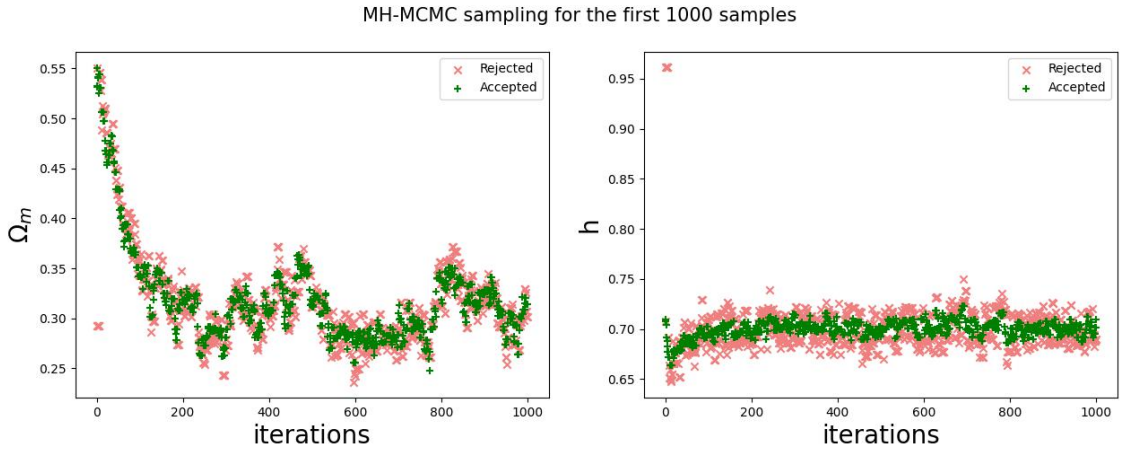
Instructor: Dr. Suman Majumdar

Results and Conclusion

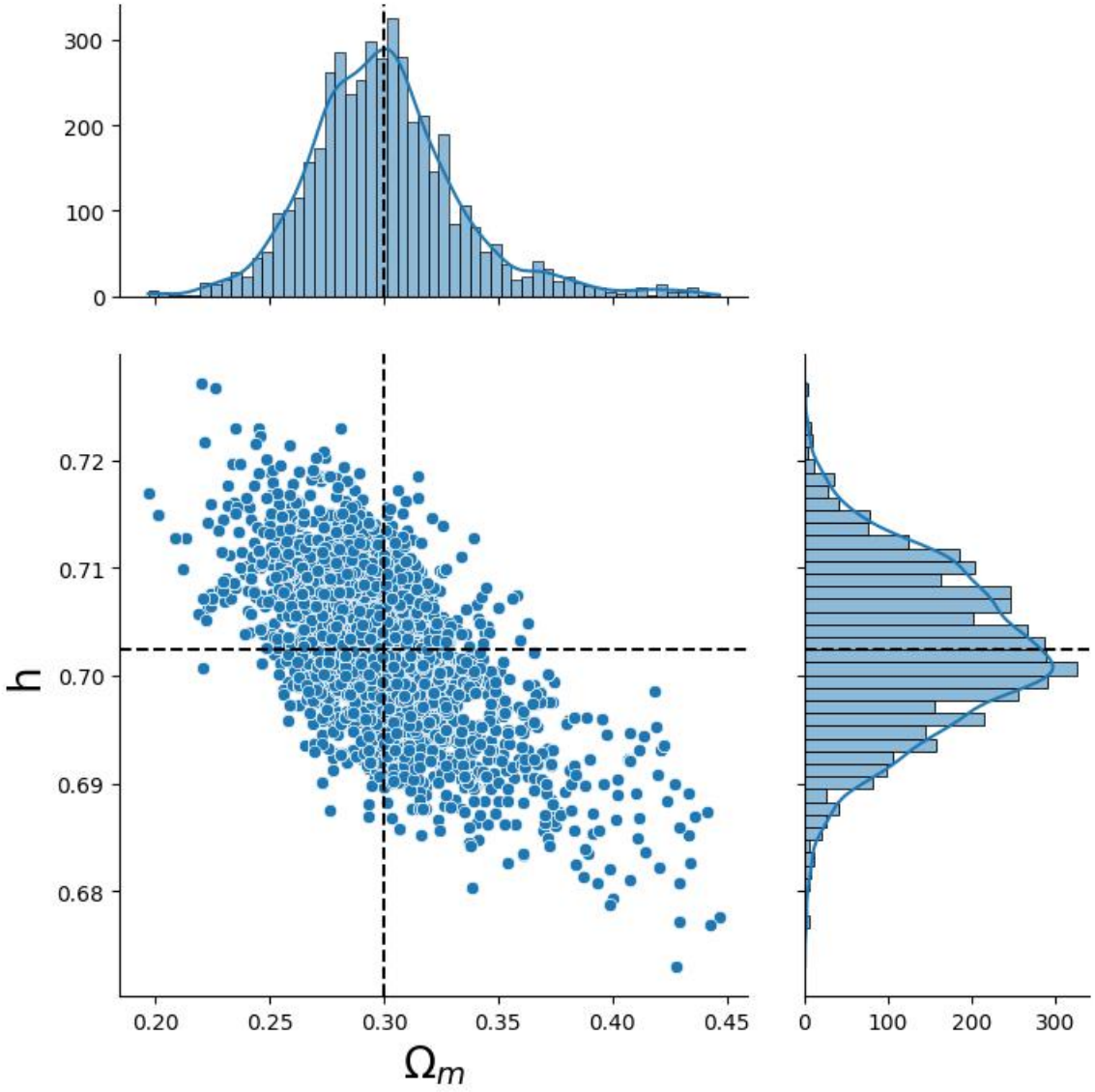
Total Number of samples considered for each chain- 5000
10% of burn-in is considered
Number of chains - 30
Width of proposal distribution - 0.01 Random seed is taken for each run. Hence the values are subjected to change with each run but with very minimal difference.

Importance Sampling

1. **Uniform Prior**

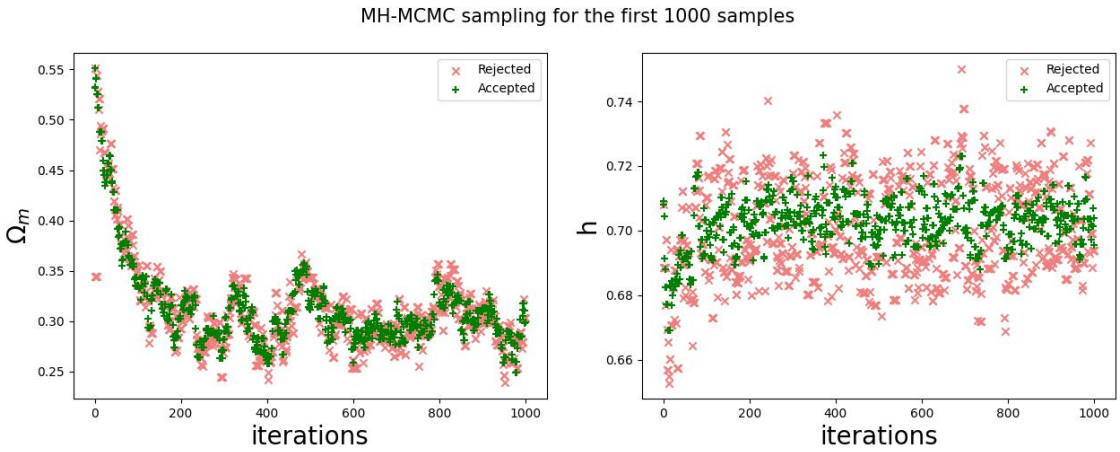


(a) The mean of both the distributions of h and Ω_m are referenced in the plot.
(b) Mean of h = 0.7024
(c) Mean of $\Omega_m = 0.3001$.
(d) Acceptance percentage = 50.71% (including burn-in points)
(e) Covariance Matrix: $\begin{bmatrix} 1.12 \times 10^{-3} & -1.55 \times 10^{-4} \\ -1.55 \times 10^{-4} & 5.297 \times 10^{-5} \end{bmatrix}$
(f) 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.

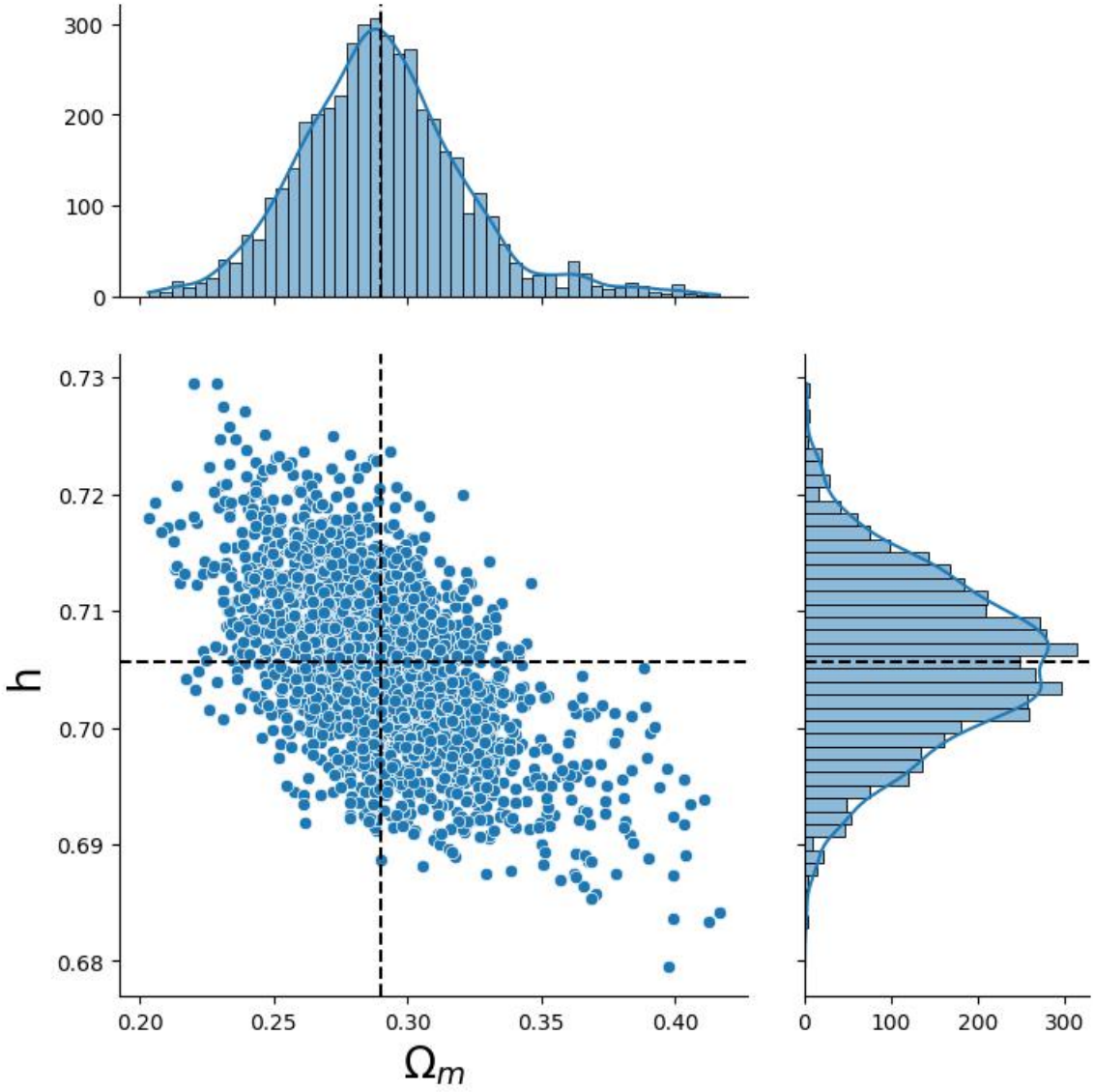


With Uniform Prior

2. With Gaussian Prior



(a) The mean of both the distributions of h and Ω_m are referenced in the plot.
(b) Mean of h = 0.70564
(c) Mean of $\Omega_m = 0.2903$.
(d) Acceptance percentage = 50.79% (including burn-in points)
(e) Covariance Matrix: $\begin{bmatrix} 9.47 \times 10^{-4} & -1.257 \times 10^{-4} \\ -1.257 \times 10^{-4} & 4.842 \times 10^{-5} \end{bmatrix}$
(f) 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.
(g) Comparing the statistics of both the prior, we observe that more points are accepted when a non-uniform prior is used.
(h) From the covariance matrices, the variances are lesser in case of Gaussian prior which means that the width of the distribution is smaller and points lie closer to the mean or in other words the points have lesser deviation from the mean



With Gaussian Prior

3. **Gelman-Rubin Convergence Test**

   (a) Convergence ratio of h = 0.9998
   (b) Convergence ratio of $\Omega_m = 1.004$.
   (c) The ratios are close to 1 and tells us that the chains are well-mixed and have all sampled the target distribution