P8160 - Bayesian Modeling of Hurricane Trajectories

Paulina Han, Waveley Qiu, Yida Wang,
Lin Yang, Jibei Zheng, Haolin Zhong

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Introduction

Data Praparation

- Self-join was performed to generate data for Gibbs sampling
- For each hurricane, 80% record was randomly selected and assigned to the train dataset, and the rest are in the test dataset. Hurricanes with less than 5 records were removed.

Gibbs Sampling

Initialize $\Theta_0 = (\mathbf{B}_0, \boldsymbol{\mu}_0, \sigma_0^2, \Sigma_0)$

for iteration i = 1,2,... **do**

Sample $\mathbf{B}_i \sim \pi(\mathbf{B}|\boldsymbol{\mu}_{i-1}, \sigma_{i-1}^2, \Sigma_{i-1}, \mathbf{Y})$

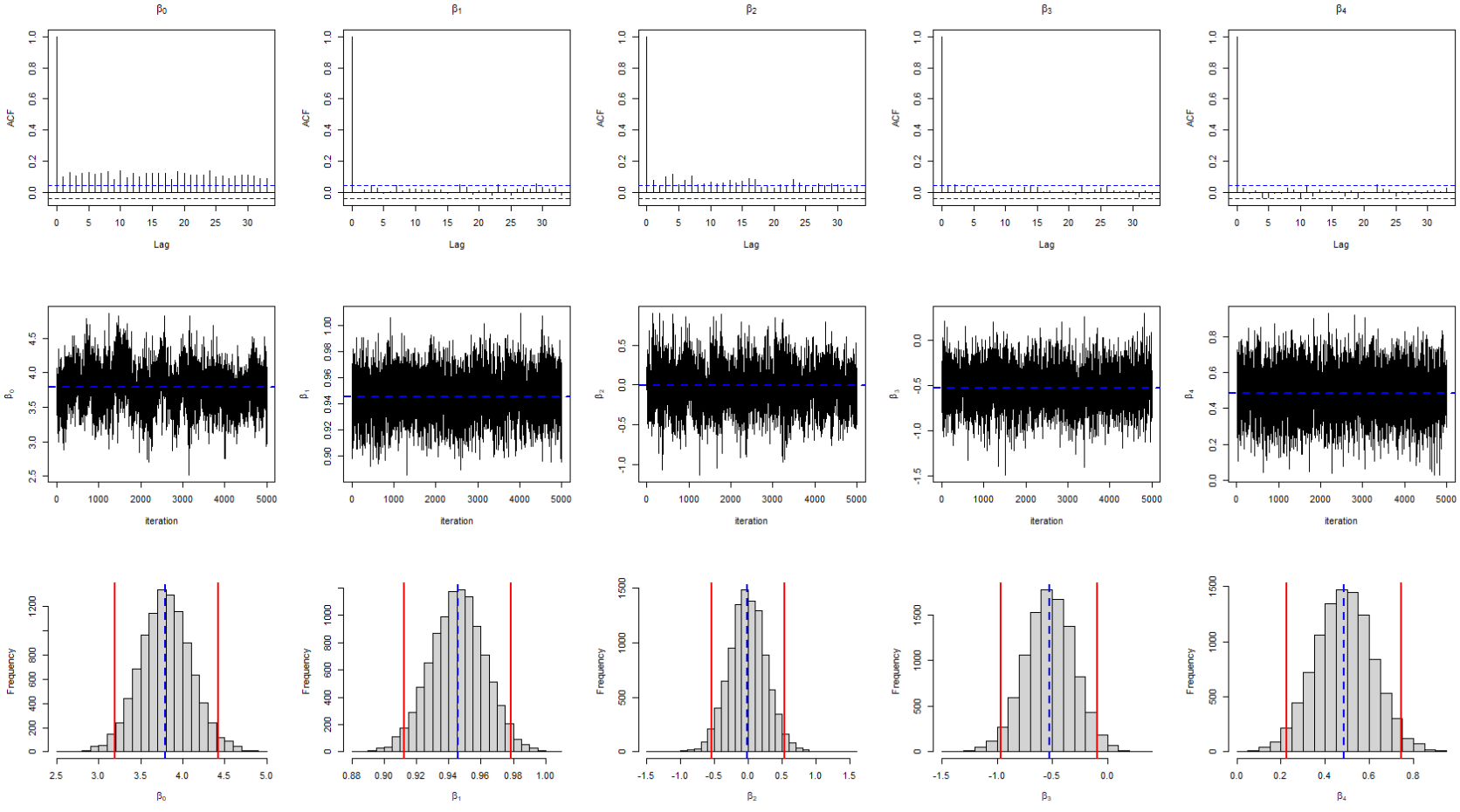
Sample $\boldsymbol{\mu}_i \sim \pi(\boldsymbol{\mu}|\mathbf{B}_i, \sigma_{i-1}^2, \Sigma_{i-1}, \mathbf{Y})$

Sample $\sigma_i^2 \sim \pi(\sigma^2|\mathbf{B}_i, \boldsymbol{\mu}_i, \Sigma_{i-1}, \mathbf{Y})$

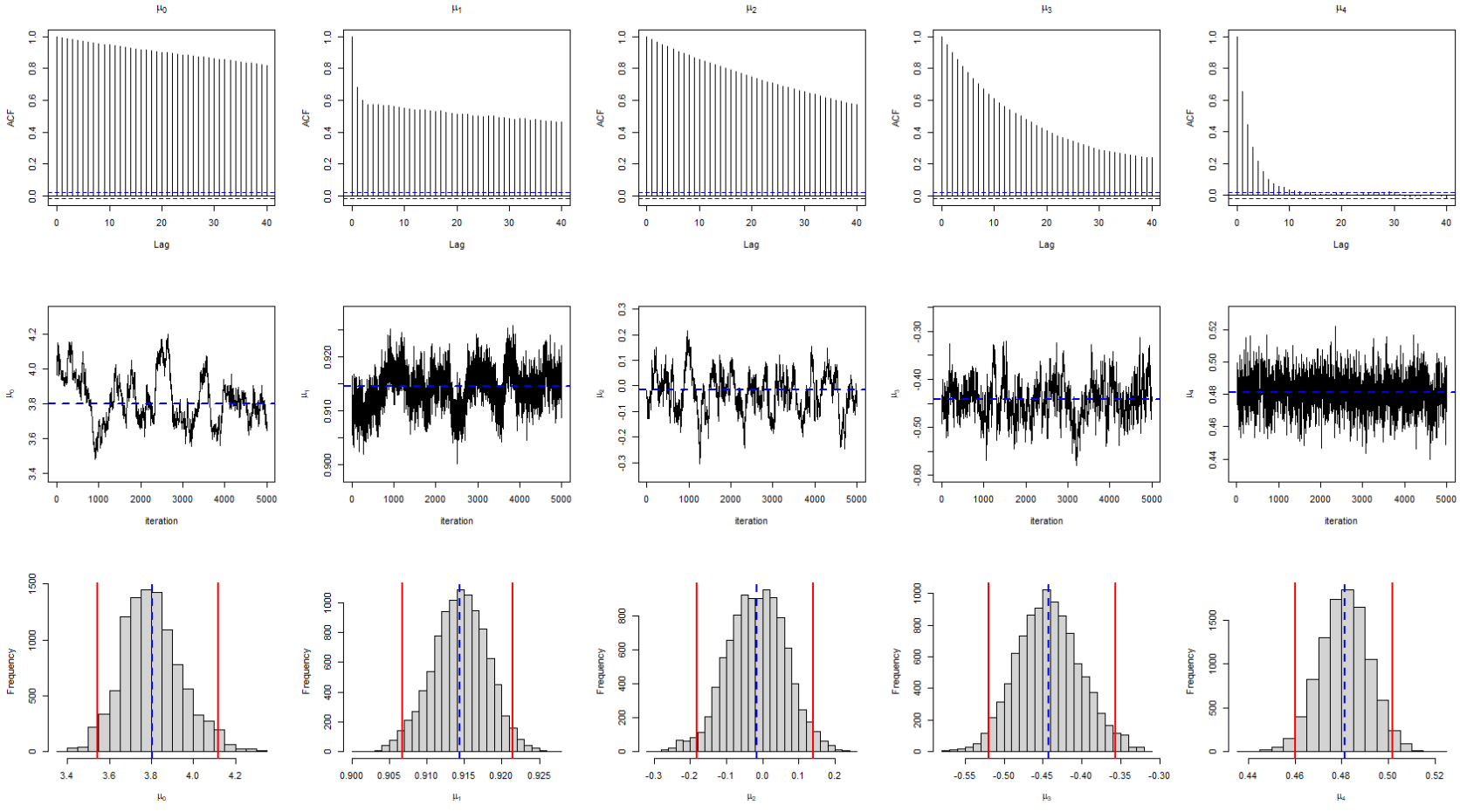
Sample $\Sigma_i \sim \pi(\Sigma|\mathbf{B}_i, \boldsymbol{\mu}_i, \sigma_i^2, \mathbf{Y})$

end for

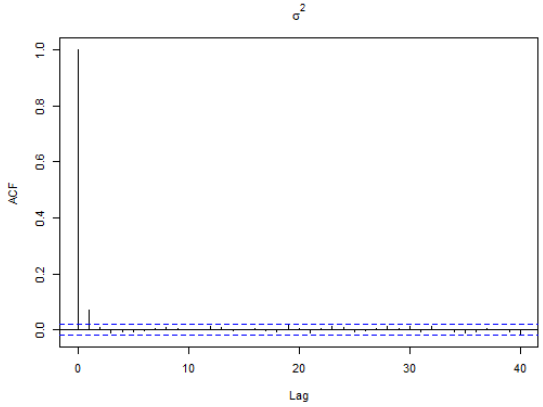
Results

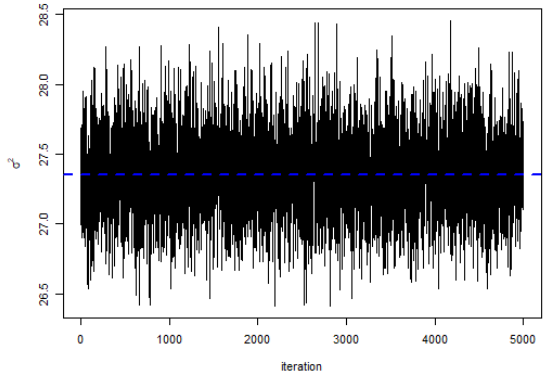


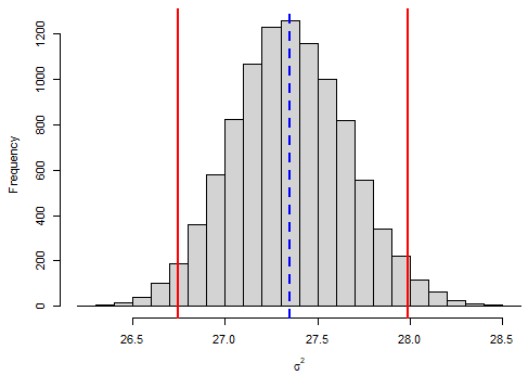
Results

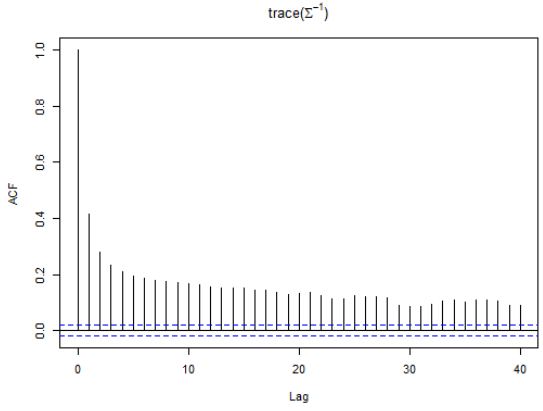


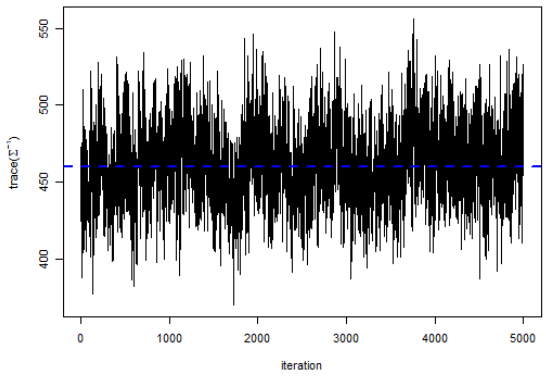
Results

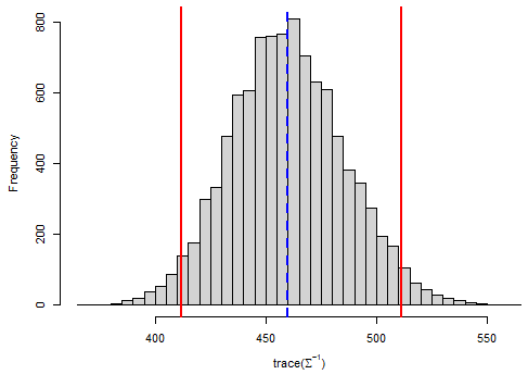

σ²
ACF
Lag


σ²
iteration


Frequency
σ²


trace(Σ⁻¹)
ACF
Lag


trace(Σ⁻¹)
iteration


Frequency
trace(Σ⁻¹)

Discussion

Strength

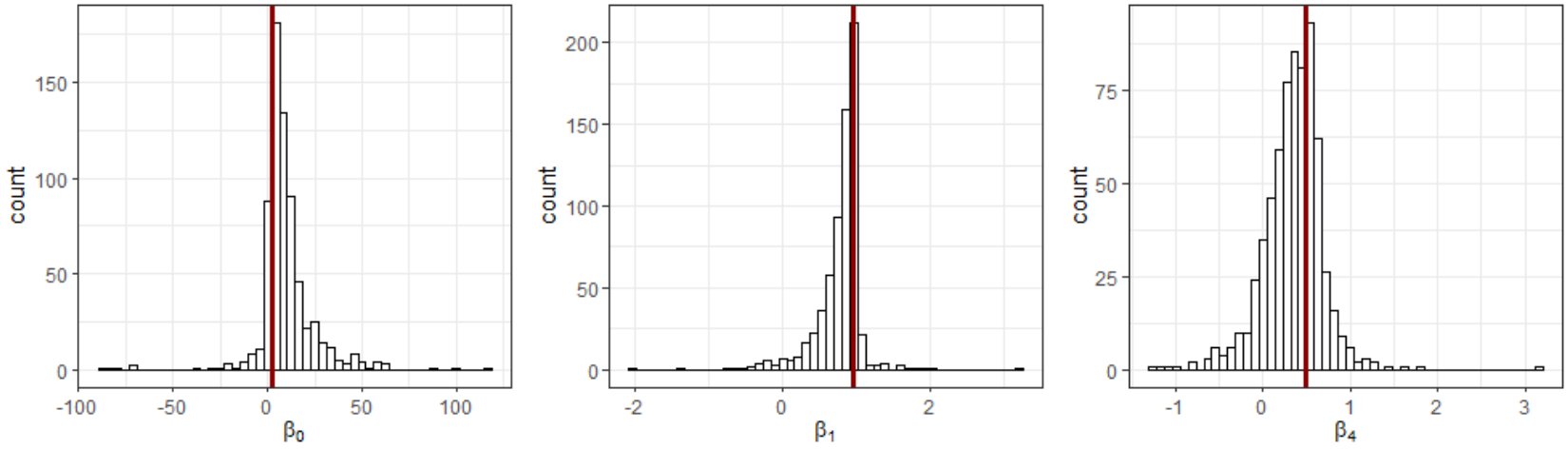
- Unlike classical modeling methods, the MCMC approach bypass coefficient optimization process and directly sample coefficients from their distributions
- Optimization methods may vary from models to models, while we only need to derive posterior conditional distribution for each coefficients when using Gibbs Sampling.

Limitation

- MCMC approaches are often computationally expensive since they involve thousands of rounds of sampling and updating.

Why Non-convergence?

- $\beta_i \sim N(\beta, \Sigma)$ may be a too strong assumption
- Distribution of β_is obtained by performing OLS for each hurricane



- red line: β obtained by performing OLS on the whole training dataset