

# P8160 - Bayesian Modeling of Hurricane Trajectories

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2022-05-09

# Introduction

## Data Preparation

- ▶ 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  $i = 1, 2, \dots$  **do**

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

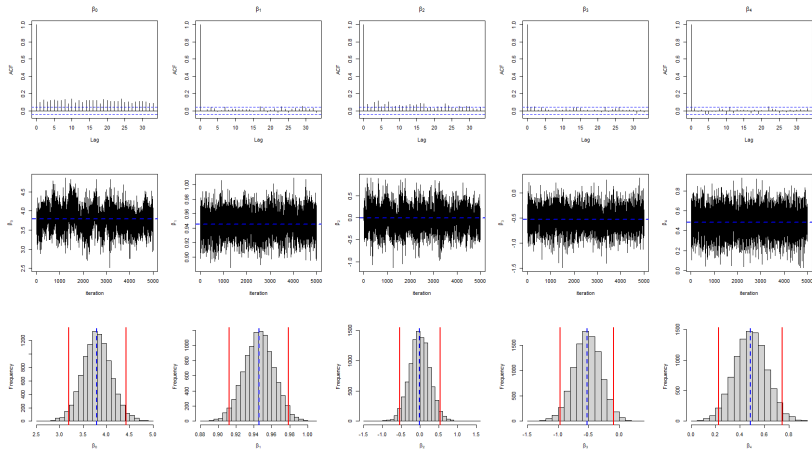
Sample  $\boldsymbol{\mu}_i \sim \pi(\boldsymbol{\mu} | \mathbf{B}_i, \sigma_{i-1}^2, \Sigma_{i-1}, \mathbf{Y})$

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

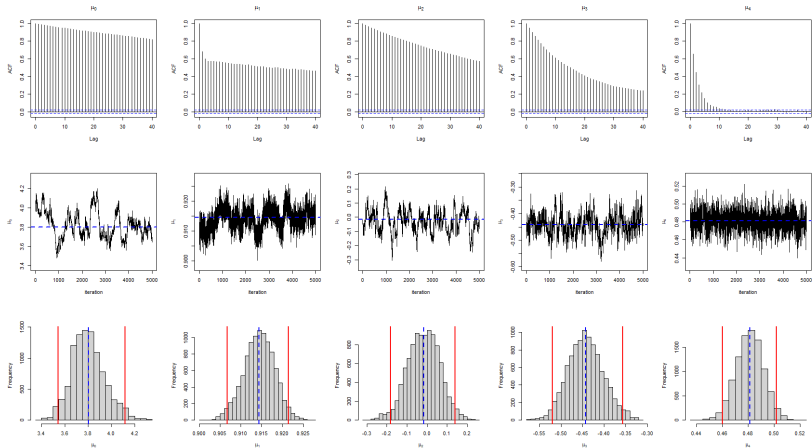
Sample  $\Sigma_i \sim \pi(\Sigma | \mathbf{B}_i, \boldsymbol{\mu}_i, \sigma_i^2, \mathbf{Y})$

**end for**

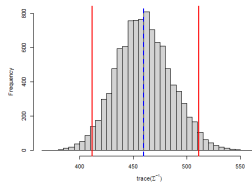
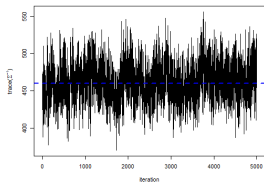
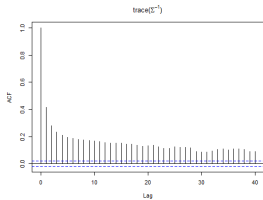
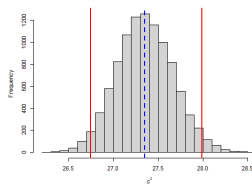
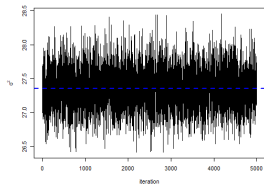
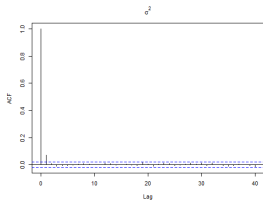
# Results



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# Forecasting Hurricane Impact

**ID:** ID of the hurricanes

**Season:** In which year the hurricane occurred

**Month:** In which month the hurricane occurred

**Nature:** Nature of the hurricane

**Damage:** Financial loss (in Billion U.S. dollars) caused by hurricanes

**Deaths:** Number of death caused by hurricanes

**Maxspeed:** Maximum recorded wind speed of the hurricane

**Meanspeed:** Average wind speed of the hurricane

**Maxpressure:** Maximum recorded central pressure of the hurricane

**Meanpressure:** Average central pressure of the hurricane

**Hours:** Duration of the hurricane in hours

**Total.Pop:** Total affected population

**Percent.Poor:** % affected population that reside in low GDP counties

**Percent.USA:** % affected population that reside in the United States

# LASSO Model for Damage

	Coefficients
(Intercept)	-533.5099174
season	3.3837824
deaths	0.0000000
monthJuly	0.0000000
monthJune	0.0000000
monthNovember	0.0000000
monthOctober	0.0000000
monthSeptember	0.0000000
natureNR	0.0000000
natureTS	0.0000000
maxspeed	1.2117851
meanspeed	0.0000000
maxpressure	0.0000000
meanpressure	0.0000000
hours	0.0000000
total_pop	0.3187361
percent_poor	0.0000000
percent_usa	0.7073409
beta0	0.0000000
beta1	0.0000000
beta2	0.0000000
beta3	0.0000000



## Refitted Linear Regression Model

	Coefficients
(Intercept)	-1316.7386136
season	0.6485139
maxspeed	0.1968674
total__pop	0.0000033
percent__usa	0.1356486

# Poisson Model for Deaths

	Estimate	Std. Error	z value	$\Pr(> z )$
(Intercept)	-199.5331639	11.8792784	-16.7967411	0.0000000
season	-0.0404185	0.0028048	-14.4104991	0.0000000
damage	0.0220163	0.0005679	38.7649762	0.0000000
monthJuly	-10.2286750	0.1604645	-63.7441688	0.0000000
monthJune	0.3928062	0.0989170	3.9710698	0.0000716
monthNovember	1.8733767	0.1664682	11.2536625	0.0000000
monthOctober	-1.6041896	0.0787720	-20.3649754	0.0000000
monthSeptember	1.2490015	0.0575033	21.7205350	0.0000000
natureNR	2.0903864	0.1371766	15.2386495	0.0000000
natureTS	-1.1903051	0.1118619	-10.6408484	0.0000000
maxspeed	0.0035207	0.0013988	2.5168778	0.0118400
meanspeed	-0.1978651	0.0039977	-49.4953412	0.0000000
maxpressure	0.0048106	0.0075485	0.6372945	0.5239331
meanpressure	0.0021204	0.0001759	12.0515409	0.0000000
total_pop	0.0000009	0.0000000	31.4237737	0.0000000
percent_poor	0.0873434	0.0010058	86.8433730	0.0000000
percent_usa	-0.0080185	0.0004884	-16.4173000	0.0000000
beta0	41.3531048	0.5634443	73.3934206	0.0000000
beta1	132.8784572	1.9305164	68.8305252	0.0000000
beta2	-10.7339527	0.5001340	-21.4621524	0.0000000
beta3	-0.4736994	0.5091748	-0.9303277	0.3522014

# 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.