P8160 - Project 3
Baysian modeling of hurricane

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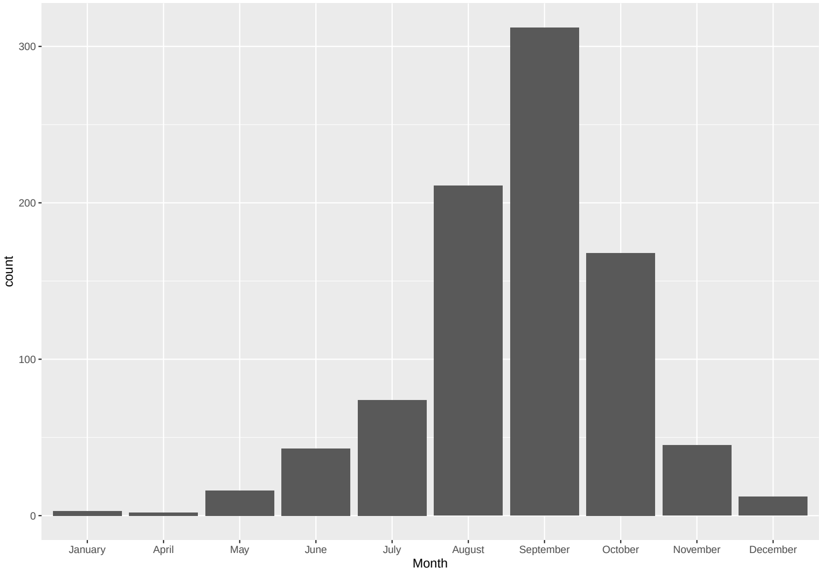
Introduction

- Hurricanes can result in death and economical damage
- There is an increasing desire to predict the speed and damage of the hurricanes
- Use Bayesian Model and Markov Chain Monte Carlo algorithm to
    - Predict the wind speed of hurricanes
    - Study how hurricanes is related to death and financial loss

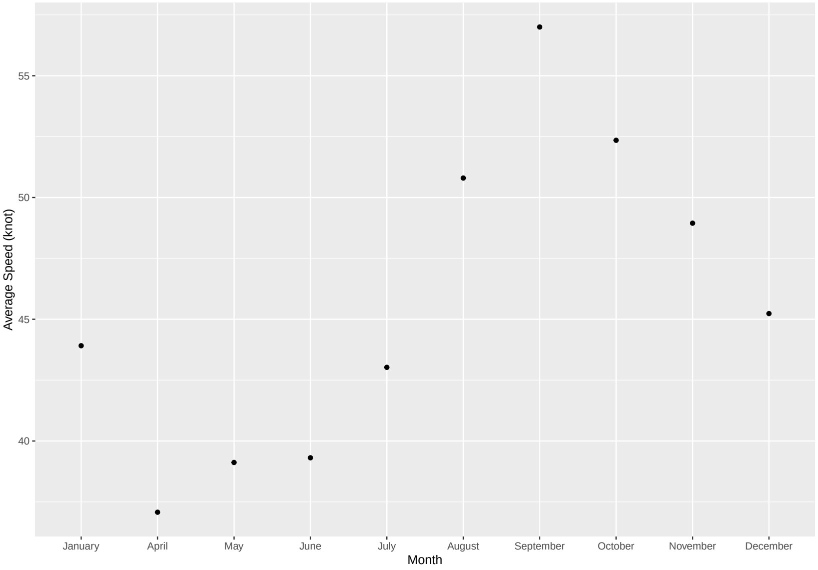
Dataset

- Hurrican703 dataset: 22038 observations $\times$ 8 variables
  - 702 hurricanes in the North Atlantic area in year 1950-2013
- Processed dataset: add 5 more variables into hurrican703
- Hurricanoutcome2 dataset: 43 observations $\times$ 14 variables

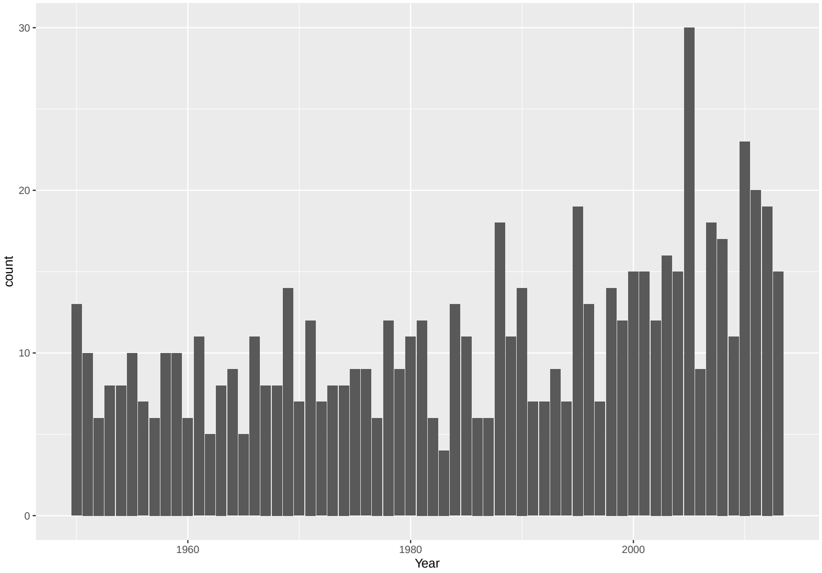
EDA - Count of Hurricanes in Each Month



EDA - Average Speed (knot) of Hurricanes in Each Month



EDA - ount of Hurricanes in Each Year



EDA - CAverage Speed (knot) of Hurricanes in Each Year

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## `geom_smooth()` using formula 'y ~ x'
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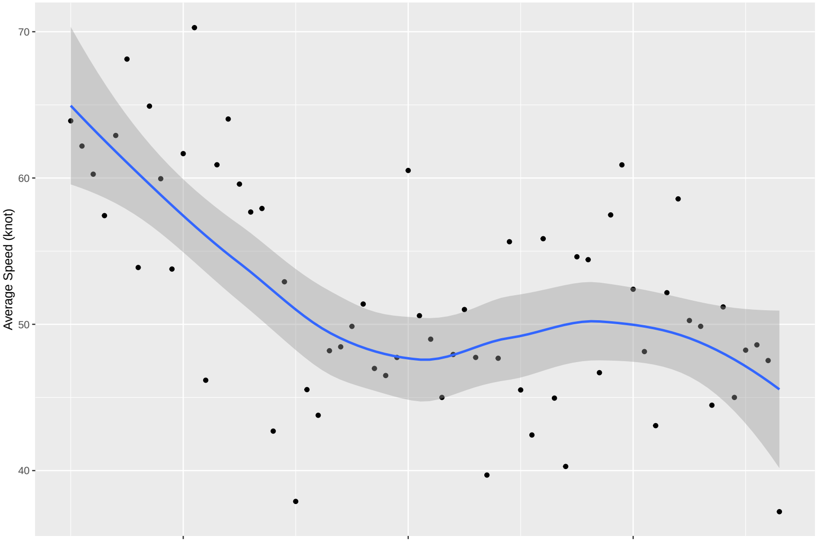
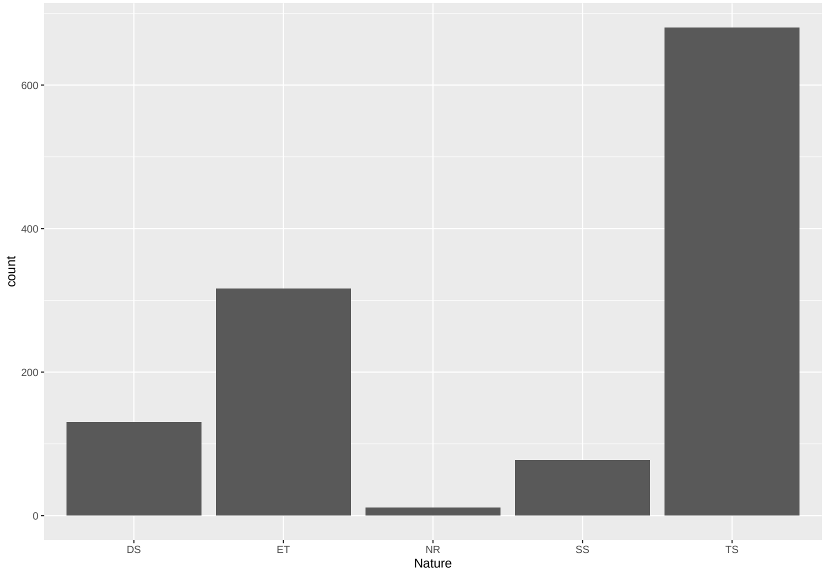
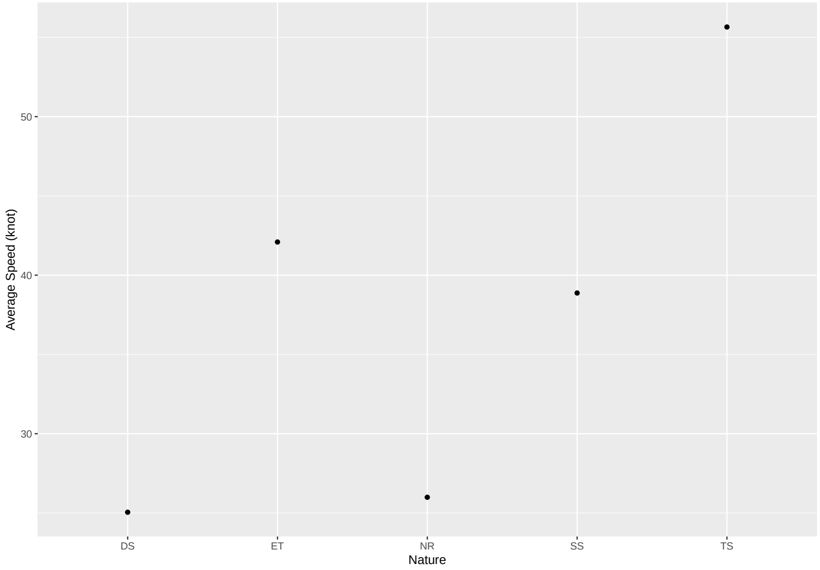


EDA - Count of Hurricanes in Each Nature



EDA - Average Speed (knot) of Hurricanes in Each Nature



Joint posterior

$$
\begin{aligned}
\pi(\Theta|Y) \\
&= \pi(\mathbf{B}^\top, \mu^\top, \sigma^2, \Sigma \mid Y) \\
&\propto \prod_{i=1}^{n} f(Y_i \mid \beta_i, \sigma^2) \prod_{i=1}^{n} \pi(\beta_i \mid \mu, \Sigma) P(\sigma^2) P(\mu) P(\Sigma^{-1}) \\
&\propto \prod_{i=1}^{n} \Big\{ (2\pi\sigma^2)^{-m_i/2} \exp\Big\{ -\frac{1}{2}(Y_i - X_i\beta_i^\top)^\top (\sigma^2 I)^{-1} (Y_i - X_i \\
&\times \prod_{i=1}^{n} \Big\{ \det(2\pi\Sigma)^{-\frac{1}{2}} \exp\Big\{ -\frac{1}{2}(\beta_i - \mu)\Sigma^{-1}(\beta_i - \mu)^\top \Big\} \Big\} \times \frac{1}{\sigma^2} \times
\end{aligned}
$$

MCMC algorithm

Conditional Posterior

- To apply MCMC using Gibbs sampling, we need to find conditional posterior distribution of each parameter, then we can implement Gibbs sampling on these conditional posterior distributions.
  - $\pi(\mathbf{B}|Y, \mu^\top, \sigma^2, \Sigma)$
  - $\pi(\sigma^2|Y, \mathbf{B}^\top, \mu^\top, \Sigma)$
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