

# Introduction to Bayes

Mevin Hooten

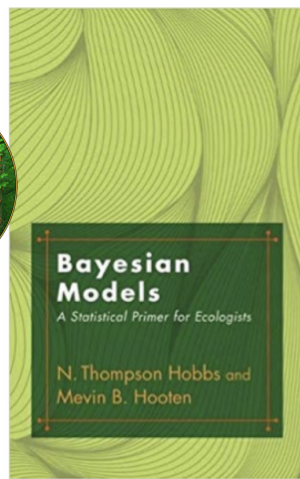
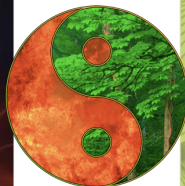
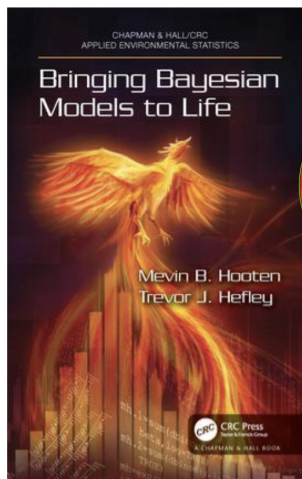
Professor

Department of Statistics and Data Sciences  
The University of Texas at Austin

# 8 Steps to Become a Better Bayesian

- 1 Build model
- 2 Write posterior
- 3 Derive full-conditionals
- 4 Code MCMC algorithm
- 5 Make predictions
- 6 Check model
- 7 Validate model
- 8 Obtain inference

# Books



# 1.) Build Model

$$y_i \sim [y_i | \boldsymbol{\theta}] , \quad i = 1, \dots, n$$
$$\boldsymbol{\theta} \sim [\boldsymbol{\theta}]$$

- Gelman, A., et al. (2013). Bayesian Data Analysis, Third Edition. Chapman & Hall/CRC.
- Hobbs, N.T. and M.B. Hooten (2015). Bayesian Models: A Statistical Primer for Ecologists. Princeton University Press.

## 2.) Write Posterior

$$\begin{aligned} [\theta|\mathbf{y}] &= \frac{[\mathbf{y}|\theta][\theta]}{[\mathbf{y}]} \\ &\propto [\mathbf{y}|\theta][\theta] \end{aligned}$$

- Hobbs, N.T. and M.B. Hooten (2015). Bayesian Models: A Statistical Primer for Ecologists. Princeton University Press.

### 3.) Derive Full-Conditionals

$$\begin{aligned} [\theta_j | \cdot] &= [\theta_j | \boldsymbol{\theta}_{-j}, \mathbf{y}] \\ &\propto [\mathbf{y} | \boldsymbol{\theta}] [\theta_j] \end{aligned}$$

- Hooten, M.B. and T.J. Hefley (2019). Bringing Bayesian Models to Life. Chapman & Hall/CRC.

## 4.) Code MCMC Algorithm

```
for  $k = 1, \dots, K$  {  
  for  $j = 1, \dots, J$  {  
     $\theta_j^{(k)} \sim [\theta_j | \cdot]$   
  }  
}
```

- Hooten, M.B. and T.J. Hefley (2019). Bringing Bayesian Models to Life. Chapman & Hall/CRC.

## 5.) Make Predictions

$$\begin{aligned} [\mathbf{y}_u | \mathbf{y}] &= \int [\mathbf{y}_u, \boldsymbol{\theta} | \mathbf{y}] d\boldsymbol{\theta} \\ &= \int [\mathbf{y}_u | \boldsymbol{\theta}, \mathbf{y}] [\boldsymbol{\theta} | \mathbf{y}] d\boldsymbol{\theta} \end{aligned}$$

- Gelman, A., et al. (2013). Bayesian Data Analysis, Third Edition. Chapman & Hall/CRC.
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## 6.) Check Model

$$\int 1_{\{g(\mathbf{y}_u) > g(\mathbf{y})\}} [\mathbf{y}_u | \mathbf{y}] d\mathbf{y}_u = \mathbf{P}(g(\mathbf{y}_u) > g(\mathbf{y}) | \mathbf{y})$$

- Conn, P.B., D.S. Johnson, P.J. Williams, S. Melin, and M.B. Hooten. (2018). A guide to Bayesian model checking for ecologists. *Ecological Monographs*, 88: 526-542.
- Gelman, A., et al. (2013). *Bayesian Data Analysis*, Third Edition. Chapman & Hall/CRC.

## 7.) Validate Model

$$\int g(\mathbf{y}_u, \mathbf{y}) [\mathbf{y}_u | \mathbf{y}] d\mathbf{y}_u$$

- Hooten, M.B. and N.T. Hobbs. (2015). A guide to Bayesian model selection for ecologists. Ecological Monographs, 85: 3-28.
- Gelman, A., et al. (2013). Bayesian Data Analysis, Third Edition. Chapman & Hall/CRC.

## 8.) Obtain Inference

$$\int g(\boldsymbol{\theta})[\boldsymbol{\theta}|\mathbf{y}]d\boldsymbol{\theta} \approx \frac{\sum_{k=1}^K g(\boldsymbol{\theta}^{(k)})}{K}$$

- Gelman, A., et al. (2013). Bayesian Data Analysis, Third Edition. Chapman & Hall/CRC.
- Hobbs, N.T. and M.B. Hooten (2015). Bayesian Models: A Statistical Primer for Ecologists. Princeton University Press.
- Hooten, M.B. and T.J. Hefley (2019). Bringing Bayesian Models to Life. Chapman & Hall/CRC.

# References

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