Bayesian Analysis of Data

Key Steps, following Krushcke, 2015 / Hobbs et al 1015

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Outline

Bayesian Analysis Steps: Krushcke, 2015

1. Identify relevant data and measurement scales.
2. Define a descriptive model for the data.
3. Specify a prior distribution on parameters.
4. Use Bayesian inference to allocate credibility.
5. Check posterior predictions against data.

Step 1: Identify Relevant Data

- Determine measurement scales.
- Identify predictor and response variables.

Step 2: Define Descriptive Model

- Choose a mathematical form for the model.
- Ensure parameters align with theoretical goals.

Step 3: Specify Prior Distribution

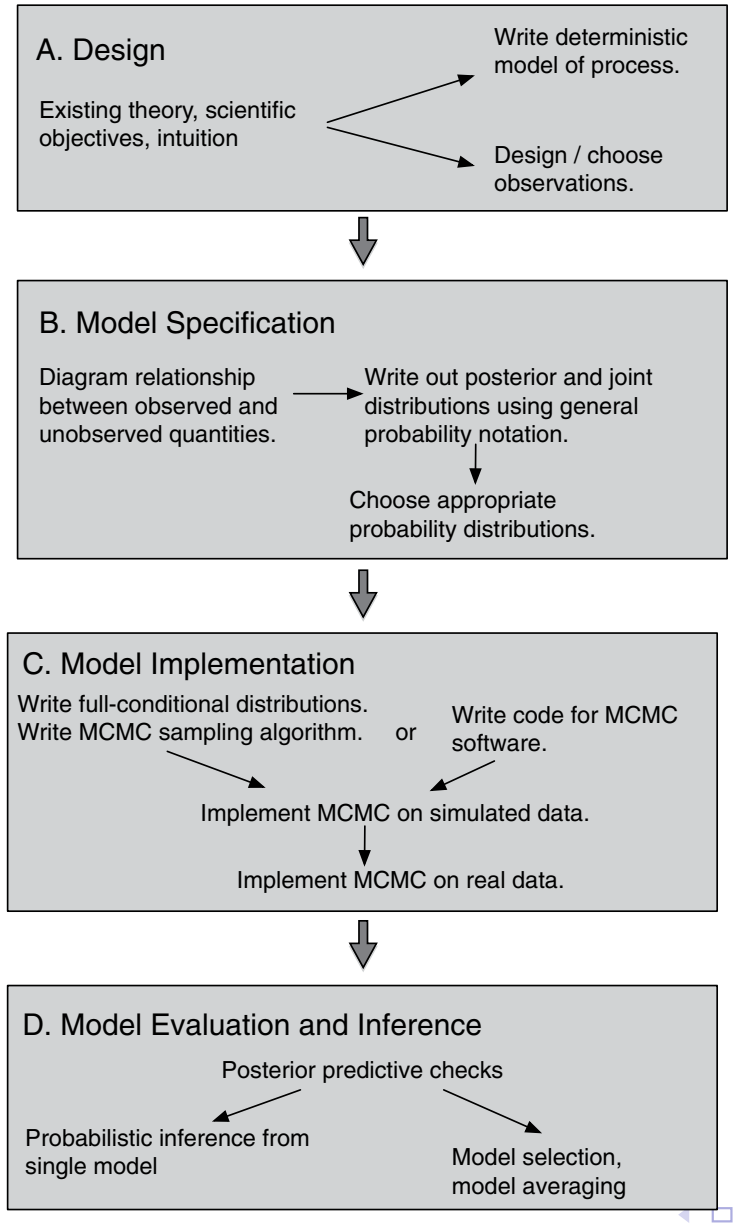
- Obtain audience approval for the prior.
- Ensure the prior reflects prior knowledge.

Step 4: Bayesian Inference

- Use data to update beliefs (Bayesian inference).
- Interpret the posterior distribution.

Step 5: Posterior Predictive Check

- Verify that posterior predictions match observed data.
- Consider alternative descriptive models if needed.


A. Design
Existing theory, scientific objectives, intuition
Write deterministic model of process.
Design / choose observations.
B. Model Specification
Diagram relationship between observed and unobserved quantities.
Write out posterior and joint distributions using general probability notation.
Choose appropriate probability distributions.
C. Model Implementation
Write full-conditional distributions.
Write MCMC sampling algorithm.
or
Write code for MCMC software.
Implement MCMC on simulated data.
Implement MCMC on real data.
D. Model Evaluation and Inference
Posterior predictive checks
Probabilistic inference from single model
Model selection, model averaging

Steps in Bayesian Data Analysis: Gelman et al. 2017/20

1. **Setting up a Full Probability Model**
   - Joint probability distribution for all observable and unobservable quantities.
   - Consistent with knowledge about the scientific problem and data collection process.
2. **Conditioning on Observed Data**
   - Calculate and interpret the posterior distribution.
   - Conditional probability distribution of unobserved quantities given the observed data.
3. **Evaluating Model Fit and Implications**
   - Assess how well the model fits the data.
   - Examine the reasonability of substantive conclusions.
   - Evaluate sensitivity to modeling assumptions from step 1.

Step 1: Setting up a Full Probability Model

- Joint probability distribution for all observable and unobservable quantities.
- Consistency with scientific knowledge and data collection process.

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- Calculate and interpret the posterior distribution.
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- Examine the reasonability of substantive conclusions.
- Evaluate sensitivity to modeling assumptions from step 1.