

# Bayesian Analysis of Data

## Key Steps

DRME

2024 01 20

# Outline

## Krushcke 2015

- 1: Identify Relevant Data
- 2: Define Descriptive Model
- 3: Specify Prior Distribution
- 4: Bayesian Inference
- 5: Posterior Predictive Check

## Hobbs et al 2015

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

- 1: Setting up a Full Probability Model
- 2: Conditioning on Observed Data
- 3: Evaluating Model Fit and Implications

## van de Schoot et al 2021

# 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.

# 1: Identify Relevant Data

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

## 2: Define Descriptive Model

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

### 3: Specify Prior Distribution

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

## 4: Bayesian Inference

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

## 5: Posterior Predictive Check

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



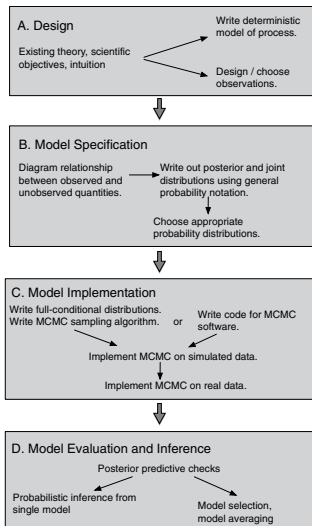


Figure 0.0.1. Gaining insight from Bayesian models involves the same sequence of

# 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.

# 1: Setting up a Full Probability Model

- ▶ Joint probability distribution for all observable and unobservable quantities.
- ▶ Consistency with scientific knowledge 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.

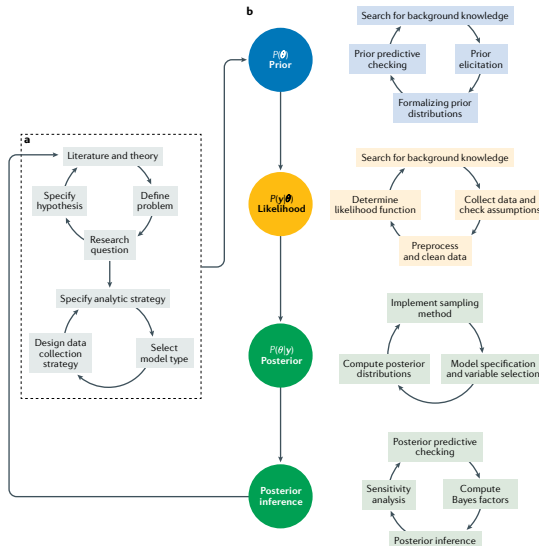


Fig. 1 | **The Bayesian research cycle.** The steps needed for a research cycle using Bayesian statistics include those of a