Bayesian Analysis: A Deep Dive into Missing Data

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Objectives

- Discuss types of missing data.
- Review other kinds of imputation.
- Explore how PROC MCMC incorporates missing data.

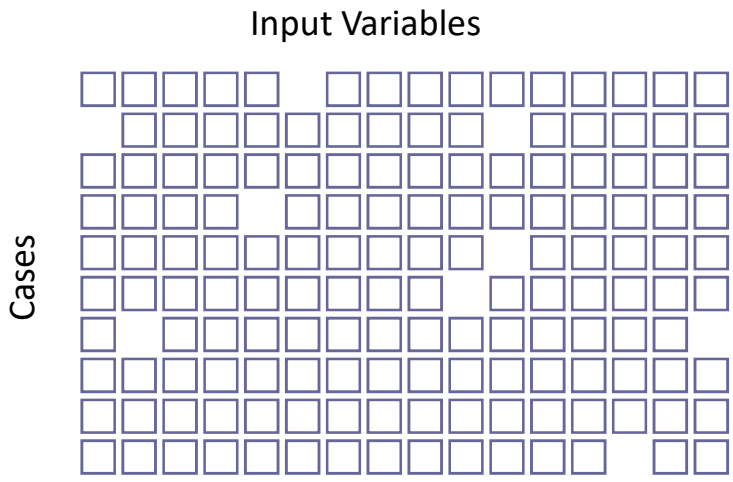
Missing Data Mechanisms

Does Pr(missing) Depend on the Unobserved Values?

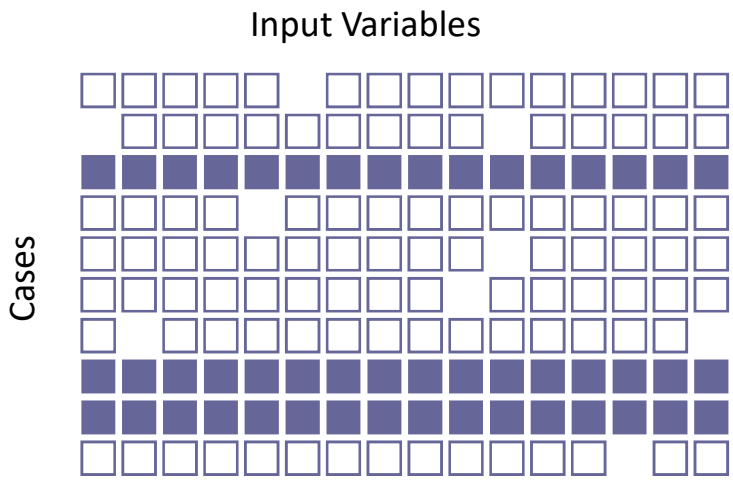
- No
  - MCAR
- Yes
  - but not after controlling for the observed values (MAR)
  - even after controlling for observed values(NMAR)

14	2
67	1
?	3
33	1
18	2
6	0
31	3
51	1

Complete Case Analysis



Complete Case Analysis



Other Methods for Handling Missing Values

- Complete Case Analysis – most procedures
- Single Imputation – PROC STDIZE
- Multiple Imputation – PROC MI
- Two-Stage Estimation – PROC MI
- Full Information Maximum Likelihood – PROC CALIS

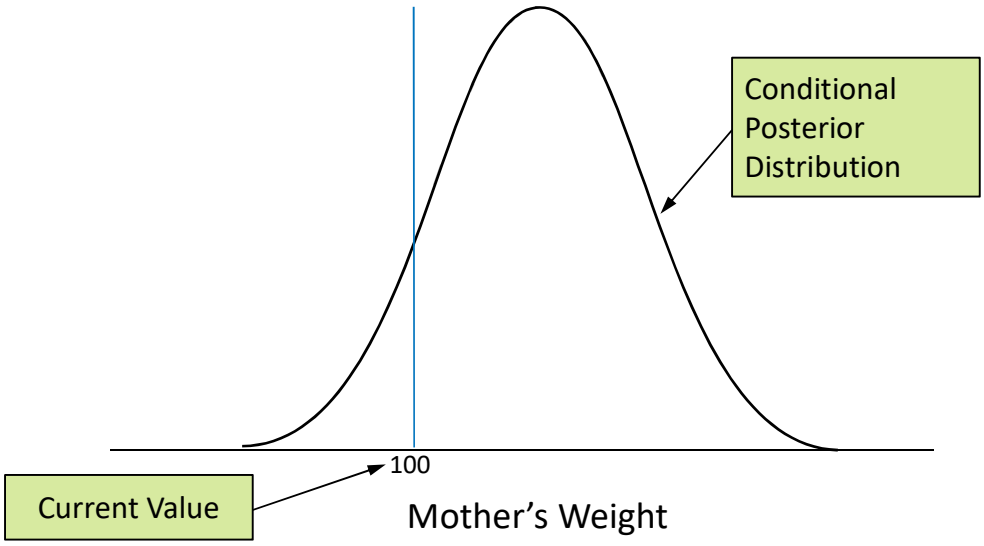
Missing Value Imputation in PROC MCMC

- The missing values are treated as unknown parameters and are sampled sequentially in a Markov chain Monte Carlo simulation.
- A common assumption is that both the missing values and observed values arise from the same distribution.
- The Bayesian approach enables you to estimate the posterior marginal distributions of the parameters of interest conditional on observed and partially observed data.

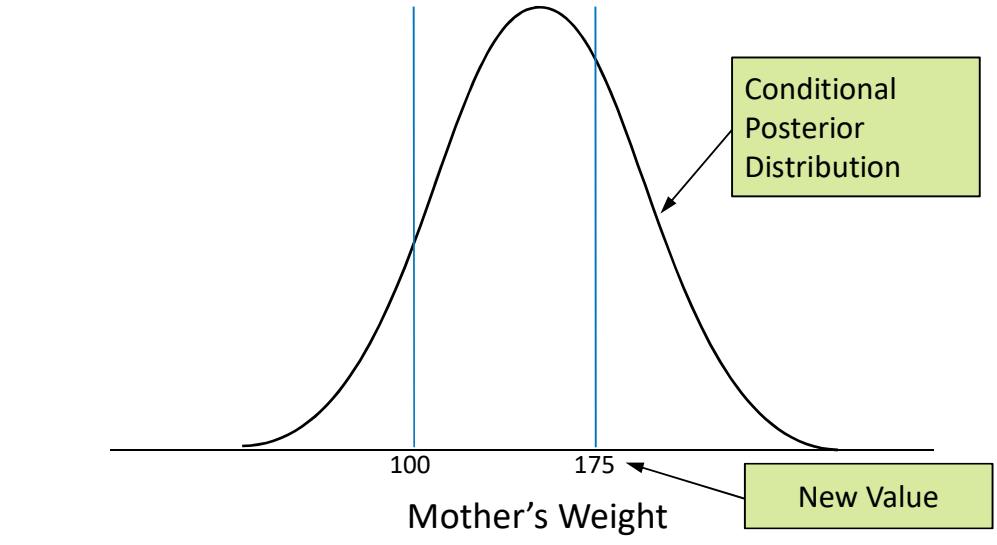
Missing Value Imputation in PROC MCMC

- To model missing values in PROC MCMC, you must declare the variable in a MODEL statement.
- During the setup stage, PROC MCMC identifies the missing values for the variable specified in the MODEL statement and creates a separate missing data variable for each missing value.
- At each iteration, PROC MCMC automatically samples each missing data variable from its conditional posterior distribution.

Bayesian Missing Value Imputation



Bayesian Missing Value Imputation



Accept or Reject

$$r = \min(1, \frac{p(\theta_{New} \mid cond\_post\_dist)}{p(\theta_{Current} \mid cond\_post\_dist)})$$

- where θ is the imputed value

Missing Value Imputation

This demonstration illustrates the concepts discussed previously.

Questions?