

## CONTENTS

<b>Series Editor's Introduction</b>	<b>v</b>
<b>1. Introduction</b>	<b>1</b>
<b>2. Assumptions</b>	<b>3</b>
Missing Completely at Random	3
Missing at Random	4
Ignorable	5
Nonignorable	5
<b>3. Conventional Methods</b>	<b>5</b>
Listwise Deletion	6
Pairwise Deletion	8
Dummy Variable Adjustment	9
Imputation	11
Summary	12
<b>4. Maximum Likelihood</b>	<b>12</b>
Review of Maximum Likelihood	13
ML With Missing Data	14
Contingency Table Data	15
Linear Models With Normally Distributed Data	18
The EM Algorithm	19
EM Example	21
Direct ML	23
Direct ML Example	25
Conclusion	26
<b>5. Multiple Imputation: Basics</b>	<b>27</b>
Single Random Imputation	28
Multiple Random Imputation	29

Allowing for Random Variation in the Parameter Estimates	30
Multiple Imputation Under the Multivariate Normal Model	32
Data Augmentation for the Multivariate Normal Model	34
Convergence in Data Augmentation	36
Sequential Versus Parallel Chains of Data Augmentation	37
Using the Normal Model for Nonnormal or Categorical Data	38
Exploratory Analysis	41
MI Example 1	41
<b>6. Multiple Imputation: Complications</b>	<b>50</b>
Interactions and Nonlinearities in MI	50
Compatibility of the Imputation Model and the Analysis Model	52
Role of the Dependent Variable in Imputation	53
Using Additional Variables in the Imputation Process	54
Other Parametric Approaches to Multiple Imputation	55
Nonparametric and Partially Parametric Methods	57
Sequential Generalized Regression Models	64
Linear Hypothesis Tests and Likelihood Ratio Tests	65
MI Example 2	68
MI for Longitudinal and Other Clustered Data	73
MI Example 3	74
<b>7. Nonignorable Missing Data</b>	<b>77</b>
Two Classes of Models	78
Heckman's Model for Sample Selection Bias	79
ML Estimation With Pattern-Mixture Models	82
Multiple Imputation With Pattern-Mixture Models	83
<b>8. Summary and Conclusion</b>	<b>84</b>
<b>Notes</b>	<b>87</b>
<b>References</b>	<b>89</b>
<b>About the Author</b>	<b>93</b>