Contents

Index of Notation

| 1 | 1.1 1.2 1.3 | troductionObjectives of Diagnostic Measurement2Diagnostic Measurement with DCMs3Selecting versus Constructing DCMs3The Role of DCMs in Diagnostic Assessment Design and Implementation4 | 1 |
|----|--------------------------------|---|----|
| I. | THEC | DRY: PRINCIPLES OF DIAGNOSTIC MEASUREMENT WITH DCM | 5 |
| 2 | Vc 2.1 2.2 2.3 2.4 | Diagnostic AssessmentsDiagnostic AssessmentsDiagnostic Assessment in Education10The Process Character of Diagnostic Assessment Implementations10Frameworks for Principled Design of Diagnostic Assessments15Frameworks for Validity Studies of Diagnostic Assessments25Chapter Conclusion28 | 9 |
| 3 | • Di | agnostic Decision Making with DCMs | 29 |
| | 3.2 3.3 3.4 | Diagnostic Characteristics of DCMs29Developing Diagnostic Rules32Contexts for Using DCMs40Reduction of Classification Error with DCMs45Chapter Conclusion47 | |
| 4 | 4.1 4.2 4.3 4.4 | tribute Specification for DCMs49The Nature of Attributes49Attribute Hierarchies55Reporting Attribute Profiles64Developing Cognitive Processing Models71Chapter Conclusion77 | 49 |

xvi

II. METHODS: PSYCHOMETRIC FOUNDATIONS OF DCMs

| • The | e Statistical Nature of DCMs | 8 |
|------------|--|-----|
| 5.2 | DCMs and Other Latent-Variable Models 81 A Taxonomy of Core DCMs 96 | |
| | Related Classification Approaches 101 | |
| | Bayesian Inference Networks 108 | |
| 5.5 | Chapter Conclusion 111 | |
| • The | e Statistical Structure of Core DCMs | 11 |
| 6.1 | General Mathematical Structure of DCMs 113 | |
| | Noncompensatory DCMs 115 | |
| 6.3 | Compensatory DCMs 130 | |
| 6.4 | Chapter Conclusion 143 | |
| The | e LCDM Framework | 144 |
| 7.1 | A Brief Introduction to Log-Linear Models 145 | |
| 7.2 | Log-Linear Models with Latent Classes 148 | |
| 7.3 | Representing DCMs as Log-Linear Models with Latent Classes 150 | |
| | The LCDM as a General DCM for Diagnostic Measurement 155 | |
| | Representing Core DCMs with the LCDM 158 | |
| 7.6 | Chapter Conclusion 168 | |
| Mo | deling the Attribute Space in DCMs | 169 |
| 8.1 | Structural Models in DCMs 169 | |
| 8.2 | Unstructured Structural Models 171 | |
| 8.3 | Log-Linear Structural Models 175 | |
| 8.4 | Unstructured Tetrachoric Models 178 | |
| 8.5 | Structured Tetrachoric Models 182 | |
| 8.6 | Summary of Parameter Complexity in Structural Models 187 | |
| | Special Topics for Structural Models 188 | |
| 8.8 | Chapter Conclusion 190 | |
| | III. APPLICATIONS: UTILIZING DCMs IN PRACTICE | |
| e Est | imating DCMs Using Makus | 193 |
| | imating DCMs Using Mplus | 170 |
| 9.1 | Sample Data Set 194 | |
| 9.2 | Basic Concepts for Estimating DCMs in <i>Mplus</i> 195 | |
| 9.3 | Preliminary Command Syntax 196 | |
| 9.4 | Parameterizing Latent Class Models for Categorical Data in <i>Mplus</i> 200 | |
| 9.5 | Syntax for Estimating the LCDM in <i>Mplus</i> 203 | |
| 9.6 0.7 | Syntax for Specifying Output Information 211 | |
| 9.7 | Running <i>Mplus</i> and Interpreting Output 213 | |
| 9.8 | Estimation of Core DCMs in <i>Mplus</i> 221 Advanced Topics for <i>Mplus</i> Estimation 224 | |
| 9.9 | Advanced Topics for <i>Mplus</i> Estimation 224 | |
| 9.10 |) Chapter Conclusion 231 | |

| 10 | Respondent Parameter Estimation in DCMs | 232 |
|----|--|-----|
| | 10.1 Principles of Estimation Relevant for Attribute Profile Estimation 232 | |
| | 10.2 Estimating Attribute Profiles23310.3 Extended Examples of Attribute Profile Estimation235 | |
| | 10.4 EAP versus MAP Estimation 239 | |
| | 10.5 The Impact of Prior Attribute Distributions on Posterior Attribute Profile Estimation 241 | |
| | Profile Estimation 241 10.6 Standard Errors for Attribute Profile Estimates 242 | |
| | 10.7 Attribute Profile Estimation in <i>Mplus</i> 243 | |
| | 10.8 Chapter Conclusion 247 | |
| 11 | Item Parameter Estimation in DCMs | 250 |
| | 11.1 Conceptual Underpinnings for Estimating Item Parameters 250 | |
| | 11.2 Estimation of Item Parameters Using the E-M Algorithm25111.3 Estimation of Item Parameter Using MCMC260 | |
| | 11.4 Chapter Conclusion 264 | |
| 12 | Evaluating the Model Fit of DCMs | 265 |
| | 12.1 Basic Statistical Principles for Constructing Fit Statistics 266 | |
| | 12.2 Problems with General Goodness-of-Fit Statistics for DCMs27012.3 Practical Approaches for Determining Goodness-of-Fit for DCMs271 | |
| | 12.5 Tractical Apploaches for Determining Goodness-of-Tit for Detris 271 12.4 An Example of Goodness-of-Fit Evaluation 275 | |
| | 12.5 Evaluating Relative Model Fit 277 | |
| | 12.6 Evaluating Person Fit27812.7 Chapter Conclusion279 | |
| | 12.7 Chapter Conclusion 219 | |
| 13 | Item Discrimination Indices for DCMs | 280 |
| | 13.1 Basic Concepts for Item Discrimination Indices281 | |
| | 13.2 Item Discrimination Indices for DCMs28313.3 Information-Based Item Discrimination Indices for DCMs294 | |
| | 13.4 Chapter Conclusion 304 | |
| 14 | Accommodating Complex Sampling Designs in DCMs | 306 |
| | 14.1 Defining Complex Sampling Designs 306 | |
| | 14.2 Accommodating Complex Sampling Designs of Respondents in DCMs30714.3 Accommodating Complex Sampling Designs of Items in DCMs310 | |
| | 14.4 Accommodating Additional Sources of Heterogeneity in DCMs 312 | |
| | 14.5 Chapter Conclusion 313 | |
| | Glossary | 315 |
| | References | 331 |
| | Author Index | 339 |
| | Subject Index | 341 |
| | About the Authors | 348 |
| | | |

For sample exercises, solutions, and data sets with associated *Mplus* code, see the book's accompanying website at *projects.coe.uga.edu/dcm*.