



Table of Contents

| | |
|---------------------------|-------------|
| Introduction | xvii |
|---------------------------|-------------|

Chapter 1

| | |
|----------------------------------|----------|
| Introduction to SAS | 1 |
|----------------------------------|----------|

| | |
|---------------------------------------|---|
| Core of Base SAS Software System..... | 4 |
|---------------------------------------|---|

| | |
|--------------------------------------|---|
| Components of the SAS Language | 5 |
|--------------------------------------|---|

| | |
|-----------------|---|
| SAS Files | 5 |
|-----------------|---|

| | |
|--------------------|---|
| SAS Datasets | 5 |
|--------------------|---|

| | |
|--------------------|---|
| SAS Libraries..... | 7 |
|--------------------|---|

| | |
|---------------------|---|
| External Files..... | 7 |
|---------------------|---|

| | |
|---------------------------------------|---|
| Database Management System Files..... | 8 |
|---------------------------------------|---|

| | |
|----------------------------|---|
| SAS Language Elements..... | 8 |
|----------------------------|---|

| | |
|-------------------------|---|
| SAS Macro Facility..... | 8 |
|-------------------------|---|

| | |
|---|---|
| How SAS Processes the Steps and Generates Output..... | 8 |
|---|---|

| | |
|-----------------------------|---|
| Starting a SAS Session..... | 9 |
|-----------------------------|---|

| | |
|-----------------------------|---|
| Types of SAS Sessions | 9 |
|-----------------------------|---|

| | |
|---|----|
| Starting SAS from the Windows Start Menu..... | 10 |
|---|----|

| | |
|--|----|
| Starting SAS from the Run Dialog Box or a Command Prompt | 11 |
|--|----|

Chapter 2

| | |
|--|-----------|
| Introduction to Base SAS | 13 |
| SAS Windows Programming Environment..... | 15 |
| Know Your SAS Windows Environment..... | 16 |
| Windows in SAS Window Programming Environment | 18 |
| Using the SAS Windows Programming Environment..... | 23 |
| Writing a New SAS Program..... | 23 |
| Running a SAS Program..... | 23 |
| A Sample Program..... | 24 |
| Using SAS Windowing Environment to Create and use Libraries and Datasets | 26 |
| Creating a SAS Library | 27 |
| Opening an Existing Library..... | 28 |
| Disabling a SAS Library..... | 29 |
| Creating a New Dataset..... | 30 |
| Deleting the SAS Dataset..... | 33 |
| Renaming a SAS Dataset | 33 |
| Copying the SAS Dataset | 34 |
| SAS Programming Basics | 35 |
| DATA Step..... | 35 |
| PROC Step | 35 |
| Programming Steps in SAS | 35 |

Chapter 3

| | |
|---|-----------|
| SAS Programming—Data Types, Variables, and Constants | 41 |
| SAS Language Conventions | 43 |
| SAS Program | 43 |
| Data Definition and Options..... | 43 |
| Data Step | 43 |
| Procedures (PROC Step)..... | 44 |
| SAS Words..... | 44 |
| Rules for Spaces in a Word..... | 44 |

| | |
|---|-----------|
| Types of SAS Words..... | 45 |
| Names..... | 45 |
| Literal..... | 46 |
| Number..... | 47 |
| Special Characters..... | 48 |
| SAS Variables | 48 |
| Types of the SAS Variables..... | 48 |
| SAS Variable Lists..... | 50 |
| SAS Variable Attributes..... | 54 |
| Missing Values..... | 54 |
| SAS Constants | 57 |
| Character Constants..... | 57 |
| Numeric Constants..... | 58 |
| Date, Time, and DateTime Constants..... | 59 |
| Bit Testing | 60 |
| SAS Expressions..... | 60 |
| SAS Operators..... | 61 |
| Order of Evaluation in Compound Expressions..... | 68 |
| | |
| Chapter 4 | |
| SAS Language Elements—DATA Step | 71 |
| System Options..... | 79 |
| DATA Step Process | 81 |
| Compilation Phase..... | 81 |
| Execution Phase..... | 83 |
| Reading Data | 84 |
| Getting Data using Import Wizard | 85 |
| Reading Data from Text Files | 91 |
| Reading Data from another Dataset..... | 110 |
| Writing the Data to the Dataset..... | 111 |
| Selecting Variables to be Written to Dataset..... | 111 |
| Renaming the Variables using RENAME Option..... | 115 |

Table of Contents

| | |
|--|-----|
| Creating Permanent Library | 115 |
| Controlling Output using OUTPUT Statement..... | 117 |
| Preparing Data | 120 |
| Creating Variables | 120 |
| Retaining Values using RETAIN and SUM Statements | 123 |
| Using Functions in Processing Data | 125 |
| Using Arrays to Deal with a Group of Variables..... | 135 |
| Writing Data to External Files | 147 |

Chapter 5

SAS Language Elements—PROC Step 153

| | |
|--|-----|
| PROC Step | 155 |
| Some More Operators..... | 157 |
| BETWEEN-AND Operator..... | 158 |
| CONTAINS / ? Operator..... | 158 |
| IS NULL or IS MISSING Operator..... | 159 |
| LIKE Operator | 160 |
| Sounds-like (=*) Operator..... | 160 |
| Functionally Base SAS Procedures | 161 |
| Report Writing | 161 |
| Statistics | 162 |
| Utilities | 162 |
| Output Delivery System..... | 163 |
| Statements in SAS Procedures..... | 164 |
| ATTRIB Statement | 165 |
| PROC PRINT Procedure | 166 |
| Syntax of PRINT Procedure | 166 |
| WHERE Statement..... | 169 |
| VAR Statement..... | 172 |
| BY Statement..... | 175 |
| SUM Statement | 181 |
| SUMBY Statement..... | 184 |
| PAGEBY Statement | 189 |

| | |
|---|------------|
| ID Statement..... | 191 |
| Chapter 6 | |
| SAS Procedures..... | 195 |
| Most Commonly Used Procedures..... | 197 |
| PROC SORT Procedure..... | 197 |
| PROC FORMAT Procedure..... | 197 |
| PROC FREQ Procedure | 197 |
| PROC MEANS Procedure..... | 197 |
| PROC CONTENTS Procedure | 198 |
| PROC REPORT Procedure | 198 |
| PROC PLOT Procedure | 198 |
| PROC TABULATE Procedure..... | 198 |
| PROC CHART Procedure | 198 |
| PROC SORT Procedure | 198 |
| Syntax of PROC SORT | 198 |
| PROC FORMAT Procedure | 201 |
| Syntax for PROC FORMAT..... | 202 |
| Formatting with VALUE Statement | 203 |
| Syntax of VALUE Statement..... | 203 |
| Formatting with INVALUE Statement | 208 |
| Formatting with PICTURE Statement..... | 208 |
| Syntax of PICTURE Statement | 208 |
| PICTURE Options..... | 210 |
| Formatting DATA, TIME, and DATETIME Values..... | 212 |
| PROC FREQ Procedure | 216 |
| Syntax of PROC FREQ | 216 |
| A Sample Program..... | 217 |
| Using the BY Statement | 219 |
| TABLES Statement | 221 |
| Syntax of Tables Statement..... | 221 |
| EXACT Statement..... | 222 |

Table of Contents

| | |
|---------------------------------|-----|
| Syntax of EXACT Statement | 222 |
| Output Statement | 225 |
| Syntax of OUTPUT Statement..... | 225 |
| Test Statement | 225 |
| Syntax of Test Statement | 225 |
| Weight Statement | 225 |
| Syntax of WEIGHT Statement..... | 225 |
| PROC MEANS Procedure..... | 226 |
| Syntax of PROC MEANS | 227 |
| PROC MEANS Statement | 228 |
| VAR Statement..... | 228 |
| Syntax of VAR statement | 229 |
| BY Statement | 229 |
| CLASS Statement..... | 229 |
| Syntax of CLASS Statement | 229 |
| FREQ Statement | 230 |
| Syntax of FREQ Statement..... | 230 |
| ID Statement | 230 |
| Syntax of ID Statement..... | 230 |
| OUTPUT Statement..... | 230 |
| Syntax of OUTPUT Statement..... | 230 |
| Types Statement..... | 232 |
| Syntax of Types Statement..... | 232 |
| WAYS Statement | 232 |
| Syntax of WAYS Statement | 232 |
| PROC CONTENTS Procedure | 232 |
| Syntax of PROC CONTENTS..... | 232 |
| PROC REPORT Procedure..... | 236 |
| Syntax of PROC REPORT | 236 |

| | |
|----------------------------------|-----|
| COLUMN Statement..... | 239 |
| Syntax of COLUMN Statement..... | 239 |
| DEFINE Statement | 241 |
| Syntax of DEFINE Statement..... | 241 |
| BREAK Statement..... | 242 |
| Syntax for BREAK Statement | 242 |
| COMPUTE Statement | 245 |
| Syntax of COMPUTE Statement..... | 245 |
| PROC PLOT Procedure | 247 |
| Syntax of PROC PLOT | 247 |

Chapter 7

SAS Functions 249

| | |
|----------------------------------|-----|
| Mathematical Functions | 252 |
| ABS Function | 252 |
| EXP Function | 253 |
| FACT Function..... | 253 |
| LOG Function..... | 254 |
| LOG10 Function..... | 254 |
| LOG2 Function..... | 255 |
| MOD Function | 255 |
| SIGN Function..... | 255 |
| SQRT Function | 256 |
| PERM Function..... | 256 |
| Date and Time Functions | 257 |
| DATDIF Function | 258 |
| DATE() or TODAY() Function | 258 |
| DATEJUL Function | 258 |
| DATEPART Function..... | 259 |
| DATETIME Function..... | 259 |
| DAY Function..... | 259 |
| HOUR Function..... | 259 |
| JULDATE FUNCTION..... | 260 |

Table of Contents

| | |
|-----------------------------------|-----|
| MDY Function..... | 260 |
| MINUTE Function..... | 260 |
| MONTH Function..... | 260 |
| QTR Function | 261 |
| SECOND Function..... | 261 |
| TIME Function | 261 |
| TIMEPART Function | 261 |
| WEEKDAY Function | 261 |
| YEAR Function..... | 262 |
| YRDIF FUNCTION | 262 |
| String Functions | 262 |
| CAT Function | 264 |
| CHOOSEN Function..... | 265 |
| COMPBL Function | 266 |
| COUNT Function..... | 266 |
| COUNTC Function..... | 267 |
| FIND Function..... | 268 |
| FINDC Function | 269 |
| INDEX Function | 269 |
| INDEXC Function..... | 270 |
| LENGTH Function..... | 271 |
| LENGTHC Function | 271 |
| LOWCASE Function..... | 272 |
| UPCASE Function..... | 272 |
| QUOTE Function..... | 272 |
| RANK Function | 273 |
| REPEAT Function | 273 |
| REVERSE Function..... | 274 |
| LEFT Function..... | 274 |
| RIGHT Function | 274 |
| STRIP Function | 275 |
| SUBSTR (right of =) Function..... | 275 |
| SUBSTR (left of =) Function | 276 |
| SUM Function..... | 277 |
| TRANSLATE Function | 277 |
| TRIM Function | 278 |
| Array Functions | 278 |
| DIM Function..... | 279 |

| | |
|----------------------------|-----|
| HBOUND Function..... | 280 |
| LBOUND Function..... | 282 |
| Statistical Functions..... | 282 |
| CSS Function..... | 284 |
| CV Function..... | 284 |
| GEOMEAN Function..... | 284 |
| HARMEAN Function..... | 285 |
| MAD Function..... | 285 |
| IQR Function..... | 285 |
| LARGEST Function..... | 286 |
| MAX Function..... | 286 |
| MIN Function..... | 287 |
| N Function..... | 287 |
| MEAN Function..... | 288 |
| MEDIAN Function..... | 288 |
| RANGE Function..... | 289 |
| STD Function..... | 289 |
| VAR Function..... | 289 |
| Truncation Functions..... | 290 |
| CEIL Function..... | 290 |
| FLOOR Function..... | 291 |
| INT Function..... | 291 |
| ROUND Function..... | 291 |
| Financial Functions..... | 292 |
| IRR Function..... | 292 |
| NETPV Function..... | 293 |
| NPV Function..... | 293 |
| PVP Function..... | 294 |
| SAVING Function..... | 295 |

Chapter 8

| | |
|---|------------|
| Working with Multiple Datasets and Modifying Datasets..... | 297 |
| Multiple Datasets..... | 299 |
| Horizontal Merging of Datasets..... | 299 |
| Syntax of PROC APPEND..... | 299 |

Table of Contents

| | |
|--------------------------------------|-----|
| Vertical Merging of DataSets..... | 301 |
| Syntax of Merge Statement..... | 301 |
| Copying DataSets | 304 |
| PROC COPY Statement..... | 304 |
| Modifying Datasets..... | 306 |
| UPDATE Statement in a DATA Step..... | 306 |

Chapter 9

Advanced SAS Procedures.....309

| | |
|---|-----|
| PROC TABULATE Procedure..... | 311 |
| Syntax of PROC TABULATE Procedure..... | 313 |
| Syntax of PROC TABULATE Statement | 314 |
| Syntax of CLASS Statement | 316 |
| Syntax of VAR Statement..... | 317 |
| Syntax of TABLE Statement..... | 317 |
| Syntax of BY Statement..... | 325 |
| Syntax of KEYLABEL Statement..... | 328 |
| Syntax of WEIGHT Statement..... | 329 |
| Syntax of FORMAT Statement..... | 330 |
| PROC CHART Procedure | 331 |
| Syntax of PROC CHART Procedure..... | 332 |
| Syntax of PROC CHART Statement..... | 332 |
| Syntax of BY Statement..... | 333 |
| Syntax of HBAR Statement..... | 333 |
| Syntax of VBAR Statement..... | 336 |
| Syntax of BLOCK Statement..... | 338 |
| Syntax of PIE Statement..... | 340 |
| Syntax of STAR Statement..... | 341 |

Chapter 10

SAS Output.....345

| | |
|---------------------------------|-----|
| SAS Log..... | 347 |
| Custom Messages in SAS Log..... | 349 |

| | |
|--|-----|
| Sending Log and Output to Other Destination | 350 |
| Output Delivery System..... | 350 |
| Templates | 350 |
| Output Objects | 352 |
| ODS Destinations..... | 352 |
| Selecting an ODS Destination..... | 353 |
| ODS Destination for HTML | 354 |
| ODS Destination for RTF..... | 356 |
| ODS Destination for PDF | 357 |
| ODS Destination for PS..... | 358 |
| ODS Templates Customizing using SYTLE= Option..... | 359 |
| Formatting Titles and Footnotes..... | 362 |

Chapter 11

SAS Macros 365

| | |
|--------------------------------------|-----|
| SAS Macro Variables..... | 367 |
| User-Defined Macro Variables..... | 368 |
| System-Defined Macro Variables..... | 369 |
| Scope of Macro Variables | 370 |
| Global Macro Variables | 370 |
| Local Macro Variables..... | 371 |
| Defining SAS Macros | 371 |
| Inserting Comments in Macros | 372 |
| Macros with Arguments..... | 372 |
| Positional Macro Arguments | 374 |
| Keyword Macro Arguments | 375 |
| Conditional Macros..... | 377 |
| Macros Repeating PROC Execution..... | 380 |
| Macro Language | 381 |
| Including External Macros | 382 |
| Autocall Macro Libraries..... | 382 |
| Printing Macro Expansions | 383 |

Table of Contents

| | |
|---|----------------|
| Macro Functions | 385 |
| SAS Macro Processor | 387 |
| Chapter 12 | |
| SAS Debugging..... | 389 |
| Types of Errors in SAS..... | 391 |
| Syntax Errors | 391 |
| Semantic Errors..... | 394 |
| Execution-Time Errors..... | 395 |
| Macro-Related Errors..... | 396 |
| Compile-Time Error..... | 396 |
| Runtime Error..... | 398 |
| Debugging in SAS | 399 |
| PUT Statement..... | 399 |
| DATA Step Debugger | 400 |
| Good Programming Practices and Attitudes..... | 401 |
| Appendix A | 403–410 |
| Appendix B | 411–416 |
| Appendix C | 417–438 |
| Appendix D | 439–442 |
| Appendix E | 443–446 |
| Appendix F | 447–448 |
| Index | 449–452 |