

# Contents at a Glance

<b>About the Authors.....</b>	<b>xix</b>
<b>Acknowledgments .....</b>	<b>xi</b>
<b>Preface .....</b>	<b>xxiii</b>
<b>■Part 1: Basics of SAS Programming for Analytics.....</b>	<b>1</b>
<b>■Chapter 1: Introduction to Business Analytics and Data Analysis Tools.....</b>	<b>3</b>
<b>■Chapter 2: SAS Introduction.....</b>	<b>29</b>
<b>■Chapter 3: Data Handling Using SAS .....</b>	<b>55</b>
<b>■Chapter 4: Important SAS Functions and Procs .....</b>	<b>95</b>
<b>■Part 2: Using SAS for Business Analytics .....</b>	<b>145</b>
<b>■Chapter 5: Introduction to Statistical Analysis .....</b>	<b>147</b>
<b>■Chapter 6: Basic Descriptive Statistics and Reporting in SAS .....</b>	<b>165</b>
<b>■Chapter 7: Data Exploration, Validation, and Data Sanitization .....</b>	<b>197</b>
<b>■Chapter 8: Testing of Hypothesis.....</b>	<b>261</b>
<b>■Chapter 9: Correlation and Linear Regression .....</b>	<b>295</b>
<b>■Chapter 10: Multiple Regression Analysis .....</b>	<b>351</b>
<b>■Chapter 11: Logistic Regression .....</b>	<b>401</b>
<b>■Chapter 12: Time-Series Analysis and Forecasting .....</b>	<b>441</b>
<b>■Chapter 13: Introducing Big Data Analytics .....</b>	<b>509</b>
<b>Index.....</b>	<b>541</b>

# Contents

<b>About the Authors.....</b>	<b>xix</b>
<b>Acknowledgments.....</b>	<b>xxi</b>
<b>Preface .....</b>	<b>xxiii</b>
<b>■Part 1: Basics of SAS Programming for Analytics.....</b>	<b>1</b>
<b>■Chapter 1: Introduction to Business Analytics and Data Analysis Tools.....</b>	<b>3</b>
Business Analytics, the Science of Data-Driven Decision Making .....	3
Business Analytics Defined .....	3
Is Advanced Analytics the Solution for You? .....	5
Simulation, Modeling, and Optimization .....	6
Data Warehousing and Data Mining .....	7
What Can Be Discovered Using Data Mining? .....	7
Business Intelligence, Reporting, and Business Analytics .....	8
Analytics Techniques Used in the Industry.....	8
Regression Modeling and Analysis.....	8
Time Series Forecasting .....	10
Conjoint Analysis .....	11
Cluster Analysis .....	11
Segmentation .....	13
Principal Components and Factor Analysis .....	13
Correspondence Analysis .....	13
Survival Analytics .....	13

<b>Some Practical Applications of Business Analytics .....</b>	<b>14</b>
Customer Analytics.....	14
Operational Analytics.....	14
Social Media Analytics.....	14
Data Used in Analytics .....	15
<b>Big Data vs. Conventional Business Analytics.....</b>	<b>15</b>
Introduction to Big Data.....	15
Introduction to Data Analysis Tools.....	20
Main Parts of SAS, SPSS, and R.....	22
Selection of Analytics Tools .....	27
<b>The Background Required for a Successful Career in Business Analytics.....</b>	<b>27</b>
Skills Required for a Business Analytics Professional .....	27
<b>Conclusion.....</b>	<b>28</b>
<b>■Chapter 2: SAS Introduction.....</b>	<b>29</b>
Starting SAS in Windows.....	29
The SAS Opening Screen.....	31
The Five Main Windows .....	31
Editor Window.....	32
Log Window .....	34
Output Window .....	35
Explorer Window .....	40
Results Window .....	41
Important Menu Options and Icons .....	42
View Options.....	44
Run Menu .....	44
Solutions Menu.....	45
Shortcut Icons .....	45
Writing and Executing a SAS Program .....	46
Comments in the Code .....	47

Your First SAS Program .....	48
Debugging SAS Code Using a Log File .....	50
Example for Warnings in Log File .....	52
Tips for Writing, Reading the Log File, and Debugging .....	53
Saving SAS Files .....	53
Exercise .....	54
Conclusion .....	54
<b>■Chapter 3: Data Handling Using SAS .....</b>	<b>55</b>
SAS Data Sets .....	56
Descriptive Portion of SAS Data Sets .....	56
Data Portion of Data Set .....	57
SAS Libraries .....	58
Creating the Library Using the GUI .....	59
Rules of Assigning a Library .....	64
Creating a New Library Using SAS Code .....	64
Permanent and Temporary Libraries .....	65
Two Main Types of SAS Statements .....	68
Importing Data into SAS .....	68
Data Set Creation Using the SAS Program .....	68
Using the Import Wizard .....	70
Import Using the Code .....	77
Data Manipulations .....	80
Making a Copy of a SAS Data Set .....	80
Creating New Variables .....	82
Updating the Same Data Set .....	87
Drop and Keep Variables .....	88
Subsetting the Data .....	90
Conclusion .....	93

<b>■Chapter 4: Important SAS Functions and Procs.....</b>	<b>95</b>
SAS Functions .....	95
Numeric Functions .....	96
Character Functions .....	101
Date Functions.....	105
Important SAS PROCs .....	108
The Proc Step .....	108
PROC CONTENTS .....	108
PROC SORT .....	112
Graphs Using SAS.....	120
PROC gplot and Gchart .....	121
PROC SQL .....	125
Data Merging.....	129
Appending the Data .....	129
From SET to MERGE.....	131
Blending with Condition.....	132
Matched Merging.....	134
Conclusion.....	143
<b>■Part 2: Using SAS for Business Analytics.....</b>	<b>145</b>
<b>■Chapter 5: Introduction to Statistical Analysis .....</b>	<b>147</b>
What Is Statistics?.....	147
Basic Statistical Concepts in Business Analytics .....	149
Population.....	149
Sample .....	149
Variable.....	150
Variable Types in Predictive Modeling Context .....	151
Parameter .....	151
Statistic .....	152
Example Exercise .....	152

<b>Statistical Analysis Methods .....</b>	<b>160</b>
Descriptive Statistics.....	160
Inferential Statistics.....	160
Predictive Statistics .....	161
<b>Solving a Problem Using Statistical Analysis .....</b>	<b>161</b>
Setting Up Business Objective and Planning.....	161
The Data Preparation.....	161
Descriptive Analysis and Visualization.....	161
Predictive Modeling.....	162
Model Validation .....	162
Model Implementation.....	162
<b>An Example from the Real World: Credit Risk Life Cycle .....</b>	<b>163</b>
Business Objective and Planning .....	163
Data Preparation.....	163
Descriptive Analysis and Visualization.....	163
Predictive Modeling.....	164
Model Validation .....	164
Model Implementation.....	164
<b>Conclusion.....</b>	<b>164</b>
<b>■Chapter 6: Basic Descriptive Statistics and Reporting in SAS .....</b>	<b>165</b>
<b>Rudimentary Forms of Data Analysis .....</b>	<b>165</b>
Simply Print the Data.....	165
Print and Various Options of Print in SAS .....	165
<b>Summary Statistics .....</b>	<b>168</b>
Central Tendencies .....	169
Calculating Central Tendencies in SAS .....	173
What Is Dispersion?.....	177
Calculating Dispersion Using SAS .....	182
Quantiles.....	185
Calculating Quantiles Using SAS .....	187

Box Plots.....	189
Creating Boxplots Using SAS .....	192
Bivariate Analysis .....	196
Conclusion.....	196
<b>■Chapter 7: Data Exploration, Validation, and Data Sanitization .....</b>	<b>197</b>
Data Exploration Steps in a Statistical Data Analysis Life Cycle .....	197
Example: Contact Center Call Volumes .....	198
Need for Data Exploration and Validation .....	201
Issues with the Real-World Data and How to Solve Them .....	204
Missing Values.....	204
The Outliers .....	205
Manual Inspection of the Dataset Is Not a Practical Solution.....	205
Removing Records Is Not Always the Right Way .....	205
Understanding and Preparing the Data .....	206
Data Exploration .....	206
Data Validation.....	206
Data Cleaning .....	207
Data Exploration, Validation, and Sanitization Case Study: Credit Risk Data.....	207
Importing the Data.....	210
Step 1: Data Exploration and Validation Using the PROC CONTENTS.....	211
Step 2: Data Exploration and Validation Using Data Snapshot.....	214
Step 3: Data Exploration and Validation Using Univariate Analysis.....	221
Step 4: Data Exploration and Validation Using Frequencies .....	232
Step 5: The Missing Value and Outlier Treatment .....	239
Conclusion.....	259
<b>■Chapter 8: Testing of Hypothesis.....</b>	<b>261</b>
Testing: An Analogy from Everyday Life .....	261
What Is the Process of Testing a Hypothesis?.....	262
State the Null Hypothesis on the Population: Null Hypothesis ( $H_0$ ) .....	266
Alternate Hypothesis ( $H_1$ ).....	266

Sampling Distribution .....	267
Central Limit Theorem .....	269
Test Statistic .....	272
Inference.....	274
Critical Values and Critical Region.....	279
Confidence Interval.....	280
<b>Tests .....</b>	<b>283</b>
T-test for Mean .....	283
Case Study: Testing for the Mean in SAS.....	283
Other Test Examples .....	286
Two-Tailed and Single-Tailed Tests.....	287
<b>Conclusion.....</b>	<b>293</b>
<b>■Chapter 9: Correlation and Linear Regression .....</b>	<b>295</b>
<b>What Is Correlation? .....</b>	<b>295</b>
Pearson's Correlation Coefficient ( $r$ ).....	297
Variance and Covariance .....	297
Correlation Matrix.....	298
Calculating Correlation Coefficient Using SAS.....	298
Correlation Limits and Strength of Association .....	301
Properties and Limitations of Correlation Coefficient ( $r$ ) .....	306
Some Examples on Limitations of Correlation.....	306
Correlation vs. Causation.....	312
Correlation Example .....	313
Correlation Summary.....	318
<b>Linear Regression .....</b>	<b>318</b>
Correlation to Regression .....	320
Estimation Example .....	322
<b>Simple Linear Regression .....</b>	<b>325</b>
Regression Line Fitting Using Least Squares .....	325
The Beta Coefficients: Example 1 .....	327

## CONTENTS

How Good Is My Model? .....	328
Regression Assumptions .....	335
When Linear Regression Can't Be Applied .....	344
Simple Regression: Example .....	345
Conclusion.....	349
<b>■Chapter 10: Multiple Regression Analysis .....</b>	<b>351</b>
Multiple Linear Regression.....	351
Multiple Regression Line .....	353
Multiple Regression Line Fitting Using Least Squares .....	354
Multiple Linear Regression in SAS .....	355
Example: Smartphone Sales Estimation .....	355
Goodness of Fit.....	357
Three Main Measures from Regression Output.....	358
Multicollinearity Defined.....	383
How to Analyze the Output: Linear Regression Final Check List .....	395
Double-Check for the Assumptions of Linear Regression .....	395
F-test .....	395
R-squared.....	395
Adjusted R-Squared:.....	395
VIF .....	396
T-test for Each Variable.....	396
Analyzing the Regression Output: Final Check List Example.....	396
Conclusion.....	399
<b>■Chapter 11: Logistic Regression .....</b>	<b>401</b>
Predicting Ice-Cream Sales: Example .....	401
Nonlinear Regression .....	404
Logistic Regression .....	407
Logistic Regression Using SAS.....	408

<b>SAS Logistic Regression Output Explanation .....</b>	<b>410</b>
Output Part 1: Response Variable Summary.....	410
Output Part 2: Model Fit Summary .....	412
Output Part 3: Test for Regression Coefficients .....	412
Output Part 4: The Beta Coefficients and Odds Ratio .....	413
Output Part 5: Validation Statistics .....	415
<b>Individual Impact of Independent Variables .....</b>	<b>415</b>
<b>Goodness of Fit for Logistic Regression.....</b>	<b>416</b>
Chi-square Test.....	416
Concordance.....	417
<b>Prediction Using Logistic Regression.....</b>	<b>419</b>
<b>Multicollinearity in Logistic Regression .....</b>	<b>419</b>
No VIF Option in PROC LOGISTIC.....	421
<b>Logistic Regression Final Check List.....</b>	<b>421</b>
<b>Loan Default Prediction Case Study .....</b>	<b>422</b>
Background and Problem Statement.....	422
Objective.....	422
Data Set.....	422
Model Building.....	426
Final Model Equation and Prediction Using the Model .....	438
<b>Conclusion.....</b>	<b>440</b>
<b>■Chapter 12: Time-Series Analysis and Forecasting .....</b>	<b>441</b>
<b>What Is a Time-Series Process?.....</b>	<b>441</b>
<b>Main Phases of Time-Series Analysis.....</b>	<b>445</b>
<b>Modeling Methodologies .....</b>	<b>445</b>
<b>Box-Jenkins Approach.....</b>	<b>446</b>
What Is ARIMA? .....	446
The AR Process.....	446

The MA Process.....	448
ARMA Process .....	450
<b>Understanding ARIMA Using an Eyesight Measurement Analogy.....</b>	<b>452</b>
<b>Steps in the Box–Jenkins Approach.....</b>	<b>453</b>
Step 1: Testing Whether the Time Series Is Stationary .....	454
Step 2: Identifying the Model.....	465
Step 3: Estimating the Parameters.....	497
Step 4: Forecasting Using the Model.....	501
Case Study: Time-Series Forecasting Using the SAS Example.....	503
Checking the Model Accuracy .....	506
Conclusion.....	507
<b>■Chapter 13: Introducing Big Data Analytics.....</b>	<b>509</b>
Traditional Data-Handling Tools.....	509
Walmart Customer Data.....	509
Facebook Data.....	510
Examples of the Growing Size of Data.....	510
What Is Big Data? .....	511
The Three Main Components of Big Data .....	511
Applications of Big Data Analytics.....	513
The Solution for Big Data Problems .....	514
Distributed Computing .....	514
What Is MapReduce?.....	515
Map Function.....	515
Reduce Function.....	515
What Is Apache Hadoop?.....	517
Hadoop Distributed File System .....	517
MapReduce.....	519
Apache Hive.....	520

Apache Pig.....	521
Other Tools in the Hadoop Ecosystem .....	521
Companies That Use Hadoop.....	523
<b>Big Data Analytics Example.....</b>	<b>524</b>
Examining the Business Problem.....	524
Getting the Data Set .....	525
Starting Hadoop.....	525
Looking at the Hadoop Components .....	527
Moving Data from the Local System to Hadoop .....	529
Viewing the Data on HDFS.....	530
Starting Hive.....	534
Creating a Table Using Hive .....	535
Executing a Program Using Hive .....	536
Viewing the MapReduce Status.....	537
The Final Result.....	539
<b>Conclusion.....</b>	<b>540</b>
<b>Index.....</b>	<b>541</b>