CONTENTS

Preface 21 About the Authors 29

Part I Decision Making and Analytics: An Overview 31

Chapter 1 An Overview of Business Intelligence, Analytics, and Decision Support 32

- 1.1 Opening Vignette: Magpie Sensing Employs Analytics to Manage a Vaccine Supply Chain Effectively and Safely 33
- **1.2** Changing Business Environments and Computerized Decision Support 35 The Business Pressures–Responses–Support Model 35
- 1.3 Managerial Decision Making 37 The Nature of Managers' Work 37 The Decision-Making Process 38
- 1.4 Information Systems Support for Decision Making 39
- 1.5 An Early Framework for Computerized Decision Support 41 The Gorry and Scott-Morton Classical Framework 41 Computer Support for Structured Decisions 42 Computer Support for Unstructured Decisions 43 Computer Support for Semistructured Problems 43
- 1.6 The Concept of Decision Support Systems (DSS) 43
 DSS as an Umbrella Term 43
 Evolution of DSS into Business Intelligence 44
- 1.7 A Framework for Business Intelligence (BI) 44 Definitions of BI 44 A Brief History of BI 44
 - The Architecture of BL 45
 - Styles of BI 45
 - The Origins and Drivers of BI 46
 - A Multimedia Exercise in Business Intelligence 46
 - APPLICATION CASE 1.1 Sabre Helps Its Clients Through Dashboards and Analytics 47

The DSS-BI Connection 48

1.8 Business Analytics Overview 49

Descriptive Analytics 50

- ► APPLICATION CASE 1.2 Eliminating Inefficiencies at Seattle Children's Hospital 51
- ► APPLICATION CASE 1.3 Analysis at the Speed of Thought 52

- ► APPLICATION CASE 1.4 Moneyball: Analytics in Sports and Movies 53
- ► APPLICATION CASE 1.5 Analyzing Athletic Injuries 54 Prescriptive Analytics 54
- APPLICATION CASE 1.6 Industrial and Commercial Bank of China (ICBC) Employs Models to Reconfigure Its Branch Network 55
 Analytics Applied to Different Domains 56
 Analytics or Data Science? 56
- **1.9** Brief Introduction to Big Data Analytics 57 What Is Big Data? 57
 - ► APPLICATION CASE 1.7 Gilt Groupe's Flash Sales Streamlined by Big Data Analytics 59
- 1.10 Plan of the Book 59
 Part I: Business Analytics: An Overview 59
 Part II: Descriptive Analytics 60
 Part III: Predictive Analytics 60
 Part IV: Prescriptive Analytics 61
 - Part V: Big Data and Future Directions for Business Analytics 61
- 1.11 Resources, Links, and the Teradata University Network Connection 61
 Resources and Links 61

Vendors, Products, and Demos 61

Periodicals 61

The Teradata University Network Connection 62

The Book's Web Site 62

Chapter Highlights 62 • Key Terms 63

Questions for Discussion 63 • Exercises 63

 END-OF-CHAPTER APPLICATION CASE Nationwide Insurance Used BI to Enhance Customer Service 64
 References 65

Chapter 2 Foundations and Technologies for Decision Making 67

- 2.1 Opening Vignette: Decision Modeling at HP Using Spreadsheets 68
- 2.2 Decision Making: Introduction and Definitions 70 Characteristics of Decision Making 70 A Working Definition of Decision Making 71 Decision-Making Disciplines 71 Decision Style and Decision Makers 71
- 2.3 Phases of the Decision-Making Process 72
- 2.4 Decision Making: The Intelligence Phase 74 Problem (or Opportunity) Identification 75

APPLICATION CASE 2.1 Making Elevators Go Faster! 75
 Problem Classification 76
 Problem Decomposition 76
 Problem Ownership 76

2.5	Decision Making: The Design Phase 77 Models 77
	Mathematical (Quantitative) Models 77
	The Benefits of Models 77
	Selection of a Principle of Choice 78
	Normative Models 79
	Suboptimization 79
	Descriptive Models 80
	Good Enough, or Satisficing 81
	Developing (Generating) Alternatives 82
	Measuring Outcomes 83
	Risk 83
	Scenarios 84
	Possible Scenarios 84
	Errors in Decision Making 84
2.6	Decision Making: The Choice Phase 85
2.7	Decision Making: The Implementation Phase 85
2.8	How Decisions Are Supported 86
2.0	Support for the Intelligence Phase 86
	Support for the Design Phase 87
	Support for the Choice Phase 88
	Support for the Implementation Phase 88
2.9	Decision Support Systems: Capabilities 89
2.5	A DSS Application 89
2.10	DSS Classifications 91
2110	The AIS SIGDSS Classification for DSS 91
	Other DSS Categories 93
	Custom-Made Systems Versus Ready-Made Systems 93
2.11	Components of Decision Support Systems 94
	The Data Management Subsystem 95
	The Model Management Subsystem 95
	APPLICATION CASE 2.2 Station Casinos Wins by Building Customer Relationships Using Its Data 96
	APPLICATION CASE 2.3 SNAP DSS Helps OneNet Make Telecommunications Rate Decisions 98
	The User Interface Subsystem 98
	The Knowledge-Based Management Subsystem 99
	► APPLICATION CASE 2.4 From a Game Winner to a Doctor! 100
	Chapter Highlights 102 • Key Terms 103
	Questions for Discussion 103 • Exercises 104
	 END-OF-CHAPTER APPLICATION CASE Logistics Optimization in a Major Shipping Company (CSAV) 104
	References 105

Part II Descriptive Analytics 107

Chapter 3 Data Warehousing 108

- 3.1 Opening Vignette: Isle of Capri Casinos Is Winning with Enterprise Data Warehouse 109
- 3.2 Data Warehousing Definitions and Concepts 111 What Is a Data Warehouse? 111 A Historical Perspective to Data Warehousing 111 Characteristics of Data Warehousing 113 Data Marts 114 Operational Data Stores 114 Enterprise Data Warehouses (EDW) 115 Metadata 115 ► APPLICATION CASE 3.1 A Better Data Plan: Well-Established TELCOs Leverage Data Warehousing and Analytics to Stay on Top in a **Competitive Industry** 115 3.3 Data Warehousing Process Overview 117 ► APPLICATION CASE 3.2 Data Warehousing Helps MultiCare Save More Lives 118 3.4 Data Warehousing Architectures 120 Alternative Data Warehousing Architectures 123 Which Architecture Is the Best? 126 3.5 Data Integration and the Extraction, Transformation, and Load (ETL) Processes 127 Data Integration 128 ► APPLICATION CASE 3.3 BP Lubricants Achieves BIGS Success 128 Extraction, Transformation, and Load 130 3.6 Data Warehouse Development 132 ► APPLICATION CASE 3.4 Things Go Better with Coke's Data Warehouse 133 Data Warehouse Development Approaches 133 ► APPLICATION CASE 3.5 Starwood Hotels & Resorts Manages Hotel Profitability with Data Warehousing 136 Additional Data Warehouse Development Considerations 137 Representation of Data in Data Warehouse 138 Analysis of Data in the Data Warehouse 139 OLAP Versus OLTP 140 OLAP Operations 140 3.7 Data Warehousing Implementation Issues 143 ► APPLICATION CASE 3.6 EDW Helps Connect State Agencies in Michigan 145 Massive Data Warehouses and Scalability 146 Real-Time Data Warehousing 147 3.8
 - ► APPLICATION CASE 3.7 Egg Plc Fries the Competition in Near Real Time 148

- **3.9** Data Warehouse Administration, Security Issues, and Future Trends 151 The Future of Data Warehousing 153
- 3.10 Resources, Links, and the Teradata University Network Connection 156 Resources and Links 156 Cases 156 Vendors, Products, and Demos 157 Periodicals 157 Additional References 157 The Teradata University Network (TUN) Connection 157 Chapter Highlights 158 • Key Terms 158 Questions for Discussion 158 • Exercises 159
 ► END-OF-CHAPTER APPLICATION CASE Continental Airlines Flies High with Its Real-Time Data Warehouse 161

```
-----
```

References 162

Chapter 4 Business Reporting, Visual Analytics, and Business Performance Management 165

- **4.1** Opening Vignette:Self-Service Reporting Environment Saves Millions for Corporate Customers 166
- **4.2** Business Reporting Definitions and Concepts 169 What Is a Business Report? 170
 - APPLICATION CASE 4.1 Delta Lloyd Group Ensures Accuracy and Efficiency in Financial Reporting 171

Components of the Business Reporting System 173

- ► APPLICATION CASE 4.2 Flood of Paper Ends at FEMA 174
- 4.3 Data and Information Visualization 175
 - APPLICATION CASE 4.3 Tableau Saves Blastrac Thousands of Dollars with Simplified Information Sharing 176

A Brief History of Data Visualization 177

- APPLICATION CASE 4.4 TIBCO Spotfire Provides Dana-Farber Cancer Institute with Unprecedented Insight into Cancer Vaccine Clinical Trials 179
- 4.4 Different Types of Charts and Graphs 180
 Basic Charts and Graphs 180
 Specialized Charts and Graphs 181
- 4.5 The Emergence of Data Visualization and Visual Analytics 184
 Visual Analytics 186
 High-Powered Visual Analytics Environments 188
- 4.6 Performance Dashboards 190
 - ► APPLICATION CASE 4.5 Dallas Cowboys Score Big with Tableau and Teknion 191

Dashboard Design 192

- APPLICATION CASE 4.6 Saudi Telecom Company Excels with Information Visualization 193
 What to Look For in a Dashboard 194
 Best Practices in Dashboard Design 195
 Benchmark Key Performance Indicators with Industry Standards 195
 Wrap the Dashboard Metrics with Contextual Metadata 195
 Validate the Dashboard Design by a Usability Specialist 195
 Prioritize and Rank Alerts/Exceptions Streamed to the Dashboard 195
 Enrich Dashboard with Business Users' Comments 195
 Present Information in Three Different Levels 196
 Pick the Right Visual Construct Using Dashboard Design Principles 196
 Provide for Guided Analytics 196
- 4.7 Business Performance Management 196 Closed-Loop BPM Cycle 197
 - ► APPLICATION CASE 4.7 IBM Cognos Express Helps Mace for Faster and Better Business Reporting 199
- 4.8 Performance Measurement 200 Key Performance Indicator (KPI) 201 Performance Measurement System 202
- 4.9 Balanced Scorecards 202
 The Four Perspectives 203
 The Meaning of Balance in BSC 204
 Dashboards Versus Scorecards 204
- 4.10 Six Sigma as a Performance Measurement System 205 The DMAIC Performance Model 206 Balanced Scorecard Versus Six Sigma 206 Effective Performance Measurement 207
 - ► APPLICATION CASE 4.8 *Expedia.com*'s Customer Satisfaction Scorecard 208

Chapter Highlights 209 • Key Terms 210 Questions for Discussion 211 • Exercises 211

END-OF-CHAPTER APPLICATION CASE Smart Business Reporting Helps Healthcare Providers Deliver Better Care 212

References 214

Part III Predictive Analytics 215

Chapter 5 Data Mining 216

- 5.1 Opening Vignette: Cabela's Reels in More Customers with Advanced Analytics and Data Mining 217
- 5.2 Data Mining Concepts and Applications 219
 - APPLICATION CASE 5.1 Smarter Insurance: Infinity P&C Improves Customer Service and Combats Fraud with Predictive Analytics 221

Definitions. Characteristics. and Benefits 222

► APPLICATION CASE 5.2 Harnessing Analytics to Combat Crime: Predictive Analytics Helps Memphis Police Department Pinpoint Crime and Focus Police Resources 226 How Data Mining Works 227 Data Mining Versus Statistics 230 5.3 Data Mining Applications 231 ► APPLICATION CASE 5.3 A Mine on Terrorist Funding 233 5.4 Data Mining Process 234 Step 1: Business Understanding 235 Step 2: Data Understanding 235 Step 3: Data Preparation 236 Step 4: Model Building 238 ► APPLICATION CASE 5.4 Data Mining in Cancer Research 240 Step 5: Testing and Evaluation 241 Step 6: Deployment 241 Other Data Mining Standardized Processes and Methodologies 242 5.5 Data Mining Methods 244 Classification 244 Estimating the True Accuracy of Classification Models 245 Cluster Analysis for Data Mining 250 APPLICATION CASE 5.5 2degrees Gets a 1275 Percent Boost in Churn Identification 251 Association Rule Mining 254 5.6 Data Mining Software Tools 258 ► APPLICATION CASE 5.6 Data Mining Goes to Hollywood: Predicting Financial Success of Movies 261 5.7 Data Mining Privacy Issues, Myths, and Blunders 264 Data Mining and Privacy Issues 264 ► APPLICATION CASE 5.7 Predicting Customer Buying Patterns—The Target Story 265 Data Mining Myths and Blunders 266 Chapter Highlights 267 • Key Terms 268 **Ouestions for Discussion** 268 • Exercises 269 ► END-OF-CHAPTER APPLICATION CASE Macys.com Enhances Its Customers' Shopping Experience with Analytics 271 References 271

Chapter 6 Techniques for Predictive Modeling 273

- 6.1 **Opening Vignette: Predictive Modeling Helps Better** Understand and Manage Complex Medical Procedures 274
- 6.2 Basic Concepts of Neural Networks 277 Biological and Artificial Neural Networks 278
 - APPLICATION CASE 6.1 Neural Networks Are Helping to Save Lives in the Mining Industry 280

Elements of ANN 281

Network Information Processing 282

Neural Network Architectures 284

- ► APPLICATION CASE 6.2 Predictive Modeling Is Powering the Power Generators 286
- 6.3 Developing Neural Network–Based Systems 288 The General ANN Learning Process 289 Backpropagation 290
- 6.4 Illuminating the Black Box of ANN with Sensitivity Analysis 292
 - ► APPLICATION CASE 6.3 Sensitivity Analysis Reveals Injury Severity Factors in Traffic Accidents 294
- 6.5 Support Vector Machines 295
 - APPLICATION CASE 6.4 Managing Student Retention with Predictive Modeling 296

Mathematical Formulation of SVMs 300

Primal Form 301 Dual Form 301 Soft Margin 301 Nonlinear Classification 302 Kernel Trick 302

- 6.6 A Process-Based Approach to the Use of SVM 303 Support Vector Machines Versus Artificial Neural Networks 304
- 6.7 Nearest Neighbor Method for Prediction 305 Similarity Measure: The Distance Metric 306 Parameter Selection 307
 - ► APPLICATION CASE 6.5 Efficient Image Recognition and Categorization with *k*NN 308

Chapter Highlights 310 • Key Terms 310 Questions for Discussion 311 • Exercises 311

END-OF-CHAPTER APPLICATION CASE Coors Improves Beer Flavors with Neural Networks 314 References 315

Chapter 7 Text Analytics, Text Mining, and Sentiment Analysis 318

- 7.1 Opening Vignette: Machine Versus Men on *Jeopardy!*: The Story of Watson 319
- 7.2 Text Analytics and Text Mining Concepts and Definitions 321
 - ► APPLICATION CASE 7.1 Text Mining for Patent Analysis 325
- 7.3 Natural Language Processing 326
 - APPLICATION CASE 7.2 Text Mining Improves Hong Kong Government's Ability to Anticipate and Address Public Complaints 328
- 7.4 Text Mining Applications 330

Marketing Applications 331

Security Applications 331

► APPLICATION CASE 7.3 Mining for Lies 332

Biomedical Applications 334

Academic Applications 335

- ► APPLICATION CASE 7.4 Text Mining and Sentiment Analysis Help Improve Customer Service Performance 336
- 7.5 Text Mining Process 337

Task 1: Establish the Corpus 338

Task 2: Create the Term–Document Matrix 339

Task 3: Extract the Knowledge 342

- APPLICATION CASE 7.5 Research Literature Survey with Text Mining 344
- 7.6 Text Mining Tools 347

Commercial Software Tools 347

Free Software Tools 347

- ► APPLICATION CASE 7.6 A Potpourri of Text Mining Case Synopses 348
- 7.7 Sentiment Analysis Overview 349
 - ► APPLICATION CASE 7.7 Whirlpool Achieves Customer Loyalty and Product Success with Text Analytics 351
- 7.8 Sentiment Analysis Applications 353
- 7.9 Sentiment Analysis Process 355

Methods for Polarity Identification 356

Using a Lexicon 357

Using a Collection of Training Documents 358

Identifying Semantic Orientation of Sentences and Phrases 358

Identifying Semantic Orientation of Document 358

7.10 Sentiment Analysis and Speech Analytics 359

How Is It Done? 359

► APPLICATION CASE 7.8 Cutting Through the Confusion: Blue Cross Blue Shield of North Carolina Uses Nexidia's Speech Analytics to Ease Member Experience in Healthcare 361

Chapter Highlights 363 • Key Terms 363

Questions for Discussion 364 • Exercises 364

END-OF-CHAPTER APPLICATION CASE BBVA Seamlessly Monitors and Improves Its Online Reputation 365

References 366

Chapter 8 Web Analytics, Web Mining, and Social Analytics 368

- 8.1 Opening Vignette: Security First Insurance Deepens Connection with Policyholders 369
- 8.2 Web Mining Overview 371
- 8.3 Web Content and Web Structure Mining 374
 - ► APPLICATION CASE 8.1 Identifying Extremist Groups with Web Link and Content Analysis 376
- 8.4 Search Engines 377

Anatomy of a Search Engine 377

1. Development Cycle 378

Web Crawler 378

Document Indexer 378

2. Response Cycle 379 Query Analyzer 379 Document Matcher/Ranker 379 How Does Google Do It? 381

- ► APPLICATION CASE 8.2 IGN Increases Search Traffic by 1500 Percent 383
- 8.5 Search Engine Optimization 384 Methods for Search Engine Optimization 385
 - ► APPLICATION CASE 8.3 Understanding Why Customers Abandon Shopping Carts Results in \$10 Million Sales Increase 387
- 8.6 Web Usage Mining (Web Analytics) 388 Web Analytics Technologies 389
 - ► APPLICATION CASE 8.4 Allegro Boosts Online Click-Through Rates by 500 Percent with Web Analysis 390

Web Analytics Metrics 392

Web Site Usability 392

Traffic Sources 393

Visitor Profiles 394

Conversion Statistics 394

- 8.7 Web Analytics Maturity Model and Web Analytics Tools 396
 Web Analytics Tools 398
 Putting It All Together—A Web Site Optimization Ecosystem 400
 A Framework for Voice of the Customer Strategy 402
- 8.8 Social Analytics and Social Network Analysis 403
 Social Network Analysis 404
 Social Network Analysis Metrics 405

APPLICATION CASE 8.5 Social Network Analysis Helps Telecommunication Firms 405

Connections406Distributions406Segmentation407

- **8.9** Social Media Definitions and Concepts 407 How Do People Use Social Media? 408
 - APPLICATION CASE 8.6 Measuring the Impact of Social Media at Lollapalooza 409
- 8.10 Social Media Analytics 410 Measuring the Social Media Impact 411 Best Practices in Social Media Analytics 411
 APPLICATION CASE 8.7 eHarmony Uses Social Media to Help Take the Mystery Out of Online Dating 413 Social Media Analytics Tools and Vendors 414 Chapter Highlights 416 • Key Terms 417 Questions for Discussion 417 • Exercises 418
 - END-OF-CHAPTER APPLICATION CASE Keeping Students on Track with Web and Predictive Analytics 418

References 420

Part IV Prescriptive Analytics 421

Chapter 9 Model-Based Decision Making: Optimization and Multi-Criteria Systems 422

- **9.1** Opening Vignette: Midwest ISO Saves Billions by Better Planning of Power Plant Operations and Capacity Planning 423
- 9.2 Decision Support Systems Modeling 424
 - APPLICATION CASE 9.1 Optimal Transport for ExxonMobil Downstream Through a DSS 425

Current Modeling Issues 426

- ► APPLICATION CASE 9.2 Forecasting/Predictive Analytics Proves to Be a Good Gamble for Harrah's Cherokee Casino and Hotel 427
- 9.3 Structure of Mathematical Models for Decision Support 429 The Components of Decision Support Mathematical Models 429 The Structure of Mathematical Models 431
- 9.4 Certainty, Uncertainty, and Risk 431
 Decision Making Under Certainty 432
 Decision Making Under Uncertainty 432
 Decision Making Under Risk (Risk Analysis) 432
 - ► APPLICATION CASE 9.3 American Airlines Uses Should-Cost Modeling to Assess the Uncertainty of Bids for Shipment Routes 433
- 9.5 Decision Modeling with Spreadsheets 434
 - ► APPLICATION CASE 9.4 Showcase Scheduling at Fred Astaire East Side Dance Studio 434
- 9.6 Mathematical Programming Optimization 437
 - APPLICATION CASE 9.5 Spreadsheet Model Helps Assign Medical Residents 437

Mathematical Programming 438 Linear Programming 438 Modeling in LP: An Example 439 Implementation 444

- 9.7 Multiple Goals, Sensitivity Analysis, What-If Analysis, and Goal Seeking 446
 Multiple Goals 446
 Sensitivity Analysis 447
 What-If Analysis 448
 Goal Seeking 448
- 9.8 Decision Analysis with Decision Tables and Decision Trees 450
 Decision Tables 450
 Decision Trees 452

Decision Trees 452

9.9 Multi-Criteria Decision Making With Pairwise Comparisons 453

The Analytic Hierarchy Process 453

► APPLICATION CASE 9.6 U.S. HUD Saves the House by Using AHP for Selecting IT Projects 453

 Tutorial on Applying Analytic Hierarchy Process Using Web-HIPRE 455 Chapter Highlights 459 • Key Terms 460 Questions for Discussion 460 • Exercises 460
 END-OF-CHAPTER APPLICATION CASE Pre-Positioning of Emergency Items for CARE International 463

References 464

Chapter 10 Modeling and Analysis: Heuristic Search Methods and Simulation 465

- **10.1** Opening Vignette: System Dynamics Allows Fluor Corporation to Better Plan for Project and Change Management 466
- Problem-Solving Search Methods 467 Analytical Techniques 468 Algorithms 468 Blind Searching 469 Heuristic Searching 469
 ► APPLICATION CASE 10.1 Chilean Government
 - APPLICATION CASE 10.1 Chilean Government Uses Heuristics to Make Decisions on School Lunch Providers 469
- 10.3 Genetic Algorithms and Developing GA Applications 471
 Example: The Vector Game 471
 Terminology of Genetic Algorithms 473
 How Do Genetic Algorithms Work? 473
 Limitations of Genetic Algorithms 475

Genetic Algorithm Applications 475

10.4 Simulation 476

- ► APPLICATION CASE 10.2 Improving Maintenance Decision Making in the Finnish Air Force Through Simulation 476
- ► APPLICATION CASE 10.3 Simulating Effects of Hepatitis B Interventions 477

Major Characteristics of Simulation 478

Advantages of Simulation 479

Disadvantages of Simulation 480

The Methodology of Simulation 480

Simulation Types 481

Monte Carlo Simulation 482

Discrete Event Simulation 483

10.5 Visual Interactive Simulation 483

Conventional Simulation Inadequacies 483

Visual Interactive Simulation 483

Visual Interactive Models and DSS 484

APPLICATION CASE 10.4 Improving Job-Shop Scheduling Decisions Through RFID: A Simulation-Based Assessment 484

Simulation Software 487

- 10.6 System Dynamics Modeling 488
- 10.7 Agent-Based Modeling 491
 - ► APPLICATION CASE 10.5 Agent-Based Simulation Helps Analyze Spread of a Pandemic Outbreak 493

Chapter Highlights 494 • Key Terms 494 Questions for Discussion 495 • Exercises 495

 END-OF-CHAPTER APPLICATION CASE HP Applies Management Science Modeling to Optimize Its Supply Chain and Wins a Major Award 495

References 497

Chapter 11 Automated Decision Systems and Expert Systems 499

- **11.1** Opening Vignette: InterContinental Hotel Group Uses Decision Rules for Optimal Hotel Room Rates 500
- 11.2 Automated Decision Systems 501
 - APPLICATION CASE 11.1 Giant Food Stores Prices the Entire Store 502
- 11.3 The Artificial Intelligence Field 505
- 11.4 Basic Concepts of Expert Systems 507 Experts 507 Expertise 508 Features of ES 508
 - APPLICATION CASE 11.2 Expert System Helps in Identifying Sport Talents 510
- 11.5 Applications of Expert Systems 510
 - APPLICATION CASE 11.3 Expert System Aids in Identification of Chemical, Biological, and Radiological Agents 511
 - Classical Applications of ES 511
 - Newer Applications of ES 512
 - Areas for ES Applications 513
- 11.6 Structure of Expert Systems 514 Knowledge Acquisition Subsystem 514 Knowledge Base 515 Inference Engine 515 User Interface 515
 - Blackboard (Workplace) 515
 - Explanation Subsystem (Justifier) 516
 - Knowledge-Refining System 516
 - APPLICATION CASE 11.4 Diagnosing Heart Diseases by Signal Processing 516
- 11.7 Knowledge Engineering 517 Knowledge Acquisition 518 Knowledge Verification and Validation 520 Knowledge Representation 520 Inferencing 521 Explanation and Justification 526

- 11.8 Problem Areas Suitable for Expert Systems 527
- 11.9 Development of Expert Systems 528
 Defining the Nature and Scope of the Problem 529
 Identifying Proper Experts 529
 Acquiring Knowledge 529
 Selecting the Building Tools 529
 Coding the System 531
 Evaluating the System 531
 ▶ APPLICATION CASE 11.5 Clinical Decision Support System for Tendon Injuries 531
- 11.10 Concluding Remarks 532 Chapter Highlights 533 • Key Terms 533 Questions for Discussion 534 • Exercises 534
 END-OF-CHAPTER APPLICATION CASE Tax Collections Optimization
 - for New York State 534 References 535

Chapter 12 Knowledge Management and Collaborative Systems 537

- **12.1** Opening Vignette: Expertise Transfer System to Train Future Army Personnel 538
- 12.2 Introduction to Knowledge Management 542 Knowledge Management Concepts and Definitions 543 Knowledge 543 Explicit and Tacit Knowledge 545
- 12.3 Approaches to Knowledge Management 546 The Process Approach to Knowledge Management 547 The Practice Approach to Knowledge Management 547 Hybrid Approaches to Knowledge Management 548 Knowledge Repositories 548
- 12.4 Information Technology (IT) in Knowledge Management 550 The KMS Cycle 550 Components of KMS 551 Technologies That Support Knowledge Management 551
- 12.5 Making Decisions in Groups: Characteristics, Process, Benefits, and Dysfunctions 553 Characteristics of Groupwork 553 The Group Decision-Making Process 554 The Benefits and Limitations of Groupwork 554
- Supporting Groupwork with Computerized Systems 556
 An Overview of Group Support Systems (GSS) 556
 Groupware 557
 Time/Place Framework 557
- **12.7** Tools for Indirect Support of Decision Making 558 Groupware Tools 558

Groupware 560 Collaborative Workflow 560 Web 2.0 560 Wikis 561 Collaborative Networks 561

12.8 Direct Computerized Support for Decision Making: From Group Decision Support Systems to Group Support Systems 562
Group Decision Support Systems (GDSS) 562
Group Support Systems 563
How GDSS (or GSS) Improve Groupwork 563
Facilities for GDSS 564
Chapter Highlights 565 • Key Terms 566
Questions for Discussion 566 • Exercises 566
END-OF-CHAPTER APPLICATION CASE Solving Crimes by Sharing Digital Forensic Knowledge 567
References 569

Part V Big Data and Future Directions for Business Analytics 571

Chapter 13	Big Data and Analytics	572	
------------	-------------------------------	-----	--

- 13.1 Opening Vignette: Big Data Meets Big Science at CERN 573
- **13.2** Definition of Big Data 576 The Vs That Define Big Data 577
 - ► APPLICATION CASE 13.1 Big Data Analytics Helps Luxottica Improve Its Marketing Effectiveness 580
- **13.3** Fundamentals of Big Data Analytics 581 Business Problems Addressed by Big Data Analytics 584
 - ► APPLICATION CASE 13.2 Top 5 Investment Bank Achieves Single Source of Truth 585
- **13.4** Big Data Technologies 586 MapReduce 587 Why Use MapReduce? 588 Hadoop 588 How Does Hadoop Work? 588 Hadoop Technical Components 589

Hadoop: The Pros and Cons 590

NoSQL 592

► APPLICATION CASE 13.3 eBay's Big Data Solution 593

- 13.5 Data Scientist 595
 Where Do Data Scientists Come From? 595
 APPLICATION CASE 13.4 Big Data and Analytics in Politics 598
 13.6 Pig Data and Data Warehousing 599
- 13.6 Big Data and Data Warehousing 599
 Use Case(s) for Hadoop 600
 Use Case(s) for Data Warehousing 601

The Gray Areas (Any One of the Two Would Do the Job) 602 Coexistence of Hadoop and Data Warehouse 602

13.7 Big Data Vendors 604 ► APPLICATION CASE 13.5 Dublin City Council Is Leveraging Big Data to Reduce Traffic Congestion 605 ► APPLICATION CASE 13.6 Creditreform Boosts Credit Rating Quality with Big Data Visual Analytics 610 13.8 Big Data and Stream Analytics 611 Stream Analytics Versus Perpetual Analytics 612 Critical Event Processing 612 Data Stream Mining 613 13.9 Applications of Stream Analytics 614 e-Commerce 614 Telecommunications 614 ► APPLICATION CASE 13.7 Turning Machine-Generated Streaming Data into Valuable Business Insights 615 Law Enforcement and Cyber Security 616 Power Industry 617 Financial Services 617 Health Sciences 617 Government 617 Chapter Highlights 618 • Key Terms 618 Questions for Discussion 618 • Exercises 619 ► END-OF-CHAPTER APPLICATION CASE Discovery Health Turns Big Data into Better Healthcare 619 References 621

Chapter 14 Business Analytics: Emerging Trends and Future Impacts 622

- **14.1** Opening Vignette: Oklahoma Gas and Electric Employs Analytics to Promote Smart Energy Use 623
- **14.2** Location-Based Analytics for Organizations 624 Geospatial Analytics 624
 - ► APPLICATION CASE 14.1 Great Clips Employs Spatial Analytics to Shave Time in Location Decisions 626

A Multimedia Exercise in Analytics Employing Geospatial Analytics 627 Real-Time Location Intelligence 628

- ► APPLICATION CASE 14.2 Quiznos Targets Customers for Its Sandwiches 629
- 14.3 Analytics Applications for Consumers 630
 - ► APPLICATION CASE 14.3 A Life Coach in Your Pocket 631
- 14.4 Recommendation Engines 633
- 14.5 Web 2.0 and Online Social Networking 634
 Representative Characteristics of Web 2.0 635
 Social Networking 635
 A Definition and Basic Information 636
 Implications of Business and Enterprise Social Networks 636

14.6	Cloud Computing and BI 637
	Service-Oriented DSS 638
	Data-as-a-Service (DaaS) 638
	Information-as-a-Service (Information on Demand) (IaaS) 641
	Analytics-as-a-Service (AaaS) 641
14.7	Impacts of Analytics in Organizations: An Overview 643
	New Organizational Units 643
	Restructuring Business Processes and Virtual Teams 644
	The Impacts of ADS Systems 644
	Job Satisfaction 644
	Job Stress and Anxiety 644
	Analytics' Impact on Managers' Activities and Their Performance 645
14.8	Issues of Legality, Privacy, and Ethics 646
	Legal Issues 646
	Privacy 647
	Recent Technology Issues in Privacy and Analytics 648
14.9	Ethics in Decision Making and Support 649
14.9	An Overview of the Analytics Ecosystem 650
	Analytics Industry Clusters 650 Data Infrastructure Providers 650
	Data Marehouse Industry 651
	Middleware Industry 652
	Data Aggregators/Distributors 652
	Analytics-Focused Software Developers 652
	Reporting/Analytics 652
	Predictive Analytics 653
	Prescriptive Analytics 653
	Application Developers or System Integrators: Industry Specific or General 654
	Analytics User Organizations 655
	Analytics Industry Analysts and Influencers 657
	Academic Providers and Certification Agencies 658
	Chapter Highlights 659 • Key Terms 659
	Questions for Discussion 659 • Exercises 660
	END-OF-CHAPTER APPLICATION CASE Southern States Cooperative Optimizes Its Catalog Campaign 660
	References 662
<i>~~•</i>	

Glossary 664 Index 678