

Wilfried Grossmann • Stefanie Rinderle-Ma

Fundamentals of Business Intelligence

 Springer

Contents

1	Introduction	1
1.1	Definition of Business Intelligence	1
1.2	Putting Business Intelligence into Context	4
1.2.1	Business Intelligence Scenarios	4
1.2.2	Perspectives in Business Intelligence	6
1.2.3	Business Intelligence Views on Business Processes	8
1.2.4	Goals of Business Intelligence	11
1.2.5	Summary: Putting Business Intelligence in Context	13
1.3	Business Intelligence: Tasks and Analysis Formats	14
1.3.1	Data Task	14
1.3.2	Business and Data Understanding Task	15
1.3.3	Modeling Task	17
1.3.4	Analysis Task	19
1.3.5	Evaluation and Reporting Task	20
1.3.6	Analysis Formats	20
1.3.7	Summary: Tasks and Analysis Formats	24
1.4	Use Cases	24
1.4.1	Application in Patient Treatment	25
1.4.2	Application in Higher Education	28
1.4.3	Application in Logistics	29
1.4.4	Application in Customer Relationship Management	30
1.5	Structure and Outline of the Book	31
1.6	Recommended Reading (Selection)	32
	References	32
2	Modeling in Business Intelligence	35
2.1	Models and Modeling in Business Intelligence	35
2.1.1	The Representation Function of Models	36
2.1.2	Model Presentation	39
2.1.3	Model Building	41

2.1.4	Model Assessment and Quality of Models	44
2.1.5	Models and Patterns	45
2.1.6	Summary: Models and Modeling in Business Intelligence	46
2.2	Logical and Algebraic Structures	46
2.2.1	Logical Structures	46
2.2.2	Modeling Using Logical Structures	48
2.2.3	Summary: Logical Structures	51
2.3	Graph Structures	51
2.3.1	Model Structure	51
2.3.2	Modeling with Graph Structures	54
2.3.3	Summary: Graph Structures	57
2.4	Analytical Structures	58
2.4.1	Calculus	58
2.4.2	Probabilistic Structures	61
2.4.3	Statistical Structures	67
2.4.4	Modeling Methods Using Analytical Structures	70
2.4.5	Summary: Analytical Structures	73
2.5	Models and Data	74
2.5.1	Data Generation	74
2.5.2	The Role of Time	76
2.5.3	Data Quality	78
2.5.4	Summary: Models and Data	82
2.6	Conclusion and Lessons Learned	82
2.7	Recommended Reading (Selection)	83
	References	83
3	Data Provisioning	87
3.1	Introduction and Goals	87
3.2	Data Collection and Description	88
3.3	Data Extraction	90
3.3.1	Extraction-Transformation-Load (ETL) Process	90
3.3.2	Big Data	93
3.3.3	Summary on Data Extraction	98
3.4	From Transactional Data Towards Analytical Data	98
3.4.1	Table Formats and Online Analytical Processing (OLAP)	100
3.4.2	Log Formats	104
3.4.3	Summary: From Transactional Towards Analytical Data	108
3.5	Schema and Data Integration	108
3.5.1	Schema Integration	108
3.5.2	Data Integration and Data Quality	112
3.5.3	Linked Data and Data Mashups	113
3.5.4	Summary: Schema and Data Integration	114
3.6	Conclusion and Lessons Learned	115

- 3.7 Recommended Reading 115
- References 115
- 4 Data Description and Visualization 119**
 - 4.1 Introduction 119
 - 4.2 Description and Visualization of Business Processes 120
 - 4.2.1 Process Modeling and Layout 121
 - 4.2.2 The BPM Tools’ Perspective 122
 - 4.2.3 Process Runtime Visualization 123
 - 4.2.4 Visualization of Further Aspects 123
 - 4.2.5 Challenges in Visualizing Process-Related Information 126
 - 4.2.6 Summary: Description and Visualization
of Business Processes 127
 - 4.3 Description and Visualization of Data in the Customer
Perspective 127
 - 4.3.1 Principles for Description and Visualization
of Collections of Process Instances 127
 - 4.3.2 Interactive and Dynamic Visualization 131
 - 4.3.3 Summary: Visualization of Process Instances 133
 - 4.4 Basic Visualization Techniques 133
 - 4.4.1 Description and Visualization of Qualitative
Information 134
 - 4.4.2 Description and Visualization of Quantitative Variables 137
 - 4.4.3 Description and Visualization of Relationships 140
 - 4.4.4 Description and Visualization of Temporal Data 143
 - 4.4.5 Interactive and Dynamic Visualization 145
 - 4.4.6 Summary: Basic Visualization Techniques 146
 - 4.5 Reporting 147
 - 4.5.1 Description and Visualization of Metadata 147
 - 4.5.2 High-Level Reporting 149
 - 4.5.3 Infographics 151
 - 4.5.4 Summary: Reporting 152
 - 4.6 Recommended Reading 153
 - References 153
- 5 Data Mining for Cross-Sectional Data 155**
 - 5.1 Introduction to Supervised Learning 155
 - 5.2 Regression Models 159
 - 5.2.1 Model Formulation and Terminology 159
 - 5.2.2 Linear Regression 161
 - 5.2.3 Neural Networks 166
 - 5.2.4 Kernel Estimates 169
 - 5.2.5 Smoothing Splines 171
 - 5.2.6 Summary: Regression Models 172

- 5.3 Classification Models 173
 - 5.3.1 Model Formulation and Terminology 173
 - 5.3.2 Classification Based on Probabilistic Structures 177
 - 5.3.3 Methods Using Trees 182
 - 5.3.4 K-Nearest-Neighbor Classification 185
 - 5.3.5 Support Vector Machines 186
 - 5.3.6 Combination Methods 190
 - 5.3.7 Application of Classification Methods 191
 - 5.3.8 Summary: Classification Models 192
- 5.4 Unsupervised Learning 193
 - 5.4.1 Introduction and Terminology 193
 - 5.4.2 Hierarchical Clustering 195
 - 5.4.3 Partitioning Methods 199
 - 5.4.4 Model-Based Clustering 201
 - 5.4.5 Summary: Unsupervised Learning 203
- 5.5 Conclusion and Lessons Learned 204
- 5.6 Recommended Reading 204
- References 205
- 6 Data Mining for Temporal Data 207**
 - 6.1 Terminology and Approaches Towards Temporal Data Mining 207
 - 6.2 Classification and Clustering of Time Sequences 212
 - 6.2.1 Segmentation and Classification Using Time Warping 214
 - 6.2.2 Segmentation and Classification Using Response Features 217
 - 6.2.3 Summary: Classification and Clustering of Time Sequences 220
 - 6.3 Time-to-Event Analysis 220
 - 6.4 Analysis of Markov Chains 224
 - 6.4.1 Structural Analysis of Markov Chains 226
 - 6.4.2 Cluster Analysis for Markov Chains 230
 - 6.4.3 Generalization of the Basic Model 231
 - 6.4.4 Summary: Analysis of Markov Chains 233
 - 6.5 Association Analysis 233
 - 6.6 Sequence Mining 237
 - 6.7 Episode Mining 240
 - 6.8 Conclusion and Lessons Learned 242
 - 6.9 Recommended Reading 243
 - References 244
- 7 Process Analysis 245**
 - 7.1 Introduction and Terminology 245
 - 7.2 Business Process Analysis and Simulation 247
 - 7.2.1 Static Analysis 248
 - 7.2.2 Dynamic Analysis and Simulation 248

- 7.2.3 Optimization..... 251
- 7.2.4 Summary: Process Analysis and Simulation..... 252
- 7.3 Process Performance Management and Warehousing 252
 - 7.3.1 Performance Management 252
 - 7.3.2 Process Warehousing 253
 - 7.3.3 Summary: Process Performance Management and Warehousing 255
- 7.4 Process Mining 255
 - 7.4.1 Process Discovery..... 256
 - 7.4.2 Change Mining 263
 - 7.4.3 Conformance Checking 266
 - 7.4.4 Summary: Process Mining 267
- 7.5 Business Process Compliance 268
 - 7.5.1 Compliance Along the Process Life Cycle..... 268
 - 7.5.2 Summary: Compliance Checking 270
- 7.6 Evaluation and Assessment 270
 - 7.6.1 Process Mining 270
 - 7.6.2 Compliance Checking..... 271
- 7.7 Conclusion and Lessons Learned 271
- 7.8 Recommended Reading 272
- References 272
- 8 Analysis of Multiple Business Perspectives 275**
 - 8.1 Introduction and Terminology 275
 - 8.2 Social Network Analysis and Organizational Mining 277
 - 8.2.1 Social Network Analysis..... 277
 - 8.2.2 Organizational Aspect in Business Processes..... 282
 - 8.2.3 Organizational Mining Techniques for Business Processes 284
 - 8.2.4 Summary: Social Network Analysis and Organizational Mining 290
 - 8.3 Decision Point Analysis..... 290
 - 8.4 Text Mining 294
 - 8.4.1 Introduction and Terminology 294
 - 8.4.2 Data Preparation and Modeling 296
 - 8.4.3 Descriptive Analysis for the Document Term Matrix 301
 - 8.4.4 Analysis Techniques for a Corpus..... 303
 - 8.4.5 Further Aspects of Text Mining 307
 - 8.4.6 Summary: Text Mining 313
 - 8.5 Conclusion and Lessons Learned..... 313
 - 8.6 Recommended Reading 315
 - References 315
- 9 Summary 319**

- A Survey on Business Intelligence Tools** 329
 - A.1 Data Modeling and ETL Support 329
 - A.2 Big Data 330
 - A.3 Visualization, Visual Mining, and Reporting 334
 - A.4 Data Mining 337
 - A.5 Process Mining 338
 - A.6 Text Mining 339
 - References 340

- Index** 343