Contents

Acknowledgments — XVII

Part I: Fundamental

1 Context-Aware Data Management Toward Ambient Intelligence — 3
1.1 Ambient Intelligence — 3
1.1.1 A Scenario — 4
1.1.2 Challenges of Context-Awareness — 5
1.2 What Is Context? — 6
1.2.1 Context Definitions — 6
1.2.2 Context Categorization — 6
1.3 Characteristics of Context — 7
1.3.1 Being Sensed — 7
1.3.2 Through Constrained Devices — 8
1.3.3 From Distributed Sources — 8
1.3.4 Continuous Change — 8
1.3.5 Mobility — 9
1.3.6 Temporality and Spatiality — 9
1.3.7 Imperfectness and Uncertainty — 9
1.4 What Does Context-Awareness Imply? — 10
1.4.1 Users' Perspectives — 10
1.4.2 Systems' Perspectives — 11
1.5 Context-Aware Querying — 13
1.5.1 Basics of Context-Aware Queries — 13
1.5.2 Context-Aware Querying Strategies — 14
1.6 Supporting Context-Aware Data Management — 17
1.6.1 Context Provider — 17
1.6.2 Service Registry — 17
1.6.3 Context Processor — 19
1.6.4 Context Consumer — 20
1.7 Recapitulation — 20
Literature — 21

Part II: Context

2 Modeling Context — 27
2.1 Six Context Representation Methods — 27
2.1.1 Key-Value — 27
2.1.2 Entity-Relationship — 27
2.1.3 Object-Orientation — 28

Bibliografische Informationen
http://d-nb.info/1130671100

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

2.1.4 Markup Schema — 28
2.1.5 Logics — 28
2.1.6 Ontology — 28
2.1.7 Methods Comparison — 29
2.2 Context Ontology — 30
2.2.1 Context Formalism — 30
2.2.2 Ontology Language – OWL — 31
2.2.3 Logic Foundation of OWL – Description Logic (DL) — 32
2.2.4 Correspondence Between OWL and DL — 35
2.2.5 A Simple Context Ontology Example — 36
2.3 Context Events — 37
2.3.1 Interpreting Context as Context Events — 37
2.3.2 Temporality of Context Events — 38
2.3.3 Temporal Operators on Context Events — 40
2.4 Recapitulation — 42
Literature — 42

3 Addressing Context Uncertainty — 44
3.1 Uncertainty — 44
3.1.1 Aleatory Uncertainty — 44
3.1.2 Epistemic Uncertainty — 45
3.2 Uncertainty Processing Theories — 45
3.2.1 Theory Overview — 45
3.2.2 Probability Theory — 46
3.2.3 Fuzzy Theory — 52
3.2.4 Information-Gap Theory — 53
3.2.5 Derived Uncertainty Theory — 56
3.3 Uncertainty Processing Practices — 57
3.3.1 Practice Overview — 57
3.3.2 In Economics — 57
3.3.3 In Engineering — 62
3.3.4 In Ecology — 69
3.3.5 In Information Science — 72
3.3.6 In Databases — 74
3.4 Context Uncertainty Management — 87
3.4.1 Context Uncertainty — 87
3.4.2 Probabilistic Context Events — 88
3.4.3 Advanced Techniques of Context Uncertainty Management — 92
3.5 Recapitulation — 94
Literature — 95

4 Acquiring Context — 102
4.1 Challenges in Context Acquisition — 102
4.2 Three Context Acquisition Mechanisms — 103

4.2.1 Offering Context Acquisition Services — 103
4.2.2 Unifying Context Acquisition Interfaces — 103
4.2.3 Building a General Context Provision and Acquisition Adaptor — 104
4.3 A Declarative Specification Language for Context Acquisition — 105
4.3.1 Point Descriptors — 106
4.3.2 Connector Descriptors — 106
4.3.3 Constraint Descriptors — 107
4.3.4 Quality Descriptors — 110
4.4 Quality-Assured Context Acquisition — 113
4.4.1 The Least Squared Error of Redundant Context Values — 113
4.4.2 Failure of Context Providers — 114
4.5 Recapitulation — 115
Literature — 115

5 Protecting Context Privacy — 117
5.1 Balancing Privacy and Smartness — 117
5.2 Privacy Protection Techniques — 118
5.2.1 Access Control — 118
5.2.2 Platform for Privacy Preferences (P3P) — 120
5.2.3 Hippocratic Databases — 121
5.2.4 Anonymity — 122
5.2.5 Encryption — 123
5.3 Search Over Encrypted XML Context Information — 124
5.3.1 A Three-Phased Search Framework — 124
5.3.2 Data Encoding Phase — 126
5.3.3 Candidate Identification Phase — 132
5.3.4 Tree Search Phase — 137
5.4 Life-Cycle Management of Context Information — 142
5.4.1 Requirements for Self-Regulation of Context Information — 142
5.4.2 Limitations of Traditional Privacy Preservation Strategies — 143
5.4.3 A Life-Cycle Policy (LCP) Model — 145
5.4.4 Use Scenarios of LCPs — 147
5.4.5 LCP-based Context Privacy Protection Diagram — 150
5.4.6 Challenges with LCP-Based Privacy Protection — 151
5.5 Recapitulation — 153
Literature — 153

Part III: Context Awareness

6 Querying Context — 159
6.1 Seven Context Query Mechanisms — 159
6.1.1 SQL Based — 159
6.1.2 XML Based — 161

6.1.3 Ontology Based — 162
6.1.4 Event Based — 163
6.1.5 Logic Based — 164
6.1.6 Programming API Based — 167
6.1.7 Graphic Interface Based — 168
6.1.8 Mechanisms Comparison — 168
6.2 Recapitulation — 171
Literature — 171

7 Detecting Context Events — 173
7.1 Integration of Stream and Event Processing — 173
7.1.1 Stream and Event Processing Operators — 173
7.1.2 Stream and Event Processing Methods — 176
7.1.3 Stream and Event Processing Systems — 177
7.2 High-Performance Context Event Detection — 178
7.2.1 Indexing Stream Records — 178
7.2.2 Condensed Composition of Stream Records — 178
7.2.3 Partitioning Stream Records for Parallel Processing — 186
7.3 Recapitulation — 198
Literature — 198

8 Energy Management in Context Querying — 201
8.1 Energy-Efficiency Requirement — 201
8.2 Energy-Efficiency Problem — 202
8.3 Solution Guidelines — 202
8.4 Energy Management at Different Computing Levels — 203
8.4.1 Energy-Efficient Hardware — 204
8.4.2 Energy-Efficient Computer Systems — 204
8.4.3 Energy-Efficient Cluster Systems — 205
8.4.4 Energy-Efficient Applications — 208
8.5 Models and Benchmarks of Energy Efficiency — 209
8.5.1 Models and Metrics — 209
8.5.2 Benchmarks — 210
8.6 Energy-Efficient Query Processing and Optimization — 210
8.6.1 Energy Management at Sensor Networks — 211
8.6.2 Energy Management at Mobile Front Ends — 212
8.6.3 Energy-Efficient Query Engines — 213
8.7 Discussion — 215
8.7.1 Redesigning Physical Context Database — 215
8.7.2 Energy-Aware Query Processing and Optimization Strategies — 215
8.7.3 Dynamic Workload and Resource Management — 216
8.8 Recapitulation — 216
Literature — 216

9 Context Query Efficiency Versus Expense — 221
9.1 Basics of Cloud Computing — 221
9.1.1 Service Models of Cloud Computing — 221
9.1.2 Characteristics and Benefits of Cloud Computing — 222
9.1.3 Key Benefits of Cloud Computing — 222
9.2 Concerns of Context Query Performance and Expense — 222
9.2.1 Performance Management — 223
9.2.2 Resource Charging — 224
9.3 Tuning of Query Performance and Expense — 224
9.3.1 Problem Formulation — 225
9.3.2 Multiple Objective Optimization — 227
9.3.3 A Genetic Approach for Multiple Objective Optimization — 228
9.3.4 Performance Evaluation — 229
9.4 Recapitulation — 234
Literature — 234

Part IV: Context-Aware Data Management

10 Context-Aware Preference Querying — 239
10.1 Query Preferences in Databases — 239
10.1.1 Qualitative Representation of Preferences — 239
10.1.2 Quantitative Representation of Preferences — 240
10.2 Implanting Context-Aware Query Preferences upon a Relational Database Management System (RDBMS) — 241
10.2.1 A Knowledge-Based Context-Aware Preference Model — 241
10.2.2 Explicating Context-Aware Preferences in a Database World — 243
10.2.3 Personalized Querying with Context-Aware Preferences — 245
10.3 Contextual Ranking of Database Querying Results — 249
10.3.1 A Motivation Example — 249
10.3.2 Database and Context Space — 250
10.3.3 Ranking Database Tuples Under Context Instances — 250
10.3.4 Building Contextual Ranking Functions by Regression — 251
10.3.5 Reducing Context Dimensionality in Contextual Ranking — 255
10.4 Recapitulation — 260
Literature — 260

11 Analyzing Sensitivity of Answer Ordering Change — 262
11.1 Motivation — 262
11.2 Sensitivity Analysis Techniques in Databases — 264
11.2.1 Attribute Selection — 264
11.2.2 Provenance and Lineage — 265
11.2.3 Causality and Responsibility — 265
11.2.4 Sensitivity Measurement and Computation — 266

11.3 Sensitivity Analysis Problem for Answer Ordering Change — 266
11.3.1 Review of the Probabilistic Database Model — 266
11.3.2 Answer Ordering Change — 268
11.3.3 Measurement of Answer Ordering Change — 268
11.3.4 Sensitivity of Answer Ordering Change — 272
11.4 Sensitivity Computation for Answer Ordering Change — 273
11.4.1 Five Computation Modules — 273
11.4.2 Sensitivity Computation Method — 279
11.4.3 Performance — 280
11.5 Recapitulation — 288
Literature — 289

12 Explaining and Scrubbing Context-Aware Query Results — 291
12.1 Motivation — 291
12.2 Result Explanation and Uncertain Data Cleaning Techniques — 292
12.2.1 Explanation in General — 292
12.2.2 Explanation in Databases — 293
12.2.3 User Feedback — 293
12.2.4 Cleaning Data Uncertainty — 294
12.3 Design Principles for Answer Explanation Facility — 294
12.4 Involving Users in Querying Uncertain Context Data — 295
12.4.1 Result Explanation — 296
12.4.2 Query Recomputation — 307
12.4.3 Performance — 308
12.4.4 Discussion — 310
12.5 Recapitulation — 312
Literature — 312

13 Context-Based Information Refinding — 314
13.1 Characteristics of Information Refinding — 314
13.1.1 Refinding Is a Common Activity — 314
13.1.2 Differences from Information Finding — 315
13.1.3 Difficulties in Information Refinding — 316
13.2 Overview of Information Refinding Techniques — 316
13.2.1 Web Information Refinding — 317
13.2.2 Personal Information Refinding — 320
13.2.3 Comparison of Different Refinding Techniques — 325
13.3 Nature-Inspired Context-Based Refinding — 327
13.3.1 Brain's Memory Recall — 327
13.3.2 Information Refinding by Structured Context — 330
13.3.3 Web Revisitation by Context and Content Keywords — 353
13.4 Recapitulation — 380
Literature — 380

Part V: Context-Aware Applications

14 A Context-Aware Ad-Hoc Meeting Planner Program — 389
14.1 Early Pioneering Context-Aware Applications — 389
14.2 Motivation — 390
14.3 Context-Awareness in ConPlan — 391
14.4 ConPlan Design Considerations — 391
14.5 ConPlan Framework — 392
14.6 ConPlan Context Management — 393
14.7 ConPlan Implementation — 396
14.8 Recapitulation — 398
Literature — 398

15 Context-Aware Learning — 400
15.1 Learning in an Ambient Intelligent World — 400
15.2 Motivation of Context-Aware Learning — 400
15.3 Five Kinds of Learning Context — 402
15.4 Enabling Techniques for Context-Aware Learning — 402
15.4.1 GPS-based Learning — 402
15.4.2 Sensor-Based Learning — 403
15.4.3 Personalized Learning — 403
15.4.4 RFID-based Learning — 405
15.5 Some Context-Aware Learning Prototypes — 407
15.6 Challenges upon Context-Aware Learning — 408
15.7 Recapitulation — 409
Literature — 410

16 Context-Aware Management of Bilingual Aviation MRO Task Cards — 412
16.1 Motivation — 412
16.2 Generating Bilingual MRO Task Cards (TaskCardGenerator^{e2c}) — 413
16.2.1 TaskCardGenerator^{e2c} Architecture — 413
16.2.2 TaskCardGenerator^{e2c} Implementation — 415
16.3 Searching Bilingual MRO Task Cards (TaskCardFinder) — 419
16.3.1 Existing Search Engines — 419
16.3.2 TaskCardFinder Functionalities — 421
16.3.3 TaskCardFinder Architecture — 421
16.3.4 TaskCardFinder Implementation — 422
16.4 User Study — 429
16.4.1 On TaskCardGenerator^{e2c} — 429
16.4.2 On TaskCardFinder — 429
16.5 Recapitulation — 430
Literature — 430