

Database Systems: Introduction to Databases and Data Warehousing

Nenad Jukic, Susan Vrbsky, Svetlozar Nestorov

© Prospect Press, 2017

DETAILED CONTENTS

<i>Preface</i>	xvii
<i>Acknowledgments</i>	xxiii
<i>About the Authors</i>	xxv
Chapter 1 INTRODUCTION	1
<i>Initial Terminology</i>	1
<i>Steps in the Development of Database Systems</i>	4
Database Requirements Collection, Definition, and Visualization	5
Database Modeling	6
Database Implementation	6
Developing Front-End Applications	7
Database Deployment	7
Database Use	7
Database Administration and Maintenance	7
<i>The Next Version of the Database</i>	7
<i>Database Scope</i>	8
<i>People Involved with Database Systems</i>	8
Database Analysts, Designers, and Developers	8
Front-End Applications Analysts and Developers	9
Database Administrators	9
Database End Users	9
<i>Operational versus Analytical Databases</i>	9
<i>Relational DBMS</i>	10
<i>Book Topics Overview</i>	10
Key Terms 11 • Review Questions 11	
Part 1 Operational Databases	13
Chapter 2 DATABASE REQUIREMENTS AND ER MODELING	13
<i>Introduction</i>	13
<i>Basic ER Modeling Constructs</i>	13
<i>Entities</i>	14
<i>Attributes (Unique and Non-Unique)</i>	14
<i>Relationships</i>	15
Cardinality Constraints	15
<i>Types of Relationships (Maximum Cardinality-Wise)</i>	17
<i>Relationships and Relationship Instances</i>	18
<i>Relationship Attributes</i>	19

<i>Example: Set of Database Requirements and ER Diagram</i>	21
<i>Composite Attributes</i>	22
<i>Composite Unique Attribute</i>	23
<i>Multiple Unique Attributes (Candidate Keys)</i>	24
<i>Multivalued Attributes</i>	25
<i>Derived Attribute</i>	25
<i>Optional Attribute</i>	26
<i>Example: Entity Containing Various Types of Attributes</i>	27
<i>Exact Minimum and Maximum Cardinality in Relationships</i>	27
<i>Unary Relationships and Relationship Roles</i>	28
<i>Multiple Relationships Between Same Entities</i>	30
<i>Weak Entity</i>	30
<i>Naming Conventions for Entities, Attributes, and Relationships</i>	33
<i>Multiple ER Diagrams</i>	33
<i>Example: Another Set of Database Requirements and an ER Diagram</i>	35
<i>Database Requirements and ER Model Usage</i>	36
<i>Various ER Notations</i>	39
<i>Enhanced ER (EER)</i>	40
<i>A Note About M:N Relationships with Multiple Instances Between the Same Entities</i>	40
<i>A Note About Associative Entities</i>	43
<i>A Note About Ternary (and Higher Degree) Relationships</i>	45
<i>Summary 50 • Key Terms 52 • Review Questions 52 • Exercises 53 • Mini Cases 53</i>	

Chapter 3 RELATIONAL DATABASE MODELING	57
<i>Introduction</i>	57
<i>Relational Database Model: Basic Concepts</i>	57
<i>Primary Key</i>	59
<i>Mapping Entities into Relations</i>	59
<i>Mapping Entities with Composite Attributes into Relations</i>	60
<i>Mapping Entities with Unique Composite Attributes into Relations</i>	61
<i>Mapping Entities with Optional Attributes into Relations</i>	62
<i>Entity Integrity Constraint</i>	62
<i>Foreign Key</i>	63
<i>Mapping Relationships into Relational Database Constructs</i>	63
<i>Mapping 1:M Relationships</i>	64
<i>Mapping M:N Relationships</i>	66
<i>Mapping 1:1 Relationships</i>	68
<i>Referential Integrity Constraint</i>	69
<i>Example: Mapping an ER Diagram into a Relational Schema</i>	70
<i>Mapping Entities with Candidate Keys (Multiple Unique Attributes) into Relations</i>	71
<i>Mapping Entities with Multivalued Attributes into Relational Database Constructs</i>	72
<i>Mapping Entities with Derived Attributes into Relations</i>	73
<i>Example: Mapping an Entity Containing Various Types of Attributes into a Relational Schema</i>	74
<i>Mapping Unary Relationships</i>	74
<i>Mapping 1:M Unary Relationships</i>	74
<i>Mapping M:N Unary Relationships</i>	75
<i>Mapping 1:1 Unary Relationships</i>	76

<i>Mapping Multiple Relationships Between the Same Entities</i>	76
<i>Mapping Weak Entities</i>	77
<i>Example: Mapping another ER Diagram into a Relational Schema</i>	78
<i>Relational Database Constraints</i>	78
Implicit Constraints	78
User-Defined Constraints	81
<i>A Note About Mapping Associative Entities</i>	83
<i>A Note About Mapping Ternary Relationships</i>	84
<i>A Note About Designer-Created Primary Keys and the Autonumber Option</i>	84
<i>A Note About Performing Both ER and Relational Modeling</i>	85
Summary 87 • Key Terms 88 • Review Questions 88 • Exercises 89 • Mini Cases 89	
Chapter 4 UPDATE OPERATIONS, UPDATE ANOMALIES, AND NORMALIZATION	91
<i>Introduction</i>	91
<i>Update Operations</i>	91
Insert Operation Example	91
Delete Operation Example	92
Modify Operation Example	92
Update Operation Terminology Note	93
<i>Update Anomalies</i>	93
Example Scenario	93
Example Relation (Containing Redundant Data)	94
Insertion Anomaly	95
Deletion Anomaly	95
Modification Anomaly	96
<i>Functional Dependencies</i>	97
Functional Dependency Notation	97
<i>Functional Dependencies Example</i>	98
<i>Streamlining Functional Dependencies</i>	99
Augmented Functional Dependencies	100
Equivalent Functional Dependencies	100
<i>Types of Functional Dependencies</i>	101
Partial Functional Dependency	102
Full Key Functional Dependency	102
Transitive Functional Dependency	102
<i>Another Functional Dependencies Example</i>	102
<i>Normalization</i>	104
First Normal Form (1NF)	105
Second Normal Form (2NF)	107
Third Normal Form (3NF)	108
Other Normal Forms	109
Eliminating Redundancy and Resolving Update Anomalies	109
<i>Another Normalization Example</i>	112
<i>A Note About Normalization Exceptions</i>	114
<i>A Note About Denormalization: Normalization versus Performance</i>	115
<i>A Note About ER Modeling versus Normalization</i>	116
<i>A Note About Designer-Added Entities (Tables) and keys for Streamlining</i>	
<i>Database Content</i>	117

Chapter 5 SQL	127
<i>Introduction</i>	127
<i>SQL Commands Overview</i>	127
Data Definition Language (DDL)	127
Data Manipulation Language (DML)	128
Data Control Language (DCL) and Transaction Control Language (TCL)	128
<i>SQL Data Types</i>	128
<i>Brief SQL Syntax Notes</i>	128
<i>CREATE TABLE</i>	129
<i>DROP TABLE</i>	131
<i>INSERT INTO</i>	132
<i>SELECT</i>	134
<i>WHERE</i>	136
<i>DISTINCT</i>	137
<i>ORDER BY</i>	138
<i>LIKE</i>	139
<i>Aggregate Functions</i>	139
<i>GROUP BY</i>	140
<i>HAVING</i>	144
<i>Nested Queries</i>	146
<i>IN</i>	147
<i>JOIN</i>	148
<i>Alias</i>	151
<i>Joining Multiple Relations</i>	152
<i>ALTER TABLE</i>	153
<i>UPDATE</i>	153
<i>DELETE</i>	154
<i>CREATE VIEW and DROP VIEW</i>	154
<i>Set Operators: Union, Intersect, Except (Minus)</i>	155
<i>Additional SQL Examples with Additional SQL Commands</i>	157
<i>CREATE TABLE (Additional Example)</i>	157
<i>INSERT INTO (Additional Example)</i>	160
<i>Constraint Management</i>	160
<i>Select (Additional Examples)</i>	163
<i>Join of a Relation with Itself (Self-JOIN)</i>	163
<i>OUTER JOIN</i>	164
<i>Join without Using a Primary Key/Foreign Key Combination</i>	166
<i>IS NULL</i>	166
<i>EXISTS</i>	166
<i>NOT</i>	167
<i>Inserting from a Query</i>	168
<i>Other SQL Functionalities</i>	168
<i>A Note About Inappropriate use of Observed Values in SQL</i>	168
<i>A Note About SQL Standard and SQL Syntax Differences</i>	169
SQL Syntax Difference Note 1: DATE and TIME Data Types	170
SQL Syntax Difference Note 2: FOREIGN KEY	170

SQL Syntax Difference Note 3: Usage of AS Keyword with Aliases	170
SQL Syntax Difference Note 4: ALTER TABLE	171
SQL Syntax Difference Note 5: Set Operators	172
SQL Syntax Difference Note 6: FULL OUTER JOIN	172
SQL Syntax Difference Note 7: Constraint Management	173
SQL Syntax Difference Note 8: GROUP BY	173
<i>Key Terms 174 • Review Questions 174 • Exercises 175 • Mini Cases 175</i>	

Chapter 6 DATABASE IMPLEMENTATION AND USE	177
<i>Introduction</i>	177
<i>Referential Integrity Constraint: Delete and Update Implementation Options</i>	177
Delete Options	178
Update Options	181
Implementing Delete and Update Options	184
<i>Implementing User-Defined Constraints</i>	185
CHECK Clause	185
Other Mechanisms for Implementing User-Defined Constraints	186
<i>Indexing</i>	187
<i>Database Front-End</i>	192
<i>Data Quality Issues</i>	197
<i>A Note About Assertions and Triggers</i>	202
<i>Key Terms 204 • Review Questions 204 • Exercises 204</i>	

Part 2 Analytical Databases 207

Chapter 7 DATA WAREHOUSING CONCEPTS	207
<i>Introduction</i>	207
<i>Analytical versus Operational Information</i>	207
Data Makeup Differences	208
Technical Differences	209
Functional Differences	210
<i>The Data Warehouse Definition</i>	212
Structured Repository	213
Integrated	213
Subject Oriented	213
Enterprise-Wide	213
Historical	213
Time Variant	213
Retrieval of Analytical Information	213
Detailed and/or Summarized Data	214
<i>Data Warehouse Components</i>	214
Source Systems	215
Data Warehouse	215
ETL	216
Data Warehouse Front-End (BI) Applications	216
<i>Data Marts</i>	216
<i>Steps in Development of Data Warehouses</i>	217

Requirements Collection, Definition, and Visualization	218
Data Warehouse Modeling	220
Creating the Data Warehouse	220
Creating ETL Infrastructure	220
Developing Front-End (BI) Applications	220
Data Warehouse Deployment	221
Data Warehouse Use	221
Data Warehouse Administration and Maintenance	221
<i>The Next Version of the Data Warehouse</i>	221
Key Terms 222 • Review Questions 222	
Chapter 8 DATA WAREHOUSE AND DATA MART MODELING	225
Introduction	225
Dimensional Modeling: Basic Concepts	225
Initial Example: Dimensional Model Based on a Single Source	226
Characteristics of Dimensions and Facts and the Analysis of the Initial Example	229
Expanded Example: Dimensional Model Based on Multiple Sources	231
Additional Possible Fact Attributes	234
Transaction Identifier in the Fact Table	235
Transaction Time in the Fact Table	237
Multiple Fact Tables in a Dimensional Model	240
Detailed versus Aggregated Fact Tables	243
Detailed Fact Table	243
Aggregated Fact Table	245
Detailed versus Aggregated Fact Table	248
Granularity of the Fact Table	248
Line-Item versus Transaction-Level Detailed Fact Table	249
Slowly Changing Dimensions and Timestamps	250
Type 1 Approach	250
Type 2 Approach	251
Type 3 Approach	252
Additional Dimensional Modeling Issues	253
Snowflake Model	254
Cubes	254
Data Warehouse (Data Mart) Modeling Approaches	255
Normalized Data Warehouse	255
An Example of a Normalized Data Warehouse	256
Dimensionally Modeled Data Warehouse	259
An Example of a Dimensionally Modeled Warehouse	260
Independent Data Marts	263
A Note About Comparing Dimensional Modeling and ER Modeling as Data Warehouse/Data Mart Design Techniques	264
Key Terms 265 • Review Questions 265 • Exercises 266 • Mini Cases 272	
Chapter 9 DATA WAREHOUSE IMPLEMENTATION AND USE	273
Introduction	273
Creating a Data Warehouse	273
ETL: Extraction, Transformation, Load	275

<i>Online Analytical Processing (OLAP)</i>	280
<i>OLAP/BI Tools</i>	281
<i>OLAP/BI Tools Functionalities</i>	282
Slice and Dice	283
Pivot (Rotate)	285
Drill Down and Drill Up	286
Additional OLAP/BI Tools Functionality Notes	288
<i>OLAP/BI Tools Purpose</i>	288
<i>Data Warehouse/Data Mart Front-End (BI) Applications</i>	289
<i>Executive Dashboard</i>	292
<i>Data Warehouse Deployment</i>	292
<i>A Note About OLAP/BI Tools Database Models</i>	293
<i>A Note About OLAP/BI Tools Data Architecture Options</i>	295
MOLAP	295
ROLAP	296
HOLAP	297
<i>Key Terms 297 • Review Questions 297 • Exercises 299</i>	

Part 3 Other Topics 301

Chapter 10 OVERVIEW OF DBMS FUNCTIONALITIES AND DATABASE ADMINISTRATION	301
<i>Introduction</i>	301
<i>DBMS Components</i>	301
<i>Database Administration Overview</i>	302
<i>Monitoring and Maintaining the Database System</i>	302
Data Dictionary	303
<i>Securing the Database against Unauthorized Access</i>	305
<i>Providing Database Backup and Recovery</i>	306
<i>Ensuring Database Integrity</i>	307
<i>Optimizing Database Performance</i>	307
<i>Developing and Implementing Database Policies and Standards</i>	308
<i>Key Terms 309 • Review Questions 309</i>	

Appendices

APPENDIX A ENHANCED ER	311
APPENDIX B FURTHER NOTES ON NORMALIZATION AND HIGHER NORMAL FORMS	317
APPENDIX C ENTERPRISE RESOURCE PLANNING (ERP)	323
APPENDIX D DATA GOVERNANCE AND MASTER DATA MANAGEMENT	326
APPENDIX E OBJECT-ORIENTED DATABASES	330
APPENDIX F DISTRIBUTED DATABASES, PARALLEL DATABASES, AND CLOUD COMPUTING	336
APPENDIX G DATA MINING	343
APPENDIX H XML	346

APPENDIX I NOSQL DATABASES	353
APPENDIX J BIG DATA	356
<i>Glossary</i>	361
<i>Index</i>	369