

Contents

<i>Preface</i>	<i>xiii</i>
<i>Acknowledgements</i>	<i>xxi</i>
<i>About the Authors</i>	<i>xxiii</i>
Chapter 1 Introduction	1
Initial Terminology	1
Steps in the Development of Database Systems	4
Database Requirements Collection, Definition, and Visualization	4
Database Modeling	6
Database Implementation	7
Developing Front-End Applications	7
Database Deployment	8
Database Use	8
Database Administration and Maintenance	9
The Next Version of the Database	9
Database Scope	9
People Involved With Database Systems	9
Database Analysts, Designers, and Developers	9
Front-End Applications Analysts and Developers	10
Database Administrators	10
Database End Users	10
Operational Versus Analytical Databases	10
Relational DBMS	11
Book Topics Overview	11
Key Terms	12
Review Questions	12
PART 1 OPERATIONAL DATABASES	15
Chapter 2 Database Requirements and ER Modeling	15
Introduction	15
Basic ER Modeling Constructs	15
Entities	16
Attributes (Unique and Non-unique)	16
Relationships	17
Cardinality Constraints	17
Types of Relationships (Maximum Cardinality-wise)	19
Relationships and Relationship Instances	20
Relationship Attributes	21
Example: Set of Database Requirements and ER Diagram	23
Composite Attributes	24
Composite Unique Attributes	25
Multiple Unique Attributes (Candidate Keys)	26
Multivalued Attributes	27
Derived Attributes	27
Optional Attributes	28
Example: Entity Containing Various Types of Attributes	29
Exact Minimum and Maximum Cardinality in Relationships	29

Unary Relationships and Relationship Roles	30
Multiple Relationships Between Same Entities	32
Weak Entity	32
Naming Conventions for Entities, Attributes, and Relationships	35
Multiple ER Diagrams	35
Example: Another Set of Database Requirements and an ER Diagram	37
Database Requirements and ER Model Usage	38
Various ER Notations	41
A Note About M:N Relationships with Multiple Instances Between the Same Entities	42
Enhanced ER (EER) Modeling	42
A Note About Associative Entities	46
A Note About Ternary (and Higher Degree) Relationships	48
A Note About Reducing the Number of Attributes by Treating Some Attributes as Attribute Values	51
Summary	53
Key Terms	55
Review Questions	56
Exercises	56
Mini Cases	58
Chapter 3 Relational Database Modeling	63
Introduction	63
Relational Database Model: Basic Concepts	63
Primary Key	65
Mapping Entities into Relations	66
Mapping Entities With Composite Attributes into Relations	66
Mapping Entities With Unique Composite Attributes into Relations	68
Mapping Entities With Optional Attributes into Relations	68
Entity Integrity Constraint	69
Foreign Key	70
Mapping Relationships into Relational Database Constructs	70
Mapping 1:M Relationships	70
Mapping M:N Relationships	73
Mapping 1:1 Relationships	75
Referential Integrity Constraint	76
Example: Mapping an ER Diagram into a Relational Schema	77
Granularity of the Table	78
Mapping Entities With Candidate Keys (Multiple Unique Attributes) into Relations	79
Mapping Entities With Multivalued Attributes into Relational Database Constructs	80
Mapping Entities With Derived Attributes into Relations	81
Example: Mapping an Entity Containing Various Types of Attributes into a Relational Schema	81
Mapping Unary Relationships	82
Mapping 1:M Unary Relationships	82
Mapping M:N Unary Relationships	83
Mapping 1:1 Unary Relationships	83
Mapping Multiple Relationships Between the Same Entities	84
Mapping Weak Entities	84
Example: Mapping Another ER Diagram Into a Relational Schema	86
Relational Database Constraints	89
Implicit Constraints	89
User-Defined Constraints	89
A Note About Mapping Associative Entities	92
A Note About Mapping Ternary Relationships	93
A Note About Designer-Created Primary Keys and the Autonumber Option	94
A Note About Performing Both ER and Relational Modeling	95
Summary	96

Key Terms	97
Review Questions	97
Exercises	98
Mini Cases	100
Chapter 4 Update Operations, Update Anomalies, and Normalization	101
Introduction	101
Update Operations	101
Insert Operation Example	101
Delete Operation Example	102
Modify Operation Example	102
Update Operation Terminology Note	103
Update Anomalies	103
Example Scenario	103
Example Relation (Containing Redundant Data)	104
Insertion Anomaly	105
Deletion Anomaly	105
Modification Anomaly	106
Functional Dependencies	107
Functional Dependency Notations	107
Functional Dependencies Example	108
Streamlining Functional Dependencies	110
Augmented Functional Dependencies	110
Equivalent Functional Dependencies	111
Types of Functional Dependencies	112
Partial Functional Dependency	112
Full Key Functional Dependency	112
Transitive Functional Dependency	113
Another Functional Dependencies Example	113
Normalization	115
First Normal Form (1NF)	115
Second Normal Form (2NF)	118
Third Normal Form (3NF)	119
3NF and Other Normal Forms	120
Eliminating Redundancy and Resolving Update Anomalies	120
Another Normalization Example	123
A Note About Normalization Exceptions	125
A Note About Denormalization: Normalization versus Performance	126
A Note About ER Modeling versus Normalization	127
A Note About Designer-Added Entities (Tables) and Keys for Streamlining Database Content	128
Key Terms	131
Review Questions	131
Exercises	131
Chapter 5 SQL	139
Introduction	139
SQL Commands Overview	139
Data Definition Language (DDL)	139
Data Manipulation Language (DML)	140
Data Control Language (DCL) and Transaction Control Language (TCL)	140
SQL Data Types	140
Brief SQL Syntax Notes	140
CREATE TABLE	141
DROP TABLE	144
INSERT INTO	145
SELECT	147

WHERE	149
DISTINCT	150
ORDER BY	151
LIKE	152
Aggregate Functions	153
GROUP BY	154
HAVING	157
Nested Queries	160
IN	162
JOIN	163
Alias	166
Joining Multiple Relations	167
ALTER TABLE	168
UPDATE	168
DELETE	169
CREATE VIEW and DROP VIEW	169
Set Operators: UNION, INTERSECT, EXCEPT (MINUS)	171
Additional SQL Examples With Additional SQL Commands	172
CREATE TABLE (Additional Example)	173
INSERT INTO (Additional Example)	175
Constraint Management	178
SELECT (Additional Examples)	179
Join of a Relation With Itself (self-JOIN)	179
INNER and OUTER JOIN	180
Join Without Using a Primary Key/Foreign Key Combination	182
IS NULL	182
EXISTS	183
NOT	183
Alternative Queries	184
Inserting From a Query	184
Other SQL Functionalities	185
A Note About Inappropriate Use of Observed Values in SQL	185
A Note About SQL Standard and SQL Syntax Differences	186
Key Terms	192
Review Questions	192
Exercises	192
Mini Cases	194
Chapter 6 Database Implementation and Use	197
Introduction	197
Referential Integrity Constraint: Delete and Update Implementation	197
Delete Options	198
Update Options	201
Implementing Delete and Update Options	204
Implementing User-Defined Constraints	206
CHECK Clause	206
Other Mechanisms for Implementing User-Defined Constraints	208
Indexing	208
Database Front End	213
Data Quality Issues	217
Key Terms	223
Review Questions	223
Exercises	224

PART 2 ANALYTICAL DATABASES	229
Chapter 7 Data Warehousing Concepts	229
Introduction	229
Analytical Versus Operational Information	229
Data Makeup Differences	230
Technical Differences	231
Functional Differences	232
The Data Warehouse Definition	235
Structured Repository	235
Integrated	235
Subject-Oriented	235
Enterprise-Wide	235
Historical	235
Time-Variant	236
Retrieval of Analytical Information	236
Detailed and/or Summarized Data	236
Data Warehouse Components	236
Source Systems	236
Data Warehouse	238
ETL	238
Data Warehouse Front-End (BI) Applications	239
Data Marts	239
Steps in Development of Data Warehouses	240
Requirements Collection, Definition, and Visualization	240
Data Warehouse Modeling	242
Creating the Data Warehouse	242
Creating ETL Infrastructure	242
Developing Front-End (BI) Applications	242
Data Warehouse Deployment	243
Data Warehouse Use	243
Data Warehouse Administration and Maintenance	243
The Next Version of the Data Warehouse	243
Key Terms	244
Review Questions	244
Chapter 8 Data Warehouse Modeling	245
Introduction	245
Dimensional Modeling: Basic Concepts	245
Initial Example: Dimensional Model Based on a Single Source	246
Characteristics of Dimensions and Facts and the Analysis of the Initial Example	249
Expanded Example: Dimensional Model Based on Multiple Sources	252
Additional Possible Fact Attributes	256
Transaction Identifier in the Fact Table	256
Transaction Time in the Fact Table	257
Multiple Fact Tables in a Dimensional Model	259
Detailed Versus Aggregated Fact Tables	263
Detailed Fact Table	264
Aggregated Fact Table	264
Detailed Versus Aggregated Fact Table	266
Granularity of the Fact Table	267
Line-Item Versus Transaction-Level Detailed Fact Table	267
Slowly Changing Dimensions and Timestamps	269
Type 1 Approach	269
Type 2 Approach	269
Type 3 Approach	271

Snowflake Model	272
Data Warehouse (Data Mart) Modeling Approaches	272
Normalized Data Warehouse	273
An Example of a Normalized Data Warehouse	274
Dimensionally Modeled Data Warehouse	277
Independent Data Marts	278
A Note About Comparing ER Modeling and Dimensional Modeling as Data Warehouse/Data Mart Design Techniques	279
Key Terms	281
Review Questions	281
Exercises	281
Mini Cases	291
Chapter 9 Data Warehouse Implementation and Use	293
Introduction	293
Creating a Data Warehouse	293
ETL: Extraction, Transformation, Load	295
Online Analytical Processing (OLAP)	301
OLAP/BI Tools	301
OLAP/BI Tools Functionalities	301
Slice and Dice	303
Pivot (Rotate)	305
Drill Down and Drill Up	306
Additional OLAP/BI Tools Functionality Note	307
OLAP/BI Tools Purpose	308
Data Warehouse/Data Mart Front-End (BI) Applications	308
Executive Dashboard	311
Data Warehouse Deployment	311
Key Terms	313
Review Questions	313
Exercises	313
Chapter 10 Big Data and Data Lakes	317
Introduction	317
Big Data Definition	317
Example – Three Types of Data Sets in a Corporation	319
Insurance Company – Operational Database	319
Insurance Company – Data Warehouse	319
Insurance Company – Big Data Set	321
MapReduce and Hadoop	322
Example – Examining V's of Big Data	324
Example – Big Data as a Source for a Data Warehouse	324
Corporate Use of Big Data	326
Data Lake	328
Key Terms	330
Review Questions	330
PART 3 OTHER TOPICS	331
Chapter 11 Overview of DBMS Functionalities and Database Administration	331
Introduction	331
DBMS Components	331
Database Administration Overview	332
Monitoring and Maintaining the Database System	332
Data Dictionary	333
Securing the Database Against Unauthorized Access	334
Providing Database Backup and Recovery	336

Ensuring Database Integrity	337
Optimizing Database Performance	337
Developing and Implementing Database Policies and Standards	338
Key Terms	339
Review Questions	339
PART 4 APPENDICES	341
Appendix 1 Enhanced ER	341
Superclass and Subclass Entities	341
EER Example 1 – Disjointed Subclasses, Total Specialization	341
EER Example 2 – Overlapping Subclasses, Total Specialization	343
EER Example 3 – Disjointed Subclasses, Partial Specialization	345
Appendix 2 Further Notes on Normalization and Higher Normal Forms	347
Candidate Keys and Functional Dependencies	347
Boyce-CODD Normal Form (BCNF)	349
Fourth Normal Form (4NF)	352
Other Normal Forms	353
Appendix 3 Enterprise Resource Planning (ERP)	355
Appendix 4 Data Governance and Master Data Management	359
Data Governance	359
Master Data Management	360
Appendix 5 Object-Oriented Databases	363
Object-Oriented Concepts	363
Object-Oriented Queries	367
Object-Relational Database	368
Appendix 6 Assertions, Triggers, Stored Procedures and Functions	369
Assertion	369
Triggers	370
Stored Procedures and Functions	371
Appendix 7 Distributed Databases, Blockchain, Parallel Databases, and Cloud Computing	375
Distributed Databases	375
Blockchain	380
Parallel Databases	381
Cloud Computing	382
Appendix 8 Data Mining	385
Association Rule Mining	385
Association Rule Mining Example	386
Appendix 9 XML Markup Languages	389
XML	390
XML Queries	391
Appendix 10 NoSQL Databases	397
Terminology of NoSQL vs. Relational Databases	397
NoSQL Database Examples – MongoDB	398
Applicability of NoSQL	399
Glossary	401
Index	413

