2.2.2 The Data Manipulation Language (DML) 42
2.2.3 Fourth-Generation Languages (4GLs) 44

2.3 Data Models and Conceptual Modeling 45
2.3.1 Object-Based Data Models 46
2.3.2 Record-Based Data Models 46
2.3.3 Physical Data Models 49
2.3.4 Conceptual Modeling 49

2.4 Functions of a DBMS 49

Chapter Summary 54
Review Questions 55
Exercises 55

Chapter 3 Database Architectures and the Web 57
3.1 Multi-user DBMS Architectures 58
3.1.1 Teleprocessing 58
3.1.2 File-Server Architecture 59
3.1.3 Traditional Two-Tier Client-Server Architecture 60
3.1.4 Three-Tier Client-Server Architecture 63
3.1.5 N-Tier Architectures 64
3.1.6 Middleware 65
3.1.7 Transaction Processing Monitors 67
3.2 Web Services and Service-Oriented Architectures 69
3.2.1 Web Services 69
3.2.2 Service-Oriented Architectures (SOA) 70
3.3 Distributed DBMSs 72
3.4 Data Warehousing 74
3.5 Components of a DBMS 77
3.6 Oracle Architecture 80
3.6.1 Oracle's Logical Database Structure 80
3.6.2 Oracle's Physical Database Structure 82

Chapter Summary 86
Review Questions 87
Exercises 87

Part 2 The Relational Model and Languages 89

Chapter 4 The Relational Model 91
4.1 Brief History of the Relational Model 92
4.2 Terminology 94
4.2.1 Relational Data Structure 94
4.2.2 Mathematical Relations 97
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3.3 Using the SQL Aggregate Functions</td>
<td>149</td>
</tr>
<tr>
<td>6.3.4 Grouping Results (GROUP BY Clause)</td>
<td>151</td>
</tr>
<tr>
<td>6.3.5 Subqueries</td>
<td>154</td>
</tr>
<tr>
<td>6.3.6 ANY and ALL</td>
<td>156</td>
</tr>
<tr>
<td>6.3.7 Multi-table Queries</td>
<td>158</td>
</tr>
<tr>
<td>6.3.8 EXISTS and NOT EXISTS</td>
<td>164</td>
</tr>
<tr>
<td>6.3.9 Combining Result Tables (UNION, INTERSECT, EXCEPT)</td>
<td>165</td>
</tr>
<tr>
<td>6.3.10 Database Updates</td>
<td>167</td>
</tr>
<tr>
<td><strong>Chapter Summary</strong></td>
<td>171</td>
</tr>
<tr>
<td><strong>Review Questions</strong></td>
<td>172</td>
</tr>
<tr>
<td><strong>Exercises</strong></td>
<td>172</td>
</tr>
</tbody>
</table>

**Chapter 7  SQL: Data Definition**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 The ISO SQL Data Types</td>
<td>176</td>
</tr>
<tr>
<td>7.1.1 SQL Identifiers</td>
<td>176</td>
</tr>
<tr>
<td>7.1.2 SQL Scalar Data Types</td>
<td>177</td>
</tr>
<tr>
<td>7.1.3 Exact Numeric Data</td>
<td>178</td>
</tr>
<tr>
<td>7.2 Integrity Enhancement Feature</td>
<td>181</td>
</tr>
<tr>
<td>7.2.1 Required Data</td>
<td>182</td>
</tr>
<tr>
<td>7.2.2 Domain Constraints</td>
<td>182</td>
</tr>
<tr>
<td>7.2.3 Entity Integrity</td>
<td>183</td>
</tr>
<tr>
<td>7.2.4 Referential Integrity</td>
<td>184</td>
</tr>
<tr>
<td>7.2.5 General Constraints</td>
<td>185</td>
</tr>
<tr>
<td>7.3 Data Definition</td>
<td>185</td>
</tr>
<tr>
<td>7.3.1 Creating a Database</td>
<td>186</td>
</tr>
<tr>
<td>7.3.2 Creating a Table (CREATE TABLE)</td>
<td>187</td>
</tr>
<tr>
<td>7.3.3 Changing a Table Definition (ALTER TABLE)</td>
<td>190</td>
</tr>
<tr>
<td>7.3.4 Removing a Table (DROP TABLE)</td>
<td>191</td>
</tr>
<tr>
<td>7.3.5 Creating an Index (CREATE INDEX)</td>
<td>192</td>
</tr>
<tr>
<td>7.3.6 Removing an Index (DROP INDEX)</td>
<td>192</td>
</tr>
<tr>
<td>7.4 Views</td>
<td>193</td>
</tr>
<tr>
<td>7.4.1 Creating a View (CREATE VIEW)</td>
<td>193</td>
</tr>
<tr>
<td>7.4.2 Removing a View (DROP VIEW)</td>
<td>195</td>
</tr>
<tr>
<td>7.4.3 View Resolution</td>
<td>196</td>
</tr>
<tr>
<td>7.4.4 Restrictions on Views</td>
<td>197</td>
</tr>
<tr>
<td>7.4.5 View Updatability</td>
<td>197</td>
</tr>
<tr>
<td>7.4.6 WITH CHECK OPTION</td>
<td>198</td>
</tr>
<tr>
<td>7.4.7 Advantages and Disadvantages of Views</td>
<td>199</td>
</tr>
<tr>
<td>7.4.8 View Materialization</td>
<td>200</td>
</tr>
<tr>
<td>7.5 Transactions</td>
<td>203</td>
</tr>
<tr>
<td>7.5.1 Immediate and Deferred Integrity Constraints</td>
<td>204</td>
</tr>
</tbody>
</table>
Part 3 Database Analysis and Design 259

Chapter 10 Database System Development Lifecycle 261

10.1 The Information Systems Lifecycle 262
10.2 The Database System Development Lifecycle 263
10.3 Database Planning 263
10.4 System Definition 266
10.4.1 User Views 266
10.5 Requirements Collection and Analysis 266
10.5.1 Centralized Approach 268
10.5.2 View Integration Approach 268
10.6 Database Design 270
10.6.1 Approaches to Database Design 271
10.6.2 Data Modeling 271
10.6.3 Phases of Database Design 272
10.7 DBMS Selection 275
10.7.1 Selecting the DBMS 275
10.8 Application Design 279
10.8.1 Transaction Design 280
10.8.2 User Interface Design Guidelines 281
10.9 Prototyping 283
10.10 Implementation 283
10.11 Data Conversion and Loading 284
10.12 Testing 284
10.13 Operational Maintenance 285
10.14 CASE Tools 286

Chapter Summary 288
Review Questions 289
Exercises 290

Chapter 11 Database Analysis and the DreamHome Case Study 291

11.1 When Are Fact-Finding Techniques Used? 292
11.2 What Facts Are Collected? 293
11.3 Fact-Finding Techniques 294
11.3.1 Examining Documentation 294
11.3.2 Interviewing 294
11.3.3 Observing the Enterprise in Operation 295
Chapter 12 Entity-Relationship Modeling

12.1 Entity Types
12.2 Relationship Types
  12.2.1 Degree of Relationship Type
  12.2.2 Recursive Relationship
12.3 Attributes
  12.3.1 Simple and Composite Attributes
  12.3.2 Single-valued and Multi-valued Attributes
  12.3.3 Derived Attributes
  12.3.4 Keys
12.4 Strong and Weak Entity Types
12.5 Attributes on Relationships
12.6 Structural Constraints
  12.6.1 One-to-One (1:1) Relationships
  12.6.2 One-to-Many (1:* ) Relationships
  12.6.3 Many-to-Many (*:* ) Relationships
  12.6.4 Multiplicity for Complex Relationships
  12.6.5 Cardinality and Participation Constraints
12.7 Problems with ER Models
  12.7.1 Fan Traps
  12.7.2 Chasm Traps
Chapter Summary
Review Questions
Exercises

Chapter 13 Enhanced Entity-Relationship Modeling

13.1 Specialization/Generalization
  13.1.1 Superclasses and Subclasses
Chapter 14 Normalization

14.1 The Purpose of Normalization
14.2 How Normalization Supports Database Design
14.3 Data Redundancy and Update Anomalies
14.3.1 Insertion Anomalies
14.3.2 Deletion Anomalies
14.3.3 Modification Anomalies
14.4 Functional Dependencies
14.4.1 Characteristics of Functional Dependencies
14.4.2 Identifying Functional Dependencies
14.4.3 Identifying the Primary Key for a Relation Using Functional Dependencies
14.5 The Process of Normalization
14.6 First Normal Form (1NF)
14.7 Second Normal Form (2NF)
14.8 Third Normal Form (3NF)
14.9 General Definitions of 2NF and 3NF

Chapter Summary
Review Questions
Exercises

Chapter 15 Advanced Normalization

15.1 More on Functional Dependencies
15.1.1 Inference Rules for Functional Dependencies
15.1.2 Minimal Sets of Functional Dependencies
18.3 The Physical Database Design Methodology for Relational Databases
Step 3: Translate Logical Data Model for Target DBMS
Step 4
Step 5: Design User Views
Step 6: Design Security Mechanisms

Chapter Summary
Review Questions
Exercises

Chapter 19 Methodology—Monitoring and Tuning the Operational System

19.1 Denormalizing and Introducing Controlled Redundancy
Step 7: Consider the Introduction of Controlled Redundancy
19.2 Monitoring the System to Improve Performance
Step 8: Monitor and Tune the Operational System

Chapter Summary
Review Questions
Exercises

Part 5 Selected Database Issues

Chapter 20 Security and Administration

20.1 Database Security
20.1.1 Threats
20.2 Countermeasures—Computer-Based Controls
20.2.1 Authorization
20.2.2 Access Controls
20.2.3 Views
20.2.4 Backup and Recovery
20.2.5 Integrity
20.2.6 Encryption
20.2.7 RAID (Redundant Array of Independent Disks)
20.3 Security in Microsoft Office Access DBMS
20.4 Security in Oracle DBMS
20.5 DBMSs and Web Security
20.5.1 Proxy Servers
20.5.2 Firewalls
### Chapter 20: Security, Data Administration, and Database Administration

- **20.5.3 Message Digest Algorithms and Digital Signatures** 539
- **20.5.4 Digital Certificates** 539
- **20.5.5 Kerberos** 540
- **20.5.6 Secure Sockets Layer and Secure HTTP** 540
- **20.5.7 Secure Electronic Transactions and Secure Transaction Technology** 541
- **20.5.8 Java Security** 542
- **20.5.9 ActiveX Security** 544

#### 20.6 Data Administration and Database Administration

- **20.6.1 Data Administration** 545
- **20.6.2 Database Administration** 546
- **20.6.3 Comparison of Data and Database Administration** 546

### Chapter Summary 547

### Review Questions 548

### Exercises 548

---

### Chapter 21: Professional, Legal, and Ethical Issues in Data Management 549

- **21.1 Defining Legal and Ethical Issues in IT** 550
  - **21.1.1 Defining Ethics in the Context of IT** 550
  - **21.1.2 The Difference Between Ethical and Legal Behavior** 551
  - **21.1.3 Ethical Behavior in IT** 552

- **21.2 Legislation and Its Impact on the IT Function** 553
  - **21.2.1 Securities and Exchange Commission (SEC) Regulations National Market System (NMS)** 553
  - **21.2.2 The Sarbanes-Oxley Act, COBIT, and COSO** 553
  - **21.2.3 The Health Insurance Portability and Accountability Act** 555
  - **21.2.4 The European Union (EU) Directive on Data Protection of 1995** 555
  - **21.2.5 The United Kingdom's Data Protection Act of 1998** 556
  - **21.2.6 International Banking—Basel II Accords** 557

- **21.3 Establishing a Culture of Legal and Ethical Data Stewardship** 558
  - **21.3.1 Developing an Organization-Wide Policy for Legal and Ethical Behavior** 558
  - **21.3.2 Professional Organizations and Codes of Ethics** 559
  - **21.3.3 Developing an Organization-Wide Policy for Legal and Ethical Behavior for DreamHome** 561

- **21.4 Intellectual Property** 563
  - **21.4.1 Patent** 563
  - **21.4.2 Copyright** 564
  - **21.4.3 Trademark** 564
<table>
<thead>
<tr>
<th>Chapter 22</th>
<th>Transaction Management</th>
<th>569</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.1 Transaction Support</td>
<td>570</td>
<td></td>
</tr>
<tr>
<td>22.1.1 Properties of Transactions</td>
<td>573</td>
<td></td>
</tr>
<tr>
<td>22.1.2 Database Architecture</td>
<td>573</td>
<td></td>
</tr>
<tr>
<td>22.2 Concurrency Control</td>
<td>574</td>
<td></td>
</tr>
<tr>
<td>22.2.1 The Need for Concurrency Control</td>
<td>574</td>
<td></td>
</tr>
<tr>
<td>22.2.2 Serializability and Recoverability</td>
<td>577</td>
<td></td>
</tr>
<tr>
<td>22.2.3 Locking Methods</td>
<td>585</td>
<td></td>
</tr>
<tr>
<td>22.2.4 Deadlock</td>
<td>591</td>
<td></td>
</tr>
<tr>
<td>22.2.5 Timestamping Methods</td>
<td>594</td>
<td></td>
</tr>
<tr>
<td>22.2.6 Multiversion Timestamp Ordering</td>
<td>597</td>
<td></td>
</tr>
<tr>
<td>22.2.7 Optimistic Techniques</td>
<td>598</td>
<td></td>
</tr>
<tr>
<td>22.2.8 Granularity of Data Items</td>
<td>599</td>
<td></td>
</tr>
<tr>
<td>22.3 Database Recovery</td>
<td>602</td>
<td></td>
</tr>
<tr>
<td>22.3.1 The Need for Recovery</td>
<td>602</td>
<td></td>
</tr>
<tr>
<td>22.3.2 Transactions and Recovery</td>
<td>603</td>
<td></td>
</tr>
<tr>
<td>22.3.3 Recovery Facilities</td>
<td>606</td>
<td></td>
</tr>
<tr>
<td>22.3.4 Recovery Techniques</td>
<td>609</td>
<td></td>
</tr>
<tr>
<td>22.3.5 Recovery in a Distributed DBMS</td>
<td>611</td>
<td></td>
</tr>
<tr>
<td>22.4 Advanced Transaction Models</td>
<td>611</td>
<td></td>
</tr>
<tr>
<td>22.4.1 Nested Transaction Model</td>
<td>613</td>
<td></td>
</tr>
<tr>
<td>22.4.2 Sagas</td>
<td>614</td>
<td></td>
</tr>
<tr>
<td>22.4.3 Multilevel Transaction Model</td>
<td>615</td>
<td></td>
</tr>
<tr>
<td>22.4.4 Dynamic Restructuring</td>
<td>616</td>
<td></td>
</tr>
<tr>
<td>22.4.5 Workflow Models</td>
<td>617</td>
<td></td>
</tr>
<tr>
<td>22.5 Concurrency Control and Recovery in Oracle</td>
<td>618</td>
<td></td>
</tr>
<tr>
<td>22.5.1 Oracle’s Isolation Levels</td>
<td>619</td>
<td></td>
</tr>
<tr>
<td>22.5.2 Multiversion Read Consistency</td>
<td>619</td>
<td></td>
</tr>
<tr>
<td>22.5.3 Deadlock Detection</td>
<td>621</td>
<td></td>
</tr>
<tr>
<td>22.5.4 Backup and Recovery</td>
<td>621</td>
<td></td>
</tr>
<tr>
<td>Chapter Summary</td>
<td>624</td>
<td></td>
</tr>
<tr>
<td>Review Questions</td>
<td>625</td>
<td></td>
</tr>
<tr>
<td>Exercises</td>
<td>625</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 23</th>
<th>Query Processing</th>
<th>627</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.1 Overview of Query Processing</td>
<td>629</td>
<td></td>
</tr>
<tr>
<td>23.2 Query Decomposition</td>
<td>632</td>
<td></td>
</tr>
</tbody>
</table>
23.3 Heuristical Approach to Query Optimization
   23.3.1 Transformation Rules for the Relational Algebra Operations 636
   23.3.2 Heuristical Processing Strategies 641

23.4 Cost Estimation for the Relational Algebra Operations 642
   23.4.1 Database Statistics 642
   23.4.2 Selection Operation (S = \sigma_{P}(R)) 643
   23.4.3 Join Operation (T = (R \bowtie S)) 650
   23.4.4 Projection Operation (S = \Pi_{A_{1},A_{2},\ldots,A_{n}}(R)) 657
   23.4.5 The Relational Algebra Set Operations (T = R \cup S, T = R \cap S, T = R - S) 659

23.5 Enumeration of Alternative Execution Strategies 660
   23.5.1 Pipelining 661
   23.5.2 Linear Trees 661
   23.5.3 Physical Operators and Execution Strategies 662
   23.5.4 Reducing the Search Space 664
   23.5.5 Enumerating Left-Deep Trees 665
   23.5.6 Semantic Query Optimization 666
   23.5.7 Alternative Approaches to Query Optimization 667
   23.5.8 Distributed Query Optimization 668

23.6 Query Optimization in Oracle 668
   23.6.1 Rule-Based and Cost-Based Optimization 668
   23.6.2 Histograms 672
   23.6.3 Viewing the Execution Plan 674

Chapter Summary 675
Review Questions 676
Exercises 676

Part 6 Distributed DBMSs and Replication 679

Chapter 24 Distributed DBMSs—Concepts and Design 681
   24.1 Introduction 682
      24.1.1 Concepts 683
      24.1.2 Advantages and Disadvantages of DDBMSs 687
      24.1.3 Homogeneous and Heterogeneous DDBMSs 690
   24.2 Overview of Networking 693
   24.3 Functions and Architectures of a DDBMS 697
      24.3.1 Functions of a DDBMS 697
      24.3.2 Reference Architecture for a DDBMS 697
      24.3.3 Reference Architecture for a Federated MDBS 699
      24.3.4 Component Architecture for a DDBMS 700
   24.4 Distributed Relational Database Design 701
      24.4.1 Data Allocation 702
      24.4.2 Fragmentation 703
### Chapter 27 Object-Oriented Database Systems—Advantages and Disadvantages of OODBMSs

- **27.8 Advantages and Disadvantages of OODBMSs**
  - **27.8.1 Advantages**
  - **27.8.2 Disadvantages**

- **27.9 Object-Oriented Database Design**
  - **27.9.1 Comparison of Object-Oriented Data Modeling and Conceptual Data Modeling**
  - **27.9.2 Relationships and Referential Integrity**
  - **27.9.3 Behavioral Design**

- **27.10 Object-Oriented Analysis and Design with UML**
  - **27.10.1 UML Diagrams**
  - **27.10.2 Usage of UML in the Methodology for Database Design**

**Chapter Summary**

**Review Questions**

**Exercises**

### Chapter 28 Object-Oriented DBMSs—Standards and Systems

- **28.1 Object Management Group**
  - **28.1.1 Background**
  - **28.1.2 The Common Object Request Broker Architecture**
  - **28.1.3 Other OMG Specifications**
  - **28.1.4 Model-Driven Architecture**

- **28.2 Object Data Standard ODMG 3.0, 1999**
  - **28.2.1 Object Data Management Group**
  - **28.2.2 The Object Model**
  - **28.2.3 The Object Definition Language**
  - **28.2.4 The Object Query Language**
  - **28.2.5 Other Parts of the ODMG Standard**
  - **28.2.6 Mapping the Conceptual Design to a Logical (Object-Oriented) Design**

- **28.3 ObjectStore**
  - **28.3.1 Architecture**
  - **28.3.2 Building an ObjectStore Application**
  - **28.3.3 Data Definition in ObjectStore**
  - **28.3.4 Data Manipulation in ObjectStore**

**Chapter Summary**

**Review Questions**

**Exercises**

### Chapter 29 Object-Relational DBMSs

- **29.1 Introduction to Object-Relational Database Systems**

- **29.2 The Third-Generation Database Manifestos**
  - **29.2.1 The Third-Generation Database System Manifesto**
  - **29.2.2 The Third Manifesto**
29.3 Postgres—An Early ORDBMS
29.3.1 Objectives of Postgres
29.3.2 Abstract Data Types
29.3.3 Relations and Inheritance
29.3.4 Object Identity

29.4 SQL:2008
29.4.1 Row Types
29.4.2 User-Defined Types
29.4.3 Subtypes and Supertypes
29.4.4 User-Defined Routines
29.4.5 Polymorphism
29.4.6 Reference Types and Object Identity
29.4.7 Creating Tables
29.4.8 Querying Data
29.4.9 Collection Types
29.4.10 Typed Views
29.4.11 Persistent Stored Modules
29.4.12 Triggers
29.4.13 Large Objects
29.4.14 Recursion

29.5 Query Processing and Optimization
29.5.1 New Index Types

29.6 Object-Oriented Extensions in Oracle
29.6.1 User-Defined Data Types
29.6.2 Manipulating Object Tables
29.6.3 Object Views
29.6.4 Privileges

29.7 Comparison of ORDBMS and OODBMS

Chapter Summary
Review Questions
Exercises

Part 8 The Web and DBMSs

Chapter 30 Web Technology and DBMSs

30.1 Introduction to the Internet and the Web
30.1.1 Intranets and Extranets
30.1.2 e-Commerce and e-Business

30.2 The Web
30.2.1 HyperText Transfer Protocol
30.2.2 HyperText Markup Language
30.2.3 Uniform Resource Locators
30.2.4 Static and Dynamic Web Pages
30.2.5 Web Services 984
30.2.6 Requirements for Web–DBMS Integration 985
30.2.7 Advantages and Disadvantages of the Web–DBMS Approach 986
30.2.8 Approaches to Integrating the Web and DBMSs 990

30.3 Scripting Languages 991
30.3.1 JavaScript and JScript 991
30.3.2 VBScript 992
30.3.3 Perl and PHP 993

30.4 Common Gateway Interface (CGI) 993
30.4.1 Passing Information to a CGI Script 995
30.4.2 Advantages and Disadvantages of CGI 997

30.5 HTTP Cookies 998

30.6 Extending the Web Server 999
30.6.1 Comparison of CGI and API 1000

30.7 Java 1000
30.7.1 JDBC 1004
30.7.2 SQLJ 1010
30.7.3 Comparison of JDBC and SQLJ 1010
30.7.4 Container-Managed Persistence (CMP) 1011
30.7.5 Java Data Objects (JDO) 1015
30.7.6 JPA (Java Persistence API) 1022
30.7.7 Java Servlets 1030
30.7.8 JavaServer Pages 1030
30.7.9 Java Web Services 1031

30.8 Microsoft's Web Platform 1032
30.8.1 Universal Data Access 1034
30.8.2 Active Server Pages and ActiveX Data Objects 1035
30.8.3 Remote Data Services 1036
30.8.4 Comparison of ASP and JSP 1039
30.8.5 Microsoft .NET 1039
30.8.6 Microsoft Web Services 1044

30.9 Oracle Internet Platform 1044
30.9.1 Oracle Application Server (OracleAS) 1045

Chapter Summary 1051
Review Questions 1052
Exercises 1053

Chapter 31 Semistructured Data and XML 1055

31.1 Semistructured Data 1056
31.1.1 Object Exchange Model (OEM) 1058
31.1.2 Lore and Lorel 1059
31.2 Introduction to XML
  31.2.1 Overview of XML 1066
  31.2.2 Document Type Definitions (DTDs) 1068

31.3 XML-Related Technologies 1071
  31.3.1 DOM and SAX Interfaces 1072
  31.3.2 Namespaces 1073
  31.3.3 XSL and XSLT 1073
  31.3.4 XPath (XML Path Language) 1074
  31.3.5 XPointer (XML Pointer Language) 1075
  31.3.6 XLink (XML Linking Language) 1076
  31.3.7 XHTML 1076
  31.3.8 Simple Object Access Protocol (SOAP) 1077
  31.3.9 Web Services Description Language (WSDL) 1077
  31.3.10 Universal Discovery, Description and Integration (UDDI) 1078

31.4 XML Schema 1081
  31.4.1 Resource Description Framework (RDF) 1087

31.5 XML Query Languages 1091
  31.5.1 Extending Lore and Lorel to Handle XML 1092
  31.5.2 XML Query Working Group 1093
  31.5.3 XQuery—A Query Language for XML 1094
  31.5.4 XML Information Set 1104
  31.5.5 XQuery 1.0 and XPath 2.0 Data Model (XDM) 1105
  31.5.6 XQuery Update Facility 1.0 1111
  31.5.7 Formal Semantics 1113

31.6 XML and Databases 1121
  31.6.1 Storing XML in Databases 1121
  31.6.2 XML and SQL 1124
  31.6.3 Native XML Databases 1135

31.7 XML in Oracle 1136

Chapter Summary 1139
Review Questions 1141
Exercises 1142

Part 9 Business Intelligence 1143

Chapter 32 Data Warehousing Concepts 1145

32.1 Introduction to Data Warehousing 1146
  32.1.1 The Evolution of Data Warehousing 1146
  32.1.2 Data Warehousing Concepts 1147
  32.1.3 Benefits of Data Warehousing 1148
  32.1.4 Comparison of OLTP Systems and Data Warehousing 1148
  32.1.5 Problems of Data Warehousing 1150
  32.1.6 Real-Time Data Warehouse 1152
32.2 Data Warehouse Architecture 1153
  32.2.1 Operational Data 1153
  32.2.2 Operational Data Store 1153
  32.2.3 ETL Manager 1154
  32.2.4 Warehouse Manager 1154
  32.2.5 Query Manager 1155
  32.2.6 Detailed Data 1155
  32.2.7 Lightly and Highly Summarized Data 1155
  32.2.8 Archive/Backup Data 1155
  32.2.9 Metadata 1156
  32.2.10 End-User Access Tools 1156

32.3 Data Warehousing Tools and Technologies 1157
  32.3.1 Extraction, Transformation, and Loading (ETL) 1158
  32.3.2 Data Warehouse DBMS 1159
  32.3.3 Data Warehouse Metadata 1162
  32.3.4 Administration and Management Tools 1164

32.4 Data Mart 1164
  32.4.1 Reasons for Creating a Data Mart 1165

32.5 Data Warehousing Using Oracle 1165
  32.5.1 New Warehouse Features in Oracle 10g/11g 1168

Chapter Summary 1169
Review Questions 1170
Exercise 1171

Chapter 33 Data Warehousing Design 1173

33.1 Designing a Data Warehouse Database 1174
33.2 Data Warehouse Development Methodologies 1174
33.3 Kimball's Business Dimensional Lifecycle 1176
33.4 Dimensionality Modeling 1177
  33.4.1 Comparison of DM and ER models 1180

33.5 The Dimensional Modeling Stage of Kimball's Business Dimensional Lifecycle 1181
  33.5.1 Create a High-Level Dimensional Model (Phase I) 1181
  Step 1: Select Business Process 1181
  Step 2: Declare Grain 1183
  Step 3: Choose Dimensions 1183
  Step 4: Identify Facts 1185
  33.5.2 Identify All Dimension Attributes for the Dimensional Model (Phase II) 1186

33.6 Data Warehouse Development Issues 1189
33.7 Data Warehousing Design Using Oracle 1190
  33.7.1 Oracle Warehouse Builder Components 1190
Chapter 34 OLAP

34.1 Online Analytical Processing
  34.1.1 OLAP Benchmarks

34.2 OLAP Applications

34.3 Multidimensional Data Model
  34.3.1 Alternative Multidimensional Data Representations
  34.3.2 Dimensional Hierarchy
  34.3.3 Multidimensional Operations
  34.3.4 Multidimensional Schemas

34.4 OLAP Tools
  34.4.1 Codd’s Rules for OLAP Tools
  34.4.2 OLAP Server—Implementation Issues
  34.4.3 Categories of OLAP Server

34.5 OLAP Extensions to the SQL Standard
  34.5.1 Extended Grouping Capabilities
  34.5.2 Elementary OLAP Operators

34.6 Oracle OLAP
  34.6.1 Oracle OLAP Environment
  34.6.2 Platform for Business Intelligence Applications
  34.6.3 Oracle Database
  34.6.4 Oracle OLAP
  34.6.5 Performance
  34.6.6 System Management
  34.6.7 System Requirements
  34.6.8 New OLAP Features in Oracle 11g

Chapter Summary
Review Questions
Exercises

Chapter 35 Data Mining

35.1 Data Mining

35.2 Data Mining Techniques
  35.2.1 Predictive Modeling
  35.2.2 Database Segmentation
35.2.3 Link Analysis 1234
35.2.4 Deviation Detection 1235

35.3 The Data Mining Process 1236
35.3.1 The CRISP-DM Model 1236

35.4 Data Mining Tools 1237

35.5 Data Mining and Data Warehousing 1238

35.6 Oracle Data Mining (ODM) 1239
35.6.1 Data Mining Capabilities 1239
35.6.2 Enabling Data Mining Applications 1239
35.6.3 Predictions and Insights 1240
35.6.4 Oracle Data Mining Environment 1240
35.6.5 New Data Mining Features in Oracle 1241

Chapter Summary 1241
Review Questions 1242
Exercises 1242

Appendices 1243

A Users’ Requirements Specification for DreamHome Case Study A-1
A.1 Branch User Views of DreamHome A-1
A.1.1 Data Requirements A-1
A.1.2 Transaction Requirements (Sample) A-3
A.2 Staff User Views of DreamHome A-4
A.2.1 Data Requirements A-4
A.2.2 Transaction Requirements (Sample) A-5

B Other Case Studies B-1
B.1 The University Accommodation Office Case Study B-1
B.1.1 Data Requirements B-1
B.1.2 Query Transactions (Sample) B-3
B.2 The EasyDrive School of Motoring Case Study B-4
B.2.1 Data Requirements B-4
B.2.2 Query Transactions (Sample) B-5
B.3 The Wellmeadows Hospital Case Study B-5
B.3.1 Data Requirements B-5
B.3.2 Transaction Requirements (Sample) B-12

C Alternative ER Modeling Notations C-1
C.1 ER Modeling Using the Chen Notation C-1
C.2 ER Modeling Using the Crow’s Feet Notation C-1
D Summary of the Database Design Methodology for Relational Databases

Step 1: Build Conceptual Data Model
Step 2: Build Logical Data Model
Step 3: Translate Logical Data Model for Target DBMS
Step 4: Design File Organizations and Indexes
Step 5: Design User Views
Step 6: Design Security Mechanisms
Step 7: Consider the Introduction of Controlled Redundancy
Step 8: Monitor and Tune the Operational System

E Introduction to Pyrrho: A Lightweight RDBMS

E.1 Pyrrho Features
E.2 Download and Install Pyrrho
E.3 Getting Started
E.4 The Connection String
E.5 Pyrrho’s Security Model
E.6 Pyrrho SQL Syntax

F File Organizations and Indexes (Online)

G When Is a DBMS Relational? (Online)

H Commercial DBMSs: Access and Oracle (Online)

I Programmatic SQL (Online)

J Estimating Disk Space Requirements (Online)

K Introduction to Object-Orientation (Online)

L Example Web Scripts (Online)

References

Further Reading

Index