

Second Edition

Beginning
**Database
Design
Solutions**

Understanding and Implementing Database
Design Concepts for the Cloud and Beyond

Rod Stephens

WILEY

สำนักหอสมุด มหาวิทยาลัยเชียงใหม่

616704940
012576815
122685224

BEGINNING

Database Design Solutions

UNDERSTANDING AND IMPLEMENTING
DATABASE DESIGN CONCEPTS FOR THE
CLOUD AND BEYOND

Second Edition

Rod Stephens



.....
..... ปี ๒๕๖๓

WILEY

CONTENTS

INTRODUCTION

XXV

PART 1: INTRODUCTION TO DATABASES AND DATABASE DESIGN

CHAPTER 1: DATABASE DESIGN GOALS	3
The Importance of Design	4
Information Containers	6
Strengths and Weaknesses of Information Containers	8
Desirable Database Features	9
CRUD	10
Retrieval	10
Consistency	11
Validity	11
Easy Error Correction	12
Speed	13
Atomic Transactions	13
ACID	14
BASE	16
NewSQL	17
Persistence and Backups	17
Low Cost and Extensibility	18
Ease of Use	19
Portability	19
Security	20
Sharing	21
Ability to Perform Complex Calculations	21
CAP Theorem	22
Cloud Considerations	22
Legal and Security Considerations	23
Consequences of Good and Bad Design	24
Summary	26
CHAPTER 2: RELATIONAL OVERVIEW	29
Picking a Database	30
Relational Points of View	31

Table, Rows, and Columns	32
Relations, Attributes, and Tuples	34
Keys	34
Indexes	36
Constraints	37
Domain Constraints	37
Check Constraints	37
Primary Key Constraints	38
Unique Constraints	38
Foreign Key Constraints	38
Database Operations	40
Popular RDBs	41
Spreadsheets	43
Summary	44
CHAPTER 3: NoSQL OVERVIEW	47
The Cloud	47
Picking a Database	50
NoSQL Philosophy	50
NoSQL Databases	50
Document Databases	51
Key-Value Database	52
Column-Oriented Databases	53
Graph Databases	53
Street Networks	54
Communication Networks	55
Social Media Apps	55
E-Commerce Programs	55
Algorithms	56
Hierarchical Databases	56
Less Exotic Options	59
Flat Files	59
XML Files	60
XML Basics	61
XML Practices	64
XML Summary	66
JSON Files	67
Spreadsheets	69
More Exotic Options	70
Object	70

Deductive	70
Dimensional	70
Temporal	71
Database Pros and Cons	72
Relational	72
General NoSQL	73
Quick Guidelines	74
Summary	76

PART 2: DATABASE DESIGN PROCESS AND TECHNIQUES

CHAPTER 4: UNDERSTANDING USER NEEDS 83

Make a Plan	84
Bring a List of Questions	85
Functionality	85
Data Needs	86
Data Integrity	86
Security	87
Environment	88
Meet the Customers	88
Learn Who's Who	89
Pick the Customers' Brains	93
Walk a Mile in the User's Shoes	93
Study Current Operations	94
Brainstorm	94
Look to the Future	95
Understand the Customers' Reasoning	96
Learn What the Customers Really Need	97
Prioritize	98
Verify Your Understanding	99
Create the Requirements Document	101
Make Use Cases	102
Decide Feasibility	106
Summary	106

CHAPTER 5: TRANSLATING USER NEEDS INTO DATA MODELS 111

What Are Data Models?	112
User Interface Models	114
Semantic Object Models	118

Classes and Objects	119
Cardinality	120
Identifiers	120
Putting It Together	121
Semantic Views	122
Class Types	124
Simple Objects	124
Composite Objects	124
Compound Objects	125
Hybrid Objects	125
Association Objects	126
Inherited Objects	128
Comments and Notes	129
Entity-Relationship Models	130
Entities, Attributes, and Identifiers	131
Relationships	132
Cardinality	133
Inheritance	134
Additional Conventions	136
Comments and Notes	137
Relational Models	137
Converting Semantic Object Models	138
Converting ER Diagrams	140
Summary	142
 CHAPTER 6: EXTRACTING BUSINESS RULES	 145
What Are Business Rules?	145
Identifying Key Business Rules	147
Extracting Key Business Rules	152
Multi-Tier Applications	154
Summary	158
 CHAPTER 7: NORMALIZING DATA	 163
What Is Normalization?	163
First Normal Form (1NF)	164
Second Normal Form (2NF)	173
Third Normal Form (3NF)	177
Stopping at Third Normal Form	181
Boyce-Codd Normal Form (BCNF)	181
Fourth Normal Form (4NF)	185

Fifth Normal Form (5NF)	190
Domain/Key Normal Form (DKNF)	193
Essential Redundancy	195
The Best Level of Normalization	197
NoSQL Normalization	197
Summary	199
CHAPTER 8: DESIGNING DATABASES TO SUPPORT SOFTWARE	203
Plan Ahead	204
Document Everything	204
Consider Multi-Tier Architecture	205
Convert Domains into Tables	205
Keep Tables Focused	206
Use Three Kinds of Tables	207
Use Naming Conventions	209
Allow Some Redundant Data	210
Don't Squeeze in Everything	211
Summary	212
CHAPTER 9: USING COMMON DESIGN PATTERNS	215
Associations	216
Many-to-Many Associations	216
Multiple Many-to-Many Associations	216
Multiple-Object Associations	218
Repeated Attribute Associations	221
Reflexive Associations	222
One-to-One Reflexive Associations	223
One-to-Many Reflexive Associations	224
Hierarchical Data	225
Hierarchical Data with NoSQL	228
Network Data	229
Network Data with NoSQL	231
Temporal Data	232
Effective Dates	232
Deleted Objects	233
Deciding What to Temporalize	234
Logging and Locking	236
Audit Trails	236
Turnkey Records	237
Summary	238

CHAPTER 10: AVOIDING COMMON DESIGN PITFALLS	241
Lack of Preparation	241
Poor Documentation	242
Poor Naming Standards	242
Thinking Too Small	244
Not Planning for Change	245
Too Much Normalization	248
Insufficient Normalization	248
Insufficient Testing	249
Performance Anxiety	249
Mishmash Tables	250
Not Enforcing Constraints	253
Obsession with IDs	253
Not Defining Natural Keys	256
Summary	257

PART 3: A DETAILED CASE STUDY

CHAPTER 11: DEFINING USER NEEDS AND REQUIREMENTS	263
Meet the Customers	263
Pick the Customers' Brains	265
Determining What the System Should Do	265
Determining How the Project Should Look	267
Determining What Data Is Needed for the User Interface	268
Determining Where the Data Should Come From	269
Determining How the Pieces of Data Are Related	269
Determining Performance Needs	271
Determining Security Needs	272
Determining Data Integrity Needs	273
Write Use Cases	275
Write the Requirements Document	279
Demand Feedback	280
Summary	281
CHAPTER 12: BUILDING A DATA MODEL	283
Semantic Object Modeling	283
Building an Initial Semantic Object Model	283
Improving the Semantic Object Model	286
Entity-Relationship Modeling	289

Building an ER Diagram	289
Building a Combined ER Diagram	291
Improving the Entity-Relationship Diagram	293
Relational Modeling	294
Putting It All Together	298
Summary	299

CHAPTER 13: EXTRACTING BUSINESS RULES 303

Identifying Business Rules	303
Courses	304
CustomerCourses	306
Customers	307
Pets	307
Employees	307
Orders	307
OrderItems	308
InventoryItems	308
TimeEntries	308
Shifts	309
Persons	309
Phones	309
Vendors	309
Drawing a New Relational Model	310
Summary	310

CHAPTER 14: NORMALIZING AND REFINING 313

Improving Flexibility	313
Verifying First Normal Form	315
Verifying Second Normal Form	318
Pets	319
TimeEntries	320
Verifying Third Normal Form	321
Summary	323

PART 4: EXAMPLE PROGRAMS

CHAPTER 15: EXAMPLE OVERVIEW 327

Tool Choices	327
Jupyter Notebook	329

Visual Studio	331
Database Adapters	332
Packages in Jupyter Notebook	333
Packages in Visual Studio	334
Program Passwords	336
Summary	336
CHAPTER 16: MariaDB IN PYTHON	339
Install MariaDB	340
Run HeidiSQL	340
Create the Program	343
Install pymysql	344
Create the Database	344
Define Tables	346
Create Data	348
Fetch Data	350
Summary	352
CHAPTER 17: MariaDB IN C#	355
Create the Program	355
Install MySqlConnection	356
Create the Database	356
Define Tables	358
Create Data	360
Fetch Data	364
Summary	366
CHAPTER 18: PostgreSQL IN PYTHON	369
Install PostgreSQL	370
Run pgAdmin	371
Design the Database	371
Create a User	371
Create the Database	373
Define the Tables	374
Define the customers Table	374
Define the orders Table	376
Define the order_items Table	377
Create the Program	378
Install Psycopg	379

Connect to the Database	379
Delete Old Data	380
Create Customer Data	380
Create Order Data	382
Create Order Item Data	383
Close the Connection	384
Perform Queries	384
Summary	386
CHAPTER 19: PostgreSQL IN C#	389
Create the Program	389
Install Npgsql	389
Connect to the Database	390
Delete Old Data	391
Create Customer Data	392
Create Order Data	393
Create Order Item Data	395
Display Orders	396
Summary	399
CHAPTER 20: Neo4j AuraDB IN PYTHON	401
Install Neo4j AuraDB	402
Nodes and Relationships	404
Cypher	404
Create the Program	405
Install the Neo4j Database Adapter	405
Action Methods	405
delete_all_nodes	406
make_node	407
make_link	407
execute_node_query	408
find_path	409
Org Chart Methods	410
build_org_chart	410
query_org_chart	411
Main Program	412
Summary	414

CHAPTER 21: Neo4j AuraDB IN C#	417
Create the Program	418
Install the Neo4j Driver	418
Action Methods	419
DeleteAllNodes	419
MakeNode	420
MakeLink	421
ExecuteNodeQuery	422
FindPath	422
Org Chart Methods	423
BuildOrgChart	424
QueryOrgChart	424
Main	426
Summary	428
CHAPTER 22: MongoDB ATLAS IN PYTHON	431
Not Normal but Not Abnormal	432
XML, JSON, and BSON	432
Install MongoDB Atlas	434
Find the Connection Code	436
Create the Program	439
Install the PyMongo Database Adapter	439
Helper Methods	440
person_string	440
connect_to_db	441
delete_old_data	442
create_data	442
query_data	444
Main Program	449
Summary	450
CHAPTER 23: MongoDB ATLAS IN C#	453
Create the Program	454
Install the MongoDB Database Adapter	454
Helper Methods	454
PersonString	455
DeleteOldData	456
CreateData	457
QueryData	458

Main Program	462
Summary	465
CHAPTER 24: APACHE IGNITE IN PYTHON	467
Install Apache Ignite	468
Start a Node	468
Without Persistence	469
With Persistence	470
Create the Program	470
Install the pyignite Database Adapter	471
Define the Building Class	471
Save Data	471
Read Data	473
Demonstrate Volatile Data	473
Demonstrate Persistent Data	474
Summary	474
CHAPTER 25: APACHE IGNITE IN C#	477
Create the Program	477
Install the Ignite Database Adapter	478
The Main Program	479
The Building Class	480
The <i>WriteData</i> Method	480
The <i>ReadData</i> Method	482
Demonstrate Volatile Data	483
Demonstrate Persistent Data	483
Summary	483
PART 5: ADVANCED TOPICS	
CHAPTER 26: INTRODUCTION TO SQL	489
Background	491
Finding More Information	491
Standards	492
Multistatement Commands	493
Basic Syntax	495
Command Overview	495
<i>Create Table</i>	498
<i>Create Index</i>	503

<i>Drop</i>	504
<i>Insert</i>	504
<i>Select</i>	506
<i>SELECT</i> Clause	506
<i>FROM</i> Clause	507
<i>WHERE</i> Clause	511
<i>GROUP BY</i> Clause	511
<i>ORDER BY</i> Clause	512
<i>Update</i>	513
<i>Delete</i>	514
Summary	515
CHAPTER 27: BUILDING DATABASES WITH SQL SCRIPTS	519
Why Bother with Scripts?	519
Script Categories	520
Database Creation Scripts	520
Basic Initialization Scripts	520
Data Initialization Scripts	520
Cleanup Scripts	521
Saving Scripts	521
Ordering SQL Commands	522
Summary	531
CHAPTER 28: DATABASE MAINTENANCE	533
Backups	533
Data Warehousing	537
Repairing the Database	538
Compacting the Database	538
Performance Tuning	538
Summary	542
CHAPTER 29: DATABASE SECURITY	545
The Right Level of Security	545
Passwords	546
Single-Password Databases	546
Individual Passwords	546
Operating System Passwords	547
Good Passwords	547
Privileges	548

Initial Configuration and Privileges	553
Too Much Security	553
Physical Security	554
Summary	555
APPENDIX A: EXERCISE SOLUTIONS	557
APPENDIX B: SAMPLE RELATIONAL DESIGNS	649
GLOSSARY	671
INDEX	683