

Contents

- 1 Introduction..... 1**
 - 1.1 Functions of an Information System..... 1
 - 1.1.1 The Memory Function 3
 - 1.1.2 The Informative Function 4
 - 1.1.3 The Active Function 6
 - 1.1.4 Examples of Information Systems..... 7
 - 1.2 Conceptual Modeling 9
 - 1.2.1 The Structural Schema..... 10
 - 1.2.2 The Information Base 14
 - 1.2.3 The Behavioral Schema..... 15
 - 1.2.4 Integrity Constraints 18
 - 1.2.5 Derivation Rules..... 20
 - 1.2.6 The Principle of Necessity for Conceptual Schemas..... 21
 - 1.3 The Abstract Architecture of an Information System..... 22
 - 1.4 Requirements Engineering..... 27
 - 1.5 Quality of Conceptual Schemas..... 28
 - 1.6 A Brief History of Conceptual Modeling 31
 - 1.6.1 Logical Models 31
 - 1.6.2 Semantic Data Models..... 32
 - 1.6.3 Conceptual Models of Information Systems 33
 - 1.6.4 Object Orientation 34
 - 1.7 Bibliographical Notes 34
- 2 Entity Types 37**
 - 2.1 Introduction 37
 - 2.1.1 Definitional Concepts 38
 - 2.1.2 Functions of a Concept 39
 - 2.1.3 Prototypical Concepts..... 39

2.1.4 Exemplar-Based Concepts.....	40
2.2 Design of Concepts.....	40
2.3 Definition of Entity Types.....	41
2.3.1 Names.....	44
2.3.2 Population.....	44
2.3.3 Subsumption.....	45
2.4 Representation in an Information System.....	45
2.4.1 State of the Information Base.....	47
2.4.2 Logical Representation.....	48
2.4.3 Representation in UML.....	49
2.4.4 Conceptual Models: Single or Multiple Classification.....	50
2.4.5 Conceptual Models: Static or Dynamic Classification.....	51
2.4.6 Properties of the Representation.....	51
2.5 Data Types.....	54
2.5.1 Data Types in UML.....	56
2.6 Bibliographical Notes.....	56
2.7 Exercises.....	58
3 Relationship Types.....	59
3.1 Definition.....	59
3.1.1 Degree.....	63
3.1.2 Pattern Sentence.....	63
3.1.3 Unary Relationship Types.....	66
3.1.4 Population.....	66
3.1.5 Subsumption.....	68
3.2 Representation in an Information System.....	68
3.2.1 State of the Information Base.....	69
3.2.2 Logical Representation.....	69
3.2.3 Representation in UML.....	70
3.2.4 Properties of the Representation.....	74
3.3 Attributes.....	75
3.3.1 Conceptual Models Based on Attributes.....	76
3.3.2 Attribute Pattern Sentence.....	77
3.3.3 Representation in UML.....	77
3.3.4 On the Use of Attributes.....	78
3.4 Bibliographical Notes.....	80
3.5 Exercises.....	81
4 Cardinality Constraints.....	83
4.1 Cardinality Constraints of Binary Relationship Types.....	83
4.1.1 Existence Dependency Relationship Types.....	86
4.1.2 Attributes.....	86

4.1.2 Recursive Relationship Types	87
4.1.3 Satisfiability of Cardinality Constraints	88
4.2 Cardinality Constraints of n -ary Relationship Types	90
4.2.1 Consistency and Inference Rules	93
4.3 Maximal Participation	95
4.4 Bibliographical Notes	98
4.5 Exercises	99
5 Particular Kinds of Relationship Type	103
5.1 Reference Relationship Types	103
5.1.1 Simple Reference	104
5.1.2 Compound Reference	105
5.1.3 Set Reference	106
5.2 Identification	107
5.2.1 Identifiability of Entity Types	109
5.3 Replacing Entities with Identifiers in Relationships	109
5.4 Elementary Relationship Types	111
5.5 Decomposing NonElementary Relationship Types	113
5.5.1 Decomposition Based on Functional Dependencies	114
5.5.2 Decomposition Based on Multivalued Dependencies	116
5.5.3 Decomposition by Absorbing a Constant Entity Type	119
5.6 Bibliographical Notes	120
5.7 Exercises	121
6 Reification	123
6.1 Definition	123
6.2 Representation in UML	126
6.2.1 Association Classes	126
6.2.2 Implicit Reification	127
6.2.3 Implicit Reification as a Schema Transformation	129
6.3 Partial Reification	130
6.4 Bibliographical Notes	133
6.5 Exercises	134
7 Generic Relationship Types	137
7.1 Definition	137
7.2 Representation in an Information System	139
7.2.1 Logical Representation	139
7.2.2 Representation in UML	140
7.3 Part–Whole Relationships	141
7.3.1 Description	141
7.3.2 Representation in UML	142

7.3.3 Part Sharing	143
7.3.4 Part Dependency	144
7.4 Grouping	145
7.4.1 Description	145
7.4.2 Representation in UML	147
7.4.3 Homogeneous Versus Heterogeneous Groups	147
7.5 Roles	147
7.5.1 Description	147
7.5.2 Representation in UML	149
7.5.3 Propagation	150
7.6 Materialization	151
7.6.1 Description	151
7.6.2 Representation in UML	152
7.6.3 Inheritance	153
7.7 Bibliographical Notes	153
7.8 Exercises	155
8 Derived Types	157
8.1 Derivability	157
8.1.1 Base Types	157
8.1.2 Derived Types	158
8.1.3 Hybrid Types	159
8.1.4 Transformation of Hybrid Types into Derived Types	159
8.1.5 Design of Derivability	160
8.2 Representation in an Information System	161
8.2.1 Logical Representation	161
8.2.2 Representation in UML	162
8.2.3 Representation of Derivation Rules by Operations	164
8.3 Particular Kinds of Derived Type	167
8.3.1 Derived by Union	167
8.3.2 Derived by Specialization	169
8.3.3 Derived by Exclusion	170
8.3.4 Derived by Participation	171
8.3.5 Transitive Closure	173
8.4 Derivation Rules for Constant Relationship Types	173
8.5 Hybrid Types in UML	175
8.6 Justification for Derived Types	176
8.7 Bibliographical Notes	178
8.8 Exercises	179
9 Integrity Constraints	181
9.1 The Concept of an Integrity Constraint	181

9.1.1 Integrity = Validity + Completeness	181
9.1.2 Integrity Constraints	182
9.1.3 Violation of Integrity Constraints	183
9.1.4 Violation Response Actions	185
9.2 Classification of Integrity Constraints	185
9.2.1 Classification According to Source	186
9.2.2 Classification According to Scope	187
9.2.3 Classification According to Cause of Violation	188
9.3 Representation in an Information System	189
9.3.1 Logical Representation	189
9.3.2 Representation in UML	192
9.3.3 Representation of Constraints by Operations	193
9.4 Particular Kinds of Static Constraint	196
9.4.1 Key Constraints	196
9.4.2 Reference Constraints	197
9.4.3 Inclusion Constraints	198
9.4.4 Disjunction Constraints	199
9.4.5 Covering Constraints	201
9.4.6 Constraints of Recursive Binary Relationship Types	202
9.4.7 Entity Type Cardinality Constraints	204
9.5 Creation-Time Constraints	204
9.6 Bibliographical Notes	206
9.7 Exercises	208
10 Taxonomies	213
10.1 Specialization	213
10.1.1 The <i>IsA</i> Relationship	214
10.1.2 Entity Types Derived by Intersection and Multiple Classification	215
10.1.3 The Entity Type <i>Entity</i>	216
10.2 Generalization	216
10.2.1 The <i>Gens</i> Relationship	217
10.2.2 Constraints on Generalizations	218
10.2.3 Generalization/Specialization Dimension	220
10.2.4 Explicit Subtypes versus Explicit Dimension Attributes	221
10.2.5 Partitions	222
10.3 The Taxonomy of a Conceptual Schema	222
10.3.1 Valid Type Configurations	223
10.3.2 Taxonomic Constraints and Derivability	224
10.3.3 Partitions and Derivability	227
10.4 Relationship Type Refinement	229
10.4.1 Participant Refinement	229

10.4.2 Particular Kinds of Participant Refinement	232
10.4.3 Cardinality Constraint Strengthening	233
10.4.4 Interaction of <i>IsA</i> and Cardinality Constraints	236
10.4.5 Derivation Rule Redefinition	236
10.4.6 Redefining a Base Relationship Type as Derived	238
10.5 Constraint Specialization	239
10.6 Specialization/Generalization of Relationship Types	241
10.6.1 <i>IsA</i> and <i>Gens</i> Between Relationship Types	241
10.6.2 Reification and Specialization	242
10.7 Bibliographical Notes	243
10.8 Exercises	244
11 Domain Events	247
11.1 Domain Events as Sets of Structural Events	248
11.1.1 Structural Events	248
11.1.2 Domain Events	251
11.2 Representation in an Information System	252
11.2.1 Domain Events as Entities	252
11.2.2 Logical Representation	255
11.2.3 UML Representation	256
11.3 Domain Event Constraints	257
11.3.1 Logical Representation	258
11.3.2 UML Representation	258
11.4 Event Effects: The Postcondition Approach	259
11.4.1 Logical Representation	261
11.4.2 UML Representation	262
11.4.3 The Frame Problem	265
11.5 Event Effects: The Procedural Approach	266
11.5.1 Logical Representation	267
11.5.2 UML Representation	268
11.6 Consistency with the Structural Schema	271
11.7 Bibliographical Notes	272
11.8 Exercises	274
12 Action Request Events	277
12.1 Actions and Action Request Events	277
12.1.1 Scope of this Chapter	281
12.2 Action Request Event Types	281
12.2.1 Characteristics of Action Request Events	283
12.2.2 Constraints of Action Request Events	284
12.3 Effects of Queries	285
12.4 Effects of Action Request Events	289

12.4.1 Effects of Domain Event Notifications.....	294
12.5 Event Specialization	295
12.6 Generating Conditions	296
12.7 Bibliographical Notes	297
12.8 Exercises	297
13 State Transition Diagrams	299
13.1 Finite State Machines	299
13.1.1 Finite Automata	300
13.1.2 Moore and Mealy Machines	300
13.2 Entities as State Machines	301
13.2.1 Entity Life Cycle	305
13.3 State Transition Diagrams in UML	306
13.3.1 Transitions Triggered by Change and Time Events	310
13.3.2 Unexpected-Event Reception	311
13.3.3 Initial State.....	311
13.3.4 Final State	312
13.3.5 Junction.....	312
13.3.6 Choice.....	314
13.4 From Domain and Action Request Events to Call Events	315
13.4.1 Localization of Event Constraints and Effects	317
13.5 Entity Types with Multiple State Transition Diagrams	321
13.6 Bibliographical Notes	322
13.7 Exercises	323
14 Statecharts	325
14.1 The State Hierarchy	325
14.1.1 Simple Composite States	327
14.1.2 State Configuration and Entity Life Cycle	327
14.1.3 Initial Pseudostate	328
14.1.4 Conflicting Transitions	329
14.2 Parallelism	329
14.2.1 Initial Pseudostate	331
14.2.2 Firing Multiple Transitions.....	332
14.2.3 Fork.....	332
14.2.4 Join	333
14.3 Bibliographical Notes	333
14.4 Exercises	334
15 Use Cases	337
15.1 Actors.....	337
15.2 Use Cases.....	338

15.2.1 Definition.....	338
15.2.2 Use Case Actors	339
15.2.3 Use Case Specification	340
15.2.4 Relationships Between Use Cases.....	343
15.2.5 Use Case Model.....	345
15.3 Mapping Use Cases to Requests.....	346
15.3.1 Textual References	347
15.3.2 Creation Dependencies	348
15.3.3 Sequence Diagrams	348
15.4 Bibliographical Notes	350
15.5 Exercises.....	350
16 Case Study.....	353
16.1 Main Domain Concepts	354
16.2 Store Configuration	354
16.2.1 Store Data	354
16.2.2 Minimum Values	358
16.3 Store Administration.....	359
16.3.1 Manufacturers.....	359
16.3.2 Categories	363
16.3.3 Products	366
16.4 Customers	370
16.5 Online Catalog.....	373
16.5.1 Shopping Carts	373
16.5.2 Orders	376
16.5.3 Show Previous Orders	380
17 Metamodeling.....	383
17.1 Meta Entity Types	383
17.1.1 Definition.....	383
17.1.2 Classification Level	385
17.1.3 <i>InstanceOf</i> versus <i>IsA</i>	387
17.1.4 Monolevel and Multilevel Information Bases	389
17.1.5 Logical Representation	391
17.1.6 Representation in UML	393
17.2 Powertypes.....	393
17.3 Class Relationship Types.....	394
17.4 Meta Relationship Types	397
17.4.1 Definition.....	397
17.4.2 Logical Representation	398
17.4.3 Representation in UML	399
17.5 Metaschemas	400

17.5.1 Definition.....	400
17.5.2 Example of a Metaschema.....	401
17.5.3 Levels of a Meta Information Base	405
17.5.4 The Importance of Metaschemas.....	405
17.5.5 Conceptual Models versus Metaschemas	406
17.5.6 The UML Metaschema.....	406
17.6 Stereotypes.....	408
17.6.1 Definition.....	408
17.6.2 Stereotypes in the Metaschema	410
17.7 Bibliographical Notes	412
17.8 Exercises.....	413
18 The MOF and XMI.....	415
18.1 Meta-Metaschemas	415
18.1.1 Definition.....	415
18.1.2 The MOF	417
18.2 The MOF as a Conceptual Modeling Language.....	420
18.2.1 The MOF as an ω -metaschema	421
18.3 XMI	422
18.3.1 XMI Representation of Entities and Relationships.....	423
18.3.2 XMI Representation of UML Schemas	425
18.4 Bibliographical Notes	428
18.5 Exercises.....	429
References.....	431
Index.....	445



<http://www.springer.com/978-3-540-39389-4>

Conceptual Modeling of Information Systems

Olivé, A.

2007, XXV, 455 p. 185 illus., Hardcover

ISBN: 978-3-540-39389-4