

Contents

Preface	xix
Part I: Narratives	1
Chapter 1: An Introductory Example	3
Gothic Security	3
<i>Miss Grant's Controller</i>	4
The State Machine Model	5
Programming Miss Grant's Controller	9
Languages and Semantic Model	16
Using Code Generation	19
Using Language Workbenches	22
Visualization	24
Chapter 2: Using Domain-Specific Languages	27
Defining Domain-Specific Languages	27
<i>Boundaries of DSLs</i>	29
<i>Fragmentary and Stand-alone DSLs</i>	32
Why Use a DSL?	33
<i>Improving Development Productivity</i>	33
<i>Communication with Domain Experts</i>	34
<i>Change in Execution Context</i>	35
<i>Alternative Computational Model</i>	36
Problems with DSLs	36
<i>Language Cacophony</i>	37
<i>Cost of Building</i>	37
<i>Ghetto Language</i>	38
<i>Blinkered Abstraction</i>	39

CONTENTS

Wider Language Processing	39
DSL Lifecycle	40
What Makes a Good DSL Design?	42
Chapter 3: Implementing DSLs	43
Architecture of DSL Processing	43
The Workings of a Parser	47
Grammars, Syntax, and Semantics	49
Parsing Data	50
Macros	52
Testing DSLs	53
<i>Testing the Semantic Model</i>	53
<i>Testing the Parser</i>	57
<i>Testing the Scripts</i>	61
Handling Errors	62
Migrating DSLs	64
Chapter 4: Implementing an Internal DSL	67
Fluent and Command-Query APIs	68
The Need for a Parsing Layer	71
Using Functions	72
Literal Collections	77
Using Grammars to Choose Internal Elements	79
Closures	80
Parse Tree Manipulation	82
Annotation	84
Literal Extension	85
Reducing the Syntactic Noise	85
Dynamic Reception	86
Providing Some Type Checking	87
Chapter 5: Implementing an External DSL	89
Syntactic Analysis Strategy	89
Output Production Strategy	92
Parsing Concepts	94
<i>Separated Lexing</i>	94
<i>Grammars and Languages</i>	95
<i>Regular, Context-Free, and Context-Sensitive Grammars</i>	96
<i>Top-Down and Bottom-Up Parsing</i>	98

Mixing-in Another Language	100
XML DSLs	101
Chapter 6: Choosing between Internal and External DSLs	105
Learning Curve	105
Cost of Building	106
Programmer Familiarity	107
Communication with Domain Experts	108
Mixing In the Host Language	108
Strong Expressiveness Boundary	109
Runtime Configuration	110
Sliding into Generality	110
Composing DSLs	111
Summing Up	111
Chapter 7: Alternative Computational Models	113
A Few Alternative Models	116
<i>Decision Table</i>	116
<i>Production Rule System</i>	117
<i>State Machine</i>	118
<i>Dependency Network</i>	119
<i>Choosing a Model</i>	120
Chapter 8: Code Generation	121
Choosing What to Generate	122
How to Generate	124
Mixing Generated and Handwritten Code	126
Generating Readable Code	127
Preparse Code Generation	128
Further Reading	128
Chapter 9: Language Workbenches	129
Elements of Language Workbenches	130
Schema Definition Languages and Meta-Models	131
Source and Projectional Editing	136
<i>Multiple Representations</i>	138
Illustrative Programming	138
Tools Tour	140
Language Workbenches and CASE tools	141
Should You Use a Language Workbench?	142

CONTENTS

Part II: Common Topics	145
Chapter 10: A Zoo of DSLs	147
Graphviz	147
JMock	149
CSS	150
Hibernate Query Language (HQL)	151
XAML	152
FIT	155
Make et al.	156
Chapter 11: Semantic Model	159
How It Works	159
When to Use It	162
The Introductory Example (Java)	163
Chapter 12: Symbol Table	165
How It Works	166
<i>Statically Typed Symbols</i>	167
When to Use It	168
Further Reading	168
Dependency Network in an External DSL (Java and ANTLR)	168
Using Symbolic Keys in an Internal DSL (Ruby)	170
Using Enums for Statically Typed Symbols (Java)	172
Chapter 13: Context Variable	175
How It Works	175
When to Use It	176
Reading an INI File (C#)	176
Chapter 14: Construction Builder	179
How It Works	179
When to Use It	180
Building Simple Flight Data (C#)	180
Chapter 15: Macro	183
How It Works	184
<i>Textual Macros</i>	184
<i>Syntactic Macros</i>	188
When to Use It	192

Chapter 16: Notification	193
How It Works	194
When to Use It	194
A Very Simple Notification (C#)	194
Parsing Notification (Java)	195
Part III: External DSL Topics	199
Chapter 17: Delimiter-Directed Translation	201
How It Works	201
When to Use It	204
Frequent Customer Points (C#)	205
<i>Semantic Model</i>	205
<i>The Parser</i>	207
Parsing Nonautonomous Statements with Miss Grant's Controller (Java)	211
Chapter 18: Syntax-Directed Translation	219
How It Works	220
<i>The Lexer</i>	221
<i>Syntactic Analyzer</i>	223
<i>Output Production</i>	226
<i>Semantic Predicates</i>	226
When to Use It	227
Further Reading	227
Chapter 19: BNF	229
How It Works	229
<i>Multiplicity Symbols (Kleene Operators)</i>	231
<i>Some Other Useful Operators</i>	232
<i>Parsing Expression Grammars</i>	233
<i>Converting EBNF to Basic BNF</i>	234
<i>Code Actions</i>	236
When to Use It	238
Chapter 20: Regex Table Lexer (<i>by Rebecca Parsons</i>)	239
How It Works	240
When to Use It	241
Lexing Miss Grant's Controller (Java)	241

CONTENTS

Chapter 21: Recursive Descent Parser (<i>by Rebecca Parsons</i>)	245
How It Works	246
When to Use It	249
Further Reading	249
Recursive Descent and Miss Grant's Controller (Java)	250
Chapter 22: Parser Combinator (<i>by Rebecca Parsons</i>)	255
How It Works	256
<i>Dealing with the Actions</i>	259
<i>Functional Style of Combinators</i>	260
When to Use It	261
Parser Combinators and Miss Grant's Controller (Java)	261
Chapter 23: Parser Generator	269
How It Works	269
<i>Embedding Actions</i>	270
When to Use It	272
Hello World (Java and ANTLR)	272
<i>Writing the Basic Grammar</i>	272
<i>Building the Syntactic Analyzer</i>	274
<i>Adding Code Actions to the Grammar</i>	276
<i>Using Generation Gap</i>	278
Chapter 24: Tree Construction	281
How It Works	281
When to Use It	284
Using ANTLR's Tree Construction Syntax (Java and ANTLR)	284
<i>Tokenizing</i>	285
<i>Parsing</i>	286
<i>Populating the Semantic Model</i>	288
Tree Construction Using Code Actions (Java and ANTLR)	292
Chapter 25: Embedded Translation	299
How It Works	299
When to Use It	300
Miss Grant's Controller (Java and ANTLR)	300
Chapter 26: Embedded Interpretation	305
How It Works	305
When to Use It	306
A Calculator (ANTLR and Java)	306

Chapter 27: Foreign Code	309
How It Works	309
When to Use It	311
Embedding Dynamic Code (ANTLR, Java, and Javascript)	311
<i>Semantic Model</i>	312
<i>Parser</i>	315
Chapter 28: Alternative Tokenization	319
How It Works	319
<i>Quoting</i>	320
<i>Lexical State</i>	322
<i>Token Type Mutation</i>	324
<i>Ignoring Token Types</i>	325
When to Use It	326
Chapter 29: Nested Operator Expression	327
How It Works	327
<i>Using Bottom-Up Parsers</i>	328
<i>Top-Down Parsers</i>	329
When to Use It	331
Chapter 30: Newline Separators	333
How It Works	333
When to Use It	335
Chapter 31: External DSL Miscellany	337
Syntactic Indentation	337
Modular Grammars	339
Part IV: Internal DSL Topics	341
Chapter 32: Expression Builder	343
How It Works	344
When to Use It	344
A Fluent Calendar with and without a Builder (Java)	345
Using Multiple Builders for the Calendar (Java)	348
Chapter 33: Function Sequence	351
How It Works	351
When to Use It	352
Simple Computer Configuration (Java)	352

CONTENTS

Chapter 34: Nested Function	357
How It Works	357
When to Use It	359
The Simple Computer Configuration Example (Java)	360
Handling Multiple Different Arguments with Tokens (C#)	361
Using Subtype Tokens for IDE Support (Java)	363
Using Object Initializers (C#)	365
Recurring Events (C#)	366
<i>Semantic Model</i>	366
<i>The DSL</i>	369
Chapter 35: Method Chaining	373
How It Works	373
<i>Builders or Values</i>	375
<i>Finishing Problem</i>	375
<i>Hierarchic Structure</i>	376
<i>Progressive Interfaces</i>	377
When to Use It	377
The Simple Computer Configuration Example (Java)	378
Chaining with Properties (C#)	381
Progressive Interfaces (C#)	382
Chapter 36: Object Scoping	385
How It Works	386
When to Use It	386
Security Codes (C#)	387
<i>Semantic Model</i>	387
<i>DSL</i>	390
Using Instance Evaluation (Ruby)	392
Using an Instance Initializer (Java)	394
Chapter 37: Closure	397
How It Works	397
When to Use It	402
Chapter 38: Nested Closure	403
How It Works	403
When to Use It	405
Wrapping a Function Sequence in a Nested Closure (Ruby)	405
Simple C# Example (C#)	408
Using Method Chaining (Ruby)	409

Function Sequence with Explicit Closure Arguments (Ruby)	411
Using Instance Evaluation (Ruby)	412
Chapter 39: Literal List	417
How It Works	417
When to Use It	417
Chapter 40: Literal Map	419
How It Works	419
When to Use It	420
The Computer Configuration Using Lists and Maps (Ruby)	420
Evolving to Greenspun Form (Ruby)	422
Chapter 41: Dynamic Reception	427
How It Works	428
When to Use It	429
Promotion Points Using Parsed Method Names (Ruby)	430
<i>Model</i>	431
<i>Builder</i>	433
Promotion Points Using Chaining (Ruby)	434
<i>Model</i>	435
<i>Builder</i>	435
Removing Quoting in the Secret Panel Controller (JRuby)	438
Chapter 42: Annotation	445
How It Works	446
<i>Defining an Annotation</i>	446
<i>Processing Annotations</i>	447
When to Use It	449
Custom Syntax with Runtime Processing (Java)	449
Using a Class Method (Ruby)	451
Dynamic Code Generation (Ruby)	452
Chapter 43: Parse Tree Manipulation	455
How It Works	455
When to Use It	456
Generating IMAP Queries from C# Conditions (C#)	457
<i>Semantic Model</i>	458
<i>Building from C#</i>	460
<i>Stepping Back</i>	465

CONTENTS

Chapter 44: Class Symbol Table	467
How It Works	468
When to Use It	469
Statically Typed Class Symbol Table (Java)	469
Chapter 45: Textual Polishing	477
How It Works	477
When to Use It	478
Polished Discount Rules (Ruby)	478
Chapter 46: Literal Extension	481
How It Works	481
When to Use It	482
Recipe Ingredients (C#)	483
Part V: Alternative Computational Models	485
Chapter 47: Adaptive Model	487
How It Works	488
<i>Incorporating Imperative Code into an Adaptive Model</i>	489
Tools	491
When to Use It	492
Chapter 48: Decision Table	495
How It Works	495
When to Use It	497
Calculating the Fee for an Order (C#)	497
<i>Model</i>	497
<i>The Parser</i>	502
Chapter 49: Dependency Network	505
How It Works	506
When to Use It	508
Analyzing Potions (C#)	508
<i>Semantic Model</i>	509
<i>The Parser</i>	511
Chapter 50: Production Rule System	513
How It Works	514
<i>Chaining</i>	515
<i>Contradictory Inferences</i>	515
<i>Patterns in Rule Structure</i>	516
When to Use It	517

Validations for club membership (C#)	517
<i>Model</i>	518
<i>Parser</i>	519
<i>Evolving the DSL</i>	520
Eligibility Rules: extending the club membership (C#)	521
<i>The Model</i>	523
<i>The Parser</i>	525
Chapter 51: State Machine	527
How It Works	527
When to Use It	529
Secret Panel Controller (Java)	530
Part VI: Code Generation	531
Chapter 52: Transformer Generation	533
How It Works	533
When to Use It	535
Secret Panel Controller (Java generating C)	535
Chapter 53: Templated Generation	539
How It Works	539
When to Use It	541
Generating the Secret Panel State Machine with Nested Conditionals (Velocity and Java generating C)	541
Chapter 54: Embedment Helper	547
How It Works	548
When to Use It	549
Secret Panel States (Java and ANTLR)	549
Should a Helper Generate HTML? (Java and Velocity)	552
Chapter 55: Model-Aware Generation	555
How It Works	556
When to Use It	556
Secret Panel State Machine (C)	557
Loading the State Machine Dynamically (C)	564
Chapter 56: Model Ignorant Generation	567
How It Works	567
When to Use It	568
Secret Panel State Machine as Nested Conditionals (C)	568

CONTENTS

Chapter 57: Generation Gap	571
How It Works	571
When to Use It	573
Generating Classes from a Data Schema (Java and a Little Ruby) ...	573
Bibliography	579
Index	581