

Beginning Regular Expressions

Andrew Watt

wrox

Programmer to Programmer®

Contents

Introduction	xxi
Who This Book Is For	xxi
What This Book Covers	xxii
How This Book Is Structured	xxii
What You Need to Use This Book	xxiii
Conventions	xxiii
Source Code	xxiv
Errata	xxiv
p2p.wrox.com	xxv
 Chapter 1: Introduction to Regular Expressions	 1
What Are Regular Expressions?	2
What Can Regular Expressions Be Used For?	5
Finding Doubled Words	5
Checking Input from Web Forms	5
Changing Date Formats	6
Finding Incorrect Case	6
Adding Links to URLs	6
Regular Expressions You Already Use	7
Search and Replace in Word Processors	7
Directory Listings	7
Online Searching	8
Why Regular Expressions Seem Intimidating	8
Compact, Cryptic Syntax	8
Whitespace Can Significantly Alter the Meaning	9
No Standards Body	12
Differences between Implementations	12
Characters Change Meaning in Different Contexts	13
Regular Expressions Can Be Case Sensitive	15
Case-Sensitive and Case-Insensitive Matching	15
Case and Metacharacters	16

Contents

Continual Evolution in Techniques Supported	16
Multiple Solutions for a Single Problem	16
What You Want "to Do with a Regular Expression	17
The Languages That Support Regular Expressions	17
Replacing Text in Quantity	17
Chapter 2: Regular Expression Tools and an Approach to Using Them	21
Regular Expression Tools	21
findstr	22
Microsoft Word	23
StarOffice Writer/OpenOffice.org Writer	27
Komodo Rx Package	28
PowerGrep	28
Microsoft Excel	28
Language- and Platform-Specific Tools	29
JavaScript and JScript	29
VBScript	29
Visual Basic.NET	29
C#	30
PHP	30
Java	30
Perl	30
MySQL	30
SQL Server 2000	31
W3C XML Schema	31
An Analytical Approach to Using Regular Expressions	31
Express and Document What You Want to Do in English	32
Consider the Data Source and Its Likely Contents	34
Consider the Regular Expression Options Available	34
Consider Sensitivity and Specificity	34
Create Appropriate Regular Expressions	35
Document All but Simple Regular Expressions	35
Document What You Expect the Regular Expression to Do	36
Document What You Want to Match	37
Document What You Don't Want to Select	37
Use Whitespace to Aid in Clear Documentation of the Regular Expression	37
Test the Results of a Regular Expression	38

Chapter 3: Simple Regular Expressions	41
Matching Single Characters	42
Matching Sequences of Characters That Each Occur Once	47
Introducing Metacharacters	49
Matching Sequences of Different Characters	54
Matching Optional Characters	56
Matching Multiple Optional Characters	59
Other Cardinality Operators	62
The * Quantifier	62
The + Quantifier	64
The Curly-Brace Syntax	66
The {n} Syntax	66
The {n,m} Syntax	67
{0,m}	67
{n,m}	69
{n,}	70
Exercises	71
Chapter 4: Metacharacters and Modifiers	73
Regular Expression Metacharacters	74
Thinking about Characters and Positions	74
The Period (.) Metacharacter	75
Matching Variably Structured Part Numbers	78
Matching a Literal Period	80
The \w Metacharacter	81
The \W Metacharacter	82
Digits and Nondigits	83
The \d Metacharacter	84
Canadian Postal Code Example	85
The \D Metacharacter	89
Alternatives to \d and \D	90
Whitespace and Non-Whitespace Metacharacters	92
The \s Metacharacter	93
Handling Optional Whitespace	96
The \S Metacharacter	98
The \t Metacharacter	98
The \n Metacharacter	99
Escaped Characters	102
Finding the Backslash	102

Contents

Modifiers	103
Global Search	103
Case-Insensitive Search	104
Exercises	104
 Chapter 5: Character Classes	 105
Introduction to Character Classes	105
Choice between Two Characters	108
Using Quantifiers with Character Classes	111
Using the \b Metacharacter in Character Classes	112
Selecting Literal Square Brackets	113
Using Ranges in Character Classes	114
Alphabetic Ranges	115
Use [A-z] With Care	116
Digit Ranges in Character Classes	117
Hexadecimal Numbers	119
IP Addresses	120
Reverse Ranges in Character Classes	128
A Potential Range Trap	129
Finding HTML Heading Elements	132
Metacharacter Meaning within Character Classes	133
The ^ metacharacter	133
How to Use the - Metacharacter	135
Negated Character Classes	136
Combining Positive and Negative Character Classes	137
POSIX Character Classes	139
The [:alnum:] Character Class	139
Exercises	141
 Chapter 6: String, Line, and Word Boundaries	 143
String, Line, and Word Boundaries	144
The ^ Metacharacter	144
The ^ Metacharacter and Multiline Mode	146
The \$ Metacharacter	149
The \$ Metacharacter in Multiline Mode	150
Using the ^ and \$ Metacharacters Together	153
Matching Blank Lines	155
Working with Dollar Amounts	158
Revisiting the IP Address Example	161
What Is a Word?	164

Identifying Word Boundaries	164
The \< Syntax	164
The \>Syntax	166
The \b Syntax	168
The \B Metacharacter	168
Less-Common Word-Boundary Metacharacters	169
Exercises	169
 Chapter 7: Parentheses in Regular Expressions	 HI
Grouping Using Parentheses	171
Parentheses and Quantifiers	173
Matching Literal Parentheses	175
U.S. Telephone Number Example	175
Alternation	177
Choosing among Multiple Options	180
Unexpected Alternation Behavior	182
Capturing Parentheses	185
Numbering of Captured Groups	185
Numbering When Using Nested Parentheses	186
Named Groups	187
Non-Capturing Parentheses	188
Back References	190
Exercises	193
 Chapter 8: Lookahead and Lookbehind	 195.
Why You Need Lookahead and Lookbehind	196
The (? metacharacters	196
Lookahead	197
Positive Lookahead	199
Positive Lookahead — Star Training Example	199
Positive Lookahead — Later in Same Sentence	200
Negative Lookahead	202
Positive Lookahead Examples	203
Positive Lookahead in the Same Document	203
Inserting an Apostrophe	205
Lookbehind	209
Positive Lookbehind	209
Negative Lookbehind	213
How to Match Positions	214
Adding Commas to Large Numbers	216
Exercises	220

Contents

Chapter 9: Sensitivity and Specificity of Regular Expressions	221
What Are Sensitivity and Specificity?	222
Extreme Sensitivity, Awful Specificity	222
Email Addresses Example	224
Replacing Hyphens Example	228
The Sensitivity/Specificity Trade-Off	230
How Metacharacters Affect Sensitivity and Specificity	230
Sensitivity, Specificity, and Positional Characters	231
Sensitivity, Specificity, and Modes	232
Sensitivity, Specificity, and Lookahead and Lookbehind	232
How Much Should the Regular Expressions Do?	232
Knowing the Data, Sensitivity, and Specificity	233
Abbreviations	234
Characters from Other Languages	234
Names	235
Sensitivity and How to Achieve It	236
Specificity and How to Maximize It	236
Revisiting the Star Training Company Example	236
Exercises	240
 Chapter 10: Documenting and Debugging Regular Expressions	 241
Documenting Regular Expressions	242
Document the Problem Definition	242
Add Comments to Your Code	243
Making Use of Extended Mode	243
Know Your Data	246
Abbreviations	246
Proper Names	246
Incorrect Spelling	247
Creating Test Cases	247
Debugging Regular Expressions	248
Treacherous Whitespace	248
Backslashes Causing Problems	251
Considering Other Causes	251
 Chapter 11: Regular Expressions In Microsoft Word	 253.
The User Interface	253
Metacharacters Available	256
Quantifiers	256
The @ Quantifier	258
The {n,m} Syntax	260

Modes	262
Character Classes	265
Back References	265
Lookahead and Lookbehind	265
Lazy Matching versus Greedy Matching	265
Examples	268
Character Class Examples, Including Ranges	268
Whole Word Searches	269
Search-and-Replace Examples	270
Changing Name Structure Using Back References	270
Manipulating Dates	273
The Star Training Company Example	275
Regular Expressions in Visual Basic for Applications	278
Exercises	280
 Chapter 12: Regular Expressions In StarOffice/OpenOffice.org Writer	 281
The User Interface	282
Metacharacters Available	284
Quantifiers	285
Modes	286
Character Classes	286
Alternation	289
Back References	292
Lookahead and Lookbehind	294
Search Example	294
Search-and-Replace Example	297
Online Chats	297
POSIX Character Classes	301
Matching Numeric Digits	302
Exercises	304
 Chapter 13: Regular Expressions Using findstr	 305
Introducing findstr	305
Finding Literal Text	306
Metacharacters Supported by findstr	308
Quantifiers	310
Character Classes	311
Word-Boundary Positions	313
Beginning- and End-of-Line Positions	315
Command-Line Switch Examples	316
The /v Switch	316
The /a Switch	318

Contents

Single File Examples	319
Simple Character Class Example	320
Find Protocols Example	320
Multiple File Example	321
A Filelist Example	322
Exercises	323
 Chapter 14: PowerGREP	 325
 The PowerGREP Interface	 325
A Simple Find Example	326
The Replace Tab	328
The File Finder Tab	329
Syntax Coloring	330
Other Tabs	331
Metacharacters Supported	331
Numeric Digits and Alphabetic Characters	332
Quantifiers	333
Back References	335
Alternation	339
Line Position Metacharacters	339
Word-Boundary Metacharacters	340
Lookahead and Lookbehind	342
Longer Examples	343
Finding HTML Horizontal Rule Elements	343
Matching Time Example	346
Exercises	349
 Chapter 15: Wildcards in Microsoft Excel	 351
 The Excel Find Interface	 351
The Wildcards Excel Supports	355
Escaping Wildcard Characters	359
Using Wildcards in Data Forms	360
Using Wildcards in Filters	362
Exercises	363
 Chapter 16: Regular Expression Functionality In SQL Server 2000	 365
 Metacharacters Supported	 366
Using LIKE with Regular Expressions	366
The % Metacharacter	366
The _ Metacharacter	372
Character Classes	373

Negated Character Classes	376
Using Full-Text Search	379
Using The CONTAINS Predicate	386
Document Filters on Image Columns	391
Exercises	391
Chapter 17: Using Regular Expressions with MySQL	393
Getting Started with MySQL	393
The Metacharacters MySQL Supports	396
Using the _ and % Metacharacters	397
Testing Matching of Literals: _ and % Metacharacters	400
Using the REGEXP Keyword and Metacharacters	401
Using Positional Metacharacters	404
Using Character Classes	406
Quantifiers	408
Social Security Number Example	410
Exercises	411
Chapter 18: Regular Expressions and Microsoft Access	413
The Interface to Metacharacters in Microsoft Access	413
Creating a Hard-Wired Query	414
Creating a Parameter Query	419
The Metacharacters Supported in Access	422
Using the ? Metacharacter	422
Using the * Metacharacter	423
Using the # Metacharacter	424
Using the # Character with Date/Time Data	425
Using Character Classes in Access	426
Exercises	428
Chapter 19: Regular Expressions In JScript and JavaScript	429
Using Regular Expressions in JavaScript and JScript	430
The RegExp Object	432
Attributes of the RegExp Object	438
The Other Properties of the RegExp Object	438
The test() Method of the RegExp Object	441
The exec() Method of the RegExp Object	441
The String Object	448
Metacharacters in JavaScript and JScript	451

Contents

Documenting JavaScript Regular Expressions	452
SSN Validation Example	452
Exercises	454
 Chapter 20: Regular Expressions and VBScript	 455
 The RegExp Object and How to Use It	 455
The RegExp Object's Pattern Property	456
The RegExp Object's Global Property	458
The RegExp Object's IgnoreCase Property	462
The RegExp Object's Test() Method	464
The RegExp Object's Replace() Method	465
The RegExp Object's Execute() Method	467
Using the Match Object and the Matches Collection	471
Supported Metacharacters	473
Quantifiers	474
Positional Metacharacters	475
Character Classes	478
Word Boundaries	479
Lookahead	479
Grouping and Nongrouping Parentheses	482
Exercises	483
 Chapter 21: Visual Basic .NET and Regular Expressions	 485
 The System.Text.RegularExpressions namespace	 486
A Simple Visual Basic .NET Example	486
The Classes of System.Text.RegularExpressions	490
The Regex Object	490
Using the Match Object and Matches Collection	492
Using the Match.Success Property and Match.NextMatch Method	495
The GroupCollection and Group Classes	497
The CaptureCollection and Capture Class	499
The RegexOptions Enumeration	502
Case-Insensitive Matching: The IgnoreCase Option	502
Multiline Matching: The Effect on the ^ and \$ Metacharacters	505
Inline Documentation Using the IgnorePatternWhitespace Option	505
Right to Left Matching: The RightToLeft Option	507
The Metacharacters Supported in Visual Basic .NET	508
Lookahead and Lookbehind	510
Exercises	510

Chapter 22: C# and Regular Expressions	511
The Classes of the System.Text.RegularExpressions namespace	512
An Introductory Example	512
The Classes of System.Text.RegularExpressions	517
The Regex Class	517
The Options Property of the Regex Class	518
The Regex Class's RightToLeft Property	518
Regex Class Methods	518
The CompileToAssemblyO Method	519
The GetGroupNamesO Method	519
The GetGroupNumbersO Method	519
GroupNumberFromNameO and GroupNameFromNumberO Methods	519
The IsMatch() Method	520
The MatchO Method	521
The Matches() Method	522
The Replace() Method	526
The Split() Method	528
Using the Static Methods of the Regex Class	531
The IsMatch() Method as a Static	531
The Match() Method as a Static	531
The MatchesQ Method as a Static	531
The Replace() Method as a Static	532
The Split() Method as a Static	532
The Match and Matches Classes	532
The Match Class	532
The GroupCollection and Group Classes	536
The RegexOptions Class	539
The IgnorePatternWhitespace Option	539
Metacharacters Supported in Visual C# .NET	542
Using Named Groups	544
Using Back References	545
Exercise	547
Chapter 23: PHP and Regular Expressions	549
Getting Started with PHP 5.0	549
How PHP Structures Support for Regular Expressions	553
The ereg() Set of Functions	553
The ereg() Function	554
The ereg() Function with Three Arguments	556

Contents

The eregiQ Function	559
The ereg_replace() Function	561
The eregi_replace() Function	563
The split() Function	564
The splitiO Function	566
The sql_regcase() Function	567
Perl Compatible Regular Expressions	568
Pattern Delimiters in PCRE	568
Escaping Pattern Delimiters	570
Matching Modifiers in PCRE	570
Using the preg_match() Function	571
Using the preg_match_all() Function	574
Using the preg_grep() Function	576
Using the preg_quote() Function	579
Using the preg_replace() Function	579
Using the preg_replace_callback() Function	580
Using the preg_split() Function	580
The Metacharacters Supported in PHP	581
Supported Metacharacters with ereg()	582
Using POSIX Character Classes with PHP	582
Supported Metacharacters with PCRE	585
Positional Metacharacters	586
Character Classes in PHP	587
Documenting PHP Regular Expressions	589
Exercises	590
 Chapter 24: Regular Expressions in W3C XML Schema	 591
W3C XML Schema Basics	592
Tools for Using W3C XML Schema	592
Comparing XML Schema and DTDs	593
How Constraints Are Expressed in W3C XML Schema	598
W3C XML Schema Datatypes	599
Derivation by Restriction	602
Unicode and W3C XML Schema	604
Unicode Overview	604
Using Unicode Character Classes	605
Matching Decimal Numbers	606
Mixing Unicode Character Classes with Other Metacharacters	607
Unicode Character Blocks	608
Using Unicode Character Blocks	609
Metacharacters Supported in W3C XML Schema	612
Positional Metacharacters	613

Matching Numeric Digits	614
Alternation	615
Using the \w and \s Metacharacters	615
Escaping Metacharacters	616
Exercises	616

Chapter 25: Regular Expressions In Java **619**

Introduction to the java.util.regex Package	620
Obtaining and Installing Java	620
The Pattern Class	620
Using the matches() Method Statically	621
Two Simple Java Examples	621
The Properties (Fields) of the Pattern Class	629
The CASEINSENSITIVE Flag	629
Using the COMMENTS Flag	630
The DOTALL Flag	632
The MULTILINE Flag	632
The UNICODE_CASE Flag	632
The UNIXJINES Flag	632
The Methods of the Pattern Class	633
The compile() Method	633
The flags() Method	633
The matcher() Method	633
The matches() Method	633
The pattern() Method	634
The split() Method	634
The Matcher Class	634
The appendReplacement() Method	635
The appendTail() Method	638
The end() Method	638
The find() Method	638
The group() Method	638
The groupCount() Method	639
The lookingAt() Method	639
The matches() Method	642
The pattern() Method	642
The replaceAll() Method	642
The replaceFirst() Method	644
The reset() Method	644
The start() Method	644
The PatternSyntaxException Class	644

Metacharacters Supported in the java.util.regex Package	645
Using the \d Metacharacter	645
Character Classes	647
The POSIX Character Classes in the java.util.regex Package	651
Unicode Character Classes and Character Blocks	652
Using Escaped Characters	653
Using Methods of the String Class	654
Using the matches() Method	654
Using the replaceFirst() Method	656
Using the replaceAll() Method	658
Using the split() Method	658
Exercises	658
 Chapter 26: Regular Expressions In Perl	 659
Obtaining and Installing Perl	659
Creating a Simple Perl Program	663
Basics of Perl Regular Expression Usage	667
Using the Perl Regular Expression Operators	667
Using the m// Operator	667
Using Other Regular Expression Delimiters	675
Matching Using Variable Substitution	676
Using the s/// Operator	678
Using s/// with the Global Modifier	679
Using s/// with the Default Variable	681
Using the split Operator	682
The Metacharacters Supported in Perl	684
Using Quantifiers in Perl	685
Using Positional Metacharacters	686
Captured Groups in Perl	687
Using Back References in Perl	689
Using Alternation	690
Using Character Classes in Perl	692
Using Lookahead	696
Using Lookbehind	698
Using the Regular Expression Matching Modes in Perl	700
Escaping Metacharacters	701
A Simple Perl Regex Tester	703
Exercises	705
 Appendix A: Exercise Answers	 707
 Index	 727