The C# Player's Guide Third Edition

RB Whitaker



Contents at a Glance

Acknowledgements

	Introduction	XiX
Pa	art 1: Getting Started	
1.	The C# Programming Language	3
2.	Installing Visual Studio	6
3.	Hello World: Your First C# Program	10
4.	Comments	19
Pa	art 2: The Basics	
5.	Variables	25
6.	The C# Type System	31
7.	Basic Math	42
8.	User Input	48
9.	More Math	53
10.	Decision Making	60
11.	Switch Statements	68
12.	Looping	71
13.	Arrays	77
14.	Enumerations	83
15.	Methods	86
16.	Value and Reference Types	97

xvii

Part 3: Object-Oriented Programming

17. Object-Oriented Basics	107
18. Making Your Own Classes	112
19. Properties	124
20. Tic-Tac-Toe	130
21. Structs	138
22. Inheritance	144
23. Polymorphism, Virtual Methods, and Abstract Classes	151
24. Interfaces	156
25. Using Generics	160
26. Making Generic Types	167
Part 4: Advanced Topics	
27. Namespaces and Using Directives	175
28. Methods Revisited	180
29. Reading and Writing Files	190
30. Error Handling and Exceptions	194
31. Pattern Matching	201
32. Delegates	206
33. Events	212
34. Operator Overloading	219
35. Indexers	223
36. Extension Methods	226
37. Lambda Expressions	230
38. Query Expressions	236
39. Threads	245
40. Asynchronous Programming	251
41. Dynamic Objects	259
42. Unsafe Code	265
43. Other Features in C#	271
Part 5: Mastering the Tools	
44. The .NET Platform	301
45. Getting the Most from Visual Studio	313
46. Dependencies and Multiple Projects	319
47. Handling Common Compiler Errors	326
48. Debugging Your Code	333
49. How Your Project Files are Organized	339

Part 6: Wrapping Up

50. Try lt Out!	345
51. What's Next?	351
Glossary	354
Tables and Charts	369
Index	374

Contents

	Acknowledgements	xvii
	Introduction	xix
	The Player's Guide	xix
	How This Book is Organized	XX
	Getting the Most from This Book	xxii
	l Genuinely Want Your Feedback	xxiii
	This Book Comes with Online Content	xxiii
Pä	art 1: Getting Started	
1.	The C# Programming Language	3
	What is C#?	3
	What is the .NET Platform?	4
	C# and .NET Versions	5
2.	Installing Visual Studio	6
	Versions of Visual Studio	7
	The Installation Process	7
	C# Programming on Mac and Linux	9
3.	Hello World: Your First C# Program	10
	Creating a New Project	10
	A Brief Tour of Visual Studio	11
	Building Blocks: Projects, Solutions, and Assemblies	12
	Modifying Your Project	13
	Compiling and Running Your Project	14
	A Closer Look at Your Program	16

	Whitespace Doesn't Matter	17
	Semicolons	18
4.	Comments	19
	What is a Comment?	19
	Why Should I Use Comments?	19
	How to Make Comments in C#	20
	How to Make Good Comments	21
Pá	art 2: The Basics	
5.	Variables	25
	What is a Variable?	25
	Creating Variables	26
	Assigning Values to Variables	27
	Retrieving the Contents of a Variable	27
	How Data is Stored	28
	Multiple Declarations and Assignments	29
	Good Variable Names	29
6.	The C# Type System	31
	An Introduction to the Type System	31
	The 'int' Type	31
	The 'byte', 'short', and 'long' Types	32
	The 'sbyte', 'ushort', 'uint', and 'ulong' Types	32
	The 'char' Type	33
	The 'float', 'double', and 'decimal' Types	34
	The 'bool' Type	36
	The 'string' Type	36
	Numeric Literal Variations	38
	Type Inference	40
7.	Basic Math	42
	Operations and Operators	42
	Addition, Subtraction, Multiplication, and Division	43
	The Remainder Operator	44
	Unary '+' and '-' Operators	45
	Operator Precedence and Parentheses	46
	Why the '=' Sign Doesn't Mean Equals	46
	Compound Assignment Operators	47
8.	User Input	48
	User Input from the Console	48
	Converting Types	48
	A Complete Sample Program	49

	Escape Characters	51
	String Interpolation	52
9.	More Math	53
	Integer Division	54
	Working with Different Types and Casting	55
	Division by Zero	56
	Infinity, NaN, e, π, MinValue, and MaxValue	56
	Overflow and Underflow	57
	Incrementing and Decrementing	58
10.	Decision Making	60
	The 'if' Statement	61
	The 'else' Statement	62
	'else if' Statements	62
	Curly Braces Not Always Needed	63
	Relational Operators: ==, !=, <, >, <=, >=	63
	Using 'bool' in Decision Making	65
	The '!' Operator	65
	Conditional Operators: && and (And and Or)	66
	Nesting If Statements	66
	The Conditional Operator ?:	67
11.	Switch Statements	68
11.	Switch Statements The Basics of Switch Statements	68 68
11.		
11.	The Basics of Switch Statements	68
	The Basics of Switch Statements Types Allowed with Switch Statements	68 70
	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through	68 70 70
	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop	68 70 70 71 71 73
	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop	68 70 70 71 71
	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops	68 70 70 71 71 73
	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop	68 70 70 71 71 73 73 74 74
	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops	68 70 70 71 71 73 73 74 74 75
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach	68 70 70 71 71 73 73 74 74
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays	68 70 70 71 71 73 73 74 74 75 76 77
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays What is an Array?	68 70 70 71 71 73 73 74 74 75 76 77
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays What is an Array? Creating Arrays	68 70 70 71 71 73 73 74 74 75 76 77 77
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays What is an Array? Creating Arrays Getting and Setting Values in Arrays	68 70 70 71 71 73 73 74 74 75 76 77 77
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays What is an Array? Creating Arrays Getting and Setting Values in Arrays More Ways to Create Arrays	68 70 70 71 71 73 73 74 74 75 76 77 77 78 78 78
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays What is an Array? Creating Arrays Getting and Setting Values in Arrays More Ways to Create Arrays Array Length	68 70 70 71 71 73 73 74 74 75 76 77 78 78 78 79
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays What is an Array? Creating Arrays Getting and Setting Values in Arrays More Ways to Create Arrays Array Length Some Examples with Arrays	68 70 70 71 71 73 73 74 74 75 76 77 77 78 78 79 79
12.	The Basics of Switch Statements Types Allowed with Switch Statements No Implicit Fall-Through Looping The While Loop The Do-While Loop The For Loop Breaking Out of Loops Continuing to the Next Iteration of the Loop Nesting Loops Still to Come: Foreach Arrays What is an Array? Creating Arrays Getting and Setting Values in Arrays More Ways to Create Arrays Array Length	68 70 70 71 71 73 73 74 74 75 76 77 78 78 78 79

14.	Enumerations	83
	The Basics of Enumerations	83
	Why Enumerations are Useful	85
	Underlying Types	85
	Assigning Numbers to Enumeration Values	85
15.	Methods	86
	Creating a Method	87
	Calling a Method	88
	Returning Stuff from a Method	89
	Passing Stuff to a Method	91
	Passing in Multiple Parameters	91
	Method Overloading	92
	Revisiting the Convert and Console Classes	94
	XML Documentation Comments	94
	The Minimum You Need to Know About Recursion	95
16.	Value and Reference Types	97
	The Stack and the Heap	97
	Memory Management and Garbage Collection	98
	References	99
	Value Types and Reference Types	99
	Null: References to Nothing	101
	Value and Reference Semantics	102
Pā	art 3: Object-Oriented Programming	
17.	Object-Oriented Basics	107
	Object Classes and Object Instances	107
	Working with an Existing Class	108
	Using an Instance	109
	The Power of Objects	110
	Classes are Reference Types	110
18.	Making Your Own Classes	112
	Creating a New Class	112
	Instance Variables	114
	Access Modifiers: private and public	114
	Constructors	115
	Methods	118
	The 'static' Keyword	120
	Using Our Class	121
	The 'internal' Access Modifier	121
	Class Design and Software Engineering	122

19.	Properties	124
	The Motivation for Properties	124
	Creating Properties	125
	Different Accessibility Levels	127
	Auto-Implemented Properties	127
	Object Initializer Syntax	128
	Anonymous Types	129
20.	Tic-Tac-Toe	130
	Requirements	130
	High-Level Design	131
	Refactoring and Iterative Design	132
	The Full Solution	132
21.	Structs	138
	Creating a Struct	138
	Structs vs. Classes	139
	Deciding Between a Struct and a Class	140
	Prefer Immutable Value Types	141
	The Built-In Types are Aliases	142
22.	Inheritance	144
	Base Classes	145
	Derived Classes	145
	Using Derived Classes	146
	Constructors and Inheritance	147
	The 'protected' Access Modifier	148
	The Base Class of Everything: object	148
	Sealed Classes	148
	Partial Classes	149
	C# Does Not Support Multiple Inheritance	150
23.	Polymorphism, Virtual Methods, and Abstract Classes	151
	Polymorphism	151
	Revisiting the 'base' Keyword	153
	Abstract Base Classes	154
	The 'new' Keyword with Methods	154
24.	Interfaces	156
	What is an Interface?	156
	Creating an Interface	157
	Using Interfaces	158
	Multiple Interfaces and Inheritance	159
25.	Using Generics	160
	The Motivation for Generics	160
	What are Generics?	162

The I	List Class	162
The I	Enumerable <t> Interface</t>	164
The I	Dictionary Class	165
26. Making	Generic Types	167
Crea	ting Your Own Generic Types	167
Usin	g Your Generic Type in Your Class	168
Gene	eric Type Constraints	169
Gene	eric Methods	171
The I	Default Operator	171
Part 4: <i>A</i>	Advanced Topics	
27. Namesp	aces and Using Directives	175
Nam	espaces	175
Fully	Qualified Names	176
Usin	g Directives	176
The I	Error 'The type or namespace X could not be found'	176
Nam	e Collisions	178
Stati	c Using Directives	179
28. Methods	s Revisited	180
Loca	l Functions	180
Optio	onal Parameters	181
Nam	ed Parameters	182
Varia	able Number of Parameters	182
The '	out' and 'ref' Keywords	183
Retu	rning Multiple Values	186
29. Reading	and Writing Files	190
The I	File Class	190
Text-	Based Files	192
Bina	ry Files	193
30. Error Ha	ndling and Exceptions	194
How	Exception Handling Works	195
Catc	hing Exceptions	196
Hand	dling Different Exceptions in Different Ways	197
Thro	wing Exceptions	197
The '	finally' Keyword	199
Exce	ption Filters	200
Som	e Rules about Throwing Exceptions	200
31. Pattern	Matching	201
Cont	rasted with Regular Expressions	201
The I	Pattern Concept	202

	•	

	Available Patterns	202
	Using Patterns in C#	203
	Expect Patterns to Expand	205
32.	Delegates	206
	Delegates: Treating Methods like Objects	206
	Creating a Delegate	206
	Using Delegates	207
	The Delegate and MulticastDelegate Classes	208
	Delegate Chaining	209
	The Action and Func Delegates	211
33.	Events	212
	Defining an Event	213
	Raising an Event	214
	Attaching and Detaching Event Handlers	215
	Common Delegate Types Used with Events	216
	The Relationship between Delegates and Events	218
34.	Operator Overloading	219
	Overloading Operators	220
35.	Indexers	223
	How to Make an Indexer	223
	Using Other Types as an Index	224
	Index Initializer Syntax	225
36.	Extension Methods	226
	Creating an Extension Method	227
37.	Lambda Expressions	230
	The Motivation for Lambda Expressions	230
	Lambda Expressions	232
	Multiple and Zero Parameters	233
	Type Inference Failures and Explicit Types	233
	Statement Lambdas	233
	Scope in Lambda Expressions	233
	Expression-Bodied Members	234
	Lambdas vs. Local Functions	235
38.	Query Expressions	236
	From Clauses	238
	Select Clauses	239
	Where Clauses	239
	Multiple From Clauses	239
	Let Clauses	240
	Join Clauses	240
	Orderby Clauses	240

	Group Clauses	241
	Into Clauses	242
	Group Joins	242
	Query Syntax and Method Call Syntax	243
	Queries are Lazy When Possible	243
39. ⁻	Threads	245
	Threading Code Basics	246
	Using ParameterizedThreadStart	247
	Thread Safety	249
40.	Asynchronous Programming	251
	What is Asynchronous Programming?	251
	Approaches from the Early Days	252
	The Task-based Asynchronous Pattern	255
	The 'async' and 'await' Keywords	256
41 .	Dynamic Objects	259
	Dynamic Type Checking	260
	Dynamic Objects and the Dynamic Language Runtime	260
	Emulating Dynamic Objects with Dictionaries	261
	ExpandoObject	262
	Extending DynamicObject	262
	When to Use Dynamic Object Variations	264
42 . ¹	Unsafe Code	265
	Unsafe Contexts	265
	Pointer Types	266
	Stack Allocations	267
	Fixed Statements	268
	Fixed Size Arrays	269
	Calling Native Code with Platform Invocation Services	270
43. (Other Features in C#	271
	Iterators and the Yield Keyword	272
	Constants	273
	Attributes	274
	The 'nameof' Operator	275
	The 'sizeof' Operator	276
	Bit Fields	277
	Reflection	280
	Using Statements and the IDisposable Interface	280
	Preprocessor Directives	281
	Nullable Types	283
	Simple Null Checks: Null Propagation Operators	283

Company of Line Augusta	205
Command Line Arguments	285
User-Defined Conversions	286
The Notorious 'goto' Keyword	287
Generic Covariance and Contravariance	290
Advanced Namespace Management	293
Checked and Unchecked Contexts	294
Volatile Fields	295
Part 5: Mastering the Tools	
44. The .NET Platform	301
Overview of the .NET Platform	301
A Brief History of the .NET Platform	304
Binary, Assembly, and Compilers	304
Virtual Machines and the Common Language Runtime	306
The .NET Standard Library	308
The .NET Framework	309
.NET Core	310
Xamarin	310
App Models	311
15. Getting the Most from Visual Studio	313
Windows	313
The Options Dialog	315
Including and Excluding Files	315
Showing Line Numbers	316
IntelliSense	316
Basic Refactoring	317
Keyboard Shortcuts	317
6. Dependencies and Multiple Projects	319
Adding DLL References	320
NuGet Packages	321
Creating and Referencing Multiple Projects	323
17. Handling Common Compiler Errors	326
Understanding Compiler Errors	326
Compiler Warnings	326
Common Compiler Errors	327
General Tips for Handling Errors	331
8. Debugging Your Code	333
Launching Your Program in Debug Mode	333
Viewing Exceptions	334
Editing Your Code While Debugging	335
Breakpoints	336

Stepping Through Your Program	336
49. How Your Project Files are Organized	339
Visual Studio's Projects Directory	340
The Solution Directory	340
The Project Directory	341
Part 6: Wrapping Up	
50. Try It Out!	345
Message from Julius Caesar	346
Reverse It!	346
Pig Dice	347
Connect Four	347
Conway's Game of Life	348
51. What's Next?	351
Other Frameworks and Libraries	351
Other Topics	352
Make Some Programs	352
Where Do I Go to Get Help?	353
Parting Words	353
Glossary	354
Tables and Charts	369
Index	374