THE EXPERT'S VOICE® IN .NET

Illustrated CH 205

C# presented clearly, concisely, and visually

Daniel Solis

Illustrated C# 2005

Daniel Solis

Illustrated C# 2005

Copyright © 2006 by Daniel Solis

All rights reserved. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage or retrieval system, without the prior written permission of the copyright owner and the publisher.

ISBN-13 (pbk): 978-1-59059-723-1 ISBN-10 (pbk): 1-59059-723-0

Printed and bound in the United States of America 9 8 7 6 5 4 3 2 1

Trademarked names may appear in this book. Rather than use a trademark symbol with every occurrence of a trademarked name, we use the names only in an editorial fashion and to the benefit of the trademark owner, with no intention of infringement of the trademark.

Lead Editor: Matthew Moodie

Technical Reviewer: Christophe Nasarre

Editorial Board: Steve Anglin, Ewan Buckingham, Gary Cornell, Jason Gilmore, Jonathan Gennick, Jonathan Hassell, James Huddleston, Chris Mills, Matthew Moodie, Dominic Shakeshaft, Jim Sumser, Matt Wade

Project Manager | Production Director: Grace Wong

Copy Edit Manager: Nicole Flores

Copy Editors: Damon Larson, Sharon Wilkey Assistant Production Director: Kari Brooks-Copony

Production Editor: Katie Stence Compositor: Pat Christenson Proofreader: Lori Bring Indexer: Michael Brinkman Cover Designer: Kurt Krames

Manufacturing Director: Tom Debolski

Distributed to the book trade worldwide by Springer-Verlag New York, Inc., 233 Spring Street, 6th Floor, New York, NY 10013. Phone 1-800-SPRINGER, fax 201-348-4505, e-mail orders-ny@springer-sbm.com, or visit http://www.springeronline.com.

For information on translations, please contact Apress directly at 2560 Ninth Street, Suite 219, Berkeley, CA 94710. Phone 510-549-5930, fax 510-549-5939, e-mail info@apress.com, or visit http://www.apress.com.

The information in this book is distributed on an "as is" basis, without warranty. Although every precaution has been taken in the preparation of this work, neither the author(s) nor Apress shall have any liability to any person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by the information contained in this work.

The source code for this book is available to readers at http://www.apress.com in the Source Code/Download section. You will need to answer questions pertaining to this book in order to successfully download the code.

I would like to dedicate this book to my parents, Sal and Amy; and to Sian and Sue.

Contents at a Glance

About the Author		XXİ
About the Technic	cal Reviewer	xxiii
Acknowledgments	S	
Introduction		
OUADTED 4	Off and the NET Everyousely	
CHAPTER 1	C# and the .NET Framework	
CHAPTER 2	Overview of C# Programming	15
CHAPTER 3	Types, Storage, and Variables	29
CHAPTER 4	Classes: The Basics	43
CHAPTER 5	Methods	61
CHAPTER 6	More About Classes	95
CHAPTER 7	Classes and Inheritance	139
CHAPTER 8	Expressions and Operators	171
CHAPTER 9	Statements	209
CHAPTER 10	Namespaces and Assemblies	239
CHAPTER 11	Exceptions	265
CHAPTER 12	Structs	285
CHAPTER 13	Enumerations	295
CHAPTER 14	Arrays	307
CHAPTER 15	Delegates	333
CHAPTER 16	Events	353
CHAPTER 17	Interfaces	371
CHAPTER 18	Conversions	397
CHAPTER 19	Generics	427
CHAPTER 20	Enumerators and Iterators	455
CHAPTER 21	Attributes	481

CHAPTER 22	Preprocessor Directives	
CHAPTER 23	Other Topics	
INDEX	543	

Contents

About the Author	, 	xx
About the Techni	ical Reviewer	xxii
Acknowledgmen	ts	XX\
Introduction		xxvi
CHAPTER 1	C# and the .NET Framework	1
	Before .NET	2
	Windows Programming in the Late 1990s	2
	Goals for the Next-Generation Platform	
	Enter Microsoft .NET	3
	Components of the .NET Framework	3
	An Improved Programming Environment	4
	Compiling to the Common Intermediate Language (CIL)	7
	Compiling to Native Code and Execution	8
	Overview of Compilation and Execution	
	The Common Language Runtime (CLR)	
	The Common Language Infrastructure (CLI)	
	Important Parts of the CLI	
	Review of the Acronyms	13
CHAPTER 2	Overview of C# Programming	15
	A Simple C# Program	16
	More About SimpleProgram	17
	Identifiers and Keywords	18
	Naming Conventions	19
	Keywords	19
	Main: The Starting Point of a Program	
	Whitespace	
	Statements	
	Simple Statements	21
	Blocks	21

	Text Output from a Program	22
	Write	22
	WriteLine	23
	The Format String	23
	Substituting Values	24
	Multiple Markers and Values	25
	Comments: Annotating the Code	26
	More About Comments	
	Documentation Comments	27
	Summary of Comment Types	28
CHAPTER 3	Types, Storage, and Variables	29
	A C# Program Is a Set of Type Declarations	20
	A Type Is a Template	
	Instantiating a Type	
	Types of Members	
	Predefined Types	
	More About the Predefined Types	
	User-Defined Types	
	The Stack and the Heap	
	The Stack	
	The Heap	
	Value Types and Reference Types	
	Storing Members of a Reference Type Object	
	Categorizing the C# Types	
	Variables	
	Variable Declarations	
	Multiple-Variable Declarations	
	Using the Value of a Variable	42
CHAPTER 4	Classes: The Basics	43
	Overview of Classes	44
	A Class Is an Active Data Structure	
	Programs and Classes: A Quick Example	
	Declaring a Class	

	Class Members
	Fields
	Methods
	Creating Variables and Instances of a Class 50
	Allocating Memory for the Data 50
	Combining the Steps 51
	Instance Members
	Access Modifiers 53
	Private and Public Access
	Accessing Members from Inside the Class 56
	Accessing Members from Outside the Class
	Putting It All Together 58
CHAPTER 5	Methods
	The Structure of a Method
	Code Execution in the Method Body
	Local Variables
	Local Variables Inside Nested Blocks
	Flow-of-Control
	Method Invocations
	Return Values
	The Return Statement and Void Methods
	Parameters 72
	Formal Parameters
	Actual Parameters73
	Value Parameters
	Reference Parameters
	Output Parameters
	Parameter Arrays 84
	Method Invocation85
	Expanded Form 85
	Arrays As Actual Parameters88
	Summary of Parameter Types
	Stack Frames 89
	Recursion
	Method Overloading

CHAPTER 6	More About Classes	95
	Class Members	96
	Order of Member Modifiers	96
	Instance Class Members	
	Static Fields	99
	Accessing Static Members from Outside the Class	100
	Example of a Static Field	100
	Lifetimes of Static Members	101
	Static Function Members	102
	Other Static Class Member Types	103
	Constants	104
	Constants Are Like Statics	105
	Local Constants	106
	Properties	107
	Property Declarations and Accessors	108
	A Property Example	109
	Using a Property	110
	Properties and Associated Fields	
	Performing Other Calculations	
	Read-Only and Write-Only Properties	
	A Computed, Read-Only Property Example	
	Example of Properties and Databases	
	Static Properties	
	Instance Constructors	
	Constructors with Parameters	
	Default Constructors	
	Static Constructors	
	Example of a Static Constructor	
	Accessibility of Constructors	
	Finalizers	
	Calling the Finalizer	
	Comparison of Constructors and Finalizers	
	The readonly Modifier	
	The this Keyword	126

	Indexers	127
	What is an indexer?	128
	Indexers and Properties	128
	Declaring an Indexer	129
	The set Accessor	130
	The get Accessor	131
	More About Indexers	131
	Declaring the Indexer for the Employee Example	132
	An Additional Example of an Indexer	133
	Indexer Overloading	134
	Access Modifiers on Accessors	135
	Partial Classes	136
CHAPTER 7	Classes and Inheritance	139
	Class Inheritance	140
	Accessing the Inherited Members	141
	All Classes are Derived From Class object	142
	Hiding Members of a Base Class	143
	Base Access	145
	Using References to a Base Class	146
	Virtual and Override Methods	148
	Overriding a Method Marked override	150
	Constructor Execution	153
	Constructor Initializers	154
	Class Access Modifiers	156
	Inheritance Between Assemblies	157
	Member Access Modifiers	159
	Regions Accessing a Member	160
	Public Member Accessibility	161
	Private Member Accessibility	161
	Protected Member Accessibility	162
	Internal Member Accessibility	162
	Protected Internal Member Accessibility	163
	Summary of Member Access Modifiers	164
	Abstract Members	165
	Abstract Classes	
	Example of an Abstract Class and an Abstract Method	167
	Sealed Classes	168
	External Methods	160

CHAPTER 8	Expressions and uperators	171
	Expressions	172
	Literals	173
	Integer Literals	174
	Real Literals	176
	Character Literals	177
	String Literals	178
	Order of Evaluation	180
	Precedence	180
	Associativity	
	Parenthesized Expressions	181
	Simple Arithmetic Operators	
	The Remainder Operator	
	Relational and Equality Comparison Operators	
	Comparison and Equality Operations	
	Increment and Decrement Operators	
	Conditional Logical Operators	
	Logical Operators	
	Shift Operators	
	Assignment Operators	
	Compound Assignment	
	The Conditional Operator	
	Unary Arithmetic Operators.	
	User-Defined Type Conversions	
	Explicit Conversion and the Cast Operator	
	Operator Overloading	
	Restrictions on Operator Overloading	
	Example of Operator Overloading	
	The typeof Operator	205
CHAPTER 9	Statements	209
	What Are Statements?	210
	Expression Statements	211
	Flow-of-Control Statements	212
	The if Statement	213
	The ifelse Statement	214

	The switch Statement	. 215
	A Switch Example	. 217
	More on the switch Statement	. 218
	Switch Labels	. 219
	The while Loop	. 220
	The do Loop	. 221
	The for Loop	. 223
	Scope of Variables in a for Statement	. 225
	Multiple Expressions in the Initializer and Iterator	. 226
	Jump Statements	. 227
	The break Statement	. 227
	The continue Statement	. 228
	Labeled Statements	. 229
	Labels	. 229
	The Scope of Labeled Statements	. 230
	The goto Statement	. 231
	The goto Statement Inside a switch Statement	. 231
	The using Statement	. 232
	Packaging Use of the Resource	. 233
	Example of the using Statement	. 234
	Multiple Resources and Nesting	. 235
	Another Form of the using Statement	. 236
	Other Statements	. 237
CHAPTER 10	Namespaces and Assemblies	. 239
	Referencing Other Assemblies	. 240
	The mscorlib Library	
	Namespaces	
	Namespace Names	
	More About Namespaces	
	Namespaces Spread Across Files	
	Nesting Namespaces	
	The using Directives	
	The using Namespace Directive	
	The using Alias Directive	
	The Structure of an Assembly	
	The Identity of an Assembly	

	Strongly Named Assemblies	. 257
	Creating a Strongly Named Assembly	. 258
	Private Deployment of an Assembly	. 259
	Shared Assemblies and the GAC	. 260
	Installing Assemblies into the GAC	. 260
	Side-by-Side Execution in the GAC	. 261
	Configuration Files	. 262
	Delayed Signing	. 263
CHAPTER 11	Exceptions	. 265
	What Are Exceptions?	. 266
	The try Statement	. 267
	Handling the Exception	. 268
	The Exception Classes	. 269
	The catch Clause	. 270
	Examples Using Specific catch Clauses	. 271
	The catch Clauses Section	. 272
	The finally Block	. 273
	Finding a Handler for an Exception	. 274
	Searching Further	. 275
	General Algorithm	. 276
	Example of Searching Down the Call Stack	. 277
	Throwing Exceptions	. 280
	Throwing Without an Exception Object	. 282
CHAPTER 12	Structs	. 285
	What Are Structs?	. 286
	Structs Are Value Types	. 287
	Assigning to a Struct	. 288
	Constructors and Finalizers	. 289
	Instance Constructors	. 289
	Static Constructors	
	Summary of Constructors and Finalizers	. 291
	Field Initializers	. 292
	Inheritance	. 292
	Boxing and Unboxing	. 292
	Structs As Return Values and Parameters	
	Additional Information About Structs	203

CHAPTER 13	Enumerations	295
	Enumerations	296
	Underlying Types and Values	297
	Setting the Underlying Type	
	Setting Explicit Values for the Members	
	Implicit Member Numbering	299
	Bit Flags	
	The Flags Attribute	301
	Example Using Bit Flags	303
	More About Enums	304
CUADTED 14	Arrovo	007
CHAPTER 14	Arrays	307
	Arrays	308
	Definitions	308
	Important Details	308
	Types of Arrays	309
	An Array As an Object	310
	One-Dimensional and Rectangular Arrays	311
	Declaring a One-Dimensional Array or a Rectangular Array	311
	Instantiating a One-Dimensional or Rectangular Array	312
	Accessing Array Elements	313
	Initializing an Array	314
	Automatic Initialization	314
	Explicit Initialization of One-Dimensional Arrays	314
	Explicit Initialization of Rectangular Arrays	315
	Syntax Points for Initializing Rectangular Arrays	
	Shortcut Syntax	316
	Putting It All Together	316
	Jagged Arrays	317
	Declaring a Jagged Array	318
	Shortcut Instantiation	318
	Instantiating a Jagged Array	
	Sub-Arrays in Jagged Arrays	
	Comparing Rectangular and Jagged Arrays	
	The foreach Statement	
	The Iteration Variable Is Read-Only	
	The foreach Statement with Multidimensional Arrays	
	Array Covariance	326

	Useful Inherited Array Members	. 327
	The Clone Method	. 329
	Comparing Array Types	. 331
CHAPTER 15	Delegates	. 333
	What Is a Delegate?	334
	Declaring the Delegate Type.	
	Creating the Delegate Object	
	Assigning Delegates	
	Combining Delegates	
	Adding Methods to Delegates	
	Deleting Methods from a Delegate	
	Invoking a Delegate	
	Delegate Example	
	Invoking Delegates with Return Values	
	Invoking Delegates with Reference Parameters	
	Anonymous Methods	
	Using Anonymous Methods	
	Syntax of Anonymous Methods	
	Scope of Variables and Parameters	
CHAPTER 16	Events	. 353
	Events Are Like Delegates	. 354
	An Event Has a Private Delegate	
	Overview of Source Code Components	
	Declaring an Event	
	An Event Is a Member	
	The Delegate Type and EventHandler	. 358
	Raising an Event	
	Subscribing to an Event	. 360
	Removing Event Handlers	. 362
	Adding Anonymous Method Event Handlers	. 363
	Standard Event Usage	. 364
	Using the EventArgs Class	. 364
	Passing Data by Extending EventArgs	. 364
	Using the Custom Delegate	. 365
	The MyTimerClass Code	. 367
	Fvent Accessors	360

CHAPTER 17	Interfaces	371
	What Is an Interface?	372
	Example Using the IComparable Interface	373
	Declaring an Interface	376
	Implementing an Interface	378
	Example with a Simple Interface	379
	An Interface Is a Reference Type	380
	Implementing Multiple Interfaces	382
	Implementing Interfaces with Duplicate Members	
	References to Multiple Interfaces	
	An Inherited Member As an Implementation	
	Explicit Interface Member Implementations.	
	Accessing Explicit Interface Member Implementations	
	Interfaces Can Inherit Interfaces	
	Using the as Operator with Interfaces	
	Example of Different Classes Implementing an Interface	394
CHAPTER 18	Conversions	397
	What Are Conversions?	398
	Implicit Conversions	399
	Explicit Conversions and Casting	400
	Casting	400
	Types of Conversions	402
	Numeric Conversions	402
	Implicit Numeric Conversions	
	Overflow Checking Context	
	Explicit Numeric Conversions	
	Reference Conversions	
	Implicit Reference Conversions	
	Explicit Reference Conversions	
	Valid Explicit Reference Conversions	
	Boxing Conversions	
	Boxing Creates a Copy	
	Unboxing Conversions	
	The Unboxing Conversions	419

	User-Defined Conversions	420
	Constraints on User-Defined Conversions	420
	Example of a User-Defined Conversion	421
	Evaluating User-Defined Conversions	423
	Example of a Multi-Step User-Defined Conversion	423
	The is Operator	425
	The as Operator	426
CHAPTER 19	Generics	427
	What Are Generics?	128
	A Stack Example	
	Generics in C#	
	Continuing with the Example	
	Generic Classes	
	Declaring a Generic Class	
	Creating a Constructed Type	
	Creating Variables and Instances	
	Comparing the Generic and Non-Generic Stack	
	. •	
	Constraints on Type Parameters	
	Where Clauses	
	Constraint Types and Order	
	Generic Structs	
	Generic Interfaces.	
	An Example Using Generic Interfaces	
	Generic Interface Implementations Must Be Unique	
	Generic Delegates	
	Generic Methods	
	Declaring a Generic Method	
	Invoking a Generic Method	
	Example of a Generic Method	452
CHAPTER 20	Enumerators and Iterators	455
	Enumerators and Enumerable Types	456
	Using the foreach Statement	456
	Types of Enumerators	457

	Using the IEnumerator Interface	458
	Declaring an IEnumerator Enumerator	461
	The IEnumerable Interface	463
	Example Using IEnumerable and IEnumerator	464
	The Non-Interface Enumerator	466
	The Generic Enumeration Interfaces	468
	The IEnumerator <t> Interface</t>	469
	The IEnumerable <t> Interface</t>	472
	Iterators	474
	Iterator Blocks	475
	More about Iterators	476
	Producing Enumerables and Enumerators	477
	Using an Iterator to Produce an Enumerable	478
	Using an Iterator to Produce an Enumerator	479
CHAPTER 21	Attributes	481
OHAI IEN EI	Attibuted	+01
	What Is an Attribute?	
	A Quick Preview	483
	The Stages of an Attribute	484
	Applying an Attribute	485
	Multiple Attributes	486
	Other Targets	486
	Global Attributes	487
	Predefined Attributes	488
	Using Custom Attributes	489
	Declaring a Custom Attribute	489
	Using Attribute Constructors	490
	Specifying the Constructor	490
	Using the Constructor	491
	Positional and Named Parameters in Constructors	492
	Restricting the Usage of an Attribute	
	Using Suggested Practices for Custom Attributes	496
	Accessing an Attribute	
	Using the IsDefined Method	497
	Using the GetCustomAttributes Method	498
	Using Reserved Attributes	499
	The Obsolete Attribute	499
	The Conditional Attribute	499

CHAPTER 22	Preprocessor Directives	. 503
	What Are Preprocessor Directives?	. 504
	General Rules	. 504
	The #define and #undef Directives	. 506
	Conditional Compilation	. 507
	The Conditional Compilation Constructs	. 508
	Diagnostic Directives	
	Line Number Directives	. 512
	Region Directives	. 513
	The #pragma warning Directive	. 514
CHAPTER 23	Other Topics	. 515
	Miscellaneous Topics	. 516
	Strings	. 516
	Using Class StringBuilder	. 517
	Formatting Numeric Strings	. 518
	Parsing Strings to Data Values	. 523
	Nullable Types	. 524
	Creating a Nullable Type	. 524
	Using Nullable User-Defined Types	. 529
	Method Main	. 531
	Documentation Comments	. 533
	Inserting Documentation Comments	. 534
	Nested Types	. 537
	Example of a Nested Class	. 538
	Visibility and Nested Types	. 539
INDEX		5/13

About the Author



DAN SOLIS holds a Bachelor of Arts in biology and English, and initially worked in research on the structure of metal crystals, until he found that he enjoyed programming much more than working in a lab. He also holds a Master of Science degree in computer science from the University of California at Santa Barbara, where he concentrated on programming languages and compiler design.

Dan has been programming professionally for more than 20 years, with more than half that time working as a consultant and contract

programmer, including several projects for Microsoft Consulting Services. His consulting projects have ranged from programs for mutual fund analysis and supply chain management to systems for missile tracking. He has also taught courses on various programming languages, Windows programming, UNIX internals, and a number of other topics, in both the United States and Europe.

Dan's first programming language was C, but he soon became intrigued by the journal articles about a new language called "C with Classes." Eventually that language was renamed C++ and released to the world. He began using C++ as soon as he could get access to a compiler, and eventually started teaching training seminars on the language as well.

With the advent of C# and .NET, he has moved on to enjoying the myriad advantages of the new language and platform, and has been working with them enthusiastically ever since.

About the Technical Reviewer



CHRISTOPHE NASARRE is a development architect for Business Objects, a company that develops desktop and web-based business intelligence solutions. In his spare time, Christophe writes articles for *MSDN* magazine, MSDN/Vista, and ASPToday; and has been reviewing books on Win32, COM, MFC, .NET, and WPF since 1996.

Acknowledgments

want to thank Sian for supporting and encouraging me on a daily basis, and I also want to thank my parents and family for their continued love and support.

I also want to express my sincere gratitude to the people at Apress who have worked with me to bring this book to fruition. I really appreciate that they understood and appreciated what I was trying to do, and worked with me to achieve it. Thanks to all of you.

Introduction

The purpose of this book is to teach you the fundamentals and mechanics of the C# programming language. Most books teach programming primarily using text. That's great for novels, but many of the important concepts of programming languages can best be understood through a combination of words, figures, and tables.

Many of us think visually, and figures and tables can help clarify and crystallize our understanding of a concept. In several years of teaching programming languages, I have found that the pictures I drew on the whiteboards were the things that most quickly helped the students understand the concepts I was trying to convey.

Illustrations alone, however, are not sufficient to explain a programming language and platform. The goal of this book is to find the best combination of words and illustrations to give you a thorough understanding of the language, and to allow the book to serve as a reference resource as well.

This book is written for anyone who wants an introduction to the C# programming language—from the novice to the seasoned programmer. For those just getting started in programming, I have included the basics. For seasoned programmers, the content is laid out succinctly, and in a form that will allow you to go directly to the information required without having to wade through oceans of words. For both sets of programmers, the content itself is presented graphically, in a form that should make the language easy to learn. Enjoy!