

Table of Contents

Preface	1
1 Modelling Functions.....	5
1.1 Goals and Objectives	5
1.2 What is a Function and why do we need Functions?.....	6
1.3 Function Pointers in C	7
1.4 Function Essentials.....	9
1.5 Modelling Algebraic Expressions using Function.....	11
1.6 Generic Functions and Functions as Data Members.....	13
1.7 Callback Functions and Notification Patterns	15
1.8 Class-based Callback Functions.....	17
1.9 Scalar, Vector and Vector-valued Functions.....	18
1.9.1 Scalar-valued Functions.....	20
1.9.2 Vector Functions	21
1.9.3 Vector-valued Functions.....	21
1.10 Conclusions and Summary	22
2 Bind.....	23
2.1 Introduction and Objectives	23
2.2 An Introduction to Function Objects	23
2.3 Predefined and User-defined Function Objects.....	26
2.4 The <code>for_each()</code> Algorithm.....	28
2.5 Function Adapters for Member Functions and Ordinary Functions	29
2.6 Introducing Bind	31
2.7 Placeholders and Arguments.....	31
2.8 Calling a Member Function	32
2.9 Using Bind with Function Objects	33
2.10 Dynamic Sorting and Bind	34
2.11 Function Composition	35
2.12 Applications and Relationships with STL and Boost	36
2.13 Summary and Conclusions	38
3 Event Notification, Observer Pattern and Signals Library	39
3.1 Introduction and Objectives	39
3.2 Notification Patterns in Object-Oriented Systems.....	39
3.3 The GOF Observer Pattern: what is it and what are the Problems?.....	40
3.3.1 The GOF Observer Pattern: Critique	44
3.4 An Introduction to the Signals Library	44
3.5 Signals and Slots	45
3.6 Slot Groups	46
3.7 Objects playing Roles of Signals and Slots.....	47
3.8 Connection Management and the <code>connection</code> Class	49
3.9 Creating Slots using Bind and Lambda	51
3.9.1 Creating Slots 'on the fly' with Lambda.....	51
3.9.2 Creating Slot Types with Bind	52
3.10 Combiners.....	53
3.11 Thread-Safe Signals Library	54
3.12 The GOF Observer Pattern revisited	55
3.13 Summary and Conclusions	56
4 Phoenix.....	57
4.1 Introduction and Objectives	57

4.2	Motivating Phoenix: a Test Case	57
4.3	Introduction to Functional Programming	59
4.3.1	Lambda Calculus and Lambda Functions.....	60
4.4	The Architecture of Phoenix.....	60
4.5	Actors, Arguments and Fundamentals	61
4.6	Composite	63
4.7	Function and Operator.....	63
4.8	Statement.....	65
4.9	Object.....	67
4.10	Scope and Local Variables	67
4.11	Bind	68
4.12	Container	70
4.13	Algorithm.....	70
4.14	Summary and Conclusions.....	71
5	Smart Pointers and Serialisation.....	72
5.1	Introduction and Objectives.....	72
5.2	An Introduction to Memory Management.....	72
5.3	An Introduction to Smart Pointers	73
5.4	Scoped Pointers and Scoped Arrays.....	74
5.5	Shared Pointer and Shared Arrays	76
5.5.1	Functionality of <code>shared_ptr</code>	77
5.5.2	Stop Sharing Ownership.....	78
5.5.3	Retrieving the Resource from Shared Data.....	78
5.5.4	Shared Arrays	79
5.5.5	Custom Deleters.....	79
5.6	Weak Pointers.....	81
5.7	Smart Pointers and Exception Handling.....	82
5.8	Using Smart Pointers with STL Containers.....	82
5.9	Test Case: creating smart Composite Objects.....	84
5.10	Serialisation and Object Persistence	85
5.10.1	Main Concepts and Initial Examples.....	86
5.10.2	STL Containers and Serialisation of more Complex Objects	88
5.10.3	XML Serialisation and Deserialisation.....	89
5.10.4	An Example from Boost Documentation: Serialisation Tutorial.....	91
5.11	Summary and Conclusions.....	95
6	Tuple.....	97
6.1	Introduction and Objectives.....	97
6.2	An Introduction to n-Tuples	97
6.3	The <code>tuple</code> Class: Fundamental Properties	98
6.4	Accessing Tuple Elements	99
6.5	Comparing Tuples.....	100
6.6	Tuples and Streaming.....	101
6.7	Applications of Tuple.....	102
6.8	Summary and Conclusions.....	103
7	Any.....	104
7.1	Introduction and Objectives.....	104
7.2	The <code>any</code> Class: Fundamental Properties	104
7.3	Using <code>any</code> with Smart Pointers.....	106
7.4	STL Containers whose Elements are of Type <code>any</code>	106

7.5	Property Sets with heterogeneous Elements	107
7.6	Initialisation of Data with Assign Library	111
7.7	Summary and Conclusions	114
8	Variant	115
8.1	Introduction and Objectives	115
8.2	What is a Discriminated Union?	115
8.3	The <code>variant</code> Class Template: Hello World Example.....	116
8.4	Member Functions in <code>variant</code>	116
8.5	Type-safe Visitation of Variants	117
8.6	Summary and Conclusions	118
9	Number Systems.....	120
9.1	Introduction and Objectives	120
9.2	A Review of STL <code>complex<T></code> Template Class	120
9.2.1	Application: Discrete Fourier Transform (DFT)	121
9.3	Complex Numbers Algorithms	124
9.4	Rational Numbers.....	125
9.5	Greatest Common Divisor (gcd) and Least Common Multiple (lcm).....	126
9.5.1	More general Cases	128
9.6	Quaternions and Octonians	129
9.7	Conversions	131
9.8	Summary and Conclusions	133
10	String Algorithm	134
10.1	Introduction and Objectives	134
10.2	Case Conversion, Trimming and Predicates	134
10.3	Find Algorithms	136
10.4	Erase and Replace	138
10.5	Split and Join	138
10.6	Finders and Formatters	139
10.7	Iterators.....	142
10.7.1	Creating Custom Formatters	143
10.8	Classification	144
10.9	Creating Name-Value Maps	145
10.10	The Range Library	145
10.11	Summary and Conclusions	147
11	Tokenizer.....	148
11.1	Introduction and Objectives	148
11.2	What is a Token?.....	148
11.3	The Token Class, Token Iterator and Token Function	149
11.3.1	Token Class.....	149
11.3.2	TokenizerFunction Concept.....	150
11.3.3	Token Iterator.....	150
11.3.4	Examples	150
11.4	Conversions and Casting Examples	151
11.5	Summary and Conclusions	152
12	Regex.....	154
12.1	Introduction and Objectives	154
12.2	Alphabet, Words and Language.....	154
12.3	An Introduction to Regular Expressions.....	155
12.4	Regex Functionality	156

12.5	The Class <code>basic_regex</code>	156
12.6	Regular Expression Matching.....	158
12.7	Searching.....	159
12.8	Text Replacement	161
12.9	Dynamic Regular Expressions and Exception Handling	161
12.10	Regex and Callbacks.....	162
12.11	Summary and Conclusions.....	163
13	An Introduction to Expression Templates and Xpressive.....	164
13.1	Introduction and Objectives.....	164
13.2	Binary Trees and Expression Trees.....	164
13.2.1	Traversing Binary Trees	166
13.2.2	Extended Binary Trees	167
13.3	An Introduction to Expression Templates	169
13.4	An Introduction to Xpressive.....	173
13.5	First Encounters with Xpressive	173
13.6	Regex Object and Matches.....	174
13.7	Nested Regex and simple Grammar.....	176
13.8	Semantic Actions.....	178
13.9	More Semantic Actions.....	180
13.10	Conclusions and Summary.....	181
14	MultiArray and Array.....	182
14.1	Introduction and Objectives.....	182
14.2	A Quick ‘101’ Tour of MultiArray	183
14.3	Overview of MultiArray Functionality	184
14.4	Specifying Array Dimensions.....	184
14.5	Accessing the Elements of a Multi-Array	185
14.6	Setting the Array Base	186
14.7	Storage Ordering.....	187
14.8	Array.....	188
14.9	Applications of Boost.Array.....	190
14.10	Four-dimensional Arrays.....	192
14.11	Views and Slices.....	192
14.11.1	Zooming.....	192
14.11.2	Slicing	194
14.12	MultiArray Adapters.....	197
14.13	Utility Print Functions.....	197
14.14	MultiArrays in Combination with other Data Structures.....	198
14.15	Summary and Conclusions.....	200
15	Random Number Generation	201
15.1	Introduction and Objectives.....	201
15.2	Overview of Random Number Generation.....	201
15.3	Random Number Generators in Boost	202
15.4	<code>variate_generator</code>	205
15.5	Performance, Reliability, Suitability and Accuracy Requirements.....	206
15.6	Examples using Random Number Generators	207
15.6.1	Calculating π	207
15.6.2	Finding Real Roots of a Quadratic Equation	208
15.6.3	Kernel Density Estimation.....	209
15.7	Conclusions and Summary.....	211

16	Flyweight and Functional/Hash	212
16.1	Introduction and Objectives	212
16.2	The “Hello World” Example.....	212
16.3	Flyweight Requirements.....	214
16.4	Key-Value Flyweights.....	217
16.5	Flyweight Factory Specification	219
16.6	Tracking and Lifecycle Policies	220
16.7	Tagging Policies.....	221
16.8	Holders	222
16.9	Locking Policies and Thread-Safe Code.....	223
16.10	Summary and Conclusions	224
16.11	Appendix: Functional/Hash	224
17	Integrating Legacy Applications with Boost	229
17.1	Introduction and Objectives	229
17.2	Migrating Legacy Code to Boost: The CADObject Project.....	229
17.3	CADObject Architecture: Version One.....	230
17.4	CADObject Architecture: Version Two	234
17.5	CADObject Architecture: Version Three	236
17.6	Using Boost.Serialization	237
17.7	Factories and Deserialisation	240
17.8	Conclusions and Summary	242
18	An Introduction to Thread	243
18.1	Introduction and Objectives	243
18.2	An Introduction to Threads.....	243
18.3	The Life of a Thread.....	244
18.3.1	How Threads Communicate.....	244
18.4	What Kinds of Applications are suitable for Multi-Threading?	244
18.4.1	Suitable Tasks for Multi-threading.....	245
18.5	The Boost <code>thread</code> class.....	245
18.6	The Life of a Thread.....	248
18.7	Basic Thread Synchronisation.....	251
18.8	Thread Interruption	253
18.9	Thread Notification	254
18.10	Thread Groups	254
18.11	Shared Queue Pattern	255
18.12	The Producer-Consumer Pattern	256
18.13	Thread Local Storage	258
18.14	Summary and Conclusions	258
	Appendix A: Generic Programming	260
	Introduction and Objectives.....	260
	Some Useful Techniques.....	260
	Traits Classes	262
	An Introduction to Policy-based Design.....	264
	Curiously Recurring Template Pattern (CRTP).....	267
	The Boost Categories	270
	Appendix B: Boost, Design Patterns and Applications	273
	Introduction and Objectives.....	273
	An Overview of Design Patterns.....	273
	Boost and Design Patterns.....	274

Which Boost Libraries ‘Bootstrap’ the GOF Design Patterns?	275
Creating Layered Software Systems	276
Appendix C: Exercises and Projects	278
Introduction and Objectives	278
Epilogue and Volume II Contents	290
Bibliography	291
Index	292
Book Registration Form	297