## Contents at a Glance

### I Getting Started
1. Introducing This Book 3
2. Installing Linux 11
3. Installing GNU C++ 31

### II C++ Fundamentals
4. Introducing GNU C++ 45
5. Compiling and Debugging C++ Programs 63
6. Creating Data Objects 89
7. Applying Fundamental Operators 133
8. Controlling Input and Output 145
9. Controlling Program Flow 167
10. Creating and Calling Functions 191
11. Managing Memory with Pointers 223

### III Object-Oriented Programming
12. Introducing the Class 255
13. Creating and Destroying Objects 275
14. Investing in Inheritance 307
15. Programming with Virtual Functions 331
16. Handling Exceptions 357
17. Creating Class Templates 379

### IV Advanced C++ Techniques
18. Overloading Your Friends 401
19. Overloading Operators 411
20. Customizing I/O Streams 439
21. Honing Your C++ Skills 473

### V C++ Class Libraries
22. Mastering the Standard string Class 507
23. Using the Standard Template Library (STL) 531
24. Building Standard Containers 565
25. Applying Standard Algorithms 599
26. Introducing X Programming 631
27. Controlling Xlib Input and Output 659

### VI X Window Development
29. Introducing the V Class Library 725
30. Developing X Software with V 743

### VII Appendixes
A. GNU C++ Reserved Words 781
B. C++ Operator Precedence and Associativity 783
C. Web and FTP Sites 785
D. Using the CD-ROM 787
E. Copyright Information—The GNU General Public License 789
# TABLE OF CONTENTS

## 1 Getting Started

1. **Introducing This Book** 3  
   - Text Styles 4  
   - Requirements 5  
     - Hardware Requirements 5  
     - Software Requirements 6  
   - Listings 7  
   - Part Summaries 7  
   - Chapter Summaries 8  
   - Summary 10

## 2 Installing Linux 11

- How to Install Linux 12  
  - CD-ROM Booting Trouble 13  
  - Standalone Installations 14  
  - Dual-Boot Installations 14  
  - Installing Mandrake-Linux 6.0 16  
  - Booting Linux 20  
  - Shutting Down 21  
- Mounting Disks and Drives 22  
  - General Disk Usage 22  
  - Mounting MS-DOS Partitions 22  
  - Automatic MS-DOS Drive Mounting 23  
  - Mounting a CD-ROM 25  
  - Using Floppy Disks 25  
  - Mounting Iomega Zip MS-DOS Disks 26  
  - Creating Linux Zip Disks 27  
  - Getting Online Information 29  
- Summary 29

## 3 Installing GNU C++ 31

- Where to Get GNU C++ 32  
- How to Install the GNU C++ Compiler 33  
  - Reinstalling Everything 33  
  - Upgrading an Existing Installation 33  
  - Installing Packages with RPM 34  
  - Downloading GNU C++ from the Internet 37  
- How to Install This Book's Sample Programs 39  
  - Mounting the CD-ROM 39  
  - Unpacking the Files 39  
- Comparing C and C++ 40  
- Summary 42

## II C++ Fundamentals

## 4 Introducing GNU C++ 45

- Welcome to C++ Programming 46  
  - The Welcome Program 46  
  - Compiling the Welcome Program 47  
  - The Output File Option 48  
  - Understanding the Welcome Program 48  
  - More About Semicolons 50  
  - Calling C Library Functions 50  
- Comments About Comments 53  
  - C-Style Comments 53  
  - C++-Style Comments 54  
  - This Book's Source File Comments 55  
  - Creating an Automatic Time Stamp 56  
- Program Entry and Exit 56  
  - The main() Function 57  
  - C-Style main() Functions 58  
  - Returning Values from main() 58  
  - Going Out in Style 59  
  - Going Down in Flames 61  
- Review of Entry and Exit Techniques 61  
- Summary 62
5 Compiling and Debugging C++ Programs 63

Warnings and Errors 64
You've Been Warned 65
To Err Is Human 65
Warning and Error Options 67
Turning Warnings into Errors 68
Compile-and-Go Script 69

Compiler Options 70
Portability Options 70
Intermediate Compilations 71
The Compilation Process 72
Separate Compilation 74
To Quote or Not to Quote 75
Include-File Options 75
Controlling the Include Paths 76
Optimizing Code 77
Optimization Levels 78
To Optimize or Not to Optimize 79

Introduction to Debugging 79
Compiling for Debugging 80
Choose Your Weapon 81
Using the gdb Console Debugger 82
Using the xxgdb X Window Debugger 84
Running gdb in Emacs 86
Useful Debugger Options 87

Summary 88

6 Creating Data Objects 89

Data Declarations 90
Type Conversions 91
Identifiers: Good, Bad, and Ugly 91
GNU C++ Reserved Words 92

Simple Data Objects 93
Integer Variables 94
Limits 95
Constants As Macros 96
Constants As Objects 97
Predefined Constants 98

Global and Local Variables 99
Multiple Variable Declarations 100
Enumerated Types 101
Boolean Variables 103
Literal Values 104
Literal Constant Ranges 105
Double Wide Integers 105
It's a Wrap 107
Floating Point Variables 108

Character Strings 110
Characters 111
C-Style String Constants 111
C-Style String Variables 111
Size Matters 112
Much to Do About Nothing 113
Comparing Strings 114
Concatenating Strings 115
Searching for Substrings 115
Character Escape Codes 116
String Conversions 118
Stir-Fried Strings 119

Arrays and Structures 120
Single-Dimensional Arrays 120
Multiple-Dimensional Arrays 121
Initializing Arrays 121
Preinitializing Arrays 122
Initializing Arrays of Strings 122
Structures 123

Debugging Data Objects 124
Identifying the Bug 124
Loading the Code 125
Other Data Debugging Commands 128
Automatically Displaying Variables 129
Assigning Values 129
Setting the Radix 130
Finding a Variable's Type 130
Debugging with the assert() Macro 130
Debugging Variables Roundup 131

Summary 132
Mutually Recursive Functions  217  
Functions and Separate  
Compilation  218  

Debugging Functions  219  
Stepping over Functions  220  
Stepping into Functions  220  
Debugging inline Functions  221  

Summary  222

11 Managing Memory with Pointers  223  

Allocating Memory  224  
Memory Management with new and  
delete  224  
Memory Leaks  227  
Memory Management with malloc()  
and free()  228  
Dealing with Memory Errors  230  

Pointers for Using Pointers  231  
Dynamic Strings  231  
Pointer Arithmetic  234  
Obtaining a Memory Block’s Size  234  
Dynamic Arrays  235  
Multidimensional Dynamic Arrays  236  
Passing Arguments to main()  238  
The getopt() Function  239  

Other Memory Matters  245  

Debugging Dynamic Memory  247  
Debugging Pointers  247  
Debugging Addressed Data  248  
Debugging Program Options  249  
Debugging main() Arguments  250  

Summary  251

III Object-Oriented Programming

12 Introducing the Class  255  

Why Use Object-Oriented  
Programming?  256  

Introducing the Class  256  

Programming with Classes and  
Objects  260  
Constructors  261  
Member Functions  262  

Constructing Objects  263  
The Default Constructor  266  
The Copy Constructor  266  
Inline Constructors  267  
Overloaded Constructors  269  

Debugging Class Objects  271  

Summary  273

13 Creating and Destroying Objects  275  

Destroying Class Objects  276  
Introducing the Destructor  276  
Using Pointers to Address Objects  277  
Dynamic Objects  278  
Using Pointers in Classes  280  
Class Memory Management  280  
Copy Constructors  283  

Initializing Data Member Objects  289  

Objects of Many Flavors  292  
Parameter Class Objects  292  
Object Function Results  294  
Arrays of Class Objects  296  
Dynamic Arrays of Class Objects  296  
Arrays of Class Object Pointers  297  
Dynamic Arrays of Class Object  
Pointers  298  
Object Arrays As Data Members  299  

Objects and Modular Programming  300  
The TDate Header File  300  
The TDate Module  301  
A TDate Host Program  304  
Classes and Data Hiding  306  

Summary  306
14 Investing in Inheritance 307

Classes As Building Blocks 308
   Single Inheritance 308
   Multiple Inheritance 309

Creating Derived Classes 309
   The TCoordinate Class 311
   Derived Class Constructors 314
   Derived Class Deststructors 317
   Copying Derived Class Objects 321

Introducing Protected Members 324
Changing Access Specifiers 324
Qualifying Selected Members 325
Debugging Derived Classes 326
   Inspecting Object Construction 327
   Inspecting Object Data Members 328
   Calling Member Functions 329
   Finding the Type of an Object 330

Summary 330

15 Programming with Virtual Functions 331

Poly Want a Morphism? 332

Creating a Container Class 334
   Abstract Classes 334
   Virtual Destructors 335
   Pure Virtual Functions 335
   The TContainer Class 336
   Calling Virtual Functions 338
   Deriving from Abstract Classes 342

Multiple Inheritance 345
   Loading the Bases 346
   Using Multiple Base Class Constructors 346
   Using Virtual Base Classes 347
   Fixing Ambigious Base Classes 350

Debugging Classes with Virtual Functions 352
   Debugging Classes in Separate Modules 352
   Debugging Virtual Function Calls 354

Summary 355

16 Handling Exceptions 357

A Few Good Terms 358

Introducing Exceptions 358
   Throwing Exception Objects 359
   The Standard exception Class 360
   Introducing try Blocks 361
   Multiple catch Statements 362
   Nesting try Blocks 362
   Using try Blocks 363

Programming with Exceptions 364
   Unhandled Exceptions 367
   Replacing unexpected() and terminate() 368
   Trapping All Exceptions 369
   Exceptions and Local Objects 373
   Exceptions and Constructors 374
   Classes That Throw Themselves Around 375

Exceptions and Memory Management 376

Debugging Exceptions 377

Summary 378

17 Creating Class Templates 379

Introducing Class Templates 380
   Template Functions 380
   Template Classes 384
### 21 Honing Your C++ Skills 473

- Copying Class Objects 474
  - Copy Constructor and Assignment Review 474
  - Memberwise Initialization 475
  - Copy Constructor 475
  - Overloaded `operator=`() Function 476
  - Calling `operator=`() from a Copy Constructor 477
  - Reference Count Ownership 477
  - Copy-on-Write Method 478
- Namespaces 488
- Odds and Ends 488
  - Explicit Constructors 488
  - Mutable Data Members 490
  - Using `typename` 492
  - Pointers to Member Functions 493
  - Static Member Functions 495
  - Persistent Objects 498
  - Nested Class Declarations 500
- Summary 503

### V C++ Class Libraries

#### 22 Mastering the Standard string Class 507

- Introducing string Templates 508
- Declaring string Objects 509
  - Reading and Writing string Objects 512
  - Getting string Facts 513
  - string Size Operations 514
  - string Exceptions 514
  - Using string Operators 516
- Calling string Member Functions 518
  - Inserting and Deleting strings 520
  - Copying strings 522
  - Converting to Null-Terminated Strings 523
  
- Comparing and Searching string Objects 526
  - Comparing string Objects 526
  - Searching string Objects 527
  - Debugging string Objects 529
- Summary 530

#### 23 Using the Standard Template Library (STL) 531

- Introducing the Standard Template Library 532
  - STL Components 533
  - Header Files 533
  - Namespaces 534
- Iterators 534
  - Types of Iterators 535
  - Pointer Iterators 535
  - Container Iterators 537
  - Constant Iterators 538
- Programming with Iterators 539
  - Input Iterators 539
  - Output Iterators 540
  - Forward Iterators 542
  - Bidirectional Iterators 542
  - Random Access Iterators 542
- Iterator Techniques 543
  - Iostreams and Iterators 543
  - Insertion Iterators 545
  - Miscellaneous Iterator Functions 547
- Functions and Function Objects 548
  - Functions and Predicates 548
  - Function Objects 552
  - Generator Function Objects 555
  - Generator Function Class Objects 558
  - Binder Function Objects 560
  - Negator Function Objects 562
- Summary 563
30 Developing X Software with V 743

Compiling This Chapter's Programs 744

Understanding V Classes 744

V Welcome Program 745
  The Main Application 746
  The Application Class 748
  The Command Window Class 749

Software Development with V 753
  Graphics 753
  Mouse Input 754
  Keyboard Input 758

V Standard Components 762
  Menus 762
  Toolbars 767
  Status Bars 770

Final Note 776

Summary 777