

CONTENTS

PREFACE xxix

CHAPTER 1: WELCOME TO MAC OS X 1

The Heritage of Mac OS X: UNIX	2
The Open Source Connection	3
The Mach Kernel	3
The GNU Project	4
The BSD UNIX System	5
Darwin	5
Overview of Mac OS X	5
Mac OS X Has a Kernel Programming Interface	5
Mac OS X Can Support Many Users	6
Mac OS X Can Run Many Tasks	7
Mac OS X Provides a Secure Hierarchical Filesystem	7
The Shell: Command Interpreter and Programming Language	8
A Large Collection of Useful Utilities	9
Interprocess Communication	10
System Maintenance and Administration	10
Additional Features of Mac OS X	10
GUIs: Graphical User Interfaces	10
(Inter)Networking Utilities	11
Standards	11
The C and Objective-C Programming Languages	12
Software Development	13
Chapter Summary	13
Exercises	14

PART I THE MAC OS X OPERATING SYSTEM 15

CHAPTER 2: GETTING STARTED 17

- Conventions Used in This Book 18
- Logging In 20
 - Graphical Login 20
 - Textual Login 21
 - Logging In Remotely: Terminal Emulation and ssh 22
- Curbing Your Power:
 - Superuser/root/Administrator Access 23
- Working with the Shell 23
 - Running the Mac OS X Command Line Interface 23
 - Correcting Mistakes 24
 - Repeating/Editing Command Lines 26
- Useful Graphical Tools 26
- Getting the Facts: Where to Find Documentation 27
 - The Help Viewer 27
 - System Documentation 28
 - man: Displaying the System Manual 28
 - info: Displaying Information About Utilities 30
 - Using the Internet to Get Help 33
- More About Logging In 34
 - What to Do if You Cannot Log In 34
 - Logging In on the Text Console 35
 - Logging Out 35
 - Changing Your Password 36
- Chapter Summary 37
- Exercises 38
- Advanced Exercises 38

CHAPTER 3: THE MAC OS X UTILITIES 39

- Special Characters 40
- Basic Utilities 41
 - ls: Lists the Names of Files 41
 - cat: Displays a Text File 42
 - rm: Deletes a File 42
 - open: Opens a File 42
 - less: Displays a Text File One Screen at a Time 42
 - hostname: Displays Your System Name 43
- Working with Files 43
 - cp: Copies a File 43
 - ditto: Copies Files and Directories 44

mv: Changes the Name of a File	45
lpr: Prints a File	45
grep: Searches for a String	46
head: Displays the Beginning of a File	47
tail: Displays the End of a File	48
sort: Displays a File in Order	49
uniq: Removes Duplicate Lines from a File	49
diff: Compares Two Files	49
file: Tests the Contents of a File	50
(Pipe): Communicates Between Processes	51
Three More Utilities	52
echo: Displays Text	52
date: Displays the Date and Time	52
script: Records a Shell Session	52
Compressing and Archiving Files	54
bzip2: Compresses a File	54
bunzip2 and bzip: Decompress a File	55
gzip: Compresses a File	55
tar: Packs and Unpacks Archives	56
Locating Commands	58
which and type: Locate a Utility	58
apropos: Searches for a Keyword	59
Obtaining User and System Information	60
who: Lists Users on the System	60
finger: Lists Users on the System	61
w: Lists Users on the System	62
Communicating with Other Users	63
write: Sends a Message	63
msg: Denies or Accepts Messages	64
Email	64
Chapter Summary	65
Exercises	67
Advanced Exercises	68

CHAPTER 4: THE MAC OS X FILESYSTEM 71

The Hierarchical Filesystem	72
Directory Files and Ordinary Files	73
Filenames	74
The Working Directory	77
Your Home Directory	77
Pathnames	78
Absolute Pathnames	78
Relative Pathnames	79

- Directory Commands 80
 - mkdir: Creates a Directory 80
 - cd: Changes to Another Working Directory 82
 - The . and .. Directory Entries 82
 - rmdir: Deletes a Directory 83
 - Using Pathnames 84
 - mv, cp: Moves or Copies a File 84
 - mv: Moves a Directory 85
- Filesystems 86
 - Nondisk Filesystems 86
 - /Volumes 86
- Access Permissions 87
 - ls -l: Displays Permissions 87
 - chmod: Changes Access Permissions 88
 - Groups 89
 - Setuid and Setgid Permissions 90
 - Directory Access Permissions 90
 - File Flags 92
- Extended Attributes 93
 - File Forks 93
 - File Attributes 95
 - Access Control Lists 97
- Types of Files 99
 - Ordinary Files, Directories, Links, and Inodes 99
 - Special Files 100
- Links 102
 - Hard Links 103
 - Symbolic Links 105
 - rm: Removes a Link 107
- Chapter Summary 108
- Exercises 109
- Advanced Exercises 111

CHAPTER 5: THE SHELL 113

- The Command Line 114
 - Syntax 114
 - Processing the Command Line 117
 - Executing the Command Line 119
- Standard Input and Standard Output 120
 - The Screen as a File 120
 - The Keyboard and Screen as Standard Input and Standard Output 121
 - Redirection 122
 - Pipes 128

Running a Program in the Background	131
Filename Generation/Pathname Expansion	133
The ? Special Character	134
The * Special Character	134
The [] Special Characters	136
Builtins	138
Chapter Summary	138
Utilities and Builtins Introduced in This Chapter	139
Exercises	140
Advanced Exercises	141

PART II THE EDITORS 143

CHAPTER 6: THE vim EDITOR 145

History	146
Tutorial: Creating and Editing a File with vim	147
Starting vim	147
Command and Input Modes	149
Entering Text	150
Getting Help	151
Ending the Editing Session	153
The compatible Parameter	153
Introduction to vim Features	154
Online Help	154
Modes of Operation	155
The Display	156
Correcting Text as You Insert It	156
Work Buffer	156
Line Length and File Size	157
Windows	157
File Locks	157
Abnormal Termination of an Editing Session	158
Recovering Text After a Crash	159
Command Mode: Moving the Cursor	160
Moving the Cursor by Characters	160
Moving the Cursor to a Specific Character	161
Moving the Cursor by Words	161
Moving the Cursor by Lines	162
Moving the Cursor by Sentences and Paragraphs	162
Moving the Cursor Within the Screen	162
Viewing Different Parts of the Work Buffer	162

- Input Mode 163
 - Inserting Text 163
 - Appending Text 164
 - Opening a Line for Text 164
 - Replacing Text 164
 - Quoting Special Characters in Input Mode 164
- Command Mode: Deleting and Changing Text 165
 - Undoing Changes 165
 - Deleting Characters 165
 - Deleting Text 165
 - Changing Text 167
 - Replacing Text 168
 - Changing Case 168
- Searching and Substituting 168
 - Searching for a Character 168
 - Searching for a String 169
 - Substituting One String for Another 172
- Miscellaneous Commands 175
 - Join 175
 - Status 175
 - . (Period) 175
- Yank, Put, and Delete Commands 175
 - The General-Purpose Buffer 176
 - Named Buffers 177
 - Numbered Buffers 178
- Reading and Writing Files 178
 - Reading Files 178
 - Writing Files 178
 - Identifying the Current File 179
- Setting Parameters 179
 - Setting Parameters from Within vim 179
 - Setting Parameters in a Startup File 180
 - The `.vimrc` Startup File 180
 - Parameters 181
- Advanced Editing Techniques 184
 - Using Markers 184
 - Editing Other Files 185
 - Macros and Shortcuts 186
 - Executing Shell Commands from Within vim 186
- Units of Measure 188
 - Character 188
 - Word 188
 - Blank-Delimited Word 188
 - Line 189
 - Sentence 189
 - Paragraph 190

Window	190
Repeat Factor	191
Chapter Summary	191
Exercises	196
Advanced Exercises	197

CHAPTER 7: THE emacs EDITOR 199

History	200
Evolution	200
emacs Versus vim	201
Tutorial: Getting Started with emacs	201
Starting emacs	202
Stopping emacs	203
Inserting Text	203
Deleting Characters	203
Moving the Cursor	203
Editing at the Cursor Position	206
Saving and Retrieving the Buffer	207
Basic Editing Commands	207
Keys: Notation and Use	208
Key Sequences and Commands	209
META-x: Running a Command Without a Key Binding	209
Numeric Arguments	209
Point and the Cursor	210
Scrolling Through a Buffer	210
Erasing Text	210
Searching	211
Online Help	213
Advanced Editing	215
Undoing Changes	215
Mark and Region	216
Cut and Paste: Yanking Killed Text	218
Inserting Special Characters	219
Global Buffer Commands	220
Files	222
Buffers	224
Windows	225
Foreground Shell Commands	227
Background Shell Commands	227
Language-Sensitive Editing	228
Selecting a Major Mode	229
Human-Language Modes	229
C Mode	232
Customizing Indention	235
Comments	235
Special-Purpose Modes	236

- Customizing `emacs` 238
 - The `.emacs` Startup File 239
 - Remapping Keys 240
 - A Sample `.emacs` File 241
- More Information 242
 - Access to `emacs` 243
- Chapter Summary 243
- Exercises 251
- Advanced Exercises 252

PART III THE SHELLS 255

CHAPTER 8: THE BOURNE AGAIN SHELL 257

- Background 258
- Shell Basics 259
 - Startup Files 259
 - Commands That Are Symbols 262
 - Redirecting Standard Error 262
 - Writing a Simple Shell Script 265
 - Separating and Grouping Commands 268
 - Job Control 272
 - Manipulating the Directory Stack 275
- Parameters and Variables 278
 - User-Created Variables 279
 - Variable Attributes 282
 - Keyword Variables 284
 - Special Characters 292
- Processes 293
 - Process Structure 293
 - Process Identification 293
 - Executing a Command 294
- History 295
 - Variables That Control History 295
 - Reexecuting and Editing Commands 296
 - The Readline Library 304
- Aliases 311
 - Single Versus Double Quotation Marks in Aliases 311
 - Examples of Aliases 312
- Functions 314
- Controlling `bash` Features and Options 316
 - Command Line Options 317
 - Shell Features 317

Processing the Command Line	321
History Expansion	321
Alias Substitution	321
Parsing and Scanning the Command Line	322
Command Line Expansion	322
Chapter Summary	331
Exercises	332
Advanced Exercises	335

CHAPTER 9: THE TC SHELL 337

Shell Scripts	338
Entering and Leaving the TC Shell	338
Startup Files	340
Features Common to the Bourne Again and TC Shells	341
Command Line Expansion (Substitution)	341
Job Control	345
Filename Substitution	346
Manipulating the Directory Stack	346
Command Substitution	346
Redirecting Standard Error	346
Working with the Command Line	348
Word Completion	348
Editing the Command Line	350
Correcting Spelling	351
Variables	352
Variable Substitution	353
String Variables	353
Arrays of String Variables	354
Numeric Variables	355
Braces	357
Special Variable Forms	357
Shell Variables	358
Control Structures	364
if	364
goto	367
Interrupt Handling	367
if...then...else	368
foreach	369
while	371
break and continue	372
switch	372
Builtins	373
Chapter Summary	377
Exercises	378
Advanced Exercises	380

PART IV NETWORKING AND MAINTENANCE 381**CHAPTER 10: NETWORKING AND THE INTERNET 383**

- Types of Networks and How They Work 385
 - Broadcast Networks 386
 - Point-to-Point Networks 386
 - Switched Networks 386
 - LAN: Local Area Network 387
 - WAN: Wide Area Network 388
 - Internetworking Through Gateways and Routers 388
 - Network Protocols 391
 - Host Address 393
 - CIDR: Classless Inter-Domain Routing 398
 - Hostnames 399
- Communicate over a Network 400
 - finger: Displays Information About Remote Users 401
 - Sending Mail to a Remote User 402
 - Mailing List Servers 402
- Network Utilities 403
 - Trusted Hosts 403
 - OpenSSH Tools 403
 - telnet: Logs In on a Remote System 404
 - ftp: Transfers Files over a Network 405
 - ping: Tests a Network Connection 405
 - traceroute: Traces a Route over the Internet 406
 - host and dig: Query Internet Nameservers 408
 - whois: Looks Up Information About an Internet Site 408
- Distributed Computing 410
 - The Client/Server Model 410
 - DNS: Domain Name Service 411
 - Ports 414
 - NFS: Network Filesystem 414
 - Internet Services 414
 - Proxy Servers 416
 - RPC Network Services 417
- Usenet 418
- WWW: World Wide Web 420
 - URL: Uniform Resource Locator 421
 - Browsers 422
 - Search Engines 422
- Chapter Summary 422
- Exercises 423
- Advanced Exercises 424

CHAPTER 11: SYSTEM MAINTENANCE 425

- Philosophy of System Administration 426
- System Administrator and Superuser 427
 - Enabling the **root** Account 430
 - System Maintenance Tools 430
 - Avoiding a Trojan Horse 434
 - Getting Help 435
- System Operation 435
 - Booting the System 436
 - Startup Scripts 436
 - Single-User Mode 437
 - Going Multiuser 437
 - Multiuser Mode 438
 - Logging In 438
 - Periodic Tasks 439
 - Running a Program and Logging Out 439
 - Bringing the System Down 439
 - Crash 441
- NetInfo 441
- Important Standard Directories and Files 444
- Useful Utilities 448
- Setting Up a Server 451
 - Configuration Files 451
 - lookupd**: Which Service to Look at First 455
 - The Superserver 456
 - Securing a Server Under Mac OS X 10.4 and Later 460
 - DHCP 464
- PAM 466
 - Configuration Files, Module Types, and Control Flags 467
 - Example 469
 - Modifying the PAM Configuration 470
- fink: Downloads and Installs Software 470
- Chapter Summary 472
- Exercises 472
- Advanced Exercises 473

PART V PROGRAMMING TOOLS 475**CHAPTER 12: PROGRAMMING TOOLS 477**

- Carbon, Cocoa, and UNIX APIs 478
- Programming in C 478
 - Checking Your Compiler 479
 - A C Programming Example 480
 - Compiling and Linking a C Program 483

Using Shared Libraries	486
Frameworks	487
Fixing Broken Binaries	488
Creating Shared Libraries	488
make: Keeps a Set of Programs Current	489
Implied Dependencies	491
Macros	494
Debugging C Programs	496
gcc: Compiler Warning Options	499
Symbolic Debuggers	500
Threads	506
System Calls	506
ktrace: Traces System Calls	507
Controlling Processes	507
Accessing the Filesystem	508
Source Code Management	509
CVS: Concurrent Versions System	510
Chapter Summary	519
Exercises	520
Advanced Exercises	520

CHAPTER 13: PROGRAMMING THE BOURNE AGAIN SHELL 523

Control Structures	524
if...then	524
if...then...else	528
if...then...elif	531
for...in	537
for	538
while	540
until	541
break and continue	543
case	545
select	551
Here Document	553
File Descriptors	555
Parameters and Variables	558
Array Variables	558
Locality of Variables	560
Special Parameters	562
Positional Parameters	564
Expanding Null and Unset Variables	569
Builtin Commands	570
type: Displays Information About a Command	570

read : Accepts User Input	571
exec : Executes a Command	574
trap : Catches a Signal	577
kill : Aborts a Process	580
getopts : Parses Options	581
A Partial List of Builtins	583
Expressions	584
Arithmetic Evaluation	585
Logical Evaluation (Conditional Expressions)	586
String Pattern Matching	587
Operators	588
Shell Programs	593
A Recursive Shell Script	593
The quiz Shell Script	596
Chapter Summary	603
Exercises	604
Advanced Exercises	606

CHAPTER 14: THE **awk** PATTERN PROCESSING LANGUAGE 609

Syntax	610
Arguments	610
Options	611
Notes	611
Language Basics	611
Patterns	612
Actions	612
Comments	613
Variables	613
Functions	614
Arithmetic Operators	614
Associative Arrays	615
printf	615
Control Structures	616
Examples	618
Advanced awk Programming	634
getline : Controlling Input	634
system : Running External Commands	637
Error Messages	637
Chapter Summary	638
Exercises	639
Advanced Exercises	639

CHAPTER 15: THE sed EDITOR 641

- Syntax 642
- Arguments 642
- Options 642
- Editor Basics 642
 - Addresses 643
 - Instructions 643
 - Control Structures 645
 - The Pattern Space and the Hold Space 645
- Examples 646
- Chapter Summary 656
- Exercises 656

PART VI COMMAND REFERENCE 657

- Standard Multiplicative Suffixes 662
- Common Options 663
- The `sample` Utility 663
 - `sample` Very brief description of what the utility does 664
 - `at` Executes commands at a specified time 665
 - `bzip2` Compresses or decompresses files 668
 - `cal` Displays a calendar 670
 - `cat` Joins and displays files 671
 - `cd` Changes to another working directory 673
 - `chgrp` Changes the group associated with a file 675
 - `chmod` Changes the access mode (permissions) of a file 676
 - `chown` Changes the owner of a file and/or the group the file is associated with 682
 - `cmp` Compares two files 684
 - `comm` Compares sorted files 686
- `configure` Configures source code automatically 688
 - `cp` Copies files 690
 - `cpio` Creates an archive, restores files from an archive, or copies a directory 693
- `crontab` Maintains crontab files 697
 - `cut` Selects characters or fields from input lines 699
- `date` Displays or sets the system time and date 701
 - `dd` Converts and copies a file 703
 - `df` Displays disk space usage 705
 - `diff` Displays the differences between two files 707
- `diskutil` Checks, modifies, and repairs local volumes 712
 - `ditto` Copies files and creates and unpacks archives 715
 - `dmesg` Displays kernel messages 717

-
- du Displays information on disk usage by file 718
 - echo Displays a message 720
 - expr Evaluates an expression 722
 - file Displays the classification of a file 726
 - find Finds files based on criteria 728
 - finger Displays information about users 734
 - fmt Formats text very simply 736
 - ftp Transfers files over a network 738
 - gcc Compiles C, Objective-C, and C++ programs 745
 - GetFileInfo Displays file attributes 749
 - grep Searches for a pattern in files 751
 - gzip Compresses or decompresses files 756
 - head Displays the beginning of a file 759
 - kill Terminates a process by PID number 761
 - killall Terminates a process by name 763
 - launchctl Controls the **launchd** daemon 765
 - less Displays text files, one screen at a time 768
 - ln Makes a link to a file 772
 - lpr Sends files to printers 774
 - ls Displays information about one or more files 777
 - make Keeps a set of programs current 783
 - man Displays documentation for commands 788
 - mkdir Creates a directory 791
 - mv Renames or moves a file 792
 - nice Changes the priority of a command 794
 - nidump Display contents of a NetInfo database 796
 - nohup Runs a command that keeps running after you log out 798
 - od Dumps the contents of a file 799
 - open Opens files, directories, and URLs 803
 - otool Displays object, library, and executable files 805
 - paste Joins corresponding lines from files 807
 - pax Creates an archive, restores files from an archive, or copies a directory 809
 - plutil Manipulates property list files 815
 - pr Paginates files for printing 817
 - ps Displays process status 819
 - rcp Copies one or more files to or from a remote system 823
 - renice Changes the priority of a process 825
 - rlogin Logs in on a remote system 826
 - rm Removes a file (deletes a link) 827
 - rmdir Removes a directory 829
 - rsh Executes commands on a remote system 830

scp	Securely copies one or more files to or from a remote system	832
SetFile	Sets file attributes	834
sleep	Creates a process that sleeps for a specified interval	836
sort	Sorts and/or merges files	837
split	Divides a file into sections	846
ssh	Securely executes commands on a remote system	847
stat	Displays information about files	851
strings	Displays strings of printable characters	853
stty	Displays or sets terminal parameters	854
sysctl	Displays and alters kernel variables	858
tail	Displays the last part of a file	859
tar	Stores or retrieves files to/from an archive file	862
tee	Copies standard input to standard output and one or more files	867
telnet	Connects to a remote system over a network	868
test	Evaluates an expression	871
top	Dynamically displays process status	874
touch	Changes a file's access and/or modification time	877
tr	Replaces specified characters	879
tty	Displays the terminal pathname	882
umask	Establishes the file-creation permissions mask	883
uniq	Displays unique lines	885
w	Displays information about system users	887
wc	Displays the number of lines, words, and bytes	888
which	Shows where in PATH a command is located	889
who	Displays information about logged-in users	890
xargs	Converts standard input into command lines	892

PART VII APPENDICES 895

APPENDIX A: REGULAR EXPRESSIONS 897

Characters	898
Delimiters	898
Simple Strings	898
Special Characters	898
Periods	899
Brackets	899
Asterisks	899
Caret and Dollar Signs	900
Quoting Special Characters	900

Rules	901
Longest Match Possible	901
Empty Regular Expressions	902
Bracketing Expressions	902
The Replacement String	902
Ampersand	903
Quoted Digit	903
Extended Regular Expressions	903
Appendix Summary	905

APPENDIX B: HELP 907

Solving a Problem	908
Finding Related Information	909
Documentation	909
Useful UNIX Sites	910
Mac OS X Newsgroups and Forums	911
Mailing Lists	911
Words	911
Software	912
Specifying a Terminal	913

APPENDIX C: MAC OS X FOR UNIX USERS 915

GLOSSARY 919

INDEX 963

