

Advanced Bash-Scripting Guide

An in-depth exploration of the art of shell scripting

Mendel Cooper

[<theqrendel.aba@gmail.com>](mailto:theqrendel.aba@gmail.com)
10
10 Mar 2014

Revision History		
Revision 6.5	05 Apr 2012	Revised by: mc
'TUNGSTENBERRY' release		
Revision 6.6	27 Nov 2012	Revised by: mc
'YTTERBIUMBERRY' release		
Revision 10	10 Mar 2014	Revised by: mc
'PUBLICDOMAIN' release		

This tutorial assumes no previous knowledge of scripting or programming, yet progresses rapidly toward an intermediate/advanced level of instruction . . . *all the while sneaking in little nuggets of UNIX® wisdom and lore.* It serves as a textbook, a manual for self-study, and as a reference and source of knowledge on shell scripting techniques. The exercises and heavily-commented examples invite active reader participation, under the premise that **the only way to really learn scripting is to write scripts.**

This book is suitable for classroom use as a general introduction to programming concepts.

This document is herewith granted to the Public Domain. **No copyright!**

Dedication

For Anita, the source of all the magic

Table of Contents

Part 1.	Introduction
	1. Shell Programming!
	2. Starting Off With a Sha-Bang
Part 2.	Basics
	3. Special Characters
	4. Introduction to Variables and Parameters
	5. Quoting
	6. Exit and Exit Status
	7. Tests
	8. Operations and Related Topics
Part 3.	Beyond the Basics
	9. Another Look at Variables
	10. Manipulating Variables
	11. Loops and Branches
	12. Command Substitution
	13. Arithmetic Expansion
	14. Recess Time
Part 4.	Commands
	15. Internal Commands and Builtins
	16. External Filters, Programs and Commands
	17. System and Administrative Commands
Part 5.	Advanced Topics
	18. Regular Expressions
	19. Here Documents
	20. I/O Redirection
	21. Subshells
	22. Restricted Shells
	23. Process Substitution
	24. Functions
	25. Aliases
	26. List Constructs
	27. Arrays
	28. Indirect References
	29. /dev and /proc
	30. Network Programming
	31. Of Zeros and Nulls
	32. Debugging
	33. Options
	34. Gotchas
	35. Scripting With Style
	36. Miscellany
	37. Bash_versions 2, 3, and 4
38.	Endnotes
	38.1. Author's Note
	38.2. About the Author
	38.3. Where to Go For Help
	38.4. Tools Used to Produce This Book
	38.5. Credits
	38.6. Disclaimer
Bibliography	
A.	Contributed Scripts
B.	Reference Cards
C.	A Sed and Awk Micro-Primer
	C.1. Sed
	C.2. Awk
D.	Parsing and Managing Pathnames
E.	Exit Codes With Special Meanings
F.	A Detailed Introduction to I/O and I/O Redirection
G.	Command-Line Options
	G.1. Standard Command-Line Options
	G.2. Bash Command-Line Options
H.	Important Files
I.	Important System Directories
J.	An Introduction to Programmatic Completion
K.	Localization
L.	History Commands
M.	Sample .bashrc and .bash_profile Files
N.	Converting DOS Batch Files to Shell Scripts
O.	Exercises
	O.1. Analyzing Scripts
	O.2. Writing Scripts
P.	Revision History
Q.	Download and Mirror Sites
R.	To Do List
S.	Copyright
T.	ASCII Table
Index	
List of Tables	
8-1.	Operator Precedence
15-1.	Job identifiers
33-1.	Bash options
	Numbers representing colors in Escape Sequences
B-1.	SPECIAL Shell Variables
B-2.	TEST Operators: Binary Comparison
B-3.	TEST Operators: Files
B-4.	Parameter Substitution and Expansion
B-5.	String Operations
B-6.	Miscellaneous Constructs
C-1.	Basic sed operators
C-2.	Examples of sed operators
E-1.	Reserved Exit Codes
N-1.	Batch file keywords / variables / operators, and their shell equivalents
N-2.	DOS commands and their UNIX equivalents
P-1.	Revision History
List of Examples	
2-1.	cleanup: A script to clean up log files in /var/log
2-2.	cleanup: An improved clean-up script
2-3.	cleanup: An enhanced and generalized version of above scripts.
3-1.	Code blocks and I/O redirection
3-2.	Setting the output of a code block to a file
3-3.	Running a loop in the background
3-4.	Backup of all files changed in last day
4-1.	Variable assignment and substitution
4-2.	Plain Variable Assignment
4-3.	Variable Assignment, plain and fancy
4-4.	Integer or string?
4-5.	Positional Parameters
4-6.	whi, whois domain name lookup
4-7.	Using shift
5-1.	Echoing Weird Variables
5-2.	Escaped Characters
5-3.	Detecting key-presses
6-1.	exit / exit status
6-2.	Negating a condition using !
7-1.	What is truth?
7-2.	Equivalence of test, /usr/bin/test, [,] and /usr/bin/t
7-3.	Arithmetic Tests using ((..))
7-4.	Testing for broken links
7-5.	Arithmetic and string comparisons
7-6.	Testing whether a string is null
7-7.	more
8-1.	Greatest common divisor
8-2.	Using Arithmetic Operations
8-3.	Compound Condition Tests Using && and
8-4.	Representation of numerical constants
8-5.	C-style manipulation of variables
9-1.	IFS and whitespace
9-2.	Timed Input
9-3.	Once more, timed input
9-4.	Timed read
9-5.	Am I root?
9-6.	arglist: Listing arguments with \$* and \$@
9-7.	Inconsistent \$* and \$@ behavior
9-8.	\$* and \$@ when \$IFS is empty
9-9.	Underscore variable
9-10.	Using declare to type variables
9-11.	Generating random numbers
9-12.	Picking a random card from a deck
9-13.	Brownian Motion Simulation
9-14.	Random between values
9-15.	Rolling a single die with RANDOM
9-16.	Reseeding RANDOM
9-17.	Pseudorandom numbers, using awk
10-1.	Inserting a blank line between paragraphs in a text file
10-2.	Generating an 8-character "random" string
10-3.	Converting graphic file formats, with filename change
10-4.	Converting streaming audio files to ogg
10-5.	Emulating getopt
10-6.	Alternate ways of extracting and locating substrings
10-7.	Using parameter substitution and error messages
10-8.	Parameter substitution and "usage" messages
10-9.	Length of a variable
10-10.	Pattern matching in parameter substitution
10-11.	Renaming file extensions;
10-12.	Using pattern matching to parse arbitrary strings
10-13.	Matching patterns at prefix or suffix of string
11-1.	Simple for loops
11-2.	for loop with two parameters in each [list] element
11-3.	Fileinfo: operating on a file list contained in a variable
11-4.	Operating on a parameterized file list
11-5.	Operating on files with a for loop
11-6.	Missing in (list) in a for loop
11-7.	Generating the (list) in a for loop with command substitution
11-8.	grep replacement for binary files
11-9.	Listing all users on the system
11-10.	Checking all the binaries in a directory for authorship
11-11.	Listing the symbolic links in a directory
11-12.	Symbolic links in a directory, saved to a file
11-13.	A C-style for loop
11-14.	Using efax in batch mode
11-15.	Simple while loop
11-16.	Another while loop
11-17.	while loop with multiple conditions
11-18.	C-style syntax in a while loop
11-19.	until loop
11-20.	Nested Loop
11-21.	Effects of break and continue in a loop
11-22.	Breaking out of multiple loop levels
11-23.	Continuing at a higher loop level
11-24.	Using continue N in an actual task
11-25.	Using case
11-26.	Creating menus using case
11-27.	Using command substitution to generate the case variable
11-28.	Simple string matching
11-29.	Checking for alphabetic input
11-30.	Creating menus using select
11-31.	Creating menus using select in a function
12-1.	Stupid script tricks
12-2.	Generating a variable from a loop
12-3.	Finding anagrams
15-1.	A script that spawns multiple instances of itself
15-2.	printf in action
15-3.	Variable assignment, using read
15-4.	What happens when read has no variable
15-5.	Multi-line input to read
15-6.	Detecting the arrow keys
15-7.	Using read with file redirection
15-8.	Problems reading from a pipe
15-9.	Changing the current working directory
15-10.	Letting let do arithmetic
15-11.	Showing the effect of eval
15-12.	Using eval to select among variables
15-13.	Echoing the command-line parameters
15-14.	Forcing a log-off
15-15.	A version of rot13
15-16.	Using set with positional parameters
15-17.	Reversing the positional parameters
15-18.	Reassigning the positional parameters
15-19.	"Exporting" a variable
15-20.	Using export to pass a variable to an embedded awk script
15-21.	Using getopt to read the options/arguments passed to a script
15-22.	"Including" a data file
15-23.	A (useless) script that sources itself
15-24.	Effects of exec
15-25.	A script that exec's itself
15-26.	Waiting for a process to finish before proceeding
15-27.	A script that kills itself
16-1.	Using ls to create a table of contents for burning a CDR disk
16-2.	Badname, eliminate file names in current directory containing bad characters and whitespace.
16-4.	Deleting a file by its inode number
16-5.	Logfile: Using xargs to monitor system log
16-6.	Copying files in current directory to another
16-7.	Killing processes by name
16-8.	Word frequency analysis using xargs
16-9.	Using expr
16-10.	Using date
16-11.	Date calculations
16-12.	Word Frequency Analysis
16-13.	Which files are scripts?
16-14.	Generating 10-digit random numbers
16-15.	Using tail to monitor the system log
16-16.	Printing out the From lines in stored e-mail messages
16-17.	Emulating grep in a script
16-18.	Crossword puzzle solver
16-19.	Looking up definitions in Webster's 1913 Dictionary
16-20.	Checking words in a list for validity
16-21.	toupper: Transforms a file to all uppercase.
16-22.	lowercase: Changes all filenames in working directory to lowercase.
16-23.	dtr: DOS to UNIX text file conversion.
16-24.	rot13: ultra-weak encryption.
16-25.	Generating "Crypto-Quote" Puzzles
16-26.	Formatted file listing.
16-28.	nl: A self-numbering script.
16-29.	manview: Viewing formatted manpages
16-30.	Using cpio to move a directory tree
16-31.	Unpacking an rpm archive
16-32.	Stripping comments from C program files
16-33.	Exploring /usr/X11R6/bin
16-34.	An "improved" strings command
16-35.	Using cmp to compare two files within a script.
16-36.	basename and dirname
16-37.	A script that copies itself in sections
16-38.	Checking file integrity
16-39.	Undecoding encoded files
16-40.	Finding out where to report a spammer
16-41.	Analyzing a spam domain
16-42.	Getting a stock quote
16-43.	Updating FC4
16-44.	Using svn
16-45.	A script that mails itself
16-46.	Generating prime numbers
16-47.	Monthly Payment on a Mortgage
16-48.	Base Conversion
16-49.	Invoking bc using a here document
16-50.	Calculating PI
16-51.	Converting a decimal number to hexadecimal
16-52.	Factoring
16-53.	Calculating the hypotenuse of a triangle
16-54.	Using seq to generate loop arguments
16-55.	Letter Count"
16-56.	Using getopt to parse command-line options
16-57.	A script that copies itself
16-58.	Exercising dd
16-59.	Capturing keystrokes
16-60.	Preparing a bootable SD card for the Raspberry Pi
16-61.	Securely deleting a file
16-62.	Filename generator
16-63.	Converting meters to miles
16-64.	Using md
17-1.	Setting a new password
17-2.	Setting an erase character
17-3.	secret password: Turning off terminal echoing
17-4.	Keypress detection
17-5.	Checking a remote server for ident
17-6.	pidof helps kill a process
17-7.	Checking a CD image
17-8.	Creating a filesystem in a file
17-9.	Adding a new hard drive
17-10.	Using umask to hide an output file from prying eyes
17-11.	backlight: changes the brightness of the (laptop) screen backlight
17-12.	killall, from /etc/passwd/init.d
19-1.	broadcast: Sends message to everyone logged in
19-2.	dummyfile: Creates a 2-line dummy file
19-3.	Multi-line message using cat
19-4.	Multi-line message, with tabs suppressed
19-5.	Here document with replaceable parameters
19-6.	Upload a file pair to Sunsite incoming directory
19-7.	Parameter substitution turned off
19-8.	A script that generates another script
19-9.	Here documents and functions
19-10.	"Anonymous" Here Document
19-11.	Commenting out a block of code
19-12.	A self-documenting script
19-13.	Prepending a line to a file
19-14.	Parsing a mailbox
20-1.	Redirecting stdin using exec
20-2.	Redirecting stdout using exec
20-3.	Redirecting both stdin and stdout in the same script with exec
20-4.	Avoiding a subshell
20-5.	Redirected while loop
20-6.	Alternate form of redirected while loop
20-7.	Redirected until loop
20-8.	Redirected for loop
20-9.	Redirected for loop (both stdin and stdout redirected)
20-10.	Redirected if/then test
20-11.	Data file names data for above examples
20-12.	Logging events
21-1.	Variable scope in a subshell
21-2.	List User Profiles
21-3.	Running parallel processes in subshells
21-4.	Running a script in restricted mode
23-1.	Code block redirection without forking
23-2.	Redirecting the output of process substitution into a loop.
24-1.	Simple functions
24-2.	Function Taking Parameters
24-3.	Functions and command-line args passed to the script
24-4.	Passing an indirect reference to a function
24-5.	Dereferencing a parameter passed to a function
24-6.	Again, dereferencing a parameter passed to a function
24-7.	Maximum of two numbers
24-8.	Converting numbers to Roman numerals
24-9.	Testing large return values in a function
24-10.	Comparing two large integers
24-11.	Real name from username
24-12.	Local variable visibility
24-13.	Demonstration of a simple recursive function
24-14.	Another simple demonstration
24-15.	Recursion using a local variable
24-16.	The Fibonacci Sequence
24-17.	The Towers of Hanoi
25-1.	Aliases within a script
25-2.	unalias: Setting and unsetting an alias
26-1.	Using an and list to test for command-line arguments
26-2.	Another command-line arg test using an and list
26-3.	Using or lists in combination with an and list
27-1.	Simple array usage
27-2.	Formatting a poem
27-3.	Various array operations
27-4.	String operations on arrays
27-5.	Loading the contents of a script into an array
27-6.	Some special properties of arrays
27-7.	Of empty arrays and empty elements
27-8.	Initializing arrays
27-9.	Copying and concatenating arrays
27-10.	More on concatenating arrays
27-11.	The Bubble Sort
27-12.	Embedded arrays and indirect references
27-13.	The Sieve of Eratosthenes, Optimized
27-16.	Complex array application: Exploring a weird mathematical series
27-17.	Simulating a two-dimensional array, then tilting it
28-1.	Indirect Variable References
28-2.	Passing an indirect reference to awk
29-1.	Using /dev/tcp for troubleshooting
29-2.	Playing music
29-3.	Finding the process associated with a PID
29-4.	On-line connect status
30-1.	Print the server environment
30-2.	IP addresses
30-3.	Hiding the cookie jar
31-2.	Setting up a swapfile using /dev/zero
31-3.	Creating a ramdisk
32-1.	A buggy script
32-2.	Missing keyword
32-3.	test24: another buggy script
32-4.	Testing a condition with an assert
32-5.	Trapping at exit
32-6.	Cleaning up after Control-C
32-7.	A Simple Implementation of a Progress Bar
32-8.	Tracing a variable
32-9.	Running multiple processes (on an SMP box)
34-1.	Numerical and string comparison are not equivalent
34-2.	Subshell Pitfalls
34-3.	Piping the output of echo to a read
36-1.	shell wrapper
36-2.	A slightly more complex shell wrapper
36-3.	A generic shell wrapper that writes to a logfile
36-4.	A shell wrapper around an awk script
36-5.	A shell wrapper around another awk script
36-6.	Perl embedded in a Bash script
36-7.	Bash and Perl scripts combined
36-8.	Python embedded in a Bash script
36-9.	A script that speaks
36-10.	A (useless) script that recursively calls itself
36-11.	A (useful) script that recursively calls itself
36-12.	Another (useful) script that recursively calls itself
36-13.	A "colorized" address database
36-14.	Drawing a box
36-15.	Echoing colored text
36-16.	A "horseshoe" game
36-17.	A Progress Bar
36-18.	Return value trickery
36-19.	Even more return value trickery
36-20.	Passing and returning arrays
36-21.	Fun with anagrams
36-22.	Widgets invoked from a shell script
36-23.	Test Suite
37-1.	String