

Bash Quick References

Bash (Bourne Again Shell) is a shell language build on-top of the original Bourne Shell which was distributed with V7 Unix in 1979 and became the standard for writing shell scripts. Today it is primary to most Linux distributions, MacOS and it has even recently been enabled to run on Windows through something called WSL (Windows Subsystem for Linux).

File Test Operators

Testing files in scripts is easy and straight forward. This is where shell scripting starts to show its glory! In Bash you can do file testing for permissions, size, date, filetype or existence.

Flag	Description
-e	File exists
-a	File exists (identical to -e but is deprecated and outdated)
-f	File is a regular file (not a directory or device file)
-s	file is not zero size
-d	file is a directory
-b	file is a block device
-c	file is a character device
-p	file is a pipe
-h	file is a symbolic link
-L	file is a symbolic link
-S	file is a socket
-t	file (descriptor) is associated with a terminal device; this test option may be used to check whether the stdin [-t 0] or stdout [-t 1] in a given script is a terminal
-r	file has read permission (for the user running the test)
-w	file has write permission (for the user running the test)
-x	file has execute permission (for the user running the test)
-g	set-group-id (sgid) flag set on file or directory
-u	set-user-id (suid) flag set on file.
-k	sticky bit set.
-O	you are owner of file
-G	group-id of file same as yours
-N	file modified since it was last read
f1 -nt f2	file f1 is newer than f2
f1 -ot f2	file f1 is older than f2
f1 -ef f2	files f1 and f2 are hard links to the same file
!	Not – reverses the sense of the tests above (returns true if condition absent).

Integer Comparison Operators

How to compare integers or arithmetic expressions in shell scripts.

Flag	Description
-eq	is equal to
-ne	is not equal to
-gt	is greater than
-ge	is greater than or equal to
-lt	is less than
-le	is less than or equal to
<	is less than – place within double parentheses
<=	is less than or equal to (same rule as previous row)
>	is greater than (same rule as previous row)
>=	is greater than or equal to (same rule as previous row)

String Comparison Operators

String comparison in Bash.

Flag	Description
=	is equal to
==	same as above
!=	is not equal to
<	is less than ASCII alphabetical order
>	is greater than ASCII alphabetical order
-z	string is null (i.e. zero length)
-n	string is not null (i.e. !zero length)

Compound Operators

Useful for boolean expressions and is similar to && and ||. The compound operators work with the test command or may occur within single brackets [<expr>].

Flag	Description
-a	logical and
-o	logical or

Job Identifiers

Job control allows you to selectively stop (suspend) the execution of processes and continue their execution at a later point in time.

Notation	Description
%N	Job number [N]
%S	Invocation (command-line) of job begins with string S
%?S	Invocation (command-line) of job contains within it string S
%%	"current" job (last job stopped in foreground or started in background)
%+	"current" job (last job stopped in foreground or started in background)
%-	Last job
%!	Last background process

List Constructs

Provides a means of processing commands consecutively and in effect is able to replace complex if/then/case structures.

Construct	Description
&&	and construct
	or construct

Reserved Exit Codes

Useful for debugging a script. Exit takes integer args in the range 0-255.

Exit Code No.	Description
1	Catchall for general errors
2	Misuse of shell builtins
126	Command invoked cannot execute
127	Command not found
128	Invalid argument to exit
128+n	Fatal error signal "n"
130	Script terminated by Control-C

Signals

UNIX System V Signals.

Name	Number	Action	Description
SIGHUP	1	exit	Hangs up
SIGINT	2	exit	Interrupts.
SIGQUIT	3	core dump	Quits.
SIGILL	4	core dump	Illegal instruction.
SIGTRAP	5	core dump	Trace trap.
SIGIOT	6	core dump	IOT instruction.
SIGEMT	7	core dump	MT instruction.
SIGFPE	8	core dump	Floating point exception.
SIGKILL	9	exit	Kills (cannot be caught or ignored).
SIGBUS	10	core dump	Bus error.
SIGSEGV	11	core dump	Segmentation violation.
SIGSYS	12	core dump	Bad argument to system call.
SIGPIPE.	13	exit	Writes on a pipe with no one to read it.
SIGALRM	14	exit	Alarm clock.
SIGTERM	15	exit	Software termination signal.

Sending Control Signals

You can use these key-combinations to send signals

Key Combo Description

Ctrl+C	The interrupt signal, sends SIGINT to the job running in the foreground.
Ctrl+Y	The delayed suspend character. Causes a running process to be stopped when it attempts to read input from the terminal. Control is returned to the shell, the user can foreground, background or kill the process. Delayed suspend is only available on operating systems supporting this feature.
Ctrl+Z	The suspend signal, sends a SIGTSTP to a running program, thus stopping it and returning control to the shell.

Check your stty settings. Suspend and resume of output is usually disabled if you are using "modern" terminal emulations. The standard xterm supports Ctrl+S and Ctrl+Q by default.

File Types

This is very different from Windows but straight forward once you get it. I'll expand this section soon with more context.

Symbol	Meaning
-	Regular file
d	Directory
l	(Symbolic) Link
c	Character device
s	Socket
p	Named pipe
b	Block device

Permissions

Now you may know what that arcane looking string `rw-rw-rw-` is when you invoke `ls`

Code	Description
s	setuid when in user column
S	setgid when in group column
t	sticky bit
0	The access right that is supposed to be on this place is not granted.
-	
4	read access is granted to the user category defined in this place
r	
2	write permission is granted to the user category defined in this place
w	
1	execute permission is granted to the user category defined in this place
x	
u	user permissions
g	group permissions
o	others permissions

Special Files

Files that are read by the shell. Listed in order of their execution.

File	Info
/etc/profile	Executed automatically at login
~.bash_profile	Whichever is found first is executed at login.
~/.bash_login	
~.profile	
~/.bashrc	Is read by every nonlogin shell.

String Manipulation

Bash supports a surprisingly big number of string operations! Unfortunately, these tools lack a unified focus. Some are a subset of parameter substitution, and others fall under the functionality of the UNIX `expr` command. This results in inconsistent command syntax and overlap of functionality.

MacOS built-in bash is from 2007 and won't support many of these.

Pattern	Description
<code>\${#var}</code>	Find the length of the string
<code>\${var%pattern}</code>	Remove from shortest rear (end) pattern
<code>\${var%%pattern}</code>	Remove from longest rear (end) pattern
<code>\${var:position}</code>	Extract substring from \$var at \$position
<code>\${var:num1:num2}</code>	Substring
<code>\${var#pattern}</code>	Remove from shortest front pattern
<code>\${var##pattern}</code>	Remove from longest front pattern
<code>\${var/pattern/string}</code>	Find and replace (only replace first occurrence)
<code>\${var//pattern/string}</code>	Find and replace all occurrences
<code>\${!prefix*}</code>	Expands to the names of variables whose names begin with prefix.
<code>\${var,}</code>	Convert first character to lowercase.
<code>\${var,pattern}</code>	Convert all characters to lowercase.
<code>\${var,,}</code>	
<code>\${var,,pattern}</code>	Convert first character to uppercase.
<code>\${var^}</code>	
<code>\${var^pattern}</code>	Convert all character to uppercase.
<code>\${var^^}</code>	
<code>\${var^^pattern}</code>	Replace first match of \$substring with \$replacement
<code>\${string/substring/replacement}</code>	
<code>\${string//substring/replacement}</code>	
<code>\${string/#substring/replacement}</code>	
<code>\${string/%substring/replacement}</code>	If \$substring matches back end of \$string, substitute \$replacement for \$substring
<code>expr match "\$string" '\$substring'</code>	Length of matching \$substring* at beginning of \$string
<code>expr "\$string" : '\$substring'</code>	Length of matching \$substring* at beginning of \$string

Pattern	Description
expr index "\$string" \$substring	Numerical position in \$string of first character in \$substring* that matches [0 if no match, first character counts as position 1]
expr substr \$string \$position \$length	Extract \$length characters from \$string starting at \$position [0 if no match, first character counts as position 1]
expr match "\$string" '\(\$substring\)'	Extract \$substring*, searching from beginning of \$string
expr "\$string" : '\(\$substring\)'	Extract \$substring* , searching from beginning of \$string
expr match "\$string" '.*\(\$substring\)'	Extract \$substring*, searching from end of \$string
expr "\$string" : '.*\(\$substring\)'	Extract \$substring*, searching from end of \$string

Quoting

The following text shows characters or that need to be quoted if you want to use their literal symbols and not their special meaning.

Symbol	Literal Meaning
;	Command seperator
&	Background execution
()	Command grouping
	Pipe
< > &	Redirection symbols
* ? [] ~ + - @ !	Filename metacharacters
" ' \	Used in quoting characters
\$	Variable, command or arithmetic substitiuon
#	Start a command that ends on a linebreak
space tab newline	Word seperators

Everything between "." is taken literally, except \$ (dollar) ` (backtick) and " (double-quotation).

Everything between '.' is taken literally, except ' (single-quote).

The characters following \ is taken literally.
Use \ to escape anything in "." or '.'

Using \$ before "." or '.' causes some special behavior. "\$..." is the same as "...", except that locale translation is done. Likewise, '\$...' is similar to '\$...' except that the quoted string is processed for escape sequences.

Command Parameters

Command parameters, also known as arguments, are used when invoking a Bash script.

Command	Description
\$0	Name of the script itself
\$1 ... \$9	Parameter 1 ... 9
\${10}	Positional parameter 10
\$*	Expands to the positional parameters, starting from one. When the expansion occurs within double quotes, it expands to a single word with the value of each parameter seperated by the first of the IFS environment variable

Command	Description
\$-	Current options
_	The underscore variable is set at shell startup and contains the absolute file name of the shell or script being executed as passed in the argument list. Subsequently, it expands to the last argument to the previous command, after expansion. It is also set to the full pathname of each command executed and placed in the environment exported to that command. When checking mail, this parameter holds the name of the mail file.
\$\$	Process id of the shell
\$?	Exit status of the most recently executed command
\$@	All arguments as separate words
\$#	Number of arguments
\$_	PID of most recently backgrounded process

History Expansion

Enables use and manipulation of previous commands.

Command	Description
!	Starts a history substitution
!!	Refers to the last command.
!n	Refers to the <n>-th command line.
!-n	Refers to the current command line minus <n>.
!string	Refers to the most recent command starting with <string>
!?string?	Refers to the most recent command containing <string> (the ending ? is optional)
^string1^string2^	Quick substitution. Repeats the last command, replacing <string1> with <string2>.
!#	Refers to the entire command line typed so far.

Variable Operations

Perform operations on variables.

Expression

\${parameter:-defaultValue}	Get default shell variables value
\${parameter:=defaultValue}	Set default shell variables value
\${parameter:? "Error Message"}	Display an error message if parameter is not set

Bash Globbing

Bash cannot recognize RegEx but understand globbing. Globbing is done to filenames by the shell while RegEx is used for searching text.

Glob	Description
*	Matches zero or more occurrences of a given pattern
?	Matches zero or one occurrences of a given pattern
+	Matches one or more occurrences of a given pattern
!	Negates any pattern matches — reverses the pattern so to speak

Regular Expressions

Always use quotes in your RegEx to avoid globbing

Operator	Effect
.	Matches any single character.
?	The preceding item is optional and will be matched, at most, once.
*	The preceding item will be matched zero or more times.
+	The preceding item will be matched one or more times.
{N}	The preceding item is matched exactly N times.
{N,}	The preceding item is matched N or more times.
{N,M}	The preceding item is matched at least N times, but not more than M times.
-	Represents the range if it's not first or last in a list or the ending point of a range in a list.
^	Matches the empty string at the beginning of a line; also represents the characters not in the range of a list.
\$	Matches the empty string at the end of a line.
[aoeiAOEI]	Matches any 1 character from the list.
[^AOEIaoei]	Matches any 1 character, not in the list!
[a-f]	Matches any 1 character in the range a-f

In basic regular expressions the metacharacters "?", "+", "{", "|", "(", and ")" lose their special meaning; instead use the backslash versions "\?", "...", "\)". Check in your system documentation whether commands using regular expressions support extended expressions.

Character Classes In BRE

A character class `[:CharClass:]` is a set of predefined patterns and comprised of the following:

Character Class	Equivalent	Explanation
<code>[:lower:]</code>	<code>[a-z]</code>	Lowercase letters.
<code>[:upper:]</code>	<code>[A-Z]</code>	Uppercase letters.
<code>[:alpha:]</code>	<code>[A-Za-z]</code>	Alphabetic letters, both upper- and lowercase.
<code>[:digit:]</code>	<code>[0-9]</code>	Numbers 0-9.
<code>[:alnum:]</code>	<code>[a-zA-Z0-9]</code>	Alphanumeric: both letters (upper- + lowercase) and digit
<code>[:xdigit:]</code>	<code>[0-9A-Fa-f]</code>	Hexadecimal digits.
<code>[:space:]</code>	<code>[\t\n\r\f\v]</code>	Whitespace. Spaces, tabs, newline and similar.
<code>[:punct:]</code>		Symbols (minus digits and letters).
<code>[:print:]</code>	<code>[[:graph]]</code>	Printable characters (spaces included).
<code>[:blank:]</code>	<code>[\t]</code>	Space and tab characters only.
<code>[:graph:]</code>	<code>[^ [:cntrl:]]</code>	Graphically printable characters excluding space.
<code>[:cntrl:]</code>		Control characters. Non-printable characters.

Shell Builtins

Shell builtins are built into Bash and are often very (if not extremely) fast compared to external programs. Some of the builtins are inherited from the Bourne Shell (sh) — these inherited commands will also work in the original Bourne Shell.

Builtin	Description
:	Equivalent to true.
.	Reads and executes commands from a designated file in the current shell.
[Is a synonym for test but requires a final argument of].
alias	Defines an alias for the specified command.
bg	Resumes a job in background mode.
bind	Binds a keyboard sequence to a read line function or macro.
break	Exits from a for, while, select, or until loop.
builtin	Executes the specified shell built-in command.
caller	Returns the context of any active subroutine call
case	
cd	Changes the current directory to the specified directory.
command	Executes the specified command without the normal shell lookup.
compgen	Generates possible completion matches for the specified word.
complete	Displays how the specified words would be completed.
comopt	
continue	Resumes the next iteration of a for, while, select, or until loop.
declare	Declares a variable or variable type.
dirs	Displays a list of currently remembered directories.
disown	Removes the specified jobs from the jobs table for the process.
echo	Displays the specified string to STDOUT.
enable	Enables or disables the specified built-in shell command.
eval	Concatenates the specified arguments into a single command, and executes the command.
exec	Replaces the shell process with the specified command.
exit	Forces the shell to exit with the specified exit status.
export	Sets the specified variables to be available for child shell processes.
fc	Selects a list of commands from the history list.
fg	Resumes a job in foreground mode.
getopts	Parses the specified positional parameters.
hash	Finds and remembers the full pathname of the specified command.
help	Displays a help file.
history	Displays the command history.
if	Used for branching.
jobs	Lists active jobs.
kill	Sends a system signal to the specified process ID (PID).
let	Evaluates each argument in a mathematical expression.
local	Creates a limited-scope variable in a function.
logout	Exits a login shell.
mapfile	
popd	Removes entries from the directory stack.

Builtin	Description
printf	Displays text using formatted strings.
pushd	Adds a directory to the directory stack.
pwd	Displays the pathname of the current working directory.
read	Reads one line of data from STDIN, and assigns it to a variable.
readonly	Reads one line of data from STDIN, and assigns it to a variable that can't be changed.
return	Forces a function to exit with a value that can be retrieved by the calling script.
set	Sets and displays environment variable values and shell attributes.
shift	Rotates positional parameters down one position.
shopt	Toggles the values of variables controlling optional shell behavior.
source	Reads and executes commands from a designated file in the current shell.
suspend	Suspends the execution of the shell until a SIGCONT signal is received.
test	Returns an exit status of 0 or 1 based on the specified condition.
times	Displays the accumulated user and system shell time.
trap	Executes the specified command if the specified system signal is received.
type	Displays how the specified words would be interpreted if used as a command.
typeset	Declares a variable or variable type.
ulimit	Sets a limit on the specific resource for system users.
umask	Sets default permissions for newly created files and directories.
unalias	Removes specified alias.
unset	Removes the specified environment variable or shell attribute.
until	Loop that is very similar to the while-loop except that it executes until the test-command executes successfully. As long as the test-command fails, the until-loop continues.
wait	Make the shell wait for a job to finish.
while	Waits for the specified process to complete, and returns the exit status.

Overview Of Bash Symbols

Here we have gathered a collection of all arcane syntax along with a brief description. A bunch of these symbols are repeated from earlier but many are new - this is a good starting point if you are new to the language.

Symbol	Quick Reference
#	used for comments
\$	\$ used for parameters and variables. Has a bunch of edge cases.
()	is used for running commands in a subshell.
\$()	is used for saving output of commands that are send to run in a subshell.
(())	is used for arithmetic.
\$(())	is used for retrieving the output of arithmetic expressions, either for usage with a command or to save the output in a variable.
[\$]	deprecated integer expansion construct which is replaced by \$(()). Evaluates integers between the square brackets
[]	is used for testing and is a built-in. Is useful in some cases for filename expansion and string manipulation.
[[]]	is used for testing. This is the one you should use unless you can think of a reason not to.
<()	Used for process substitution and is similar to a pipe. Can be used whenever a command expects a file and you can use multiple at once.
{ }	is used for expansion of sequences
\${ }	is used for variable interpolation and string manipulation.
	is a pipe which is used for chaining commands together.
<	used for feeding input to commands from a file
>	used for sending output to a file and erasing any previous content in that file.
	logical or
&&	logical and
-	used for option prefixes
--	used for the long-option prefixes
&	used to send a job to the background
<<WORD	is used for heredocs
<<-WORD	
<<'WORD'	
<<-'WORD'	
<<<	is used for herestrings
>>	is used to append output to a file.
' '	single quotes are used to preserve the literal value
" "	double quotes are used to preserve the literal value of all characters except \$, ` ` and \
\	backslash is used to escape otherwise interpreted symbols/characters which has a special meaning
/	used for seperating the components of a filename

Symbol	Quick Reference
:	similar to a NOP – a do nothing operation. It is a shell builtin with an exit status of true
;	used to seperate commands intended to run sequentially.
,	used for linking together arithmetic operations. All are evalutated but only the last is returned
.	represents the current directory.
..	represents parent directory.
~	expands to home directory.
` `	is deprecated and should not be used. Read further in its respective section.

Flow Control

Flow control structures in Bash are straight forward, albeit Bash is unforgiving if you get the syntax wrong.

View examples on how to use control flow in bash.

Syntax Structure	Associated Keywords or Key Symbols	Description
If	if then fi	Test a condition.
If-else	if then else fi	Test a condition and use a fallback if the test fails.
If-elif-else	if then elif else fi	Provides additional testing plus a fallback if all tests fail. You may skip the elif conditions or add as many in-between as you like. Similarly, you may skip the else fallback.
For	or do done	Iterate over a sequence, a list or anything as far as the imagination goes.
While	while do done	While a condition is true - repeat until that condition is no longer true
Until	until do done	The inverse of the while loop - as long as the test-command fails, the until-loop continues.
Select	select in do done	Selectselect in do done Used for easy menu generation. Any statement within can be another select construct, thus enabling sub-menu creation.
Case	case) ;; esac	Alternative if-branching. Each case is an expression which matches a given pattern (i.e., a case).