
Index

- [] (brackets) wildcard, 12
- { } (curly braces) in variables, 41
- () (parentheses) in variables, 41
- += (append) operator, 45
- * (asterisk) wildcard, 12
- \$\$ automatic variable, 16
- \$\$+ automatic variable, 17
- \$\$< automatic variable, 16
- \$\$? automatic variable, 16
- \$\$@ automatic variable, 16
- \$\$^ automatic variable, 17
- \$\$* automatic variables, 17
- (dash) command prefix, 93
- ^ in patterns, 12
- := operator, 43
- ?= operator
 - conditional variable assignment operator, 44
 - environment variables, 52
- % (percent) character, pattern rules, 22
- + (plus) command modifier, 93
- ? (question mark) wildcard, 12
- @ sign
 - command prefix, echo and, 92
 - performance and, 188
- ~ (tilde) wildcard, 12

A

- add-manifest function, jars, 176
- addprefix function, 75
- addsuffix function, 74
- all target, 15
- ALL_TREES variable, 155

- always-make option, 249
- Ant (Java), 160
 - build files, 160
 - mkdir program, 162
 - portability, 162
 - tasks, 161
- append operator (+=), 45
- ar command, archive libraries, 34
- archive libraries, 34
- archive members, automatic variables
 - and, 16
- arguments, patterns as built-in functions, 65
- arithmetic, performing with make, 260
- arrays, files array and command-line
 - limits, 102
- assert function, 76
- automake tool, 139
- automatic variables, 16, 53
 - archive members, 16
 - empty targets and, 16
 - prerequisites, 16
 - targets and, 16
 - VPATH and, 19
 - vpath and, 19

B

- basename function, 73
- bash shell, benchmarking and, 183
- benchmarking, 182
 - bash shell, 183
 - Cygwin and, 184
 - subst function calls and, 185
 - variable assignment speed, 185

We'd like to hear your suggestions for improving our indexes. Send email to index@oreilly.com.

- binary trees
 - ALL_TREES variables, 155
 - filesystem layout and, 126
 - multiple, 154
 - searches, 156
 - separate, 125
 - source tree separation, 141–149
- book makefile, 196–205
 - m4 macros and, 210
 - output generation, 213
 - source validation, 216
 - XML preprocessing, 210
- bottlenecks, 186
 - dependencies and, 187
- build files, XML, 160
- build targets, recursive make and, 112
- build-classpath function, 173
- builds
 - automation, 128
 - Linux kernel makefile, 220
 - testing, 128
- built-in functions, 64–80
 - filenames and, 72
 - flow control and, 75
 - patterns as arguments, 65
 - string functions, 65
 - syntax, 64
- built-in rules, 22
 - implicit rules, 25
 - variables, 27
 - (see also rules)

C

- C directory option, 249
- call function, 63
- calling functions, wildcards and, 12
- canned sequences (see macros)
- case-sensitivity in variables, 41
- chaining rules, 22
 - intermediate files and, 27
- character classes, wildcards and, 12
- characters in variables, 41
- check target, 15
- circular references, libraries, 39
- circularities, libraries, 39
- CLASSPATH variable, Java makefile, 171
- clean target, 15

- code
 - debugging
 - defensive coding, 238
 - writing for, 236
 - duplicating, recursive make and, 114
- command scripts, 9
 - error messages, 243
 - evaluation, 99
 - parsing and, 89
 - (see also scripts), 9
- command-line
 - debugging options, 230
 - limits, 100
 - echo command line, 101
 - Linux kernel makefile options, 218
 - recursive make and, 111
 - subshells, 96
 - targets as arguments, 4
 - variable definition and, 51
- commands
 - ar (archive library), 34
 - awk, phony targets and, 14
 - df, phony targets and, 14
 - empty, 97
 - environments, 98
 - file descriptors, 98
 - MAKEFLAGS variable, 98
 - MAKELEVEL variable, 98
 - errors in, ignoring, 93
 - help, 29
 - long, 90
 - make, execution order, 6
 - makefile, execution order, 6
 - multiline, 95
 - no-op, 95
 - options, errors and, 94
 - parsing, 88
 - command scripts and, 89
 - editors and, 90
 - prefixes
 - @, 92
 - (dash), 93
 - + (plus), 93
 - shell, sequences, 90
 - status code, 93
 - targets, overriding, 244
 - variable expansion, 49
- comments, 9

- commercial development model, 124
- compile-bean function (Java), 178
- computed variables, assert function and, 76
- Concurrent Version Systems (see CVS)
- conditional directives
 - ifdef, 55
 - ifeq, 55
 - ifndef, 55
 - ifneq, 55
 - syntax, 54
- conditional processing directives, 54
- conditional variable assignment operator
 - (?=), 44
- configuring Linux kernel makefile, 220
- constants, user-customized variables, 42
- cookies, 15
 - (see also empty targets)
- counter function, 17
- CPPFLAGS variable, 50
- CURDIR variable, 57
- curly braces ({}) in variables, 41
- CVS (Concurrent Version Systems)
 - binary files, large, 157
 - implicit rules and, 28
- cwd (current working directory), CURDIR
 - variable and, 57
- Cygwin, 62
 - benchmarking and, 184
 - conflicts, 134
 - line termination, 131
 - portability and, 131
 - regtool, 172
 - Windows filesystem and, 132

D

- data structures, 252
 - illegal, 260
 - trapping, 260
- debug option, 234
- debug-enter variable, 81
- debugging
 - code writing and, 236
 - command script error messages, 243
 - command-line options, 230
 - defensive coding and, 238
 - error messages, 241
 - introduction, 229
 - macros and, 81
 - make output, phony targets and, 14
 - overriding commands, targets, 244
 - syntax errors, 242
 - techniques for, 239
 - warning function and, 229
- debug-leave variable, 81
- declarations, reusable, library functions, 18
- deferred expansion, 48
- define directive, macros, 46
- .DELETE_ON_ERROR target modifier, 31
- dependencies, 113
 - bottlenecks and, 187
 - generating, 149
 - automatically, 31
 - include directive and, 56
 - Java makefile, 170
 - make-depend, 152
 - recursion and, 110
 - rules, 4
- dependency checking, 6
- development environments, variables, 53
- development requirements, 124
- development styles, 124
- dir function, 72
- directives
 - conditional processing, 54
 - conditional, syntax, 54
 - define, 46
 - include, 54, 55
 - dependencies and, 56
 - optimization, 121
 - vpath, 20
- directories
 - ~ (tilde) and, 12
 - multidirectory projects, nonrecursive
 - make and, 117
- distclean target, 15
- distributed make, 194
- distribution, performance and, 194
- double-colon rules, 40

E

- echo command line, limits, 101
- Eclipse, 163
- EJB (Enterprise Java Beans), 178
- ejb-rule function, 181
- EJBS variable, 180
- else keyword, 54
- Emacs JDEE, 163
- embedded periods, variable definition
 - and, 252
- empty commands, 97
- empty targets, 15
 - automatic variables and, 16

- encapsulation, Java packages, 159
- endif keyword, 46
- endif keyword, 54
- Enterprise JavaBeans (EJB), 178
- environment variables, ?= operator, 52
- environment-overrides option, 249
- environments
 - commands, 98
 - file descriptors, 98
 - MAKEFLAGS variable, 98
 - MAKELEVEL variable, 98
 - variable definition and, 51
- error function, 76
- error handling, recursive make and, 112
- error messages
 - command scripts, 243
 - debugging and, 241
 - fatal, printing, 76
- errors, commands
 - ignoring, 93
 - options, 94
- eval function, 82
 - parsing and, 83
- expanding macros
 - deferred versus immediate, 48
 - macros invoked from another, 63
- expanding text, foreach function and, 77
- expanding variables, 47
 - curly braces and, 41
 - deferred, 48
 - immediate, 48
- explicit rules, 10, 10–16
 - empty targets and, 15
 - phony targets, 13
 - wildcards, 12
- exporting variables, 52

F

- fatal error messages, 76
- file descriptors, 98
- file management, 134
 - source tree layout, 137
- file option, 249
- filenames
 - built-in functions and, 72
 - functions
 - addprefix, 75
 - addsuffix, 74
 - basename, 73
 - dir, 72
 - join, 75
 - notdir, 73
 - suffix, 73
 - wildcard function, 72
- patterns (see pattern rules)
- suffixes, functions, 73
- timestamps and, 71

files

- variable definition and, 51
- wildcards, 12

- files array, command-line limits and, 102
- filesystems layout, binary trees and, 126
- filter function, 65
- filter-out function, 66
- find command, module definition, 122
- findstring function, 66
- firstword function, 69
- flow control functions, 75
 - assert, 76
 - error, 76
 - foreach, 77
 - if, 75
- foreach function, 77
- free software model development, 124
- functions
 - add-manifest, 176
 - addprefix, 75
 - addsuffix, 74
 - assert, 76
 - basename, 73
 - build-classpath, 173
 - built-in, 64–80
 - call, 63
 - filename, 72
 - flow control, 75
 - patterns as arguments, 65
 - string functions, 65
 - syntax, 64
 - calling, wildcards and, 12
 - compile-bean, 178
 - counter, 17
 - defslot, 257
 - dir, 72
 - ejb-rule, 181
 - error, 76
 - eval, 82
 - filter, 65
 - filter-out, 66
 - findstring, 66
 - firstword, 69
 - flow control, 75
 - foreach, 77
 - generated-source, 121

- hooks, 86
- if, 75
- join, 75
- library, declarations, 18
- make-library, 120
- miscellaneous, 79, 80
- notdir, 73
- origin, 79
- parameters, passing to, 86
- patsubst, 68
- remote-file, 253
- search and replace, strings, 67
- shell, 69
- sort, 69
- source-to-object, 121
- space-to-question, 136
- string functions, 65
- strip, 79
 - whitespace removal, 55
- subst, 67
- suffix, 73
- user-defined, 61–64
 - advanced, 80–87
 - Linux kernel makefile, 224
 - parameters and, 62
 - value, 85
 - variables, 42
- warning, 80
- whitespace manipulation, 68
- wildcard, 72
- wildcard-spaces, 136
- word, 69
- wordlist, 69
- words, 68

G

- generated-source function, 121
- generating dependencies, 149
- globbing, 12
- GNU Free Documentation License, 263–270
- grep command, variables and, 98

H

- header files, include directory, 18
- Hello World makefile file, 3
- help commands, 29
- help option, 250
- home directory, ~ (tilde) and, 12

- hooks, functions, 86

I

- IDEs (Integrated Development Environments), 159, 163
- if function, 75
- ifdef conditional directive, 55
- ifeq conditional directive, 55
- ifndef conditional directive, 55
- ifneq conditional directive, 55
- immediate expansion, 48
- implicit rules, 10, 25
 - built-in, 25
 - source control and, 28
 - CVS, 28
- include directive, 54, 55
 - dependencies and, 56
 - header files, 18
 - optimization, 121
- include processing, 54
- include-dir option, 250
- incrementing, 260
- info target, 15
- initialization, performance and, 188
- input files, text printing, 7
- install target, 15
- installers, reference builds and, 157
- Integrated Development Environments (see IDEs)
- interfaces, phony targets and, 15
- intermediate files, chaining rules and, 27
- .INTERMEDIATE target modifier, 30
- invoking make, 7

J

- jar program, 175
 - reference trees, 177
 - third-party, 177
- jars (Java), 175
- Java
 - Ant, 160
 - build file, 160
 - mkdir program, 162
 - portability, 162
 - tasks, 161
 - Eclipse, 159
 - EJB, 178
 - IDEs, 163

- jars and, 175
- make and, 159
- makefile (generic), 164
 - CLASSPATH variable, 171
 - dependencies and, 170
 - packages, 159
- Java virtual machine (JVM), 159
- JBuilder, 163
- JIT (just-in-time) optimization, 159
- jobs option, 190
- join function, 75
- just-in-time (JIT) optimization, 159
- just-print option, 250
- just-print option, debugging, 230
- JVM (Java virtual machine), 159

K

- keep-going option, 250
- keywords
 - else, 54
 - endif, 54
- killing processes, user-defined functions and, 62

L

- large projects, 107–128
- libraries
 - archive libraries, 34
 - circular references, 39
 - creating, 36
 - double-colon rules, 40
 - make-library function, 120
 - as prerequisites, 38
 - recursion and, 110
 - reference builds and, 157
 - .SECONDARY target modifier, 30
 - updating, 36
- library functions, reusable, 18
- line termination, Cygwin, 131
- Linux kernel makefile, 218
 - command echo, 223
 - command-line options, 218
 - configuration versus building, 220
 - user-defined functions, 224
- long commands, 90

M

- m4 macros, book makefile and, 210
- macros
 - debugging and, 81
 - define directive, 46

- defining, 48
- expanding, 47
- implementing, scoping and, 64
- introduction, 45
- invoking from another macro, 63
- program-variables, 82
- rules in, 83

make

- automation and, 3
- command execution, 6
- comments, 9
- dependency checking, 6
- escape character, 9
- invoking, 7
- scripts and, 3

make shell command, benchmarking and, 186

\$(MAKE) variable, 109

MAKECMDGOALS variable, 58

makedepend, 152

MAKEFILE_LIST variable, 58

makefiles

- book makefile, 196–205
 - m4 macros, 210
 - output generation, 213
 - source validation, 216
 - XML preprocessing, 210
- command execution, 6
- Hello World, 3
- Java, generic for, 164
- Linux kernel, 218
 - command echo and, 223
 - command-line options, 218
 - configuration versus building, 220
 - user-defined functions, 224
- syntax, 8
- targets as command-line arguments, 4
- top-down style, 6

MAKEFLAGS variable, command environment and, 98

MAKELEVEL variable, command environments, 98

make-library function, 120

MAKE_VERSION variable, 57

matched rules, automatic variables, 16

members of archive libraries, 34

miscellaneous functions, 79

- warning, 80

module definition, find command, 122

module.mk include files, 118

multiline commands, 95

N

- new-file option, 250
- newline rule, 7
- nonrecursive make, 117
- no-op commands, 95
- notdir function, 73

O

- object files, updates, 27
- \$(OBJECTS) variable, 23
- old-file option, 250
- options
 - commands, errors and, 94
 - portability and, 130
- origin function, 79
- output, book makefile example, 213

P

- packages, Java, 159
- parallelism
 - jobs option, 190
 - performance and, 190
 - pmake, 194
- parameters
 - passing to functions, 86
 - user-defined functions, 62
- parentheses, variables and, 41, 78
- parsing
 - commands, 88
 - command scripts and, 89
 - editors and, 90
 - eval function and, 83
- partial source trees, 156
- passing parameters to functions, 86
- passing variables, recursive make and, 111
- paths, portability and, 130
- patsubst function, 68
- pattern rules, 10, 21
 - % (percent) character, 22
 - implicit rules and, 10
 - patterns, 22
 - static pattern rules, 23
 - suffix rules, 24
 - deleting, 24
- patterns, 22
 - as arguments in built-in functions, 65
 - filter function, 65
- pattern-specific variables, 50
- performance
 - @ sign and, 188
 - benchmarking and, 182

- bottlenecks, 186
- distribution and, 194
- initialization and, 188
- introduction, 182
- parallelism and, 190
- recursive variables, 187
- simple variables, 187
- .PHONY target modifier, 13
- phony targets, 13
 - interfaces and, 15
 - nonrecursive make and, 117
 - output
 - debugging, 14
 - reading, 14
 - prerequisites, 13
 - special targets, 30
 - standard, 15
- pmake, 194
- portability, 129
 - Ant (Java), 162
 - Cygwin, 131
 - nonportable tools, 137
 - options and, 130
 - paths and, 130
 - program behavior and, 130
 - program names and, 130
 - shell and, 130, 139
- .PRECIOUS target modifier, 30
- prefixes
 - on commands
 - @, 92
 - (dash), 93
 - + (plus), 93
 - pattern rules, 23
- prerequisites
 - automatic variables and, 16
 - libraries as, 38
 - phony targets, 13
 - rules and, 4
 - saving, 39
 - targets
 - chaining, 6
 - .INTERMEDIATE modifier and, 30
 - .SECONDARY modifier, 30
 - updates, ordering and, 110
- print-data-base option, 250
 - debugging and, 230
- program behavior, portability and, 130
- program management, 134
- program names, portability and, 130
- program-variables macro, 82

R

- RCS source control, implicit rules and, 28
- read-only source, 149
- rebuilt, minimizing, 7
- recursion, 107
- recursive make, 108
 - build targets and, 112
 - code duplication, 114
 - command-line and, 111
 - dependencies and, 110
 - error handling, 112
 - \$(MAKE) variable, 109
 - variables, passing, 111
 - (see also nonrecursive make)
- recursive variables
 - performance and, 187
 - shell function and, 70
- recursively expanded variables, 43
- reference builds
 - installers and, 157
 - libraries and, 157
- reference trees, jar program, 177
- regtool, 172
- relative paths, converting to Java class name, 71
- release tree layout, 127
- remote-file function, 253
- reusable library functions, declarations, 18
- rule chaining, 22
- rules
 - any character, 7
 - chaining, intermediate files, 27
 - customization, variables and, 27
 - default rule, 4
 - dependents, 4
 - double-colon, 40
 - explicit, 10, 10–16
 - empty targets, 15
 - phony targets, 13
 - implicit, 10, 25
 - built-in, 25
 - source control and, 28
 - macros, 83
 - matching, automatic variables and, 16
 - newline, 7
 - pattern, 10, 21
 - suffix rules, 24
 - prerequisites and, 4
 - static pattern, 10, 23
 - structure, 27
 - suffix, 10
 - targets, 4

- multiple, 10
- variables, customization and, 27

run-make shell script, running book makefile, 208

S

- SCCS source control, implicit rules and, 28
- scoping, macro implementation and, 64
- scripts
 - command scripts, parsing and, 89
 - make and, 3
- search and replace functions, strings, 67
- substitution references, 68
- searches
 - binary trees, 156
 - source treese, 156
 - VPATH and, 17
 - vpath and, 17
- .SECONDARY target modifier, 30
- separators, missing (error messages), 242
- shell
 - command lines, subshells, 96
 - portability and, 130, 139
- shell commands, sequences, 90
- shell function, 69
 - variables, 70
- simple variables
 - performance and, 187
 - shell function and, 70
- simply expanded variables, 43
- sort function, 69
- source
 - binary tree separation, 141–149
 - src directory, 18
 - validation, book makefile, 216
- source trees
 - layout, file management and, 137
 - partial, 156
 - read-only, 149
 - searches, 156
- sources of variables, 51
- source-to-object function, 121
- space-to-question function, 136
- special targets, 30
- src directory, source files, 18
- static pattern rules, 10, 23
- status code, commands, 93
- stderr file descriptor, 98
- stdin file descriptor, 98
- stdout file descriptor, 98
- string functions, 65
 - filter, 65

- filter-out, 66
- findstring, 66
- firstword, 69
- patsubst, 68
- search and replace functions, 67
- subst, 67
- wordlist, 69
- words, 68
- strip function, 79
 - whitespace removal, 55
- structure of rules, 27
- subshells, command lines and, 96
- subst function, 67
- substitution references, string functions, 68
- suffix function, 73
- suffix rules, 24
 - implicit rules and, 10
- suffixes
 - filenames, functions, 73
 - pattern rules, 23
 - deleting, 24
 - targets, 24
- syntax
 - built-in functions, 64
 - conditional directives, 54
 - editors, 90
 - errors, debugging and, 242
 - makefile, 8
 - target-specific variables, 51

T

- tab character, error message, 242
- TAGS target, 15
- targets
 - automatic variables and, 16
 - build targets, recursive make and, 112
 - as command-line arguments, 4
 - commands, overriding, 244
 - deleting, 96
 - empty, 15
 - modifiers, 30
 - .DELETE_ON_ERROR, 31
 - .INTERMEDIATE, 30
 - .PHONY, 13
 - .PRECIOUS, 30
 - .SECONDARY, 30
 - phony targets, 13
 - special targets, 30
 - prerequisites
 - chaining, 6
 - saving, 39

- rules, 4
 - explicit rules, 10
 - multiple, 10
 - special targets, 30
 - static pattern rules, 23
 - suffixes, 24
 - updating, rule chaining and, 22
- target-specific variables, 50
 - syntax, 51
- tasks (Ant), 161
- text expansion, foreach function and, 77
- timestamps
 - empty files and, 15
 - filenames and, 71
- top-down style, makefiles, 6
- touch option, 250

U

- updates
 - libraries, 36
 - object files, rules, 27
 - prerequisites, ordering and, 110
 - targets, rule chaining, 22
- user-defined functions, 61–64
 - advanced, 80–87
 - killing processes and, 62
 - Linux kernel makefile, 224
 - parameters and, 62
 - variables and, 42

V

- validating source, book makefile, 216
- value function, 85
- .VARIABLES variable, 59
- variables, 16–17
 - ALL_TREES, 155
 - assigning, speed, 185
 - automatic, 16, 53
 - empty targets and, 16
 - built-in rules, 27
 - case-sensitivity, 41
 - characters allowed, 41
 - CLASSPATH, Java makefile, 171
 - computed, assert function and, 76
 - constants, user-customized, 42
 - CPPFLAGS, 50
 - CURDIR, 57
 - debug-enter, 81
 - debug-leave, 81
 - development environment, 53
 - EJBS, 180

- error messages, 243
- expanding, 47
 - curly braces and, 41
- exporting, 52
- functions, user-defined, 42
- grep command, 98
- introduction, 41
- macros and, 46
- MAKE, 109
- MAKECMDGOALS, 58
- MAKEFILE_LIST, 58
- MAKEFLAGS, command environment and, 98
- MAKELEVEL, 98
- MAKE_VERSION, 57
- OBJECTS, 23
- operators
 - :=, 43
 - =, 42
 - += (append), 45
 - ?= (conditional variable assignment operator), 44
- origins, origin function, 79
- parentheses and, 41, 78
- passing, recursive make and, 111
- pattern-specific, 50
- periods, embedded, 252
- recursive, performance and, 187
- recursively expanded, 43
- shell function, 70
- simple, performance and, 187
- simply expanded, 43
- sources, 51
- target-specific, 50
- trailing spaces and, 42
- uses, 42

- .VARIABLE, 59
- VARIABLES, 59
- VPATH (see VPATH)
- VARIABLES variable, 59
- VPATH, 17
- vpath, 17
- vpath directive, 20

W

- warning function, 80
 - debugging and, 229
- warn-undefined-variables option, 251
 - debugging and, 233
- whitespace
 - functions for manipulating, 68
 - removing, 64
 - strip function, 79
- wildcard function, 72
- wildcards, 12
 - ? (question mark), 12
 - ~ (tilde), 12
 - calling functions and, 12
 - character classes, 12
 - expanding, 12
 - misuse, 12
 - pattern rules and, 10
 - (see also globbing)
- wildcard-spaces function, 136
- Windows filesystem, Cygwin and, 132
- Windows, using Cygwin and make on, 131
- word function, 69
- wordlist function, 69
- words function, 68

X

XML

build files, 160

preprocessing book makefile, 210