

index

Numbers

51515 LEGO set 1

A

absolute value (abs) operator 179

accelerometer 1

detecting motion 28

detecting taps 28

accessing individual characters from a text

string 208

accompaniment 213

adding an extension palette 48

add item to list block 164

align feet, custom block 88

and (logic operator) block 30

angle

pitch 87

roll 87, 181

yaw 87

Animation Library 9

animation, selecting an 10

API, Python 216

app 2, 6

Application Programming Interface (API) 216

arcade game 123, 139

arpeggio 205

array. *See* lists

assembling the models. *See* building instructions

average, computing 136, 138

averaging sensor readings 203

avoiding obstacles 48

B

backing track 200

backlash 134

Baseball Batter 3-12

battery, charging 1

beats per minute (BPM) 212

become biped custom block 88

become car custom block 88

beeps, playing 205

behavior 118

planning for a robot 118

representation for a robot 118

biped RC, custom block 89

BLE (Bluetooth Low Energy) 216

blocks 7, 217

Control 223

forever loop 27

if then 33

if then else 32

repeat loop 48, 51

repeat until 89, 137

stop all 27

stop other stacks 136

wait for seconds 28

wait until 28, 169

copying and pasting 206

duplicating 134, 137

Events 222

broadcast message 87

broadcast message and wait 87

when 167, 181

when color is 9

when I receive message 87

when program starts 8

Light 220

light up distance sensor 179

light up distance sensor 51

play animation until done 28

set orientation 28

start animation 9, 28

turn on 5x5 light matrix 117

turn on for seconds 207

turn on light matrix 121, 165

write 33

More Motors 230

motor go to relative position at speed 88

relative position 212

set motor to coast at stop 212

set motor to hold position at stop 180

set relative position 88, 212

More Movement 229

set movement acceleration 51

start moving with steering at speed 90

Motors 218

motor go to position 8

motor speed 179

set motor speed 8

start motor 28

stop motor 29

Movement 219

move for rotations 52

set movement motors 51

set movement speed 51

start moving 51

stop moving 91

Operators 29, 30, 225

/ (divide) 181

- (minus) 134

* (multiply) 89

+ (plus) 202

abs (math functions) 179

and 30

ceiling (math functions) 202

equal 30

floor (math functions) 181

greater than 30

is between operator 89

join strings 166

less than 30

letter of string 208

mod (modulo) 167

not (logic) 31, 117

or (logic) 30, 117

pick random number 33

round 134

Remote Control 227

joystick axis 86

when button is 87

when joystick is 86

when joystick is moved 91

when joystick is released 91

Sensors 224

hub angle 87

is color? 28, 167

is distance? 52

is shaken 27

is tapped 27, 28, 121

reset timer 118

set yaw angle 87

timer 117

Sound 221

start playing beep 205

start sound 9

Variables 228

add item to list 164

change variable by 119

delete all of list 165

- blocks, Variables (*continued*)
 - delete item of list 164
 - item at index in list 165
 - list 164
 - set variable to 119
 - variable (read value) 119
- blues scale 200
- Bluetooth
 - communication with other hubs 216
 - connection
 - establishing 7
 - pairing 1
 - troubleshooting 7
- Bluetooth Low Energy (BLE) 216
- Boolean 51
- BOOST devices 216
- BPM (beats per minute) 212
- brightness level 179
 - of a pixel 117, 165
- broadcast message and wait block 87
- broadcast message block 87
- broken chord 205
- building instructions
 - Baseball Batter 4
 - control knobs of the Guitar 209
 - Gobbler 14
 - Guitar 184
 - Pinball base 140
 - Pinball bumpers 169
 - SARKIAP-1 the Transformer 36
 - Shelly the Turtle 94
 - walking biped robot 36
 - Whac-a-Mole 124
- building technique, large sturdy assemblies 183
- buttons
 - Code 6
 - Community 6
 - Home 6
 - on the Hub 1
 - Open Hub Connection 7
 - Play 11
 - Projects 6
 - Select Storage Position 11, 30
 - Settings 6
 - Stop 11
- C**
- car RC, custom block 89
- C-block 27
- ceiling operator 202
- chance 33
- change mode custom block 206
- change scale custom block 200
- change variable by block 119
- changing the value of a variable 119
- charging the Hub's battery 1
- cheating, preventing in Pinball game 181
- chord 205
 - progression 206
- clockwise motor direction 8
- Code button 6
- coding 6
- collection of data 164
- color selection drop-down menu 9
- Color Sensor 2
 - reflected light mode 205
- combine logic conditions. *See* logic conditions
- communication issues 7
- community 216
- Community button 6
- companion website 2
- comparing letters or words 30
- comparison operators 30
- compatible devices 2
- computer. *See* Hub
- computing average 136
- computing the score for the Whac-a-Mole game 136
- condition 28
- conditional statement 28, 32
- condition-based choices 32
- connecting to other hubs 216
- connecting to the Hub 7
- CONTROL+ motors 216
- control knobs of the Guitar 209
- controller, creating a remote 83
- controlling display with text strings 165
- controlling Distance Sensor lights with text strings 179
- control structures 27
- converting string to number 209
- copying blocks 134, 137, 206
- correspondence of the pixels to the control string 166
- counterclockwise motor direction 8
- creating custom blocks 49
- creating custom patterns on the Hub display 117
- creating a custom remote-control interface 83
- creating a list 164
- custom blocks 49-51
 - align feet 88
 - become biped 88
 - become car 88
 - biped RC 89
 - car RC 89
 - change mode 206
 - change scale 200
 - creating 49
 - definition 49
 - eat 119
 - editing 51
 - get note 202
 - hide head 116
 - inactive behavior 120
 - increase score by (amount) and light up (LED) when motor (port) speed is greater than (speed) 179
 - initialize display 167
 - make a block dialog 49
 - move up/down (mole) 136
 - move up/down (mole) 134
 - purpose 49, 88
 - scared behavior 120
 - set up blues scale 200
 - set up chords major 206
 - set up chords minor 206
 - set up (guitar solo) 200
 - set up major scale 200
 - set up pentatonic scale 200
 - show head 116
 - sleepy behavior 120
 - to walk and turn 48, 89
 - tremble N times 119
 - turn left by N steps (biped) 48
 - turn left by N steps (turtle) 116
 - turn left (remote-controlled biped) 89
 - turn right by N steps (biped) 48
 - turn right by N steps (turtle) 116
 - turn right (remote-controlled biped) 89
 - update display 167
 - wait to be left alone 116
 - walk backward 48
 - walk backward (remote-controlled) 89
 - walk forward 48
 - walk forward (remote-controlled) 89
 - walk forward (turtle) 116
 - wander 119
- custom blocks with inputs 50

D

data. *See also* variable
 storing and retrieving 118
 types of 119

data collection 164

dead zone of the joystick 89

decoding numbers from text strings 209

decreasing the value of a variable 168

delete all of list block 165

delete item of list block 164

deleting a block 32

detecting Pinball tilt 182

diagram of a state machine 118

digits, displaying two column wide 165

display 1
 controlling pixels with text strings 165
 orientation 165

display two-digit numbers 165

Distance Sensor 2
 range 2
 reading 52
 working principle 2

Distance Sensor lights, controlling with text strings 179

divide (/) operator 134, 181

Download mode 11

driving a couple motors 51

driving motors in sync 51

duplicating a stack of blocks 134, 137

duration of a note from BPM 212

E

eat custom block 119

electronic devices
 Color Sensor 2
 Distance Sensor 2
 Hub. *See* Hub
 Medium Motor 1

Ellerkamp, Frank 165

encoder 134. *See* rotation sensor

equal block 30

equation of a line passing through two points 204

EV3 Intelligent Brick

event 12, 118

event-based programming 167

events, managing widgets' 90

exercises 12, 33, 52, 181, 182
 adding another mole to the Whac-a-Mole game 138
 biped robot patrol 52
 changing Shelly the Turtle's behavior 120

 displaying Pinball score in the hundreds 182
 improving the Pinball by adding active bumpers 182
 making the Gobbler answer questions on red paper 33
 reading a program in natural language 52
 using the Distance Sensor to detect the ball 12
 walking backward 52
 Whac-a-Mole multiplayer game 138

expanding the hardware 216

exporting blocks 206

extension palette, adding 48

eyes (lights) of the Distance Sensor 179

F

Facebook community 216

filtering measurement noise 203

flag 137

flipped over (Shelly) 117

floor operator 181

forever loop block 27

formula
 to compute Whac-a-Mole score 136
 equation of a line passing through two points 204
 note duration from knob position 212

G

game logic, for Whac-a-Mole 136

games 123, 139

gearing 134

gear train 134

generating random numbers 33

get note custom block 202

Gobbler 13-33

grayscale measurement 2, 205

greater than block 30

Guitar 183-213
 playing chords 205
 playing solos 200
 playing songs 206

Guitar chords program 206-209

Guitar size 183

Guitar solo program 200-205

gyroscope 1

H

hardware, expanding 216

hat block 7

help page, official 2

hexagonal slot of a block 28

hide head custom block 116

holding motor position 180

Home button 6

how to
 add an extension palette 48
 control Distance Sensor lights with text strings 179
 create custom blocks 49
 create a list 164
 create a remote-control interface 83
 create a variable 119
 play solos on the Guitar 200, 202
 play songs on the Guitar 206
 save and run a program 10

Hub 1
 accelerometer 87
 angle along three axes 87
 display 1, 165
 display custom patterns 117
 orientation in space, reading 87

hub2hub Python library 216

hub angle block 87

Hub Program menu 11

I

if then block 33

if then else block 32

images. *See* creating custom patterns on the Hub display

importing blocks 206

IMU (inertial measurement unit) 87

inactive behavior custom block 120

increase score by (amount) and light up (LED) when motor (port) speed is greater than (speed) custom block 179, 180

increasing the value of a variable 137

indexing digits in a text string 208

index of a list item 164

inertial measurement unit (IMU) 1

initialize display custom block 167

input, defined 3

inputs of a custom block 50

instructions for building the projects.
 See building instructions

instructions for programming the projects.
 See programs

interpolation 204

interrupting the execution of a stack of blocks 136

is between operator block 89

is color? block 28, 167

is distance? block 52
is shaken block 27
is tapped block 27, 28, 121
item at index in list block 165

J

join strings block 166
join strings operator 167
joystick axis block 86
joystick dead zone 89

K

keyboard 202
key, changing 208

L

Lechner, David 216
LED (light-emitting diode) 179
LEGO MINDSTORMS Robot Inventor set box
 content 1
LEGO modules (units) 4
LEGO Power Functions 2.0 devices 216
LEGO SPIKE Prime 216
LEGO support page 2
LEGO Technic CONTROL+ 216
LEGO Technic set 8852 35
less than block 30
letter of string operator block, 208
light 179
light-emitting diode (LED) 1, 179
light patterns 117
light up distance sensor block 51, 179
linear equation 204
linear interpolation 202, 204
line passing through two points 204
list block 164
lists 164
 blocks to manage 164
 creating 164
lobby of the app 6
logic
 conditions 28
 how to make composite 30, 117
 data 28
 of the Pinball game 168
 of a timed challenge 180
 of the Whac-a-Mole game 136
 operators 30
 values 51
loop 27

M

major scale 200
make a block 49. See custom blocks
measurement noise 169, 203
measuring
 actual speed of a motor 179
 angle of a motor shaft 134
 LEGO axles and beams 4
 LEGO parts 4
 time 117
medium motor. See servomotor
melodic line 212
memory. See variable
messages, broadcasting and receiving 87
minimum requirements for the app 2
minus (-) block 134
mistakes in color detection 169
mode
 Download 11
 Streaming 30
mod (modulo) operator 167
mood of a musical scale 200
mood simulation for a robot 118
motion 28
motor go to position block 8
motor go to relative position at speed
 blocks 88
motor relative position, difference from
 motor position 212
motors. See also servomotor
 synchronized 51
motor speed block 179
motors used as sensors 134, 179
move for rotations block 52
move up/down (mole) custom block 134, 136
multiple ports selection for motor blocks 134
multiply (*) block 89
multitasking 87, 136
musical notation
 of chords 205
 of scales 200
musical scales 200
music score of chords built on C major and
 C minor scale 205
My Blocks 49. See also custom blocks

N

natural language. See pseudocode
noise in measurements 203
non-blocking wait loop 122
note duration from BPM, computing 212

not (logic operator) block 31, 117
numbers within a text string, extracting 208

O

obstacles, avoiding robot 48
ones
 getting from number 168
 getting from text string 208
online community 216
Open Hub Connection button 7
operators 29
Operators palette 29
orientation
 of the display 165
 of the Hub in space, reading 87
or (logic operator) block 30, 117
Output 4

P

palettes 7
paper strips, width for the Gobbler 27
parallel execution of blocks 87, 136
parsing numbers from text strings 208
passive steering mechanism 90
pasting blocks 206
pentatonic scale 200
percentage readings 205
piano keyboard 202
pick random number block 33
Pinball 139–182
 changing bumper sensitivity 180
 prevent cheating 181
pitch
 angle 87
 changing 208
pixel brightness 165
pixels, controlling with text strings 165
planning a program. See pseudocode
play animation until done block 28
Play button 11
playing chords on the Guitar 205
playing further on the Guitar 212
playing pop songs on the Guitar 206
playing solos on the Guitar 200, 202
playing the Pinball game
 base 168
 with bumpers 180
 earning extra balls 180
playing the Whac-a-Mole game 134
plunger 168
plus (+) operator 202
pointy blocks. See logic data

- pop songs, playing 206
 - preventing a variable from exceeding a value 181, 203
 - probability 33
 - Processing 3
 - program 7
 - programming area of the app 7
 - programming a walking robot 48, 115–117
 - programming blocks. *See* blocks
 - programs
 - Baseball Batter 8–10
 - in Python 215
 - calibrating the robot torso 66
 - control structures 27
 - Gobbler
 - answering questions 31–33
 - base 27–29
 - enhanced 29–31
 - Guitar
 - chords 206–209
 - solo 200–205
 - Pinball
 - base 166–169
 - enhanced 179–181
 - planning. *See* pseudocode
 - SARKIAP-1 the Transformer, remote control 87–91
 - Shelly the Turtle
 - autonomous behavior 118
 - base 115–118
 - tempo control (Guitar chords) 212
 - transposition control
 - Guitar chords 212
 - Guitar solo 212
 - walking and turning biped robot 48–52
 - Whac-a-Mole game 134–138
 - program storage position
 - Download 11
 - Streaming 30
 - progression of chords, common 206
 - Project menu 11
 - projects
 - Baseball Batter 3–12
 - The Gobbler 13–33
 - Guitar 183–213
 - Pinball 139–182
 - SARKIAP-1 the Transformer 35
 - Shelly the Turtle 93–122
 - Whac-a-mole 123–138
 - Projects button 6
 - pseudocode 12
 - Baseball Batter 12
 - checking if one or another condition is true 117
 - Gobbler
 - answering questions 33
 - base program 28
 - Shelly the Turtle base program 115
 - waiting until a condition becomes false 31
 - waiting until a condition becomes true 31
 - waiting until one or another condition becomes true 31, 117
 - Pybricks 216
 - Python 215
- R**
- random numbers 33
 - for unpredictable actions 120
 - range 89
 - checking if number is inside 89
 - checking if number is outside 117
 - of the Distance Sensor 2
 - of random number 33
 - reacting to remote control inputs 86
 - reading the orientation of the Hub in space 87
 - reading a variable 119
 - readings from the Distance Sensor 52
 - reflected light mode of the Color Sensor 205
 - relative position of a motor 212
 - remembering data. *See* variable
 - remote-control interface
 - creating 83
 - hiding 85
 - reacting to inputs 86
 - remote control program 87
 - renaming
 - a program 11
 - a remote-control widget 85
 - a variable 119
 - repeat loop block 48, 51
 - repeat until block 89, 137
 - reset timer block 118
 - result of an operation in Streaming mode 31
 - retrieving data 119
 - from list 165
 - reversing the direction of rotation of a shaft
 - in the program 89
 - rhythm 202
 - robustness in a robotic system 29
 - roll angle 87, 117
 - rotation sensor 1, 134
 - round block 134
 - running blocks in parallel 87, 136
- S**
- SARKIAP-1 the Transformer 35–91
 - saving and running a program 10
 - scales 200
 - scared behavior custom block 120
 - Scratch 3.0 7
 - Select Storage Position button 11, 30
 - sensing motor's movement 134, 179
 - sensor port selection drop-down menu 9
 - series of data. *See* lists
 - servomotor 1
 - using as sensor 134, 179
 - set motor speed block 8
 - set movement acceleration block 51
 - set movement motors block 51
 - set movement speed block 51
 - set orientation block 28
 - set relative position block 88
 - Settings button 6
 - set up blues scale custom block 200
 - set up chords major custom block 206
 - set up chords minor custom block 206
 - set up (guitar solo) custom block 200
 - set up major scale custom block 200
 - set up pentatonic scale custom block 200
 - set variable to block 119
 - set yaw angle block 87
 - Shelly the Turtle 93–122
 - shifting up/down notes 208
 - shortest path, motor block option 8
 - shortest path, of a motor 9
 - Show Block Extensions button 48
 - show head custom block 116
 - size. *See* measuring
 - size of the Guitar 183
 - sleepy behavior custom block 120
 - snapping, blocks 8
 - social networks 216
 - social tag 216
 - software. *See* app
 - solo, playing 200, 202
 - songs, playing on the Guitar 206
 - Sound Library 10
 - sound, selecting a 10
 - source code website 2
 - speed of a motor 179
 - SPIKE Prime kit 7, 216
 - splitting a number into tens and ones 168
 - stages of a robotic system 3
 - stall (of a motor) 29
 - start animation block 9, 28

- starting multiple stacks running together 87
- start motor block 28
- start moving block 51
- start moving with steering at speed block 90
- start playing beep block 205
- start sound block 9
- state machine diagram 118
- steering
 - input of a Movement block 51
 - passive mechanism 90
- step-by-step instructions. *See* building instructions
- stop all block 27
- Stop button 11
- stop motor block 29
- stop moving block 91
- stop other stacks block 136
- Storage Position, selection for a program 11
- storing data 119
- Streaming mode 30
- Strijbosch, Nard 216
- string 30
- strumming strings of the Guitar 205
- support page, official 2
- synchronize two motors 51

T

- tag, social 216
- tempo 212
 - changing 212
- tempo control for the Guitar chords program 212
- tens
 - getting from number 168
 - getting from text string 208
- text strings, extracting numbers 208
- three-way choice 32
- tilting the Pinball 181
- tilt sensor, axes visualized 87. *See also* accelerometer
- timer 117, 168
- timer block 117
- tinkering 216
- together, running blocks 87
- transformation sequence 35
- transformer robot 35–91

- transition, state 118
- transposing to other keys 208
- transposition control for the Guitar chords program 212
- transposition control for the Guitar solo program 212
- tremble N times custom block 119
- tremolo guitar technique 212
- true and false values 51
- truth table 30
 - and operator 30
 - not operator 31
 - or operator 31
- turning program for a biped walking robot 48
- turn left by N steps (biped) custom block 48
- turn left by N steps (turtle) custom block 116
- turn left (remote-controlled biped) custom block 89
- turn on for seconds block 207
- turn on light matrix block 117, 121, 165
- turn right by N steps (biped) custom block 48
- turn right by N steps (turtle) custom block 116
- turn right (remote-controlled biped) custom block 89
- two-digit numbers on the display 165

U

- ultrasonic sensor 2
- ultrasonic sound waves 2
- uniform distribution 33
- unpredictability 33
- update display custom block 167
- USB 1
 - using lists 164
- using motors as sensors 134, 179
- using the timer 168

V

- Valk, Laurens 216
- variable 118
 - changing the value 119
 - creating 119
 - definition 118

- reading a value 119
- renaming 119
- using 118
- writing a value 119

variable block 119

W

- wait for seconds block 28
- waiting for a condition to become true while doing something 122
- waiting for a condition to be true for a certain amount of time 117
- waiting until a condition becomes true or false 31
- waiting until one or another condition becomes true 31, 117
- wait to be left alone custom block 116
- wait until block 28, 169
- walk backward custom block 48
 - remote-controlled 89
- walk forward custom block 48
 - remote-controlled 89
 - turtle 116
- walking program for a biped robot 48
- wander custom block 120
- website, for support 2
- WeDo 2.0 devices 216
- Whac-a-Mole 123–138
- when button is block 87
- when color is block 9
- when hat block 167, 168, 181
- when I receive message block 87
- when joystick is block 86
- when joystick is moved block 91
- when joystick is released block 91
- when program starts block 8
- widgets
 - events 90
 - for remote controller, adding 84
 - for remote controller, editing 85
- width of the paper strips for the Gobbler 27
- word blocks. *See* blocks
- write block 33
- writing to a variable 119

Y

- Yamada, Kazuo 123
- yaw angle 87