



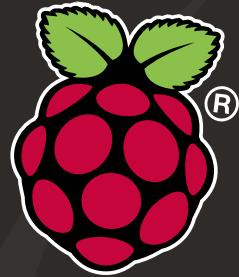
HACKING AND MAKING IN MINECRAFT



CODE VIRTUAL WORLDS
ON YOUR *Raspberry Pi*

Written by **The MagPi team**

The MagPi Magazine



THE OFFICIAL RASPBERRY PI MAGAZINE



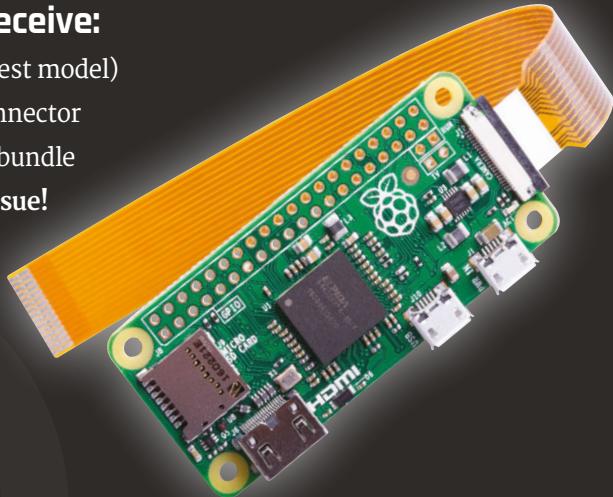
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WELCOME TO HACKING & MAKING IN **MINECRAFT**

Minecraft is a game that's achieved monumental success – over 30 million copies, across all its various supported formats, have been sold; not bad for a game which doesn't really have a point! It's classified as an Indie Sandbox game, but if it does have a point, it's to make stuff (and people have really done that!), from fully functioning computers to scale models of the Starship Enterprise. What about Minecraft: Pi Edition? The two best things are that it's free and it comes with an API – highly unusual features you don't see with any other version of the game.

Using the API, you can make *Minecraft* your own. You can create mods which will allow you do amazing things, link it up with the real world using the Raspberry Pi's GPIO pins, make your own mini-games, or just about anything else you can imagine.

Martin O'Hanlon
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The MagPi

ESSENTIALS

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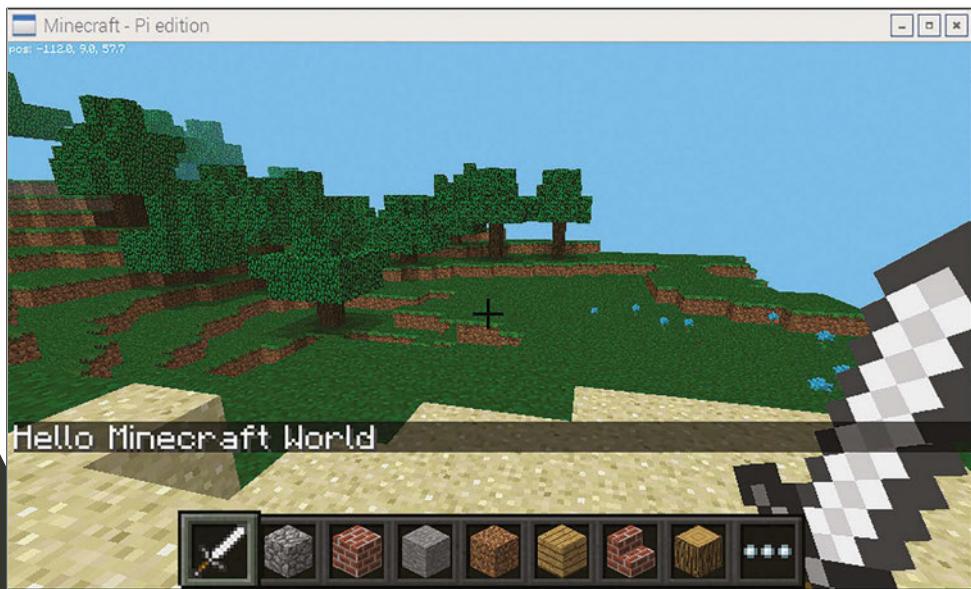
PI EDITION –
PYTHON API REFERENCE

[CHAPTER ONE]

GETTING STARTED WITH MINECRAFT: PI EDITION

Get off to a good start with Minecraft: Pi Edition. Play the game and write your first program using the API

Below Use the API to write a 'Hello Minecraft World' program



If you've never played Minecraft and want to be a master block builder, we'll help you get stuck into Minecraft, build a house, and get started with the API.

Minecraft is a game which has achieved monumental success; over 30 million copies, across all its versions, have been sold. Not bad for a game which doesn't really have a point! If it does have a point, as an indie sandbox game, it's to make stuff. And people have really made stuff, from fully functioning computers to scale models of the Starship Enterprise.

The best things about Minecraft: Pi Edition are that it's free and comes with an API; you don't get this with any other version of Minecraft.

Minecraft is installed by default on Raspbian. If you have an older version, you can get it by opening a terminal (Menu > Accessories > Terminal), typing the commands pressing Enter after each one:

```
sudo apt-get update
sudo apt-get install minecraft-pi
```

Playing the game

Click **Menu > Games > Minecraft: Pi Edition** to run the game.

Minecraft: Pi Edition offers one playing mode, Classic, which is all about exploring and building. Click Start Game, then click Create New (or choose an existing one) to enter a world:

- ▶ **The mouse** changes where you look
- ▶ **Holding the left button** destroys blocks
- ▶ **Right button** places blocks
- ▶ **W, S, A, D** move you forward, backward, left, and right
- ▶ **1, 2, 3, 4, 5, 6, 7, 8** change what you are holding
- ▶ **E** opens the inventory
- ▶ **ESC** takes you back and to the **Menu**
- ▶ **Space** is jump; double-tapping Space makes you fly or stop flying

The API

The API (application programming interface) allows you to write programs which control, alter and interact with the Minecraft world, unlocking a whole load of Minecraft hacking. How about creating massive houses at the click of a button, a game which uses a LED and buzzer to help you find a block, or recreating Nintendo's Splatoon in Minecraft?

The API works by changing the world as the game is being played, allowing you to:

- ▶ Get the player's position
- ▶ Change (or set) the player's position
- ▶ Get the type of block
- ▶ Change a block
- ▶ Change the camera angle
- ▶ Post messages to the player

[WATCH
FOR RED
TEXT]

Any errors in
your program
will appear in the
Python shell in
red text.

Hello Minecraft World

The first program all programmers create when learning something new is called "Hello World", which puts "Hello World" on the screen. You're going to do the same, but in Minecraft:

01. Go to the Minecraft menu with ESC, but leave the game playing.
02. Open IDLE by clicking Menu > Programming > Python 3.
03. Use File > New Window to create a new program and save it as **hellominecraftworld.py**.
04. At the top of your program type the following code to import the **minecraft** module, which will allow you to use the API and talk to the game:

```
import mcpi.minecraft as minecraft
```

05. Create a connection from your program to Minecraft and call it **mc**:

```
mc = minecraft.Minecraft.create()
```

06. Use your Minecraft connection and the function **postToChat()** to put a message in the chat window:

```
mc.postToChat("Hello Minecraft World")
```

07. Run your program by clicking Run > Run Module.

[PYTHON IS CASE-SENSITIVE]

Beware of upper- and lower-case letters; “Minecraft” and “minecraft” are different things to Python.

Switch back to Minecraft and you should see the message “Hello Minecraft World” on the screen; be quick, though, as the message will only stay on the screen for 10 seconds before it disappears.

Any errors will appear in red text in the Python shell window; check your code carefully for spelling mistakes, and ensure that you have used the right upper- or lower-case letters.

When you have successfully got the message to appear on the screen, try changing it and running the program again.



Left Minecraft Pi Edition is free and has an API you can use to program it

Teleportation

Using your new Python programming skills and the Minecraft API, you can teleport Steve around the world by adding just one more line of code to your program.

Minecraft is a world of blocks, all about 1m x 1m x 1m. The player and every block in the world has a position made up of x, y, and z; x and z are the horizontal positions and y is the vertical. By changing the player's x, y, and z position, you can teleport them wherever you want.

The player starts at position x = 0, y = 0, z = 0, which is the spawn point, and the player's current position is shown on the top-left of the screen.

Add the following code to your Hello Minecraft World program to teleport the player to position x = 0, y = 100, z = 0, which will put your player 100 blocks up in the air:

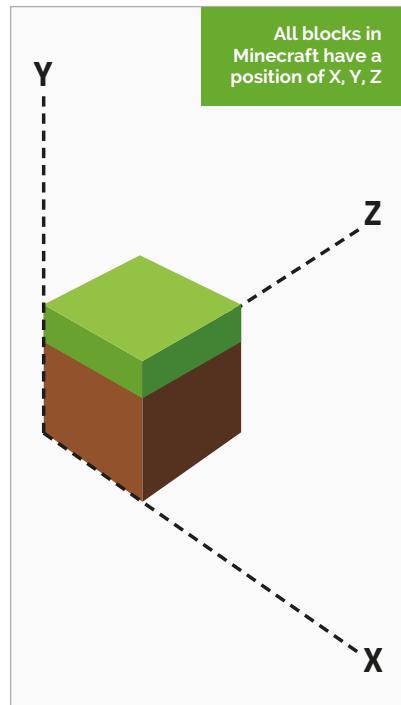
01. Teleport the player by setting their position:

```
mc.player.setPos(0, 100, 0)
```

02. Run your program by clicking Run > Run Module.

03. Switch back to Minecraft to see your player fall to the floor.

Try changing the values in `setPos()` to teleport your player to different places around the world; use values -125 to 125 for x and z and -64 to 64 for y, otherwise the player will be teleported outside the world.





[CHAPTER TWO]

CONTROLLING

BLOCKS

Learn how to control blocks
in Minecraft: Pi Edition
using the Python API

Y

ou will now write a program to turn Steve into Ice Man; he will leave trails of snow wherever he walks, and be able to turn any block into ice with a touch of his sword. A house of ice will also appear automatically, giving Steve somewhere cold to live.

The Minecraft: Pi Edition API lets you turn any block in the world into any other block: dirt into diamond, water into lava or stone into air!

By combining functions that get the player's position with those that change blocks, you can make the world change around the player without them doing anything.

Changing blocks

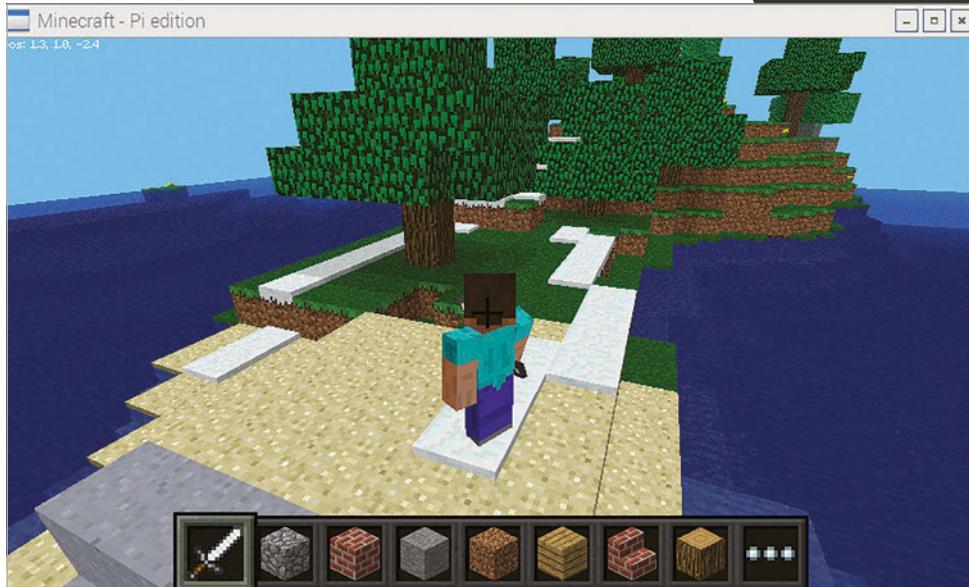
You will use the API to make the block which the player is standing on turn to snow; by using a loop you can make this run forever then as the player moves, the blocks underneath him will keep turning to snow:

01. Open IDLE by clicking Menu > Programming > Python 3.
02. Use File > New Window to create a new program and save it as '**iceman.py**'.
03. At the top of your program import the **minecraft** and **block** modules to use the API:
`import mcpi.minecraft as minecraft
import mcpi.block as block`
04. Create a connection from your program to Minecraft and call it **mc**:
`mc = minecraft.Minecraft.create()`
05. Get the player's 'tile' position (the block Steve is standing on), and store it in a variable called **p**:
`p = mc.player.getTilePos()`
06. Use the **setBlock** function to change this block to snow:
`mc.setBlock(p.x, p.y, p.z, block.SNOW)`
07. Run your program by clicking Run > Run Module.

Go back to Minecraft and look down: the block you're standing on will now be covered in snow. Make sure you're standing on the ground and not flying, as you can't put snow in the air!

Next, change the program so that it loops forever, always getting the player's position and turning that block to snow; that way, Steve will create snow wherever he walks:

Below Modify Minecraft so that Steve leaves snow wherever he walks



01. Go back to Python and modify your **iceman.py** program.
02. Add a **while** loop to the bottom of your program. This loop will continue forever:
while True:
03. The rest of your program will be indented under the **while** loop. If IDLE doesn't indent the next line for you, press Tab. Add the code to find the player's position and create the snow block:
while True:
 p = mc.player.getTilePos()
 mc.setBlock(p.x, p.y, p.z, block.SNOW)
04. Run your program by clicking Run > Run Module.

Now snow will automatically cover the blocks wherever Steve walks. Try changing **block.SNOW** to use different blocks and see what happens: you can find a complete list of blocks at magpi.cc/294zAfk.

Hitting blocks

When a block is hit with a sword by right-clicking, you can use the API to change those blocks. You're going to change your program so that when Steve hits a block it will instantly turn to ice.

Modify your `iceman.py` program so that it uses the **events**.
`pollBlockHits()` function to get any blocks which have been hit and turn them to ice:

- At the end of your program, indented under the `while` loop, add the code to get the blocks which have been hit:

```
while True:  
    for hit in mc.events.pollBlockHits():
```

- Indented under the `for` loop created above, add the code to turn the block which has been hit to ice.

```
mc.setBlock(hit.pos.x, hit.pos.y, hit.pos.z, block.ICE)
```

- Run your program by clicking Run > Run Module.

Snow should continue to cover the ground wherever Steve walks, but now when you hit a block (right-clicking while holding a sword), it will turn to ice.

Right Turn any block to ice by hitting it with your sword

[HITTING BLOCKS]

If blocks don't turn to ice, check that you're right-clicking and holding a sword.



Creating lots of blocks

When you want to create lots of blocks you can use the function **setBlocks()** which, when passed two positions, will fill the gap in between with any block you want. The quickest and easiest way to create buildings in Minecraft is by creating a cube and then hollowing it out by creating a cube of air in the middle.

Create a new program which will build an ice house:

01. Open IDLE by clicking Menu > Programming > Python 3.

02. Use File > New Window to create a new program and save it as **icehouse.py**.

03. Import the **minecraft** and **block** modules.

```
import mcpi.minecraft as minecraft
import mcpi.block as block
```

04. Create a connection from your program to Minecraft and call it **mc**.

```
mc = minecraft.Minecraft.create()
```

05. Get the player's position:

```
p = mc.player.getTilePos()
```

06. Use the **setBlocks()** function to create a cube of ice next to Steve of size 11 x 5 x 11:

```
mc.setBlocks(p.x + 1, p.y, p.z + 1,
             p.x + 10, p.y + 5, p.z + 10,
             block.ICE)
```

07. Create a cube of air inside the ice, making it hollow:

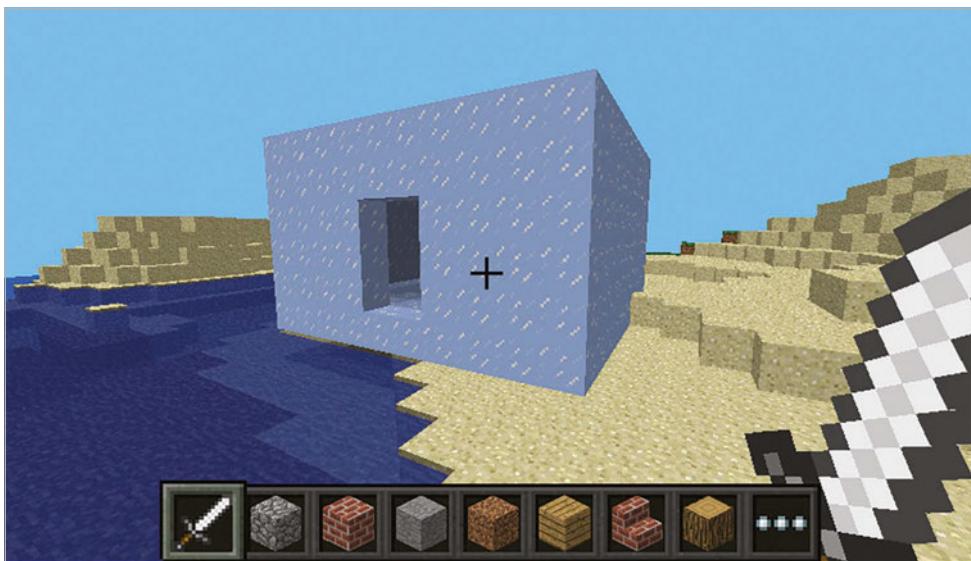
```
mc.setBlocks(p.x + 2, p.y + 1, p.z + 2,
             p.x + 9, p.y + 4, p.z + 9,
             block.AIR)
```

08. Run your program by clicking Run > Run Module.

A large cube of ice will appear next to Steve; if you break some of the ice blocks, you'll see that it's hollow and you can walk inside.

The ice house is still pretty basic and at the moment there's no way to get in, so modify your program to create a door and put some carpet on the floor:

Below Use code, not building, to create an ice house



01. Add the code to your program to make a gap in the front of the ice cube for a door:

```
mc.setBlocks(p.x + 5, p.y + 1, p.z + 1,
            p.x + 6, p.y + 3, p.z + 1,
            block.AIR)
```
02. Use **setBlocks** again to change the blocks on the floor to be made of red wool:

```
mc.setBlocks(p.x + 2, p.y, p.z + 2,
            p.x + 9, p.y, p.z + 9,
            block.WOOL.id, 14)
```
03. Run your program by clicking Run > Run Module.

[USING DIFFERENT BLOCKS]

You will find a complete list of blocks and their data at:
[magpi.cc/
294zAfk](http://magpi.cc/294zAfk)

A door will now appear in the ice house and a red wool carpet will be on the floor.

The number 14 on the line `block.WOOL.id, 14` makes the wool red. Try changing it to a different number between 0 – 15 and running the program again, until you find a colour you like.

iceman.py

```
from mcpi.minecraft import Minecraft
from mcpi import block

mc = Minecraft.create()

while True:
    p = mc.player.getTilePos()
    mc.setBlock(p.x, p.y, p.z, block.SNOW)

    for hit in mc.events.pollBlockHits():
        mc.setBlock(hit.pos.x, hit.pos.y, hit.pos.z, block.ICE)
```

Download
[magpi.cc/
29eyNf](https://magpi.cc/29eyNf)

icehouse.py

```
from mcpi.minecraft import Minecraft
from mcpi import block

mc = Minecraft.create()

p = mc.player.getTilePos()

mc.setBlocks(p.x + 1, p.y, p.z + 1,
            p.x + 10, p.y + 5, p.z + 10,
            block.ICE)

mc.setBlocks(p.x + 2, p.y + 1, p.z + 2,
            p.x + 9, p.y + 4, p.z + 9,
            block.AIR)

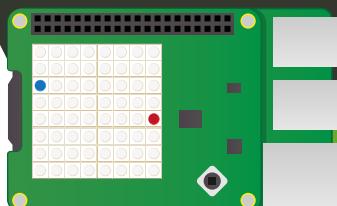
mc.setBlocks(p.x + 5, p.y + 1, p.z + 1,
            p.x + 6, p.y + 3, p.z + 1,
            block.AIR)

mc.setBlocks(p.x + 2, p.y, p.z + 2,
            p.x + 9, p.y, p.z + 9,
            block.WOOL.id, 14)
```

[CHAPTER THREE]

WALKING WITH STEVE

Tired of using your fingers to tap keys to move in Minecraft?
Then why not use your wrist instead, and take advantage
of the awesome power of the Sense HAT?



YOU'LL NEED A
SENSE HAT FOR
THIS PROJECT!

[MINECRAFT & SENSE HAT]

The Sense HAT is an add-on board which attaches to the Pi's GPIO pins. It has lots of sensors, such as the humidity sensor and the magnetometer. The sensor we'll be using in this project is the accelerometer. It also has an 8×8 LED matrix.

Yne of the cool things about the console edition of *Minecraft* is that you can use a controller instead of a keyboard. The Pi edition might sometimes seem a little basic, but you can make your game more like the console edition by deploying your Sense HAT as a tiltable controller, instead of using a keyboard. If you don't know which way to tilt it, the arrows appearing on the LED matrix will help you.

The first thing you need to do is to install all the necessary modules. An obvious one is the Sense HAT library: if you have Raspbian Jessie, this comes bundled with it, but if not, you can install it by typing:

```
sudo pip install sense_hat
```

You'll also need another Python module, which in turn requires the Xlib library:

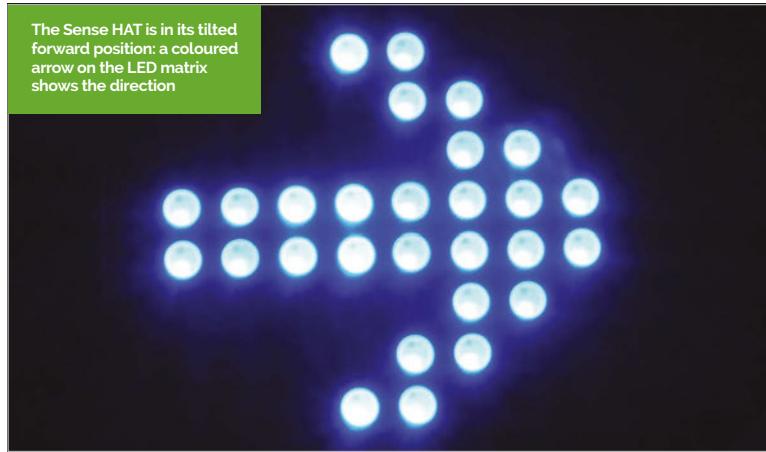
```
sudo apt-get install python-xlib
sudo pip install pyautogui
```

Using the **pyautogui** functions, you can simulate keys as if they were actually pressed. This is how you make Steve walk around his blocky world.

Instead of pressing keys, we'll use the Sense HAT's accelerometer to find out which direction the HAT is being tilted. Each time we measure, we get values representing the acceleration intensity of the x, y, and z axes (in Gs). These are sometimes called roll, pitch, and yaw, like on an aeroplane or a spaceship. We only need the x and y axes, as the z axis is rotation and we're not using that.

[LIGHT THE WAY]

The arrows displayed on the LED matrix while you're moving look really cool, but are actually easy to generate. Using Python, we make a 64-element list containing the arrow shape - you can customise this to make your own shape of arrow - and then simply display it using a different RGB colour value and with a different rotation. The Sense HAT API makes this whole process very simple.



How to use it

Download or type up the code from the listing (right) into IDLE, then press **F5** to run it. Make sure Minecraft is running and you've entered a world when you run it, otherwise lots of errors will appear! If you tilt the Sense HAT forward, the **pyautogui** module will trigger a W key and move Steve forward; make sure your mouse is clicked in the Minecraft window when this happens, otherwise it will just generate a 'w' in the Python shell. The same thing happens when you tilt it backwards, but it will generate an S. If you tilt it to the side, it will generate a D or an A, depending on which direction you've tilted. You still need to use the mouse to look around, and the E key to open your inventory. So, the idea is for you to get all the items you need in your hotbar, then hold the mouse in one hand and the Sense HAT in the other.

Using Minecraft

When the program is running, you'll only be able to walk (or fly) around using the keys when the Sense HAT is in the level position (all the LEDs will be red). Even then, you'll only move if you tap the key repeatedly instead of holding it down. So you're better off sticking to the Sense HAT!

Once you have written and understood this program, you could try to improve it by making the Sense HAT's joystick open your inventory or whatever else you can think of!

WalkingWithSteve.py

Download
[magpi.cc/
1Qr7wjw](http://magpi.cc/1Qr7wjw)

```

01. from mcpi.minecraft import Minecraft
02. import pyautogui as pag
03. import time
04. from sense_hat import SenseHat
05. sh = SenseHat()
06.
07. # unpresses all the keys
08. def unpress():
09.     for key in ['s','w','a','d']:
10.         pag.keyUp(key)
11.
12. # presses the correct key
13. def move(direction):
14.     unpress()
15.     pag.keyDown(direction)
16.
17. # the arrow
18. def displayArrow(c,rot):
19.     arrow = [
20.         e,e,e,c,c,e,e,e,
21.         e,e,c,c,c,e,e,
22.         e,c,c,c,c,c,e,
23.         c,c,e,c,c,e,c,c,
24.         c,e,e,c,c,e,e,c,
25.         e,e,e,c,c,e,e,e,
26.         e,e,e,c,c,e,e,e,
27.         e,e,e,c,c,e,e,e]
28.     sh.set_rotation(rot)
29.     sh.set_pixels(arrow)
30.
31. # define the colours
32. r = [255,0,0]
33. e = [0,0,0]
34. g = [0,255,0]
```

```
35. b = [0,0,255]
36. stop = [ # the stop sign
37. r,r,r,r,r,r,r,r,
38. r,r,r,r,r,r,r,r,
39. r,r,r,r,r,r,r,r,
40. r,r,r,r,r,r,r,r,
41. r,r,r,r,r,r,r,r,
42. r,r,r,r,r,r,r,r,
43. r,r,r,r,r,r,r,r,
44. r,r,r,r,r,r,r,r]
45.
46. mot = 'SSSS'
47. while True: # main loop
48.     x, y, z = sh.get_accelerometer_raw().values()
49.     x = round(x, 0)
50.     y = round(y, 0)
51.     if x == -1 and abs(y) == 0 and mot != 'rrrr':
52.         displayArrow(b,0)
53.         move('d') # right
54.         mot = 'rrrr'
55.     elif x == 1 and abs(y) == 0 and mot != 'llll':
56.         displayArrow(b,180)
57.         move('a') # left
58.         mot = 'llll'
59.     elif y == -1 and mot != 'wwww':
60.         displayArrow(g,270)
61.         move('w') # fwd
62.         mot = 'wwww'
63.     elif y == 1 and mot != 'bbbb':
64.         displayArrow(g,90)
65.         move('s') # back
66.         mot = 'bbbb'
67.     elif abs(x) == 0 and abs(y) == 0:
68.         unpress() # stop
69.         sh.set_pixels(stop)
70.         mot = 'SSSS'
```



[CHAPTER FOUR] THE MINECRAFT LAVA TRAP

Program a game in Minecraft and see whether you can escape the Lava Trap!



Above Can you escape the Lava Trap?

Y

ou're going to create a mini-game. A lava pit will instantly appear and Steve will be put at the centre of it; soon, the block he's standing on will disappear so he will have to move, but hang on: all the blocks keep disappearing!

Welcome

The first task is to start your program and get "Welcome to the Lava Trap" to appear on the screen:

01. Start Minecraft by clicking Menu > Games > Minecraft and create a new world.
02. Press ESC to go back to the Minecraft menu but leave the game playing.
03. Open IDLE by clicking Menu > Programming > Python 3.
04. Use File > New Window to create a new program and save it as **lavatrap.py**.
05. Type the following code into the program to import the modules you'll need:

```
import mcpi.minecraft as minecraft  
import mcpi.block as block  
from time import sleep
```

06. Create a connection to Minecraft using this code:

```
mc = minecraft.Minecraft.create()
```

07. Post a message to the chat window:

```
mc.postToChat("Welcome to the Lava Trap")
```

08. Run your program by clicking Run > Run Module.

You should see your message appear in the Minecraft chat window.

Lava

Update your program so it creates the pit of lava under Steve, by adding the following code:

01. Put a 3 second delay into your program so that you can see what's going on:

```
sleep(3)
```

02. Find out where Steve is in the world:

```
pos = mc.player.getTilePos()
```

03. Use `setBlocks()` to create an area of **STONE** two blocks below Steve for the **LAVA** to sit on:

```
mc.setBlocks(pos.x - 5, pos.y - 2, pos.z - 5,
            pos.x + 5, pos.y - 2, pos.z + 5,
            block.STONE.id)
```

04. Then create the **LAVA** under Steve:

```
mc.setBlocks(pos.x - 5, pos.y - 1, pos.z - 5,
            pos.x + 5, pos.y - 1, pos.z + 5,
            block.LAVA.id)
```

05. Run your program by clicking Run > Run Module or by pressing F5.

There will be a 3 second delay before the lava pit appears and Steve burns...
Create a diamond block in the middle for Steve to stand on:

01. Create the diamond block:

```
mc.setBlock(pos.x, pos.y - 1, pos.z, block.DIAMOND_BLOCK.id)
```

02. Run your program. Steve will be stuck in the middle of the lava pit.

Make a game

Update your program to make blocks under Steve disappear:

01. Post messages to the chat screen to warn the player the game is about to start:
`mc.postToChat("Get Ready")
mc.postToChat("Blocks under you will keep disappearing")
sleep(3)
mc.postToChat("Go")`
02. Create a variable called **gameover** and set it to False. It will be set to True at the end of the game:
`gameover = False`
03. Create a loop which will continue until the game is over:
`while gameover == False:`
04. Indented under the while loop, add the code to get Steve's position:
`p = mc.player.getTilePos()`
05. Turn the block under Steve to **OBSIDIAN** as a warning and wait for 2 seconds:
`mc.setBlock(p.x, p.y - 1, p.z, block.OBSIDIAN.id)
sleep(2)`
06. After the warning, turn the block to **AIR**. If Steve is standing on it, he's going to be in the lava pit:
`mc.setBlock(p.x, p.y - 1, p.z, block.AIR.id)
sleep(0.5)`
07. Run the program. The game will start and you'll have to put blocks down in the lava pit to escape, as otherwise they're going to disappear and Steve will fall in.

Game over

The game is over if Steve falls into the lava. You need to modify your program to check if he has fallen into the lava and put a message on the screen:

01. Use an if statement to see if Steve's height (y) is not equal to where he started. If it is, set the **gameover** variable to True:
`if p.y != pos.y:
 gameover = True`

02. Put a message on the screen to let the player know they have been caught in the lava trap:

```
mc.postToChat("Game over.")
```

03. Run your program and see how long you can stay out of the lava.

Next steps

This game is just the start: can you finish it? Here are some challenges:

- ▶ Make the game harder.
- ▶ Make a better game arena, perhaps building a stadium or walls around it so Steve can get out.
- ▶ Add points to the game; each time Steve doesn't fall in, he gets a point.
- ▶ Change the game so it starts easy but gets harder the longer you play.
- ▶ Add a two-player (or even multiplayer!) option.



Above You'll have to put blocks down into the lava to escape

lavatrap.py

Download
[magpi.cc/
z9eyAlC](http://magpi.cc/z9eyAlC)

```
import mcpi.minecraft as minecraft
import mcpi.block as block
from time import sleep
mc = minecraft.Minecraft.create()
mc.postToChat("Welcome to the Lava Trap")

sleep(3)
pos = mc.player.getTilePos()
mc.setBlocks(pos.x - 5, pos.y - 2, pos.z - 5,
            pos.x + 5, pos.y - 2, pos.z + 5,
            block.STONE.id)
mc.setBlocks(pos.x - 5, pos.y - 1, pos.z - 5,
            pos.x + 5, pos.y - 1, pos.z + 5,
            block.LAVA.id)

mc.setBlock(pos.x, pos.y - 1, pos.z, block.DIAMOND_BLOCK.id)

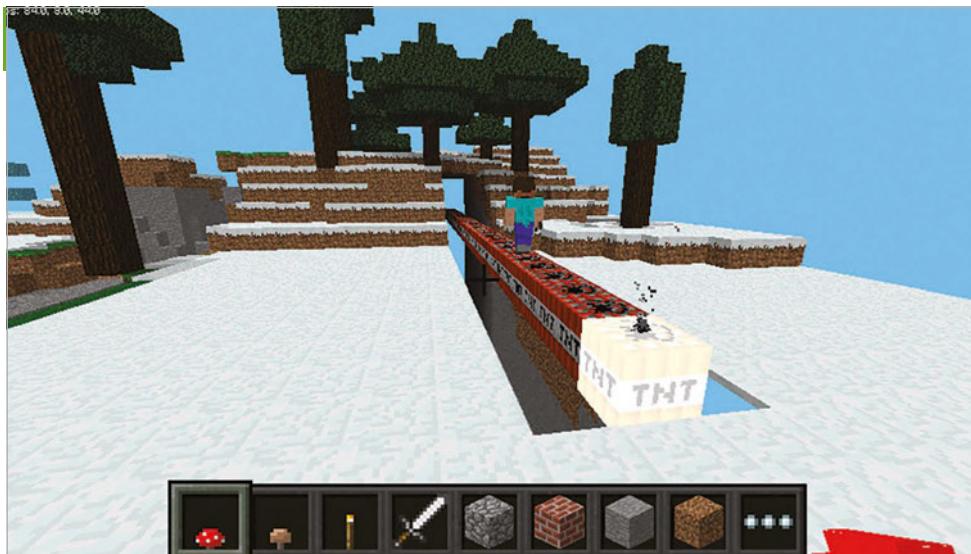
mc.postToChat("Get Ready")
mc.postToChat("Blocks under you will keep disappearing")
sleep(3)
mc.postToChat("Go")
gameover = False
while gameover == False:
    p = mc.player.getTilePos()
    mc.setBlock(p.x, p.y - 1, p.z, block.OBSIDIAN.id)
    sleep(2)
    mc.setBlock(p.x, p.y - 1, p.z, block.AIR.id)
    sleep(0.5)
    if p.y != pos.y:
        gameover = True
mc.postToChat("Game over.")
```



[CHAPTER FIVE]

TNT RUN!

Can you outrun an explosion? Test your speed with this marvellous Minecraft mini-game!



Above Bash the first block to trigger the chain reaction along the TNT

One of the many amazing things about Raspberry Pis is that they have their own edition of Minecraft for free; what's even better is you can code it in Python using the Minecraft API! In the next 30 minutes you'll create a game called TNT Run, in which you start at one end of a long line of TNT and have to make it to the safe area without the TNT exploding in your face.

The Minecraft API gives us complete control over many elements of the game; this includes teleporting players around the world and displaying helpful messages on the screen. We are also able to place blocks automatically: not just one at a time, but as a three-dimensional collection of blocks.

This game will also include a block which is unique to Pi and Pocket editions: invisible bedrock. We use this block to keep the TNT from falling to the ground when lit, and as an invisible path leading to the safe area. You may find something strange about this block when you place it next to a non-invisible block, so try experimenting with that; you need to look directly into the invisible bedrock.

TNT also behaves differently in the Pi edition. Whereas in other editions you set off TNT with flint and steel, a fire charge or a flaming arrow, in the Pi edition you just need to hit it a couple of times with

anything. However, you can't just do this with any old TNT block: first, we need to set its block data value to an odd number (1, 3, 5, 7, or 9). Most blocks have a block data value and by changing this, it will alter the block's behaviour. For example, when you set Nether Reactor Core's block data value to 1, it appears in a red colour; if you set it to 2 then it will come out as a dark blue colour. We use these cool-looking blocks to mark where the teleporter is and as a part of the end podium. The teleporter function in the code is designed so that if you manage to get to a certain point along the line of TNT, it gives you a boost and teleports you forward.

When you create your Minecraft world, fly around it and find a cool location to create your TNT course (i.e. not when you are near a cliff or the end of the world). Your code takes the player's position and constructs the TNT course, using this location as the starting point. When you run the code, make sure Minecraft is running, otherwise your code will give you a connection error.

Once you have finished the project, you can customise your own version of the TNT Run game by adding changes like making the row of TNT longer, or creating a fancier safe area. Also, when you're connected to a network with other Raspberry Pis, you can join someone else's world, create two lines of TNT and race to the safe areas simultaneously!



Left This is the safe area you need to run to: if you make it there, you've won

TNTRUN.py

```
01. # import all the necessary modules
02. from mcpi.minecraft import Minecraft
03. from mcpi import block
04. import time
05.
06. # connect with the Minecraft world
07. mc=Minecraft.create()
08.
09. # get the player's position
10. pos=mc.player.getTilePos()
11.
12. # check if the end of the world will engulf your creation and move you if you're too close
13. if pos.z<-40:
14.     mc.postToChat(
15.         'teleporting to safer distance in progress!')
16.     mc.player.setPos(pos.x,pos.y,-40)
17.     pos=mc.player.getTilePos()
18.
19. # mark where the teleport is
20. zpos=pos.z-40
21.
22. # create the valley by hollowing it out with air
23. mc.setBlocks(pos.x-1,pos.y+3,pos.z,pos.x+1,pos.y-7,pos.z-88,block.AIR.id)
24.
25. # build the invisible bedrock support
26. mc.setBlocks(pos.x,pos.y-1,pos.z,pos.x,
27. pos.y-7,pos.z,block.BEDROCK_INVISIBLE.id)
28. mc.setBlocks(pos.x-1,pos.y-1,pos.z,pos.x,
29. pos.y-7,pos.z,block.BEDROCK_INVISIBLE.id)
30. mc.setBlocks(pos.x+1,pos.y-1,pos.z,pos.x,
31. pos.y-7,pos.z,block.BEDROCK_INVISIBLE.id)
32. mc.setBlocks(pos.x,pos.y-1,pos.z-88,pos.x-1,pos.y-7,pos.z-88,block.BEDROCK_INVISIBLE.id)
33. mc.setBlocks(pos.x-1,pos.y-1,
34. pos.z-88,pos.x,pos.y-7,pos.z-88,
35. block.BEDROCK_INVISIBLE.id)
36. mc.setBlocks(pos.x+1,
```

Download
[github.com/
snake48/
TNTRUN](https://github.com/snake48/TNTRUN)

```
37. pos.y-1, pos.z-88, pos.x,  
38. pos.y-7, pos.z-88, block.BEDROCK_INVISIBLE.id)  
39. mc.setBlocks(pos.x, pos.y, pos.z, pos.x,  
40. pos.y-7, pos.z-92, block.BEDROCK_INVISIBLE.id)  
41.  
42. # build the bomb  
43. mc.setBlocks(pos.x, pos.y, pos.z, pos.x, pos.y,  
44. pos.z-88, block.TNT.id, 1)  
45.  
46. # build the end podium  
47. mc.setBlocks(pos.x-2, pos.y, pos.z-93,  
48. pos.x+2, pos.y, pos.z-97, block.GLOWING_OBSIDIAN.id)  
49. mc.setBlocks(pos.x-1, pos.y+1, pos.z-94, pos.x+1,  
50. pos.y+1, pos.z-96, block.NETHER_REACTOR_CORE.id, 1)  
51. mc.setBlock(pos.x, pos.y+2, pos.z-95,  
52. block.REDSTONE_ORE.id)  
53.  
54. # set how many teleports you have  
55. teleport=1  
56.  
57. # build the display teleport signal block  
58. mc.setBlock(pos.x+1, pos.y+1, pos.z-44,  
59. block.NETHER_REACTOR_CORE.id, 2)  
60. mc.setBlock(pos.x-1, pos.y+1, pos.z-44,  
61. block.NETHER_REACTOR_CORE.id, 2)  
62.  
63.  
64. # teleport player when at a certain position  
65. while teleport ==1:  
66.     pos=mc.player.getTilePos()  
67.     if pos.z==zpos:  
68.         mc.player.setPos(pos.x, pos.y, pos.z-24)  
69.         teleport=0
```

[CHAPTER SIX]

TERRAFORMING

MINECRAFT

Everyone has their favourite Minecraft block.
What if you could have an entire world made out of them?

- In this world we added snow to the blocks not to be transformed (add them to the keepblocks list in the code)

The default setting for a placed TNT block is inert. If you want to be able to detonate them, you'll have to set their data value to 1



You'll Need

- Initial State account initialstate.com
- ISStreamer and Python 3 library
- psutil Python 3 library

Imagine fields of gold, fit for King Midas or the dragon Smaug. Or how about a frozen landscape where everything has been turned to ice? Just think what you could do in a world where everything is primed TNT.

Using Python, we can start a terraforming process to remake a Minecraft world to your specifications. Even on a Pi 3, this won't be a quick process: depending on how complex your landscape is, and how much you want to transform, it may take several days. So we'll monitor our progress by uploading data to an Initial State dashboard so that we can keep track of things remotely. If you just want to do the terraforming, there's another version of the code without the Initial State functionality in the same GitHub repository ([terraforming_no_is.py](#)).

>STEP-01

Generate your world

Before you start coding, you need to create your Minecraft: Pi Edition world and select the block type with which you want to fill your world. This can be any block of your choice, but it has to be a solid block (not ladders or torches). Manipulating the Minecraft ecosystem can be tricky. For example, if you try to turn water directly to lava, you'll probably end up with lakes of obsidian, so you might need an

intermediate step: turn all the water to something inert like wool, then transform it to lava. There may also be some blocks you want to keep – snow or water, for example.

>STEP-02

Get the code

Make sure your Pi is up to date and, if you want to create a remote monitoring dashboard on Initial State, download and install its data streaming library:

```
sudo pip3 install ISStreamer psutil
```

Then download the `is_terraforming.py` code (magpi.cc/234A3hY). Note that you'll need to change some of the values to suit your Minecraft environment and to include your Initial State account details.

>STEP-03

Tune the code

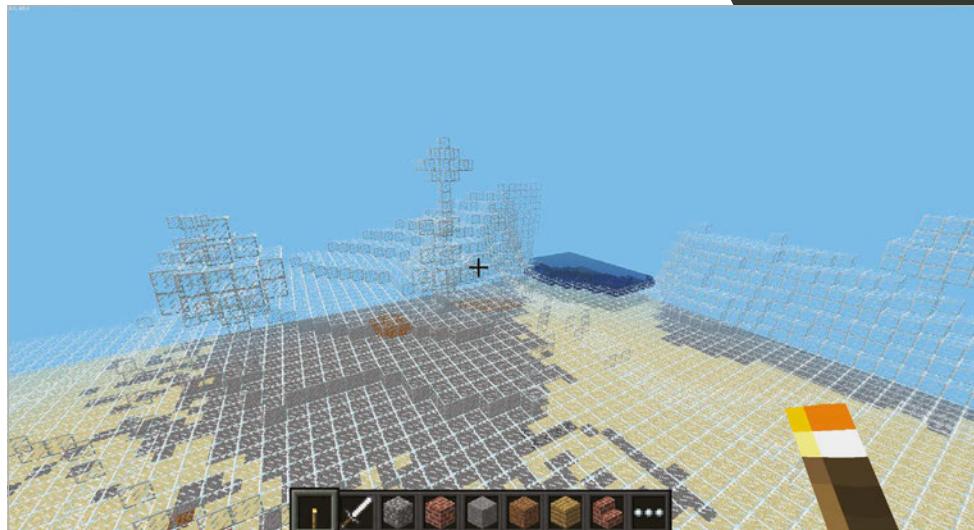
Terraforming can take a long time – we're talking days rather than minutes. However, we can tune our code to speed things up. Explore your world and find the tallest mountain range and deepest valley. Make a note of the height (the third value displayed in the top-left corner of the screen). You can then plug these values into the code.

We've set the default terraforming height range from -3 to 35 on the y axis, but you can make this bigger (this will take longer) or shorter (this will take less time), depending on the size of the geological features in your world.

>STEP-04

Set the speed for the power of your Pi

This code should work on any Pi, but older, less powerful models may struggle if you terraform at full speed. If Minecraft can't keep up with all the changes it's asked to make to the landscape, it may hang. So it's a good idea to pause after a certain number of blocks, to let Minecraft catch up. On a Pi 3, you can comfortably transform 500+ blocks before having to pause, but for a Model B you may need to deal with 50 blocks at a time. You'll probably want to run a few experiments to find the optimum configuration for your setup.



>STEP-05

Register for an Initial State account

Initial State allows you to upload live data and plot interesting charts and graphs. A free account lets you stream 25,000 events a month and examine the last 24 hours' worth of data in any bucket. Once you've registered for an account, click on the 'create HTTPS bucket' button (the plus symbol) and give it a suitable name. Then check 'Configure Endpoint Keys' and copy the Bucket Key and Access Key into your version of the code.

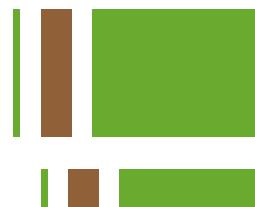
Above You can create some very strange-looking worlds, like this one where everything on the surface is made of glass

>STEP-06

Start terraforming!

If you're using a free account, edit the code and set the **Free_account** variable to True. This will throttle the amount of data sent to Initial State and allow you to record the whole process without exceeding the data cap.

Start your code running and check the console for any errors. You can fly to the corner of your world and should soon be able to see the changes taking place. Once the first data reaches Initial State, you can create a cool dashboard: use the Tiles interface and play around with the different types available.



is_terraforming.py

```
01. import mcpi.minecraft as minecraft # Load libraries
02. from ISStreamer.Streamer import Streamer
03. import mcpi.block as block
04. import time, datetime, psutil
05.
06. for pros in psutil.pids(): # Get the Linux process number for the Minecraft program
07.     if psutil.Process(pros).name() == 'minecraft-pi' and len(psutil.Process(pros).cmdline()) == 1:
08.         pm = psutil.Process(pros)
09. streamer=Streamer(
10.     bucket_name=":mushroom: Terraforming", bucket_key="", access_key="<eneter here>")
11. Free_account = False # If using a free IS account, set to True to limit data uploads and avoid
12. exceeding monthly limit
13. # Function to upload various bits of data to IS
14. def upload_data_to_IS(
15.     speed,elapsed,blocks_processed, blocks_transformed,cpu,y,x,z,mem,pm,num_blocks):
16.     print('Uploading to Initial State')
17.     streamer.log(":snail: Run Speed",speed)
18.     streamer.log(":jack_o_lantern: Run2 Time since last "+ str(num_blocks) + "blocks",elapsed)
19.     streamer.log(":volcano: Run2 Total Blocks",blocks_processed)
20.     streamer.log(":chocolate_bar:Run2 Blocks transformed",blocks_transformed)
21.     streamer.log(":up: CPU %",cpu)
22.     streamer.log(":arrow_down: Y",y)
23.     streamer.log(":arrow_right: X",x)
24.     streamer.log(":arrow_left: Z",z)
25.     streamer.log(":question: Memory used %",mem.percent)
26.     streamer.log(":question: Minecraft Process memory used %",pm.memory_percent())
27.
28.     time.sleep(1)
29.     mc=minecraft.Minecraft.create() # Connect to Minecraft
30.     keepblocks=[block.AIR.id,block.WATER.id,block.LAVA.id,block.SNOW.id,
31.                 block.WATER_FLOWING.id,block.WATER_STATIONARY]
32.     counter = 0 # A bunch of variables to keep track of how many blocks have been processed
33.     blocks_processed = 0
34.     blocks_transformed = 0
35.     blocks_since = 0
36.     throttle = 5 # Use this when Free_account is True, to restrict amount of data uploaded
37.     num_blocks = 1000 # How many blocks to transform before pausing to let Minecraft catch up
```

Download
[magpi.cc/
234A3hY](http://magpi.cc/234A3hY)

```

34. start = time.time()
35. for x in range(-128,128): # the x-direction
36.     for y in range(-4,35): # the y-direction (up/down)
37.         for z in range(-128,128): # the z-direction
38.             print(x,y,z)
39.             test = mc.getBlock(x,y,z) # Read a block at x, y, z
40.             blocks_processed+=1
41.             blocks_since+=1
42.             if test not in keepblocks: # Don't transform these blocks (should always contain AIR)
43.                 counter+=1
44.                 if counter > num_blocks:
45.                     blocks_transformed+=num_blocks
46.                     counter = 0
47.                     stop = time.time()
48.                     elapsed = stop - start # How long since last group of blocks were processed?
49.                     speed = blocks_since/elapsed # Calculate speed
50.                     cpu = psutil.cpu_percent() # Read CPU utilisation
51.                     mem = psutil.virtual_memory() # Read memory usage data
52.                     if Free_account: # Only bother to throttle if using free IS account
53.                         if throttle == 0:
54.                             upload_data_to_IS(
55.                                 speed,elapsed,blocks_processed, blocks_transformed,cpu,y,x,z,mem,pm,num_blocks)
56.                             throttle = 5
57.                         else:
58.                             throttle-=1
59.                             print('reducing throttle')
60.                         else:
61.                             upload_data_to_IS(
62.                                 speed,elapsed,blocks_processed, blocks_transformed,cpu,y,x,z,mem,pm, num_blocks)
63.                             time.sleep(5) # Pause to allow Minecraft to catch up
64.                             start = time.time()
65.                             blocks_since=0
66.                             mc.setBlock(x,y,z,block.REDSTONE_ORE.id)

67.                             print('Changing Block: ' + str(test) + ' (counter = ' + str(counter) + ')')
68.                             time.sleep(0.1)
else:
    print('Not changing Block: ' + str(test) + ' (counter = ' + str(counter) + ')')

```

[CHAPTER **SEVEN**] **CREATE NATURAL DISASTERS IN MINECRAFT**

Cause peril in your Minecraft world by adding catastrophes such as meteors and earthquakes

Right A volcano emerges, spewing out liquid hot magma. It's a good thing you're invincible!



I've created natural disasters in Minecraft using Python," ten-year-old CrazySqueak writes on his blog. "It adds many disasters to your Minecraft that happen randomly, wherever you are in your world. The program randomly starts disasters on its own, so you should keep moving to avoid getting hit."

This excellent Python script for Minecraft does something very different from other hacks that require player interaction: it actually adds to the world in the way a normal PC game mod might. With earthquakes, sinkholes, meteors, geysers, and volcanic eruptions each acting differently and independently, a lot of work has gone into this program.

The code works by setting up the parameters of each disaster. Each type has individual timing for when it occurs, once triggered, and how long it works for. They all use the Minecraft Python API to create or remove blocks, such as creating lava for the eruption and meteor, or creating an empty space with the sinkhole and earthquake.

All the disasters are triggered at random in the code, and are based around your location in the game – that's why CrazySqueak suggests staying on the move! You can also trigger each function individually to see how it works, and some even come with sound clips to further add to the effect of the mod.

As well as creating natural disasters, CrazySqueak received a Highly Commended award for a submission to Astro Pi. We can't wait to see what other mashups he creates for Minecraft in the future.

natural_disasters.py

```
01. import mcpi.minecraft as minc
02. import mcpi.block as block
03. mc = minc.Minecraft.create()
04. import random, time, pygame
05. pygame.mixer.init()
06. earthSound = pygame.mixer.Sound('earthquake.ogg')
07. eruptSound = pygame.mixer.Sound('lava.ogg')
08. meteorSound = pygame.mixer.Sound('meteor.ogg')
09. def earthquake(x, z):
10.     mc.postToChat('Earthquake!')
11.     y = mc.getHeight(x, z)
12.     endtime = time.time() + 60
13.     nearhtime = time.time()
14.     while endtime > time.time():
15.         if time.time() > nearhtime:
16.             earthSound.play()
17.             nearhtime = time.time() + 5
18.         ppos = mc.player.getPos()
19.         if ppos.x < x+15 and ppos.x > x-15:
20.             if ppos.y < y+15 and ppos.y > -60:
21.                 if ppos.z < z+15 and ppos.z > z-15:
22.                     mc.player.setPos(ppos.x, ppos.y, ppos.z)
23.                     bx = random.randint(x-15, x+15)
24.                     by = y
25.                     bz = random.randint(z-15, z+15)
26.                     if mc.getHeight(bx, bz) > -50:
27.                         by = mc.getHeight(bx, bz)
28.                         if mc.getBlock(bx, by, bz) in [block.GLASS.id, block.GLASS_PANE.id]:
29.                             mc.setBlock(bx, by, bz, block.AIR.id)
30.                             continue
31.                         mc.setBlock(bx, by, bz, block.GRAVEL.id)
32.                         mc.setBlocks(bx, by-1, bz, bx, -60, bz, block.AIR.id)
33. def sinkhole(x, z):
34.     blks = []
35.     y = mc.getHeight(x, z)
36.     xdist = random.randint(1, 5)
37.     for bx in range(-xdist, xdist+1):
38.         zdist = random.randint(1, 5)
39.         for bz in range(-zdist, zdist+1):
```

Download
[magpi.cc/
 1NUZ8Zm](https://magpi.cc/1NUZ8Zm)

```

40.         blks.append([x+bx, z+bz])
41.     earthSound.play()
42.     for blk in blks:
43.         mc.setBlocks(
44.             blk[0], mc.getHeight(blk[0], blk[1]), blk[1], blk[0], -60, blk[1], block.AIR.id)
45.             mc.setBlocks(blk[0], -55, blk[1], blk[0], -60, blk[1], block.LAVA.id)
46.     for blk in blks:
47.         mc.setBlock(blk[0], y, blk[1], block.GRAVEL.id)
48. def geyser(x, z):
49.     y = mc.getHeight(x, z)
50.     mc.setBlocks(x-2, y+5, z-2, x+2, -60, z+2, block.WATER.id)
51.     time.sleep(25)
52.     mc.setBlocks(x-2, y+5, z-2, x+2, -60, z+2, block.AIR.id)
53. def eruption(x, z):
54.     y = mc.getHeight(x, z)
55.     for i in range(3):
56.         eruptSound.play()
57.         mc.setBlocks(x-2, y+9, z-2, x+2, y+9, z+2, block.LAVA.id)
58.         eruptSound.play()
59.         for i in range(15):
60.             time.sleep(1)
61.             eruptSound.play()
62.             eruptSound.play()
63.             mc.setBlocks(x-2, y+10, z-2, x+2, y+10, z+2, block.WATER.id)
64.             eruptSound.play()
65.             for i in range(5):
66.                 time.sleep(1)
67.                 eruptSound.play()
68.                 eruptSound.play()
69.                 mc.setBlocks(x-2, y+10, z-2, x+2, y+10, z+2, block.AIR.id)
70.                 eruptSound.play()
71.                 for i in range(5):
72.                     time.sleep(1)
73.                     eruptSound.play()
74.                     eruptSound.play()
75.                     y += 1
76.                     eruptSound.play()
77.     def meteor(x, z):
78.         mc.postToChat('Meteor approaching!')
79.         y = 64
80.         h = mc.getHeight(x, z)
81.         x -= (64 - h)
```

```
81.     meteorSound.play()
82.     while y > h:
83.         y -= 1
84.         x += 1
85.         mc.setBlocks(x-2, y-2, z-2, x+2, y+2, z+2, block.OBSIDIAN.id)
86.         time.sleep(0.05)
87.         mc.setBlocks(x-2, y-2, z-2, x+2, y+2, z+2, block.AIR.id)
88.         mc.setBlocks(x-2, y-2, z-2, x+2, y+2, z+2, block.LAVA.id)
89.     def meteor_shower(x, z):
90.         for i in range(10):
91.             mx = random.randint(x-15, x+15)
92.             mz = random.randint(z-15, z+15)
93.             meteor(mx, mz)
94.     def heatwave(x, z):
95.         y = mc.getHeight(x, z)
96.         endtime = time.time() + random.randint(50, 90)
97.         while time.time() < endtime:
98.             blkid = block.AIR.id
99.             while blkid == block.AIR.id:
100.                 bx = random.randint(x-10, x+10)
101.                 by = random.randint(y, y+10)
102.                 bz = random.randint(z-10, z+10)
103.                 blkid = mc.getBlockWithData(bx, by, bz).id
104.                 blk = blkid
105.                 blkd = mc.getBlockWithData(bx, by, bz).data
106.                 if blkid == block.GRASS.id:
107.                     blk = block.DIRT.id
108.                     blkd = 0
109.                 elif blkid in [
110. block.WATER.id, block.WATER_FLOWING.id, block.WATER_STATIONARY.id]:
111.                     blk = block.WATER.id
112.                     blkd = 1
113.                 elif blkid == block.LEAVES.id:
114.                     blk = block.COBWEB.id
115.                     blkd = 0
116.                 elif blkid == block.WOOD.id:
117.                     blk = block.LAVA_STATIONARY.id
118.                     blkd = 1
119.     def tsunami(x, z):
120.
```

```

121.     tend = time.time() + 15
122.     tx = x
123.     while time.time() < tend:
124.         h = mc.getHeight(tx, z)
125.         mc.setBlocks(tx, h-5, z-5, tx, h+5, z+5, block.WATER_STATIONARY.id)
126.         time.sleep(0.1)
127.         mc.setBlocks(tx, h-5, z-5, tx, h+5, z+5, block.AIR.id)
128.         time.sleep(0.1)
129.         tx += 1
130.     hm = 5
131.     while hm > -1:
132.         h = mc.getHeight(tx, z)
133.         mc.setBlocks(
134.             tx, h-int(hm), z-5, tx, h+int(hm), z+5, block.WATER_STATIONARY.id)
135.             time.sleep(0.1)
136.             mc.setBlocks(tx, h-int(hm), z-5, tx, h+int(hm), z+5, block.AIR.id)
137.             time.sleep(0.1)
138.             tx += 1
139.             hm -= 0.2
139. disasters = [
140.     tsunami, heatwave, meteor, meteor_shower, geyser, earthquake, sinkhole]
140. def main(disasters, mc):
141.     baseed = random.randint(1, 10000)
142.     while True:
143.         t = random.randint(15, 180)
144.         t = 15
145.         time.sleep(t)
146.         random.seed(baseed + t)
147.         baseed = random.randint(1, 10000)
148.         random.shuffle(disasters)
149.         disaster = random.choice(disasters)
150.         ppos = mc.player.getTilePos()
151.         # mc.postToChat(str(disaster) + ' in')
152.         # for c in range(3, 0, -1):
153.             # mc.postToChat(str(c))
154.             # time.sleep(0.33)
155.             disaster(ppos.x, ppos.z)
156. try:
157.     import _thread as thread
158. except ImportError:
159.     import thread
160. thread.start_new_thread(main, (disasters, mc))

```

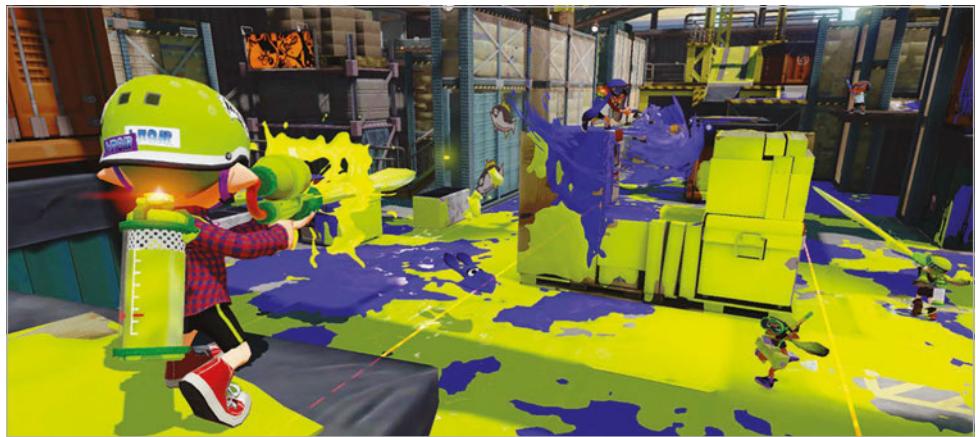
[CHAPTER EIGHT]

MINECRAFT

SPLAT

Create an exciting two-player game in Minecraft: Pi, inspired by Nintendo's hit game game Splatoon...

Below Can you escape the Lava Trap?



You can play Minecraft: Pi Edition in multiplayer mode when two or more Raspberry Pis on the same network join the same world. In this guide, we use this technique to create a simple versus game that's similar to Nintendo's Splatoon, which sees two teams trying to paint the game area in their team colours.

The objective of our game is very similar: to splat (turn to your team colour) as many blocks as possible for your side, while the opposing team will also be splatting blocks and claiming your splats for themselves. You will earn points for each block that's still your colour at the end of the game, and the player with the most splats wins!

MINECRAFT SPLAT IS SPLIT INTO 5 PARTS:

- 01** Create the framework for the program and make sure your code runs.
- 02** Build the pitch that will appear when the game starts and be the splat battleground.
- 03** Splat blocks by hitting them with a sword.
- 04** Game over and displaying the winner.
- 05** Making a better game.

CREATE THE PROGRAM

Open Python 2 from the Programming menu. The Python shell will appear; when it does, create a new program using File>New Window. It's also a good idea to save your program now, using File>Save.

Import the Python modules you'll need:

```
from mcpi.minecraft import Minecraft
from mcpi import block
from time import sleep, time
from random import getrandbits
```

You'll need a constant to hold the colour each team will use; it's the colour of the wool block that will be used when a player splats a block. Create a list which holds two values: 13 for green and 14 for red.

```
TEAMCOLS = [13,14]
```

Create the definition for two functions, which you will complete later in this tutorial:

```
def buildPitch(mc, pos):
    pass
def splatBlock(mc, x, y, z, team):
    pass
```

You'll need a list to hold the points each team has scored. The first element will be team 1's score and the second team 2's – they should both be set to 0:

```
points = [0,0]
```

Create the connection to Minecraft and post a message to the screen:

```
mc = Minecraft.create()
mc.postToChat("Minecraft Splat")
```

At this point, you can run your program and if everything is set up, you should see the 'Minecraft Splat' message posted to the screen.

Now start up Minecraft: Pi Edition. Create a new game and then run your program by clicking Run>Run Module.

BUILD THE PITCH

The game needs a pitch where the action can take place; it's a glass 'room' with two glass walls running down the middle.

Find the **buildPitch** function in your program:

```
def buildPitch(mc, pos):
    pass
```

The Minecraft connection, **mc**, and a position, **pos**, where the pitch should be built, should be passed to the function.

Delete the **pass** statement and replace it with the following code, which will create a cube of glass blocks. Then create a cube of air inside it before building the central walls of glass:

```
def buildPitch(mc, pos):
    # glass cube
    mc.setBlocks(pos.x - 5, pos.y - 1, pos.z - 10,
                pos.x + 5, pos.y + 3, pos.z + 10,
                block.GLASS.id)
    # hollow it out
    mc.setBlocks(pos.x - 4, pos.y, pos.z - 9,
                pos.x + 4, pos.y + 3, pos.z + 9,
                block.AIR.id)
```



```
# add 2 walls down the middle
mc.setBlocks(pos.x, pos.y, pos.z - 7,
             pos.x, pos.y + 3, pos.z - 1,
             block.GLASS.id)
mc.setBlocks(pos.x, pos.y, pos.z + 1,
             pos.x, pos.y + 3, pos.z + 7,
             block.GLASS.id)
```

The **buildPitch** function now needs to be called from your program. Add the following code to the end of the program to get the player's position and call the function:

```
pos = mc.player.getTilePos()
buildPitch(mc, pos)
```

Before the game starts, you should also include a delay to let the players get ready, and a message to let them know the game has started:

```
sleep(3)
mc.postToChat("Go!")
```

Run the program. You should see the pitch appear around your player and the message to 'Go!'.


SPLATTING BLOCKS

The blocks of the pitch's walls and floor can be splatted by hitting them (right-clicking) with a sword – when you splat a glass block, it'll turn it into a wool block of your team's colour; splatting a block belonging to the opposition will turn it back to glass.

You earn points for each block splatted with your team's colour, and the opposition will lose a point for each block you turn back to glass.

Find the **splatBlock** function in your program:

```
def splatBlock(mc, x, y, z, team):
    pass
```

Change the function so that it splats the block at the position **x, y, z** for **team**, which are variables passed to the function. When executed, the function will return the number of points scored for each team.

Delete the **pass** statement and create a list which will hold the points scored for each team:

```
def splatBlock(mc, x, y, z, team):
    pointsScored = [0,0]
```

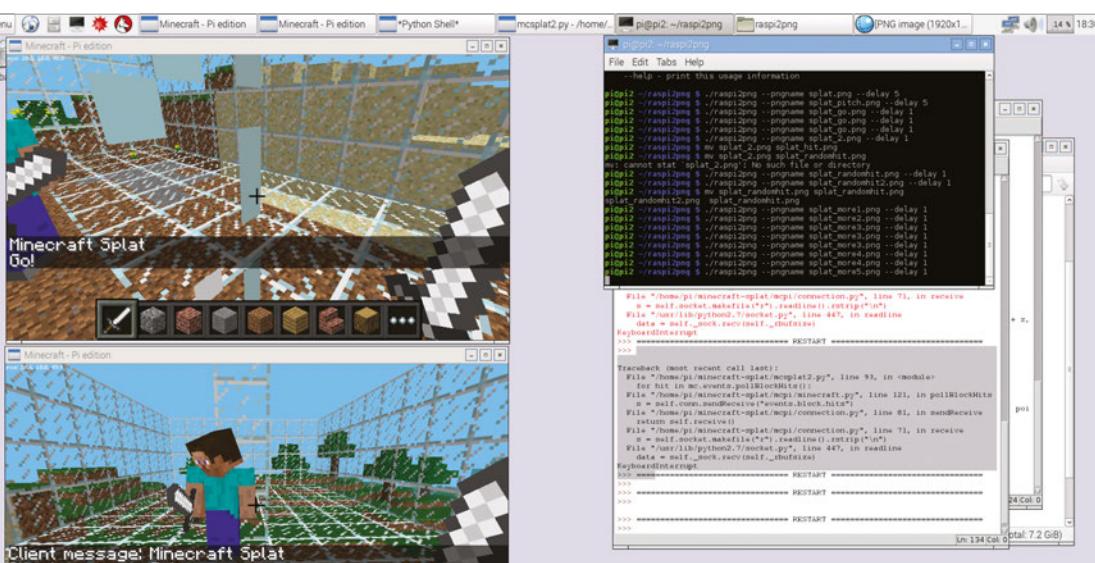
The variable **team**, which is passed into **splatBlock**, will hold either a 0 or 1, depending on which team splatted the block. Use this value to create a variable to hold the other team:

```
otherTeam = 1 - team
```

Check to see if the block that was hit was a glass block; if it was, turn it into a wool block of the team's colour, and increase the team's score by 1:

```
blockHit = mc.getBlockWithData(x, y, z)
if blockHit.id == block.GLASS.id:
    mc.setBlock(x, y, z, block.WOOL.id, TEAMCOLS[team])
    pointsScored[team] += 1
```

If the block isn't glass, check to see if it's a wool block of the other team's colour, before turning it back to glass and decreasing the other team's score:



```
elif blockHit.id == block.WOOL.id:
    if blockHit.data == TEAMCOLS[otherTeam]:
        mc.setBlock(x, y, z, block.GLASS.id)
        pointsScored[otherTeam] -= 1
```

The last step in the **splatBlock** function is to return the number of points scored:

```
return pointsScored
```

Now that the **splatBlock** function is complete, you need to add to the code at the bottom of your program which will start the game.

You'll find out how many players are in the game, create a loop which will continue until the end of the game, and call **splatBlock** each time a block is hit.

Get a list of players currently in the game and the time the game started, and store them in variables:

```
players = mc.getPlayerEntityIds()
start = time()
```

Set the variable **gameOver** to False before creating a **while** loop, which will continue until **gameOver** is set to True when the game finishes:

```
gameOver = False
while not gameOver:
```

Use **pollBlockHits()** to find out if any blocks have been hit, before looping through each ‘hit’ with a **for** loop:

```
blockHits = mc.events.pollBlockHits()
for hit in blockHits:
```

Every player in *Minecraft* has an entity ID and these are held in the **players** list you created earlier. The player’s position in the list will determine what team they are on: even = team 1, odd = team 2. Use the **players** list and the entity ID of the player who hit the block to work out what team they are on:

```
team = players.index(hit.entityId) % 2
```

Call the **splatBlock** function, passing the position of the block which was hit and the team who hit it, and add the points scored to the total points for the team:

```
pointsScored = splatBlock(mc,
    hit.pos.x, hit.pos.y, hit.pos.z, team)
points[0] += pointsScored[0]
points[1] += pointsScored[1]
```

Run your program and, as before, the pitch should appear around your player. Now, however, hitting blocks (right-clicking while holding a sword) should turn the blocks to coloured wool. You could even get a friend to join your game and test turning your opponent’s blocks back to glass.

As you haven’t created the code to end the game, the program will continue forever. You can use **CTRL+C** or click Shell>Restart Shell in the Python shell to end the program.

GAME OVER

Each match is 30 seconds long and the game is over when the time runs out. Under the **while** loop, you need to check whether the time now minus the time the game started is greater than 30 seconds. Once the game is over, you should post the team's points to the chat window, along with the winner:

```
if time() - start > 30:  
    gameOver = True  
    mc.postToChat("Game Over")  
    mc.postChat(  
        "Green Team = " + str(points[0]))  
    mc.postToChat(  
        "Red Team = " + str(points[1]))  
    if points[0] > points[1]:  
        mc.postToChat("Green Team wins")  
    else:  
        mc.postToChat("Red Team wins")
```

Find a friend with a Raspberry Pi, challenge them to a game of Minecraft Splat, and run your program.



MAKING A BETTER SPLAT

The splat made at the moment is less of a splat and more of a blob. If you want to take the program further, in the next section you will use randomisation to splatter the blocks around the block that was hit as well.

After your code to splat the block, loop through each of the blocks around the one which was hit:

```
for hit in blockHits:
    team = players.index(hit.entityId) % 2

    pointsScored = splatBlock(
        mc, hit.pos.x, hit.pos.y, hit.pos.z, team)

    points[0] += pointsScored[0]
    points[1] += pointsScored[1]

    for x in [-1, 0, 1]:
        for y in [-1, 0, 1]:
            for z in [-1, 0, 1]:
```

Using the code `getrandbits(1)`, you can randomly generate a 1 or 0, giving a 50/50 chance of it being 1. If it is, splat the block for the team and add the points to the total:

```
if getrandbits(1) == 1:
    pointsScored = splatBlock(mc,
        hit.pos.x + x,
        hit.pos.y + y,
        hit.pos.z + z,
        team)
    points[0] += pointsScored[0]
    points[1] += pointsScored[1]
```

Run your program again. Now, each time you splat a block, it should randomly splatter the blocks around it too.

This is just one improvement you can make to the game; the only limit is your imagination. How will you take it forward and make it your own?

The code for Minecraft Splat is on GitHub at [magpi.cc/29qpm3r](https://github.com/magpi.cc/29qpm3r).

MCsplat.py

```
01. # import modules
02. from mcpi.minecraft import Minecraft
03. from mcpi import block
04. from time import sleep, time
05. from random import getrandbits
06.
07. TEAMCOLS = [13,14]
08.
09. def buildPitch(mc, pos):
10.     # create the glass cube playing area
11.     mc.setBlocks(pos.x - 5, pos.y - 1, pos.z - 10,
12.                 pos.x + 5, pos.y + 3, pos.z + 10,
13.                 block.GLASS.id)
14.
15.     # hollow it out
16.     mc.setBlocks(pos.x - 4, pos.y, pos.z - 9,
17.                 pos.x + 4, pos.y + 3, pos.z + 9,
18.                 block.AIR.id)
19.
20.     # add 2 walls down the middle
21.     mc.setBlocks(pos.x, pos.y, pos.z - 7,
22.                 pos.x, pos.y + 3, pos.z - 1,
23.                 block.GLASS.id)
24.
25.     # add 2 walls down the middle
26.     mc.setBlocks(pos.x, pos.y, pos.z + 1,
27.                 pos.x, pos.y + 3, pos.z + 7,
28.                 block.GLASS.id)
29.
30. def splatBlock(mc, x, y, z, team):
31.
32.     pointsScored = [0,0]
33.
34.     # who is the other team?
35.     otherTeam = 1 - team
36.
37.     # what type of block has been hit?
38.     blockHit = mc.getBlockWithData(x, y, z)
39.     # has a glass block been hit?
40.     if blockHit.id == block.GLASS.id:
```

Download
[magpi.cc/
29qpm3r](http://magpi.cc/29qpm3r)

```
41.         # claim it for the team
42.         mc.setBlock(
43.             x, y, z, block.WOOL.id, TEAMCOLS[team])
44.             # increase the team's score
45.             pointsScored[team] += 1
46.
47.             # was it a wool block?
48.             elif blockHit.id == block.WOOL.id:
49.                 # if other team's colour turn it back to GLASS
50.                 if blockHit.data == TEAMCOLS[otherTeam]:
51.                     mc.setBlock(x, y, z, block.GLASS.id)
52.                     # reduce the other team's score
53.                     pointsScored[otherTeam] -= 1
54.
55.             return pointsScored
56.
57. # set up points
58. points = [0,0]
59.
60. # create connection to Minecraft
61. mc = Minecraft.create()
62.
63. # post the message to the screen
64. mc.postToChat("Minecraft Splat")
65.
66. # find out the host player's position
67. pos = mc.player.getTilePos()
68.
69. # build the pitch
70. buildPitch(mc, pos)
71.
72. sleep(3)
73.
74. mc.postToChat("Go!")
75.
76. # get a list of the players
77. players = mc.getPlayerEntityIds()
78.
79. start = time()
80.
81. gameOver = False
82.
```

```
83.    # continue till the end of the game
84.    while not gameOver:
85.
86.        # has a block been hit?
87.        blockHits = mc.events.pollBlockHits()
88.        for hit in blockHits:
89.
90.            # which team was it?
91.            team = players.index(hit.entityId) % 2
92.
93.            pointsScored = splatBlock(
94.                mc, hit.pos.x, hit.pos.y, hit.pos.z, team)
95.
96.            # update the points
97.            points[0] += pointsScored[0]
98.            points[1] += pointsScored[1]
99.
100.           # splat blocks around it
101.           for x in [-1, 0, 1]:
102.               for y in [-1, 0, 1]:
103.                   for z in [-1, 0, 1]:
104.                       if getrandbits(1) == 1:
105.                           pointsScored = splatBlock(mc,
106.                                         hit.pos.x + x,
107.                                         hit.pos.y + y,
108.                                         hit.pos.z + z,
109.                                         team)
110.
111.           # update the points
112.           points[0] += pointsScored[0]
113.           points[1] += pointsScored[1]
114.
115.       # if the time has run out, set game over
116.       if time() - start > 30:
117.           gameOver = True
118.           mc.postToChat("Game Over")
119.           mc.postToChat("Green Team = " + str(points[0]))
120.           mc.postToChat("Red Team = " + str(points[1]))
121.           if points[0] > points[1]:
122.               mc.postToChat("Green Team wins")
123.           else:
124.               mc.postToChat("Red Team wins")
```



[CHAPTER NINE]

USING THE GPIO TO FIND A BLOCK

Program Minecraft, and connect an LED and a buzzer to a Raspberry Pi.



Above A gold block will be hidden at a random position; the buzzer and LED will help you find it

You're going to learn how to connect an LED and buzzer to your Raspberry Pi and create a program which will hide a gold block in Minecraft with their help. The LED will light up when you are close to the block, and the buzzer will let you know when you are walking towards the block.

You'll Need

- Breadboard
- LED and resistor
- Buzzer
- GPIO Zero
[magpi.cc/
294zLHk](http://magpi.cc/294zLHk)

Get Started

The first task is to start your program and get a message to appear on the Minecraft screen:

01. Start Minecraft by clicking Menu > Games > Minecraft and create a new world.
02. Press ESC to go back to the Minecraft menu but leave the game playing.
03. Open IDLE by clicking Menu > Programming > Python 3.
04. Use File > New Window to create a new program and save it as **findablock.py**.
05. At the top of your program, type the following code to import the Minecraft modules you'll need:
import mcpi.minecraft as minecraft
import mcpi.block as block

06. Create a connection to Minecraft using this code:

```
mc = minecraft.Minecraft.create()
```

07. Post a message to the chat window:

```
mc.postToChat("Go find the block")
```

08. Run your program by clicking Run > Run Module.

You should see your message appear in the Minecraft chat window.

Hide a Block

Using the **random** module, you can generate a position near the player and use the Minecraft API to create a gold block there which the player will have to find:

01. At the top of your program import the **randint** function from the **random** module.

```
from random import randint
```

02. Add the following code to the bottom of your program to find out the player's position:

```
p = mc.player.getTilePos()
```

03. Generate 3 random numbers for the coordinates of the gold block:

```
x = p.x + randint(-20, 20)
```

```
y = p.y + randint(-5, 5)
```

```
z = p.z + randint(-20, 20)
```

04. Create the gold block at this position:

```
mc.setBlock(x, y, z, block.GOLD_BLOCK.id)
```

05. Run your program by clicking Run > Run Module or by pressing F5.

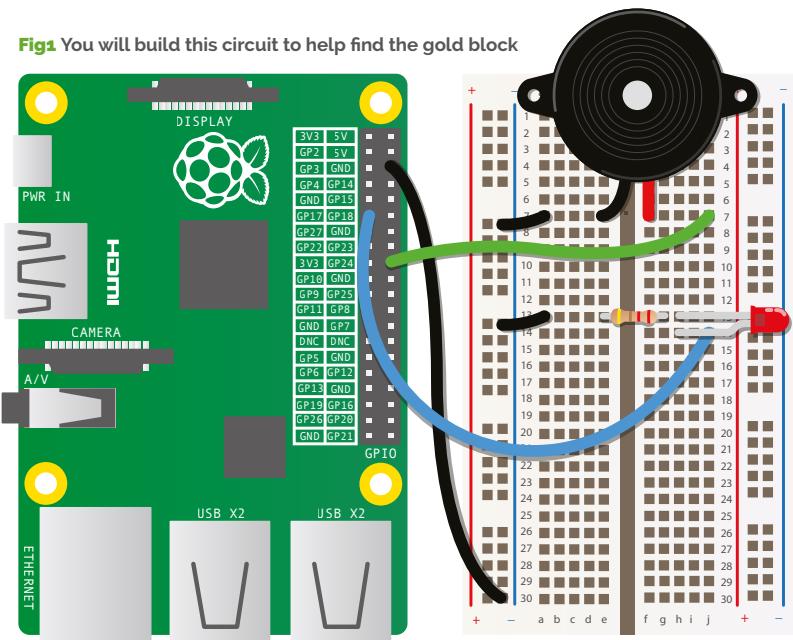
A gold block will be created within 20 blocks of the player – see if you can find it!

LEDs & Buzzers

To help the player find the block, you're going to use an LED which will indicate when the player is close by, and a buzzer to let the player know they are walking towards the block.

Use your breadboard, jumper cables, LED, resistor, and buzzer to build the circuit as shown in the diagram [fig1].

Fig1 You will build this circuit to help find the gold block



When the circuit is complete, update your program to flash the LED and buzz the buzzer to let the player know the game has started:

01. Import **LED**, **Buzzer** and **sleep** from the **gpiozero** and **time** Python modules:

```
from gpiozero import LED, Buzzer
from time import sleep
```
02. Create the LED, which is connected to GPIO 24:

```
led = LED(24)
```
03. Create the buzzer, which is connected to GPIO 17:

```
buzz = Buzzer(17)
```
04. Turn the LED and buzzer on, sleep for 1 second and then turn them back off:

```
led.on()
buzz.on()
sleep(1)
led.off()
buzz.off()
```
05. Run your program; the LED and buzzer will turn on for 1 second.

Making the Buzzer ‘Buzzzzz’

The buzzer should buzz when the player is getting further away from the gold block, so if the buzzer remains silent you’re getting closer.

Update your program so that it works out the distance between the player and the block, and turns the buzz on or off:

- To calculate the distance you will use the maths square root (`sqrt`) function, so import it now:

```
from math import sqrt
```

- Create a variable called `dist` (for distance) and set it to 0:

```
dist = 0
```

- Create a variable called `gameover` and set it to False – it will be set to True at the end of the game when the player has found the block:

```
gameover = False
```

- Create a loop which will continue until the game is over:

```
while gameover == False:
```

- Indented under the while loop, add the code to get the player’s position:

```
p = mc.player.getTilePos()
```

- Work out the distance between the player and the gold block:

```
xd = p.x - x
```

```
yd = p.y - y
```

```
zd = p.z - z
```

```
dist_now = sqrt((xd*xd) + (yd*yd) + (zd*zd))
```

- If the distance is going up, turn the buzzer on, else turn it off:

```
if dist_now > dist:
```

```
    buzz.on()
```

```
else:
```

```
    buzz.off()
```

- Set the variable `dist` to `dist_now` so it can be compared next time around the loop:

```
dist = dist_now
```

- Run the program. The buzzer should buzz when the player is getting further away from the gold.

Nearly there LED

To give the player a chance to find the block when he is close by, the LED should light up.

01. Turn the LED on when the distance to the gold block is less than 5:

```
if dist_now < 5:  
    led.on()  
else:  
    led.off()
```

02. Run your program and when you get close, the LED should light up.

Game over

Once the player finds the block, the game is over.

01. When the distance between the player is less than 1.5, set the **gameover** variable to True and post a message to let the player know:

```
if dist_now < 1.5:  
    gameover = True  
    mc.postToChat("You got GOLD")
```

02. Finally, clean up by turning off your LED and buzzer:

```
led.off()  
buzz.off()
```

03. Run your program and find the gold block!

Next steps

Can you take this program forward and make it your own? Some ideas:

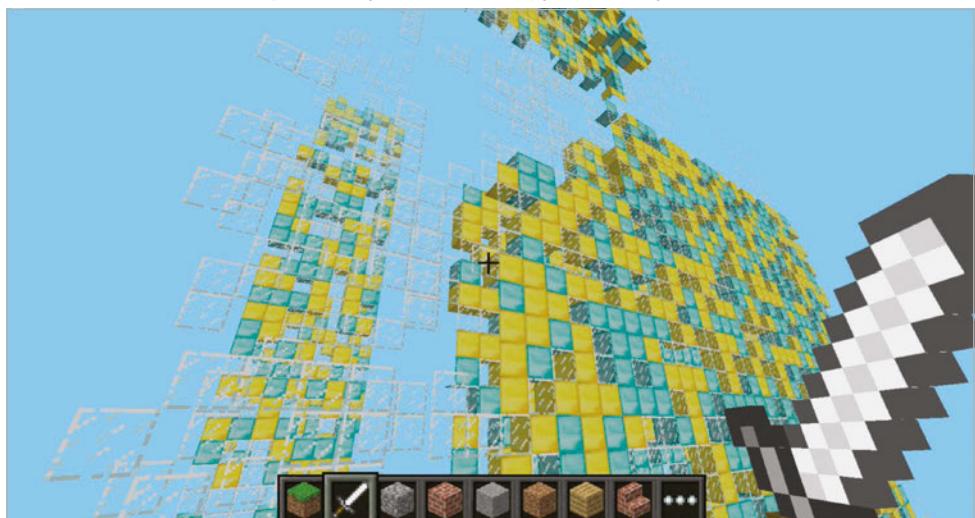
- ▶ Create a timer so that you can have races trying to find the gold block.
- ▶ Add more LEDs (i.e. red, yellow and green) which show when you're getting nearer to the gold.
- ▶ Hide several blocks which the player has to find in order.



[CHAPTER TEN] BECOME A MINECRAFT VJ

Use Sonic Pi with Minecraft to create amazing visuals for your music as you perform it!

Below All of this is powered by Sonic Pi, allowing you to make your visualisations match the music



[MINECRAFT & SONIC PI]

Node-RED is a visual tool for wiring the Internet of Things. It takes care of technicalities, like GPIO access or internet protocols, and lets you focus on your workflow.

Yeveryone has built amazing structures, designed cunning traps, and even created elaborate cart tracks in Minecraft. How many of you have performed with Minecraft? We bet you didn't know that you could use Minecraft to create amazing visuals, just like a professional VJ.

As well as coding with Python, you can also program Minecraft with an app called Sonic Pi, which makes the coding not only easy but also incredibly fun. In this article, we'll be showing you some of the tips and tricks that we've used to create performances in nightclubs and music venues around the world.

Enter a new world in Minecraft and open Sonic Pi. When we're using Minecraft to create visuals, we try to think about what will both look interesting and also be easy to generate from code. One nice trick is to create a sandstorm by dropping sand blocks from the sky. For that, all we need are a few basic fns (Sonic Pi functions):

- **sleep** – for inserting a delay between actions
- **mc_location** – to find our current location
- **mc_set_block** – to place sand blocks at a specific location
- **rrand** – to allow us to generate random values within a range
- **live_loop** – to allow us to continually make it rain sand



Let's make it rain a little first, before unleashing the full power of the storm. Grab your current location and use it to create a few sand blocks up in the sky nearby:

```
x, y, z = mc_location
mc_set_block :sand, x, y + 20, z + 5
sleep 2
mc_set_block :sand, x, y + 20, z + 6
sleep 2
mc_set_block :sand, x, y + 20, z + 7
sleep 2
mc_set_block :sand, x, y + 20, z + 8
```

When you press Run, you might have to look around a little, as the blocks may start falling down behind you depending on which direction you're currently facing. Don't worry: if you missed them, just press Run again for another batch of sand rain – just make sure you're looking the right way!

Let's quickly review what's going on here. On the first line, we grabbed Steve's location as coordinates with the fn **mc_location** and placed them into the vars **x**, **y**, and **z**. Then, on the next lines, we used the **mc_set_block** fn to place some sand at the same coordinates as Steve, but with some modifications. We chose the same x coordinate, a y coordinate 20 blocks higher, and then successively larger z coordinates, so the sand dropped in a line away from Steve.

Why don't you take that code and start playing around with it yourself? Try adding more lines, changing the sleep times, try mixing **:sand** with **:gravel**, and choose different coordinates. Just experiment and have fun!

[HELP WITH FUNCTIONS]

If you're unfamiliar with any of the built-in fns such as **rrand**, just type the word into your buffer, click on 'int', and then press the keyboard combo **CTRL+I** to bring up the built-in documentation. Alternatively, you can navigate to the 'lang' tab in the Help system and then look up the fns directly, along with all the other exciting things you can do.



Live loops unleashed

Okay, it's time to get the storm raging by unleashing the full power of the **live_loop**, Sonic Pi's magical ability, which unleashes the full power of live-coding: changing code on the fly while it's running!

```
live_loop :sand_storm do
  x, y, z = mc_location
  xd = rrand(-10, 10)
  zd = rrand(-10, 10)
  co = rrand(70, 130)
  synth :cnoise, attack: 0, release: 0.125, cutoff: co
  mc_set_block :sand, x + xd, y+20, z+zd
  sleep 0.125
end
```

What fun! We're looping round pretty quickly (eight times a second), and during each loop we're finding Steve's location like before but then generating three random values:

- ▶ **xd** – the difference for x, which will be between -10 and 10
- ▶ **zd** – the difference for z, also between -10 and 10
- ▶ **co** – a cutoff value for the low pass filter, between 70 and 130

We then use those random values in the fns **synth** and **mc_set_block**, giving us sand falling in random locations around Steve, along with a percussive rain-like sound from the **:cnoise** synth.

For those of you new to live loops, this is where the fun really starts with Sonic Pi. While the code is running and the sand is pouring down, try changing one of the values, perhaps the **sleep** time to **0.25** or the **:sand** block type to **:gravel**. Now press the Run button again. Hey presto! Things have changed without the code even stopping. This is your gateway to performing like a real VJ. Keep practising and changing things around. How different can you make the visuals without stopping the code?

Epic block patterns

Finally, another great way of creating interesting visuals is to generate huge patterned walls to fly towards and get close to. For this effect, we'll need to move from placing the blocks randomly to placing them in an ordered manner. We can do this by nesting two sets of iteration; press the Help button and navigate to section 5.2 of the tutorial, 'Iteration and Loops', for more background on iteration. The funny `|xd|` after the `do` means that `xd` will be set for each value of the iteration. So, the first time it will be 0, then 1, then 2, and so on. By nesting two lots of iteration together like this, we can generate all the coordinates for a square. We can then randomly choose block types from a ring of blocks for an interesting effect:

```
x, y, z = mc_location
bs = (ring :gold, :diamond, :glass)
10.times do |xd|
  10.times do |yd|
    mc_set_block bs.choose, x + xd, y + yd, z
  end
end
```

Pretty neat. Whilst we're having fun here, try changing `bs.choose` to `bs.tick` to move from a random pattern to a more regular one. Try changing the block types – the more adventurous of you might want to try sticking this within a `live_loop` so that the patterns keep changing automatically.

Now for the VJ finale. Change the two `10.times` to `100.times` and press Run. Kaboom: a gigantic wall of randomly placed bricks. Imagine how long it would take you to build that manually with your mouse! Double-tap **SPACE** to enter fly mode and start swooping by for some great visual effects. Don't stop here, though – use your imagination to conjure up some cool ideas and then use the coding power of Sonic Pi to make it real. When you've practised enough, dim the lights and put on a VJ show for your friends!

[CHAPTER ELEVEN]

NODE-RED AND

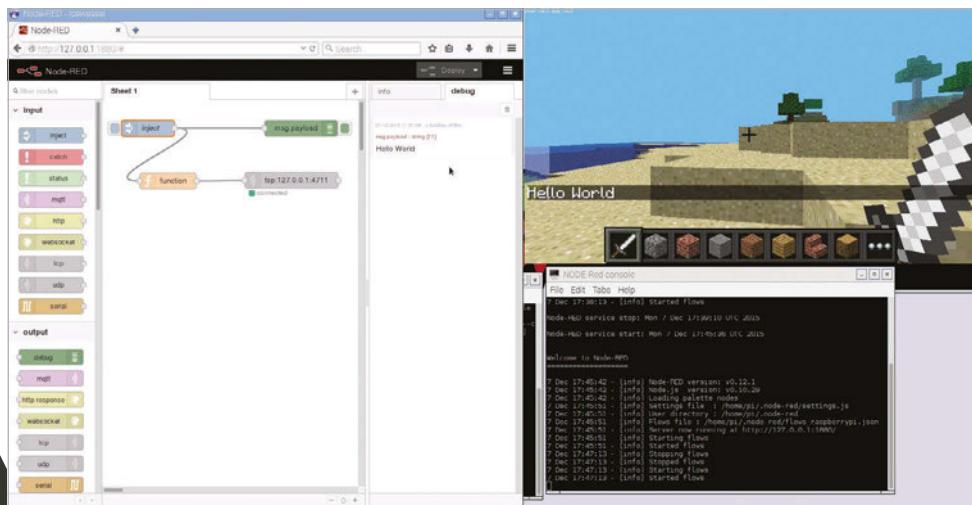
CONTROLLING MINECRAFT

WITH JAVASCRIPT

PART 1

JavaScript is an interpreted programming language and one of the main components of interactive websites. With Node-RED, you can easily use it to control Minecraft

Below Node-RED and Minecraft on one screen can look a bit busy. Once you're comfortable, however, Steve's world is under your control.



MINECRAFT & NODE-RED

Node-RED is a visual tool for wiring the Internet of Things. It takes care of technicalities, like GPIO access or internet protocols, and lets you focus on your workflow.

This article should give you a taste of a workshop Boris taught at a recent CamJam. Here, we'll show you just how easy Node-RED is to use. You can refer to the original tutorial (magpi.cc/1jLWFST) for a lot more detail and theory.

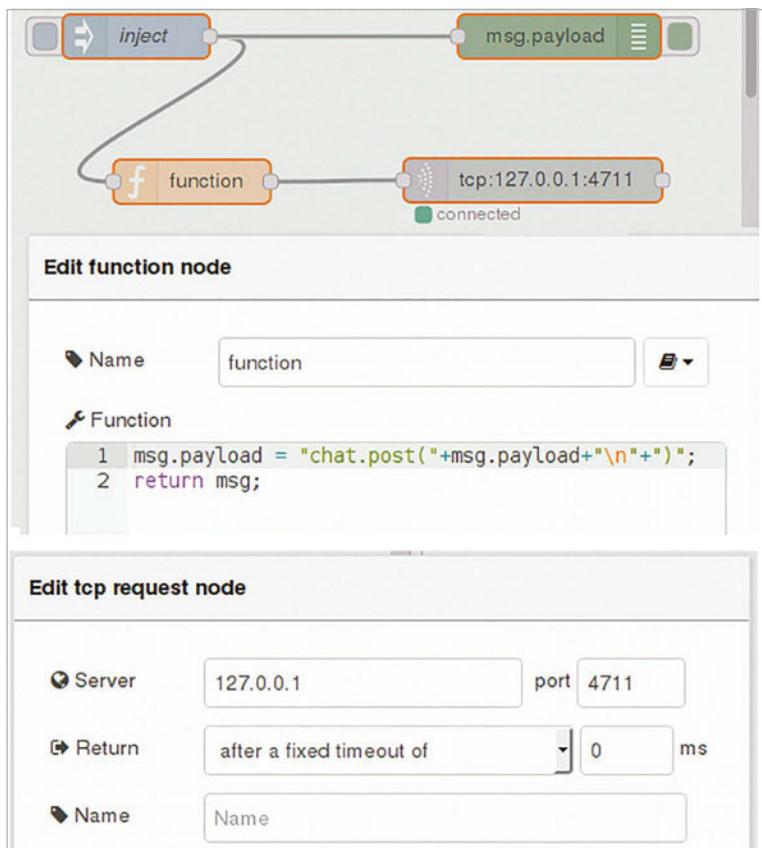
Preparation

Start Minecraft and open a new world. Fire up Node-RED from the **Programming** submenu on the Raspbian desktop. After a few moments, Node-RED is going to run as a service in the background. Open a web browser (Iceweasel works best with Node-RED) and direct it to 127.0.0.1:1880 to see the programming environment. On the left, there's a panel with nodes. These are visual components that you can use to build your flow. In the middle is the flow editor where you can simply drag and drop your flow together. On the right, you can switch between the help panel and the debug panel. Note that while 'debug' often has some negative connotation, it's your default text output in Node-RED.

A TOOL FOR THE INTERNET OF THINGS

Node-RED encapsulates great functionality in already existing nodes. Let the Twitter output node feed into the Minecraft chat, or the GPIO input node trigger your flow with a physical button!

Right Your first flow: the code you need to write into your function node, and configuration details for the TCP request node



Hello World in Minecraft

Drag and drop an inject node from the nodes panel into the flow editor. Once you've selected that inject node, you should see a general explanation about its functionality in the help panel – this is especially useful info when you select complex nodes with many different options.

Double-click your inject node in the flow editor. Once the associated dialogue opens, change the Payload to type ‘string’ and write ‘Hello World’ in the empty text field below.

The flow of information is modelled through the exchange of messages in Node-RED, which happens by passing along a variable

called **msg**. It has two main properties: topic and payload.

In simple terms, these could be interpreted like the subject and body of an email. Drag and drop a debug node from the nodes library into the flow editor.

Drag and drop a function node into the editor. This is the node type that allows you to directly interact with the **msg** object in JavaScript.

In your function node, before the line with **return msg;**, write:

```
msg.payload = "chat.post("+msg.payload+)\n";
```

This line is going to take the incoming payload ‘Hello World’, and assign the new content "**chat.post(Hello World)\n**" to the variable. **chat.post** is a command from the Minecraft API, which you can read about in a file called **mcpi_protocol_spec.txt** in the Minecraft API directory. The end of our command is indicated by a line break, the Unix character **\n**.

Drag and drop a TCP request node from the function section of the node panel. The server is 127.0.0.1, and the port is 4711. As we’re not expecting a return value, we’ll Return after a fixed timeout of 0ms. This connects Node-RED to the Minecraft TCP socket. If you’re keen to understand what a socket is, have a look at the original workshop material: magpi.cc/1jLWFST.

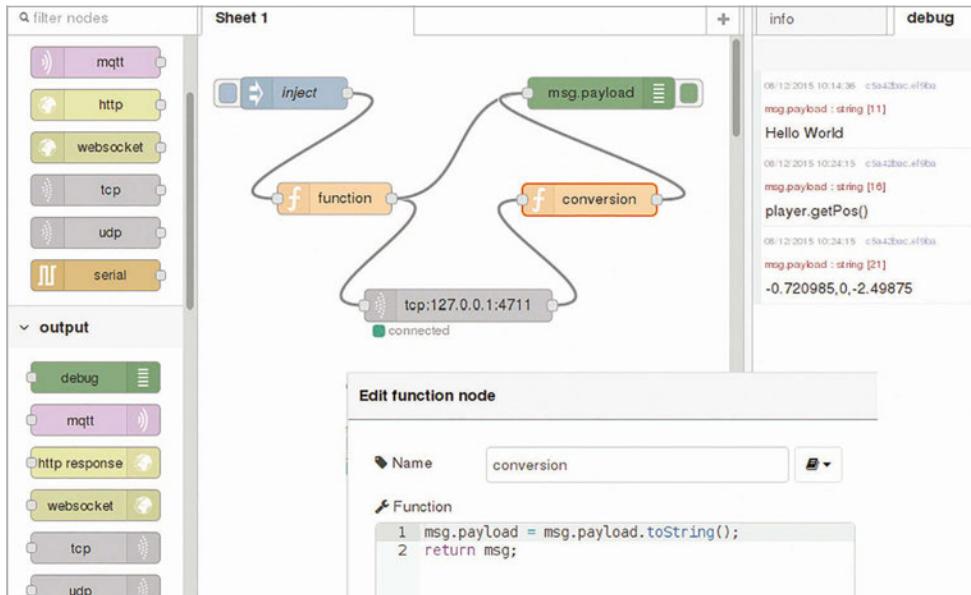
Connect the nodes by drawing connections, as in the screenshots here. Start your flow by pressing the red Deploy button in the upper-right corner. Trigger your flow by pressing the rounded rectangle to the immediate left of your inject button. Do you see your message in Minecraft?

Retrieve values from Minecraft

So far, our interaction with Minecraft has been rather one-directional. We just sent a command string that had an effect on the Minecraft world. Now we’re going to modify our flow so we can query values like our own position via the API.

In the function node, before the line with **return msg;**, set:

```
msg.payload = "player.getPos()\n";
```



Instead of leaving the TCP request node after some time, we expect our Return ‘when character is received’, namely `\n`.

By default, the TCP request node returns a buffer, and we need to convert the information from Node-RED using:

```
msg.payload = msg.payload.toString();
```

in a new function node. The result of this new function node goes straight to our debug node.

Deploy your Node-RED flow. Now have a walk around Minecraft and trigger your flow with the inject node. Do you see what you expected in the debug panel?

Look out for the second part of this tutorial, which will cover aspects of event-driven development with Node-RED, including the interaction of Minecraft with the physical world.

Hello World

```
[{"id":"945e5f77.182da8","type":"function","z":"a59a50d2.5a65b","name":"function","func":"msg.payload = \"chat.\npost(\"+msg.payload+\\"\n\"+\"\")\";\\nreturn msg;","outputs":1,"noerr":0,"x":124,"y":152,"wires":[[{"ec2d4ccc.7365b"}]],{"id":"c5a42bac.ef9ba","type":"debug","z":"a59a50d2.5a65b","name":"","active":true,"console":false,"complete":false,"x":374,"y":53,"wires":[]},{ "id": "f1098e71.8eb9d", "type": "inject", "z": "a59a50d2.5a65b", "name": "inject", "topic": "", "payload": "Hello World", "payloadType": "string", "repeat": "", "crontab": "", "once": false, "x": 86, "y": 53, "wires": [[{"945e5f77.182da8", "c5a42bac.ef9ba"}]]}, {"id": "ec2d4ccc.7365b", "type": "tcp request", "z": "a59a50d2.5a65b", "server": "127.0.0.1", "port": "4711", "out": "time", "splitc": "0", "name": "", "x": 356, "y": 151, "wires": [[]]}]
```

Download

Hello World
[magpi.cc/
1Qr4USK](https://magpi.cc/1Qr4USK)

Player Position
[magpi.cc/
1Qr4Xht](https://magpi.cc/1Qr4Xht)

Player Position

```
[{"id":"945e5f77.182da8","type":"function","z":"a59a50d2.5a65b","name":"function","func":"msg.payload = \"player.\ngetPos()\\n\";\\nreturn msg;","outputs":1,"noerr":0,"x":128,"y":153,"wires":[[{"ec2d4ccc.7365b", "c5a42bac.ef9ba"}]], {"id": "c5a42bac.ef9ba", "type": "debug", "z": "a59a50d2.5a65b", "name": "", "active": true, "console": false, "complete": false, "x": 378, "y": 54, "wires": []}, {"id": "f1098e71.8eb9d", "type": "inject", "z": "a59a50d2.5a65b", "name": "inject", "topic": "", "payload": "Hello World", "payloadType": "string", "repeat": "", "crontab": "", "once": false, "x": 90, "y": 54, "wires": [[{"945e5f77.182da8"}]]}, {"id": "ec2d4ccc.7365b", "type": "tcp request", "z": "a59a50d2.5a65b", "server": "127.0.0.1", "port": "4711", "out": "char", "splitc": "\\n", "name": "", "x": 244, "y": 253, "wires": [{"f4f5b8bd.154d68"}]}, {"id": "f4f5b8bd.154d68", "type": "function", "z": "a59a50d2.5a65b", "name": "conversion", "func": "msg.payload = msg.payload.toString();\\nreturn msg;", "outputs": 1, "noerr": 0, "x": 367, "y": 154, "wires": [{"c5a42bac.ef9ba"}]}]
```

[CHAPTER SIX]

NODE-RED AND

CONTROLLING MINECRAFT

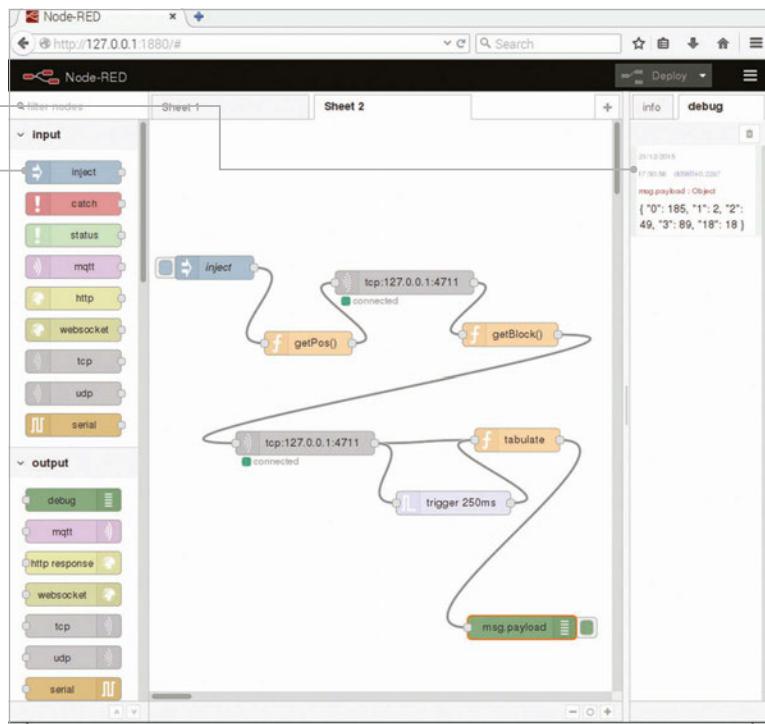
WITH JAVASCRIPT

PART 2

With Node-RED you can mine like a pro. Give Steve an additional sense to see if there are any exciting blocks in the neighbourhood

This is a summary of the block types. For example, we have 185 blocks of air (ID "0") around us

This is the flow that tabulates all block types around us



You'll Need

- > Raspbian
[raspberrypi.org /downloads](http://raspberrypi.org/downloads)
- > Node-RED – pre-installed on Raspbian
nodered.org
- > Iceweasel – installed via terminal
[wiki.debian.org /Iceweasel](http://wiki.debian.org/Iceweasel)

P

art one of this mini-series introduced linear flows with Node-RED and Minecraft, and you should go through it before embarking on the next adventure. In part two, you'll dive deeper into Node-RED and JavaScript. Learn how to react to events, loop over a set of variables, and retain values from previous executions of a node in your flow. With this tutorial, we've got you well covered for any further explorations with Node-RED!

This tutorial takes off where we left in part one. In that tutorial, we taught you how to make a Minecraft 'Hello World' and how to read data from it.

Preparation

To get back to where you were, start Minecraft and open a world. Fire up Node-RED from the Programming sub-menu. Open a web browser (Iceweasel works best with Node-RED) and direct it to **127.0.0.1:1880**

Edit function node

Name: getBlock()

Function:

```

1 var arr = msg.payload.toString().replace(/\n|\r|$/,"").split(",");
2
3 var x = parseInt(arr[0]);
4 var z = parseInt(arr[1]);
5 var y = parseInt(arr[2])
6 var cube_size = 3;
7
8 var coord_set = []
9 for (var h = -x*cube_size; h < x*cube_size+1; h++) {
10   for (var k = -z*cube_size; k < z*cube_size+1; k++) {
11     for (var l = -y*cube_size; l < y*cube_size+1; l++) {
12       coord_set.push({payload: "world.getBlock(\""+h+"','"+k+"','"+l+"")\n"});
13     }
14   }
15 }
16 return [coord_set];

```

Above The 'getBlock()' function. Lines 8–16 populate an array with 343 (73³) elements, each carrying a payload with a world.getBlock statement for the TCP node

flows directory (magpi.cc/1Qr4Xht) and import it before you proceed.

Calculate and store the coordinates

Edit the **conversion** function node, and rename it to **getBlock()** to reflect its new role. There's a bit of magic in this one. The **replace()** and **split()** functions remove the trailing line break from the Minecraft message and break the components of Steve's position into character strings. These are put into an array – a variable that saves a few values in a list – which is called **arr**. Convert the strings from the list into whole numbers and assign them to variables **x**, **z**, and **y** with **parseInt()** to be able to do calculations on them.

Define a variable **cube_size** that keeps half of the size of a cube in whose centre we're located. With three nested **for** loops, iterate over this cube that spans from $x - \text{cube_size}$, $z - \text{cube_size}$, $y - \text{cube_size}$ to $x + \text{cube_size}$, $z + \text{cube_size}$, $y + \text{cube_size}$. For each tuple (**h**, **k**, **l**), create a **payload** object that carries a string of the format "**world.getBlock(h,k,l)\n**", and store it as an element of an array, **coord_set**. The **function** node returns **[coord_set]**, which makes Node-RED invoke the next flow element for each list element.

Drag and drop another **TCP request** node from the function section of the node panel. As before, the server is 127.0.0.1 and port 4711, and we expect the returned message to be finished with **\n**.

Drag and drop a **trigger** node. Configure it such that it sends nothing and waits for 250ms, and then sends the string payload "**trigger**". Check the extend delay option. This essentially means that as long as there are incoming messages at least every 250ms, the node will remain silent, but if there are no new messages, we send the trigger

to see the programming environment. Arrange the windows so you can see what's going on in Node-RED and the Minecraft world.

You should see your last flow, the one that retrieved Steve's position and printed the coordinates in the debug panel. If not, you can download the Player Position flow from the Node-RED

message. In our case, this will indicate that the TCP request node is done with all requests.

A final function node called **tabulate** does a few clever bits. First, it checks if the incoming payload is “**trigger**”. If that’s the case, it publishes the results of a variable **context.table** as payload, but deletes **context.table**. Remember, that’s only happening after all TCP requests are finished. If TCP requests are still incoming, the second part after the **else** statement is relevant: the request buffer with a Minecraft block ID is converted into a string. Have a look at magpi.cc/1PvHAh4 to see what they mean; for example, 0 is air and 17 is wood. If it’s the first time we’re entering this part of the code, we’ll create an empty variable **context.table**: **context** is a special variable in Node-RED that’s persistent between different times a node is called up. If there’s no table entry for ID, we’ll create one and set it to 0, otherwise we take its current value, then we add 1. With that, the node expects more incoming IDs until the trigger message arrives.

Ultimately, we’ll have a directory of elements which we can print with a debug node; this is happening in the **return** statement in the **tabulate** node. The block type IDs are shown in quotes; the number of occurrences follows the colon. These should add up to 343, the volume of the cube around us.

We hope that this tutorial has helped you understand a few concepts that aren’t immediately obvious when using Node-RED for the first time. In part one, we promised interaction with the real world... well... just add the GPIO node. We’re sure you’ll figure it out!

Edit function node

Name: tabulate

Function:

```

1 if (msg.payload === "trigger") {
2   msg.payload = context.table;
3   context.table = undefined;
4   return msg;
5 } else {
6   var ID = msg.payload.toString().replace(/(\n|\r)+$/, '');
7
8   context.table = context.table || {};
9   context.table[ID] = context.table[ID] || 0;
10  context.table[ID] = context.table[ID]+1;
11}

```

Left The ‘tabulate’ function. Lines 1-4 are executed if the trigger node doesn’t receive any more results from the TCP node

Download

Block Inventory
[magpi.cc/
1n59yKr](http://magpi.cc/1n59yKr)

Block Inventory

```
[{"id": "533edf4.facc12", "type": "function", "z": "e13b1b02.1ec4e8",  
"name": "getPos()", "func": "msg.payload = \\\"player.getPos()\\n\\\";\\nreturn msg;", "outputs": 1, "noerr": 0, "x": 207, "y": 151, "wires": [{"714  
29f10.8ebd6"}]}, {"id": "dd58ffe0.22a7", "type": "debug", "z": "e13b1b02.  
.1ec4e8", "name": "", "active": true, "console": "false", "complete": "pay  
load", "x": 642, "y": 278, "wires": []}, {"id": "cc9ed7e5.336128", "type": "  
inject", "z": "e13b1b02.1ec4e8", "name": "inject", "topic": "", "payload"  
: "trigger", "payloadType": "string", "repeat": "", "crontab": "", "once":  
false, "x": 98, "y": 53, "wires": [{"533edf4.facc12"}]}, {"id": "71429f10.8  
ebd6", "type": "tcp request", "z": "e13b1b02.1ec4e8", "server": "127.0.0.  
1", "port": "4711", "out": "char", "splitc": "\\n", "name": "", "x": 329, "y":  
74, "wires": [{"a9afe2c4.56502"}]}, {"id": "a9afe2c4.56502", "type": "fun  
ction", "z": "e13b1b02.1ec4e8", "name": "getBlock()", "func": "var arr =  
msg.payload.toString().replace(/((\\n|\\r)+$/ , '').split('\\n');\\n\\n  
var x = parseInt(arr[0]);\\nvar z = parseInt(arr[1]);\\nvar y =  
parseInt(arr[2])\\nvar cube_size = 3;\\n\\nvar coord_set = []\\n for  
(var h = x-cube_size; h < x+cube_size+1; h++) {\\n for (var k =  
z-cube_size; k < z+cube_size+1; k++) {\\n for (var l =  
y-cube_size; l < y+cube_size+1; l++) {\\n coord_set.  
push({payload: \"world.getBlock(\" + h + \", \" + k + \", \" + l + \")\\n\\\"});\\n  
}\\n }\\n }\\nreturn [coord_set];", "outputs": 1, "noerr": 0, "x": 46  
3, "y": 140, "wires": [{"9713fdf5.68ec"}]}, {"id": "9713fdf5.68ec", "type": "  
": "tcp request", "z": "e13b1b02.1ec4e8", "server": "127.0.0.1", "port":  
"4711", "out": "char", "splitc": "\\n", "name": "", "x": 203, "y": 277, "wire  
s": [{"4958e94e.b6a718", "e8e39686.171c68"}]}, {"id": "4958e94e.b6a718"  
, "type": "function", "z": "e13b1b02.1ec4e8", "name": "tabulate", "func": "  
if (msg.payload === \"trigger\") {\\n msg.payload = context.table;\\n  
context.table = undefined;\\n return msg;\\n} else {\\n var ID = msg.  
payload.toString().replace(/((\\n|\\r)+$/ , '');\\n \\n context.table  
= context.table || {}\\n context.table[ID] = context.table[ID] ||  
0;\\n context.table[ID] = context.table[ID]+1;\\n}", "outputs": 1, "noer  
r": 0, "x": 470, "y": 278, "wires": [{"dd58ffe0.22a7"}]}, {"id": "e8e39686.17  
1c68", "type": "trigger", "z": "e13b1b02.1ec4e8", "op1": "1", "op2": "trigge  
r", "op1type": "nul", "op2type": "val", "duration": "250", "extend": true, "u  
nits": "ms", "name": "", "x": 362, "y": 354, "wires": [{"4958e94e.b6a718"}]}
```



[CHAPTER FOURTEEN]

MINECRAFT:

PI EDITION

API REFERENCE

Learn all the API functions of Minecraft: Pi
from the mcpi Python library...

MINECRAFT

This is the main class and is how you create a connection to Minecraft and access the API.

.create(address = "localhost", port = 4711)

Create a connection to Minecraft => connection : Minecraft().

```
# use default address and port
mc = minecraft.Minecraft.create()
# specify ip address and port
mc = minecraft.Minecraft.create("192.168.1.1", 4711)
```

.getBlock(x,y,z)

Get a block => block id : int.

```
# retrieves the block type for the block at 0,0,0
blockType = mc.getBlock(0,0,0)
```

.getBlockWithData(x,y,z)

Get a block with data => block data : Block().

```
# retrieves a block object for the block at 0,0,0
blockObj = mc.getBlockWithData(0,0,0)
```

.setBlock(x,y,z)

Set a block.

```
# sets a block at an x,y,z coordinate to a particular type
mc.setBlock(0,0,0,block.DIRT.id)
# sets a block to a particular type and 'subtype'
mc.setblock(0,0,0,block.WOOL.id, 1)
```

.setBlocks(x0, y0, z0, x1, y1, z1, blockType, blockData)

Set a cuboid of blocks.

```
# sets many blocks at a time, filling the gap between 2  
sets of x,y,z coordinates  
mc.setBlocks(-1, -1, -1, 1, 1, 1, block.STONE.id)
```

.getHeight(x,z)

Get the height of the world => int.

```
# find the y (vertical) of an x,z coordinate which  
represents the 'highest' (non-air) block  
y = mc.getHeight(0,0)
```

.getPlayerEntityIds()

Get the entity IDs of the connected players => [id:int].

```
entityIds = mc.getPlayerEntityIds()  
for entityId in entityIds:  
    print entityId
```

.saveCheckpoint()

Save a checkpoint that can be used for restoring the world.

```
mc.saveCheckpoint()
```

.restoreCheckpoint()

Restore the world state to the checkpoint.

```
mc.restoreCheckpoint()
```

.postToChat(message)

Post a message to the game chat.

```
# write 'Hello Minecraft World' to the chat window
mc.postToChat("Hello Minecraft World")
```

.setting(setting, status)

Set a world setting.

```
# change world immutable to True
mc.setting("world_immutable", True)
# change name tags visible setting to False
mc.setting("nametags_visible", False)
```

MINECRAFT.PLAYER

The player class allows you to interact with the main player in the game. In a multiplayer game, this is the player who is hosting the game.

.getPos()

Gets the player's position in the world as an x, y, z of floats (decimal numbers) i.e. if the player is in the middle of a block, x.5 is returned.

```
# get player's position as floats
playerPos = mc.player.getPos()
```

.setPos(x,y,z)

Moves the player to a position in the world by passing x, y, z coordinates.

```
# set the player's position as floats
mc.player.setPos(0.0,0.0,0.0)
```

.getTilePos()

Gets the position of the ‘tile’ the player is currently on as an x, y, z of integers (whole numbers).

```
# get the position of the tile the player is on  
playerTile = mc.player.getTilePos()
```

.setTilePos(x,y,z)

Move the player to a tile position in the world by passing x, y, z coordinates.

```
# set the position of the tile the player is on  
mc.player.setTilePos(0,0,0)
```

.setting(setting, status)

Set a player setting (setting, status) – setting keys: autojump.

```
# change the autojump setting to True  
mc.player.setting("autojump", True)
```

MINECRAFT.ENTITY

The entity class allows you to interact with other players in the game, not just the main player, and is useful when creating programs for multiplayer games.

The entity functions should be used in conjunction with the `Minecraft.getPlayerEntityIds()` function.

```
entityIds = mc.getPlayerEntityIds()
```

```
player1EntityId = entityIds[0]
```

```
player2EntityId = entityIds[1]
```

.getPos(entityId)

Gets an entity's position in the world as an x, y, z of floats (decimal numbers)
i.e. if the entity is in the middle of a block, x.5 is returned.

```
# get first entity position as floats
entityPos = mc.entity.getPos(entityId)
```

.setPos(entityId,x,y,z)

Moves the entity to a position in the world by passing x, y, z coordinates.

```
# set the entity's position as floats
mc.player.setPos(entityId,0.0,0.0,0.0)
```

.getTilePos(entityId)

Gets the position of the 'tile' the entity is currently on.

```
# get the position of the tile the entity is on
entityTile = mc.entity.getTilePos(entityId)
```

.setTilePos(entityId, x,y,z)

Move the entity to a tile position in the world by passing x, y, z coordinates.

```
# set the position of the tile the entity is on
mc.player.setTilePos(entityId,0,0,0)
```

MINECRAFT. CAMERA

The camera class allows you to modify the view that the player sees.

.setNormal(entityId)

Set camera mode to normal Minecraft view.

```
# set camera mode to normal for a specific player  
mc.camera.setNormal(entityId)
```

.setFixed()

Set camera mode to fixed view.

```
# set camera mode to fixed  
mc.camera.setFixed()
```

.setFollow(entityId)

Set camera mode to follow a player.

```
# set camera mode to follow a specific player  
mc.camera.setFollow(entityId)
```

.setPos(x,y,z)

Set the camera position which will point down.

```
# set camera position to a specific position of x, y, z  
mc.camera.setPos(0,0,0)
```

MINECRAFT.EVENTS

.pollBlockHits()

Gets block hits, triggered by right-clicking with a sword, since the last time the function was run => BlockEvent().

```
# get block event hits
blockEvents = mc.events.pollBlockHits()
for blockEvent in blockEvents:
    print blockEvent
```

.clearAll()

Clear all old events.

```
# clear all events that have happened since the last
.pollBlockHits call
mc.events.clearAll()
```

BLOCKEVENT

The BlockEvent class is how you get information about block hit events which have been returned by the Minecraft **events.pollBlockHits()** function.

```
blockEventType = blockEvent.type
```

.type

Type of block event. There is only 1 event currently implemented – BlockEvent.HIT = 0.



```
blockEventType = blockEvent.type
```

.pos

The position of the block which was hit as x, y, z coordinates.



```
blockEventPos = BlockEvent.pos
```

.face

The face of the block which was hit, as a number 0 – 6.

```
blockEventFace = BlockEvent.face
```

.entityId

The entity ID of the player who hit the block.

```
blockEventPlayer = BlockEvent.entityId
```



BLOCK

The block module provides constants which let you use blocks by their names rather than their IDs. Many blocks also have data types which let you change a block - e.g. the wool block has the ID 35 and the constant WOOL; a data ID between 0 – 16 changes the colour.

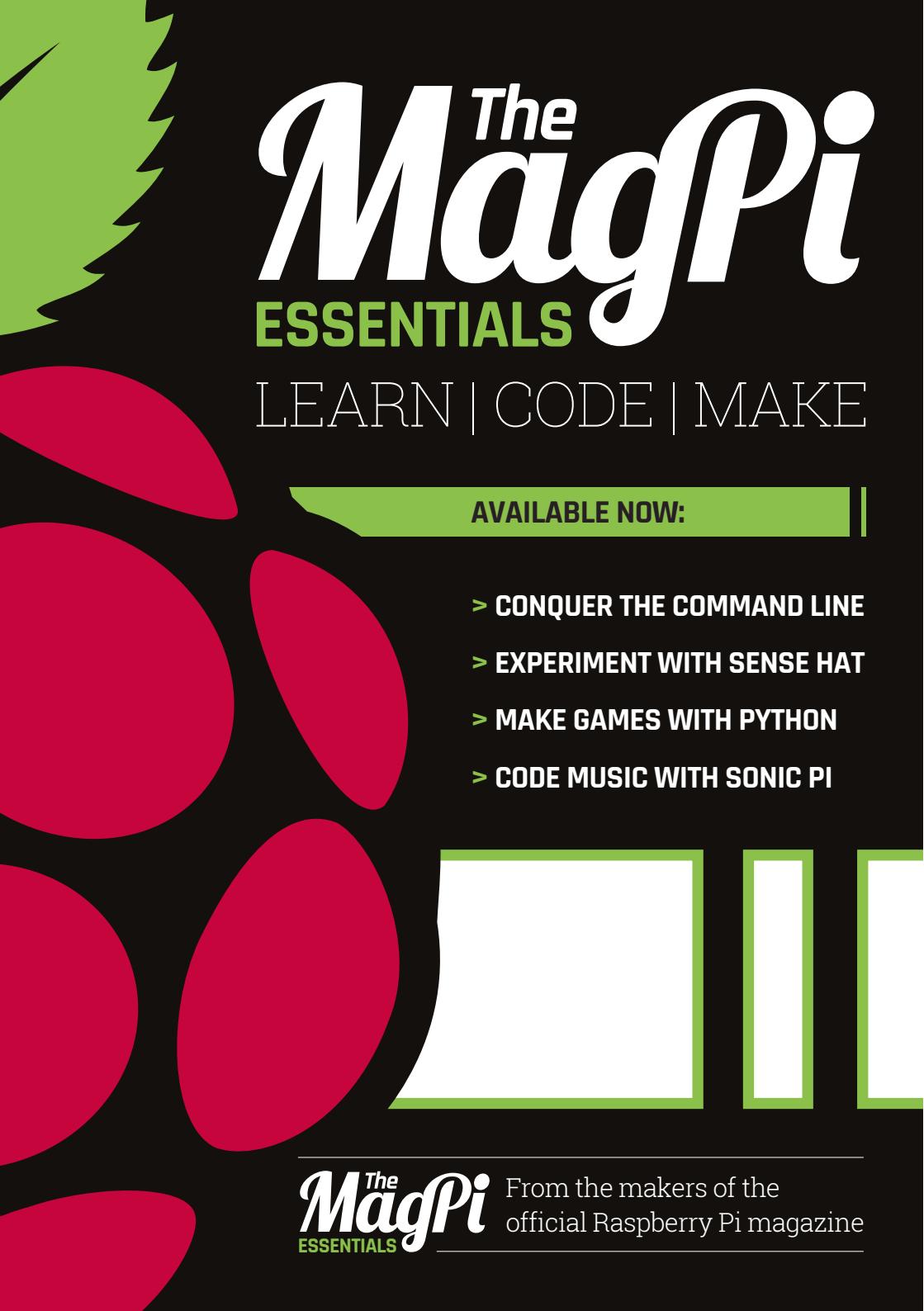
.id	Constant	.data	Sub-type
0	AIR	-	-
1	STONE	-	-
2	GRASS	-	-
3	DIRT	-	-
4	COBBLESTONE	-	-
5	WOOD_PLANKS	0	Oak
		1	Spruce
		2	Birch
		3	Jungle
6	SAPLING	0	Oak
		1	Spruce
		2	Birch
		3	Jungle
7	BEDROCK	-	-
8	WATER_FLOWING WATER	-	-
9	WATER_STATIONARY	0	High
		7	Low
10	LAVA_FLOWING LAVA	-	-
11	LAVA_STATIONARY	0	High
		7	Low
12	SAND	-	-
13	GRAVEL	-	-
14	GOLD_ORE	-	-
15	IRON_ORE	-	-
16	COAL_ORE	-	-
17	WOOD	0	Oak (up/down)

.id	Constant	.data	Sub-type
		1	Spruce (up/down)
		2	Birch (up/down)
		3	Jungle (up/down)
		4	Oak (east/west)
		5	Spruce (east/west)
		6	Birch (east/west)
		7	Jungle (east/west)
		8	Oak (north/south)
		9	Spruce (north/south)
		10	Birch (north/south)
		11	Jungle (north/south)
		12	Oak (only bark)
		13	Spruce (only bark)
		14	Birch (only bark)
		15	Jungle (only bark)
18	LEAVES	1	Oak leaves
		2	Spruce leaves
		3	Birch leaves
20	GLASS	-	-
21	LAPIS_LAZULI_ORE	-	-
22	LAPIS_LAZULI_BLOCK	-	-
24	SANDSTONE	0	Sandstone
		1	Chiselled Sandstone
		2	Smooth Sandstone
26	BED	-	-
30	COBWEB	-	-
31	GRASS_TALL	0	Shrub
		1	Grass
		2	Fern
		3	Grass (colour by biome)
35	WOOL	0	White
		1	Orange
		2	Magenta
		3	Light Blue
		4	Yellow

.id	Constant	.data	Sub-type
		5	Lime
		6	Pink
		7	Grey
		8	Light Grey
		9	Cyan
		10	Purple
		11	Blue
		12	Brown
		13	Green
		14	Red
		15	Black
37	FLOWER_YELLOW	-	-
38	FLOWER_CYAN	-	-
39	MUSHROOM_BROWN	-	-
40	MUSHROOM_RED	-	-
41	GOLD_BLOCK	-	-
42	IRON_BLOCK	-	-
43	STONE_SLAB_DOUBLE	0	Stone
		1	Sandstone
		2	Wooden
		3	Cobblestone
		4	Brick
		5	Stone Brick
		6	Nether Brick
		7	Quartz
44	STONE_SLAB	0	Stone
		1	Sandstone
		2	Wooden
		3	Cobblestone
		4	Brick
		5	Stone Brick
		6	Nether Brick
		7	Quartz
45	BRICK_BLOCK	-	-
46	TNT	0	Inactive

.id	Constant	.data	Sub-type
		1	Ready to explode
47	BOOKSHELF	-	-
48	MOSS_STONE	-	-
49	OBSIDIAN	-	-
50	TORCH	0	Standing on the floor
		1	Pointing east
		2	Pointing west
		3	Pointing south
		4	Pointing north
51	FIRE	-	-
53	STAIRS_WOOD	0	Ascending east
		1	Ascending west
		2	Ascending south
		3	Ascending north
		4	Ascending east (upside down)
		5	Ascending west (upside down)
		6	Ascending south (upside down)
		7	Ascending north (upside down)
54	CHEST	2	Facing north
		3	Facing south
		4	Facing west
		5	Facing east
56	DIAMOND_ORE	-	-
57	DIAMOND_BLOCK	-	-
58	CRAFTING_TABLE	-	-
60	FARMLAND	-	-
61	FURNACE_INACTIVE	2	Facing north
		3	Facing south
		4	Facing west
		5	Facing east
62	FURNACE_ACTIVE	2	Facing north
		3	Facing south
		4	Facing west
		5	Facing east
64	DOOR_WOOD	-	-

.id	Constant	.data	Sub-type
65	LADDER	2	Facing north
		3	Facing south
		4	Facing west
		5	Facing east
67	STAIRS_COBBLESTONE	0	Ascending east
		1	Ascending west
		2	Ascending south
		3	Ascending north
		4	Ascending east (upside down)
		5	Ascending west (upside down)
		6	Ascending south (upside down)
		7	Ascending north (upside down)
71	DOOR_IRON	-	-
73	REDSTONE_ORE	-	-
78	SNOW	0	Lowest
		7	Highest
79	ICE	-	-
80	SNOW_BLOCK	-	-
81	CACTUS	-	-
82	CLAY	-	-
83	SUGAR_CANE	-	-
85	FENCE	-	-
89	GLOWSTONE_BLOCK	-	-
95	BEDROCK_INVISIBLE	-	-
98	STONE_BRICK	0	Stone brick
		1	Mossy stone brick
		2	Cracked stone brick
		3	Chiseled stone brick
102	GLASS_PANE	-	-
103	MELON	-	-
107	FENCE_GATE	-	-
246	GLOWING_OBSIDIAN	-	-
247	NETHER_REACTOR	0	Unused
		1	Active
		2	Stopped / used up



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