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The Python Book

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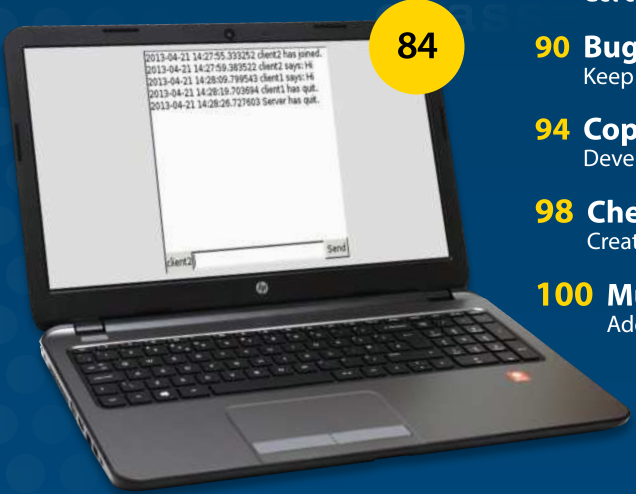
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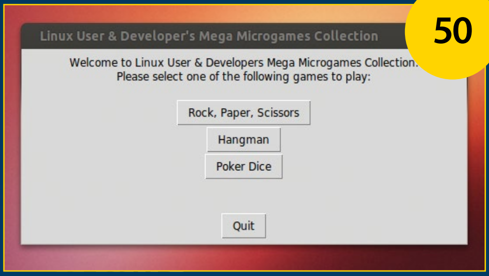
```
2013-04-21 14:27:55.333252 client2 has joined.
2013-04-21 14:27:59.383522 client2 says: Hi
2013-04-21 14:28:09.799543 client1 says: Hi
2013-04-21 14:28:19.703694 client1 has quit.
2013-04-21 14:28:26.727603 Server has quit.
```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Linux User & Developer's Mega Microgames Collection

Welcome to Linux User & Developers Mega Microgames Collection.
Please select one of the following games to play:

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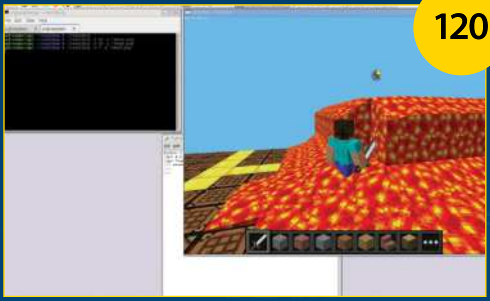
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R2D2 is © LucasFilm

Get started with Python

Always wanted to have a go at programming? No more excuses, because Python is the perfect way to get started!

Python is a great programming language for both beginners and experts. It is designed with code readability in mind, making it an excellent choice for beginners who are still getting used to various programming concepts.

The language is popular and has plenty of libraries available, allowing programmers to get a lot done with relatively little code.

You can make all kinds of applications in Python: you could use the Pygame framework to write simple 2D games, you could use the GTK libraries to create a windowed application, or you could try something a little more ambitious like an app such as creating one using Python's Bluetooth and Input libraries to capture the input from a USB keyboard and relay the input events to an Android phone.

For this guide we're going to be using Python 2.x since that is the version that is most likely to be installed on your Linux distribution.

In the following tutorials, you'll learn how to create popular games using Python programming. We'll also show you how to add sound and AI to these games.

Hello World

Let's get stuck in, and what better way than with the programmer's best friend, the 'Hello World' application! Start by opening a terminal. Its current working directory will be your home directory. It's probably a good idea to make a directory for the files we'll be creating in this tutorial, rather than having them loose in your home directory. You can create a directory called Python using the command mkdir Python. You'll then want to change into that directory using the command cd Python.

The next step is to create an empty file using the command 'touch' followed by the filename. Our expert used the command touch hello_world.py. The final and most important part of setting up the file is making it executable. This allows us to run code inside the hello_world.py file. We do this with the command chmod +x hello_world.py. Now that we have our file set up, we can go ahead and open it up in nano, or any text editor of your choice. Gedit is a great editor with syntax highlighting support that should be available on any distribution. You'll be able to install it using your package manager if you don't have it already.

```
$ mkdir Python
$ cd Python/
$ touch hello_world.py
$ chmod +x hello_world.py
$ nano hello_world.py
```

Our Hello World program is very simple, it only needs two lines. The first line begins with a 'shebang' (the symbol #! – also known as a hashbang) followed by the path to the Python interpreter. The program loader uses this line to work out what the rest of the lines need to be interpreted with. If you're running this in an IDE like IDLE, you don't necessarily need to do this.

The code that is actually read by the Python interpreter is only a single line. We're passing the value Hello World to the print function by placing it in brackets immediately after we've called the print function. Hello World is enclosed in quotation marks to indicate that it is a literal value and should not be interpreted as source code. As expected, the print function in Python prints any value that gets passed to it from the console.

You can save the changes you've just made to the file in nano using the key combination Ctrl+O, followed by Enter. Use Ctrl+X to exit nano.

```
#!/usr/bin/env python3
print("Hello World")
```

You can run the Hello World program by prefixing its filename with ./ – in this case you'd type: ./hello_world.py.

```
$ ./hello_world.py
Hello World
```

TIP

If you were using a graphical editor such as Gedit, then you would only have to do the last step of making the file executable. You should only have to mark the file as executable once. You can freely edit the file once it is executable.

Variables and data types

A variable is a name in source code that is associated with an area in memory that you can use to store data, which is then called upon throughout the code. The data can be one of many types, including:

Integer	Stores whole numbers
Float	Stores decimal numbers
Boolean	Can have a value of True or False
String	Stores a collection of characters. "Hello World" is a string

As well as these main data types, there are sequence types (technically, a string is a sequence type but is so commonly used we've classed it as a main data type):

List	Contains a collection of data in a specific order
Tuple	Contains a collection immutable data in a specific order

A tuple would be used for something like a co-ordinate, containing an x and y value stored as a single variable, whereas a list is typically used to store larger collections. The data stored in a tuple is immutable because you aren't able to change values of individual elements in a tuple. However, you can do so in a list.

It will also be useful to know about Python's dictionary type. A dictionary is a mapped data type. It stores data in key-value pairs. This means that you access values stored in the dictionary using that value's corresponding key, which is different to how you would do it with a list. In a list, you would access an element of the list using that element's index (a number representing the element's position in the list).

Let's work on a program we can use to demonstrate how to use variables and different data types. It's worth noting at this point that you don't always have to specify data types in Python. Feel free to create this file in any editor you like. Everything will work just fine as long as you remember to make the file executable. We're going to call ours variables.py.

"A variable is a name in source code that is associated with an area in memory that you can use to store data"

Interpreted vs compiled languages

An interpreted language such as Python is one where the source code is converted to machine code and then executed each time the program runs. This is different from a compiled language such as C, where the source code is only converted to machine code once – the resulting machine code is then executed each time the program runs.

```
#!/usr/bin/env python3

# We create a variable by writing the name of the variable we want followed
# by an equals sign, which is followed by the value we want to store in the
# variable. For example, the following line creates a variable called
# hello_str, containing the string Hello World.
hello_str = "Hello World"

hello_int = 21

hello_bool = True

hello_tuple = (21, 32)

hello_list = ["Hello,", "this", "is", "a", "list"]

# This list now contains 5 strings. Notice that there are no spaces
# between these strings so if you were to join them up to make a sentence
# you'd have to add a space between each element.

hello_list = list()
hello_list.append("Hello,")
hello_list.append("this")
hello_list.append("is")
hello_list.append("a")
hello_list.append("list")

# The first line creates an empty list and the following lines use the append
# function of the list type to add elements to the list. This way of using a
# list isn't really very useful when working with strings you know of in
# advance, but it can be useful when working with dynamic data such as user
# input. This list will overwrite the first list without any warning as we
# are using the same variable name as the previous list.

hello_dict = { "first_name" : "Liam",
          "last_name"  : "Fraser",
          "eye_colour" : "Blue" }

# Let's access some elements inside our collections
# We'll start by changing the value of the last string in our hello_list and
# add an exclamation mark to the end. The "list" string is the 5th element
# in the list. However, indexes in Python are zero-based, which means the
# first element has an index of 0.

print(hello_list[4])
hello_list[4] += "!"
# The above line is the same as
hello_list[4] = hello_list[4] + "!"
print(hello_list[4])
```

The following line creates an integer variable called hello_int with the # value of 21. Notice how it doesn't need to go in quotation marks

The same principal is true of Boolean values

We create a tuple in the following way

And a list in this way

You could also create the same list in the following way

We might as well create a dictionary while we're at it. Notice how we've aligned the colons below to make the code tidy

Notice that there will now be two exclamation marks when we print the element

TIP

At this point, it's worth explaining that any text in a Python file that follows a # character will be ignored by the interpreter. This is so you can write comments in your code.

"Any text in a Python file that follows a # character will be ignored"

Remember that tuples are immutable, although we can access the elements of them like so

```
print(str(hello_tuple[0]))
# We can't change the value of those elements like we just did with the list
# Notice the use of the str function above to explicitly convert the integer
# value inside the tuple to a string before printing it.
```

Let's create a sentence using the data in our hello_dict

```
print(hello_dict["first_name"] + " " + hello_dict["last_name"] + " has " +
    hello_dict["eye_colour"] + " eyes.")
```

A tidier way of doing this would be to use Python's string formatter

```
print("{0} {1} has {2} eyes.".format(hello_dict["first_name"],
                    hello_dict["last_name"],
                    hello_dict["eye_colour"]))
```

Control structures

In programming, a control structure is any kind of statement that can change the path that the code execution takes. For example, a control structure that decided to end the program if a number was less than 5 would look something like this:

```
#!/usr/bin/env python3

import sys # Used for the sys.exit function

int_condition = 5

if int_condition < 6:
    sys.exit("int_condition must be >= 6")
else:
    print("int_condition was >= 6 - continuing")
```

The path that the code takes will depend on the value of the integer int_condition. The code in the 'if' block will only be executed if the condition is true. The import statement is used to load the Python system library; the latter provides the exit function, allowing you to exit the program, printing an error message. Notice that indentation (in this case four spaces per indent) is used to indicate which statement a block of code belongs to.

'If' statements are probably the most commonly used control structures. Other control structures include:

- 'For' statements, which allow you to iterate over items in collections, or to repeat a piece of code a certain number of times;
- 'While' statements, a loop that continues while the condition is true.

We're going to write a program that accepts user input from the user to demonstrate how control structures work. We're calling it **construct.py**.

The 'for' loop is using a local copy of the current value, which means any changes inside the loop won't make any changes affecting the list. On the other hand however, the 'while' loop is directly accessing elements in the list, so you could change the list there should you want to do so. We will talk about variable scope in some more detail later on. The output from the above program is as follows:

Indentation in detail

As previously mentioned, the level of indentation dictates which statement a block of code belongs to. Indentation is mandatory in Python, whereas in other languages, sets of braces are used to organise code blocks. For this reason, it is essential that you use a consistent indentation style. Four spaces are typically used to represent a single level of indentation in Python. You can use tabs, but tabs are not well defined, especially if you happen to open a file in more than one editor.

"The 'for' loop uses a local copy, so changes in the loop won't affect the list"

```
$ ./construct.py
How many integers? acd
You must enter an integer

$ ./construct.py
How many integers? 3
Please enter integer 1: t
You must enter an integer
Please enter integer 1: 5
Please enter integer 2: 2
Please enter integer 3: 6
Using a for loop
5
2
6
Using a while loop
5
2
6
```

More about a Python list

A Python list is similar to an array in other languages. A list (or tuple) in Python can contain data of multiple types, which is not usually the case with arrays in other languages. For this reason, we recommend that you only store data of the same type in a list. This should almost always be the case anyway due to the nature of the way data in a list would be processed.

The number of integers we want in the list

A list to store the integers

These are used to keep track of how many integers we currently have

If the above succeeds then isint will be set to true: isint =True

By now, the user has given up or we have a list filled with integers. We can loop through these in a couple of ways. The first is with a for loop

```
#!/usr/bin/env python3

# We're going to write a program that will ask the user to input an arbitrary
# number of integers, store them in a collection, and then demonstrate how the
# collection would be used with various control structures.

import sys # Used for the sys.exit function

target_int = raw_input("How many integers? ")

# By now, the variable target_int contains a string representation of
# whatever the user typed. We need to try and convert that to an integer but
# be ready to # deal with the error if it's not. Otherwise the program will
# crash.
try:
    target_int = int(target_int)
except ValueError:
    sys.exit("You must enter an integer")


ints = list()

count = 0

# Keep asking for an integer until we have the required number
while count < target_int:
    new_int = raw_input("Please enter integer {0}: ".format(count + 1))
    isint = False
    try:
        new_int = int(new_int)

    except:
        print("You must enter an integer")

    # Only carry on if we have an integer. If not, we'll loop again
    # Notice below I use ==, which is different from =. The single equals is an
    # assignment operator whereas the double equals is a comparison operator.

    if isint == True:
        # Add the integer to the collection
        ints.append(new_int)
        # Increment the count by 1
        count += 1


print("Using a for loop")
for value in ints:
    print(str(value))
```

TIP

You can define defaults for variables if you want to be able to call the function without passing any variables through at all. You do this by putting an equals sign after the variable name. For example, you can do: `def modify_string (original=" Default String")`

```
# Or with a while loop:
print("Using a while loop")
# We already have the total above, but knowing the len function is very
# useful.
total = len(ints)
count = 0
while count < total:
    print(str(ints[count]))
    count += 1
```

Functions and variable scope

Functions are used in programming to break processes down into smaller chunks. This often makes code much easier to read. Functions can also be reusable if designed in a certain way. Functions can have variables passed to them. Variables in Python are always passed by value, which means that a copy of the variable is passed to the function that is only valid in the scope of the function. Any changes made to the original variable inside the function will be discarded. However, functions can also return values, so this isn't an issue. Functions are defined with the keyword def, followed by the name of the function. Any variables that can be passed through are put in brackets following the function's name. Multiple variables are separated by commas. The names given to the variables in these brackets are the ones that they will have in the scope of the function, regardless of what the variable that's passed to the function is called. Let's see this in action.

The output from the program opposite is as follows:

"Functions are used in programming to break processes down in"

```
#!/usr/bin/env python3

# Below is a function called modify_string, which accepts a variable
# that will be called original in the scope of the function. Anything
# indented with 4 spaces under the function definition is in the
# scope.
def modify_string(original):
    original += " that has been modified."
    # At the moment, only the local copy of this string has been modified

def modify_string_return(original):
    original += " that has been modified."
    # However, we can return our local copy to the caller. The function
    # ends as soon as the return statement is used, regardless of where it
    # is in the function.
    return original


test_string = "This is a test string"

modify_string(test_string)
print(test_string)

test_string = modify_string_return(test_string)
print(test_string)

# The function's return value is stored in the variable test string,
# overwriting the original and therefore changing the value that is
# printed.
```

We are now outside of the scope of the modify_ string function, as we have reduced the level of indentation

The test string won't be changed in this code

However, we can call the function like this

```
$ ./functions_and_scope.py
This is a test string
This is a test string that has been modified.
```

Scope is an important thing to get the hang of, otherwise it can get you into some bad habits. Let's write a quick program to demonstrate this. It's going to have a Boolean variable called cont, which will decide if a number will be assigned to a variable in an 'if' statement. However, the variable hasn't been defined anywhere apart from in the scope of the 'if' statement. We'll finish off by trying to print the variable.

```
#!/usr/bin/env python3
cont = False
if cont:
    var = 1234
print(var)
```

In the section of code above, Python will convert the integer to a string before printing it. However, it's always a good idea to explicitly convert things to strings – especially when it comes to concatenating strings together. If you try to use the + operator on a string and an integer, there will be an error because it's not explicitly clear what needs to happen. The + operator would usually add two integers together. Having said that, Python's string formatter that we demonstrated earlier is a cleaner way of doing that. Can you see the problem? Var has only been defined in the scope of the 'if' statement. This means that we get a very nasty error when we try to access var.

```
$ ./scope.py
Traceback (most recent call last):
  File "./scope.py", line 8, in <module>
    print(var)
NameError: name 'var' is not defined
```

If cont is set to True, then the variable will be created and we can access it just fine. However, this is a bad way to do things. The correct way is to initialise the variable outside of the scope of the 'if' statement.

```
#!/usr/bin/env python3

cont = False

var = 0
if cont:
    var = 1234

if var != 0:
    print(var)
```

The variable var is defined in a wider scope than the 'if' statement, and can still be accessed by the 'if' statement. Any changes made to var inside the 'if' statement are changing the variable defined in the larger scope. This example doesn't really do anything useful apart from illustrate the potential problem, but the worst-case scenario has gone from the program crashing to printing a zero. Even that doesn't happen because we've added an extra construct to test the value of var before printing it.

Coding style

It's worth taking a little time to talk about coding style. It's simple to write tidy code. The key is consistency. For example, you should always name your variables in the same manner. It doesn't matter if you want to use camelCase or use underscores as we have. One crucial thing is to use self-documenting identifiers for variables. You shouldn't have to guess what a variable does. The other thing that goes with this is to always comment your code. This will help anyone else who reads your code, and yourself in the future. It's also useful to put a brief summary at the top of a code file describing what the application does, or a part of the application if it's made up of multiple files.

Comparison operators

The common comparison operators available in Python include:

<	strictly less than
<=	less than or equal
>	strictly greater than
>=	greater than or equal
==	equal
!=	not equal

Summary

This article should have introduced you to the basics of programming in Python. Hopefully you are getting used to the syntax, indentation and general look and feel of a Python program. The next step is to learn how to come up with a problem that you want to solve, and break it down into small enough steps that you can implement in a programming language.

Google, or any other search engine, is very helpful. If you are stuck with anything, or have an error message you can't work out how to fix, stick it into Google and you should be a lot closer to solving your problem. For example, if we Google 'play mp3 file with python', the first link takes us to a Stack Overflow thread with a bunch of useful replies. Don't be afraid to get stuck in – the real fun of programming is solving problems one manageable chunk at a time.

Happy programming!

50 ESSENTIAL PYTHON COMMANDS

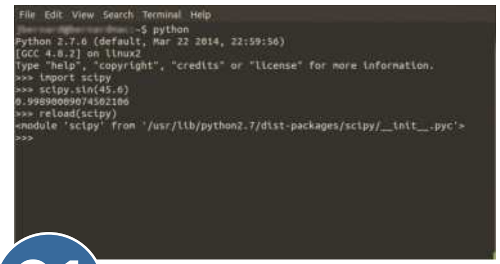
Python is known as a very dense language, with lots of modules capable of doing almost anything. Here, we will look at the core essentials that everyone needs to know

Python has a massive environment of extra modules that can provide functionality in hundreds of different disciplines. However, every programming language has a core set of functionality that everyone should know in order to get useful work done. Python is no different in this regard. Here, we will look at 50 commands that we consider to be essential to programming in Python. Others may pick a slightly different set, but this list contains the best of the best.

We will cover all of the basic commands, from importing extra modules at the beginning of a program to returning values to the calling environment at the end. We will also be looking at some commands that are useful in learning about the current session within Python, like the current list of variables that have been defined and how memory is being used.

Because the Python environment involves using a lot of extra modules, we will also look at a few commands that are strictly outside of Python. We will see how to install external modules and how to manage multiple environments for different development projects. Since this is going to be a list of commands, there is the assumption that you already know the basics of how to use loops and conditional structures. This piece is designed to help you remember commands that you know you've seen before, and hopefully introduce you to a few that you may not have seen yet.

Although we've done our best to pack everything you could ever need into 50 tips, Python is such an expansive language that some commands will have been left out. Make some time to learn about the ones that we didn't cover here, once you've mastered these.



```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> import scipy
>>> scipy.sin(45.6)
0.99890009074502106
>>> reload(scipy)
<module 'scipy' from '/usr/lib/python2.7/dist-packages/scipy/__init__.pyc'>
>>>
```

01 Importing modules

The strength of Python is its ability to be extended through modules. The first step in many programs is to import those modules that you need. The simplest import statement is to just call 'import modulename'. In this case, those functions and objects provided are not in the general namespace. You need to call them using the complete name (modulename.methodname). You can shorten the 'modulename' part with the command 'import modulename as mn'. You can skip this issue completely with the command 'from modulename import *' to import everything from the given module. Then you can call those provided capabilities directly. If you only need a few of the provided items, you can import them selectively by replacing the '*' with the method or object names.

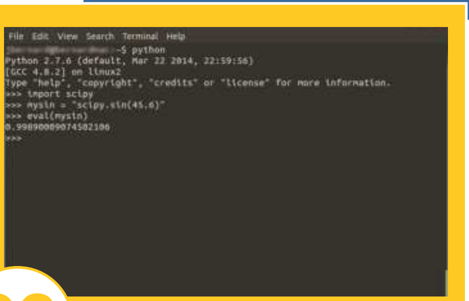
02 Reloading modules

When a module is first imported, any initialisation functions are run at that time. This may involve creating data objects, or initiating connections. But, this is only done the first time within a given session. Importing the same module again won't re-execute any of the initialisation code. If you want to have this code re-run, you need to use the reload command. The format is 'reload(modulename)'. Something to keep in mind is that the dictionary from the previous import isn't dumped, but only written over. This means that any definitions that have changed between the import and the reload are updated correctly. But if you delete a definition, the old one will stick around and still be accessible. There may be other side effects, so always use with caution.

03 Installing new modules

While most of the commands we are looking at are Python commands that are to be executed within a Python session, there are a few essential commands that need to be executed outside of Python. The first of these is pip. Installing a module involves downloading the source code, and compiling any included external code. Luckily, there is a repository of hundreds of Python modules available at http://pypi.python.org. Instead of doing everything manually, you can install a new module by using the command 'pip install modulename'. This command will also do a dependency check and install any missing modules before installing the one you requested. You may need administrator rights if you want this new module installed in the global library for your computer. On a Linux machine, you would simply run the pip command with sudo. Otherwise, you can install it to your personal library directory by adding the command line option '—user'.

"Every programming language out there has a core set of functionality that everyone should know in order to get useful work done. Python is no different"



```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> import scipy
>>> mysin = "scipy.sin(45.6)"
>>> eval(mysin)
0.99890009074502106
>>>
```

04 Executing a script

Importing a module does run the code within the module file, but does it through the module maintenance code within the Python engine. This maintenance code also deals with running initialising code. If you only wish to take a Python script and execute the raw code within the current session, you can use the 'execfile("filename.py")' command, where the main option is a string containing the Python file to load and execute. By default, any definitions are loaded into the locals and globals of the current session. You can optionally include two extra parameters the execfile command. These two options are both dictionaries, one for a different set of locals and a different set of globals. If you only hand in one dictionary, it is assumed to be a globals dictionary. The return value of this command is None.

05 An enhanced shell

The default interactive shell is provided through the command 'python', but is rather limited. An enhanced shell is provided by the command 'ipython'. It provides a lot of extra functionality to the code developer. A thorough history system is available, giving you access to not only commands from the current session, but also from previous sessions. There are also magic commands that provide enhanced ways of interacting with the current Python session. For more complex interactions, you can create and use macros. You can also easily peek into the memory of the Python session and decompile Python code. You can even create profiles that allow you to handle initialisation steps that you may need to do every time you use iPython.

06 Evaluating code

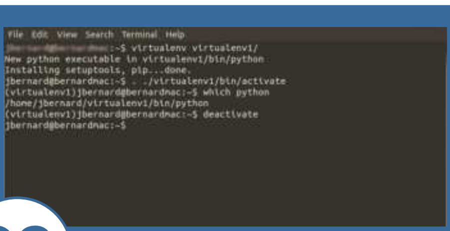
Sometimes, you may have chunks of code that are put together programmatically. If these pieces of code are put together as a string, you can execute the result with the command 'eval("code_string")'. Any syntax errors within the code string are reported as exceptions. By default, this code is executed within the current session, using the current globals and locals dictionaries. The 'eval' command can also take two other optional parameters, where you can provide a different set of dictionaries for the globals and locals. If there is only one additional parameter, then it is assumed to be a globals dictionary. You can optionally hand in a code object that is created with the compile command instead of the code string. The return value of this command is None.

07 Asserting values

At some point, we all need to debug some piece of code we are trying to write. One of the tools useful in this is the concept of an assertion. The assert command takes a Python expression and checks to see if it is true. If so, then execution continues as normal. If it is not true, then an AssertionError is raised. This way, you can check to make sure that invariants within your code stay invariant. By doing so, you can check assumptions made within your code. You can optionally include a second parameter to the assert command. This second parameter is Python expression that is executed if the assertion fails. Usually, this is some type of detailed error message that gets printed out. Or, you may want to include cleanup code that tries to recover from the failed assertion.

08 Mapping functions

A common task that is done in modern programs is to map a given computation to an entire list of elements. Python provides the command 'map()' to do just this. Map returns a list of the results of the function applied to each element of an iterable object. Map can actually take more than one function and more than one iterable object. If it is given more than one function, then a list of tuples is returned, with each element of the tuple containing the results from each function. If there is more than one iterable handed in, then map assumes that the functions take more than one input parameter, so it will take them from the given iterables. This has the implicit assumption that the iterables are all of the same size, and that they are all necessary as parameters for the given function.

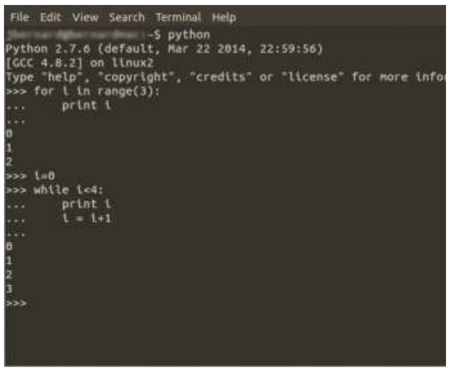


```
[redacted]:~$ virtualenv virtualenv1/
New python executable in virtualenv1/bin/python
Installing setuptools, pip....done.
jbernard@bernardmac:~$ . ./virtualenv1/bin/activate
(virtualenv1)jbernard@bernardmac:~$ which python
/home/jbernard/virtualenv1/bin/python
(virtualenv1)jbernard@bernardmac:~$ deactivate
jbernard@bernardmac:~$
```

09 Virtualenvs

Because of the potential complexity of the Python environment, it is sometimes best to set up a clean environment within which to install only the modules you need for a given project. In this case, you can use the virtualenv command to initialise such an environment. If you create a directory named 'ENV', you can create a new environment with the command 'virtualenv ENV'. This will create the subdirectories bin, lib and include, and populate them with an initial environment. You can then start using this new environment by sourcing the script 'ENV/bin/activate', which will change several environment variables, such as the PATH. When you are done, you can source the script 'ENV/bin/deactivate' to reset your shell's environment back to its previous condition. In this way, you can have environments that only have the modules you need for a given set of tasks.

"While not strictly commands, everyone needs to know how to deal with loops. The two main types of loops are a fixed number of iterations loop (for) and a conditional loop (while)"



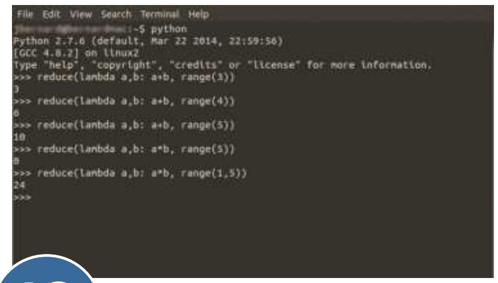
```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more infor
>>> for i in range(3):
...     print i
...
0
1
2
>>> i=0
>>> while i<4:
...     print i
...     i = i+1
...
0
1
2
3
>>>
```

10 Loops

While not strictly commands, everyone needs to know how to deal with loops. The two main types of loops are a fixed number of iterations loop (for) and a conditional loop (while). In a for loop, you iterate over some sequence of values, pulling them off the list one at a time and putting them in a temporary variable. You continue until either you have processed every element or you have hit a break command. In a while loop, you continue going through the loop as long as some test expression evaluates to True. While loops can also be exited early by using the break command, you can also skip pieces of code within either loop by using a continue command to selectively stop this current iteration and move on to the next one.

11 Filtering

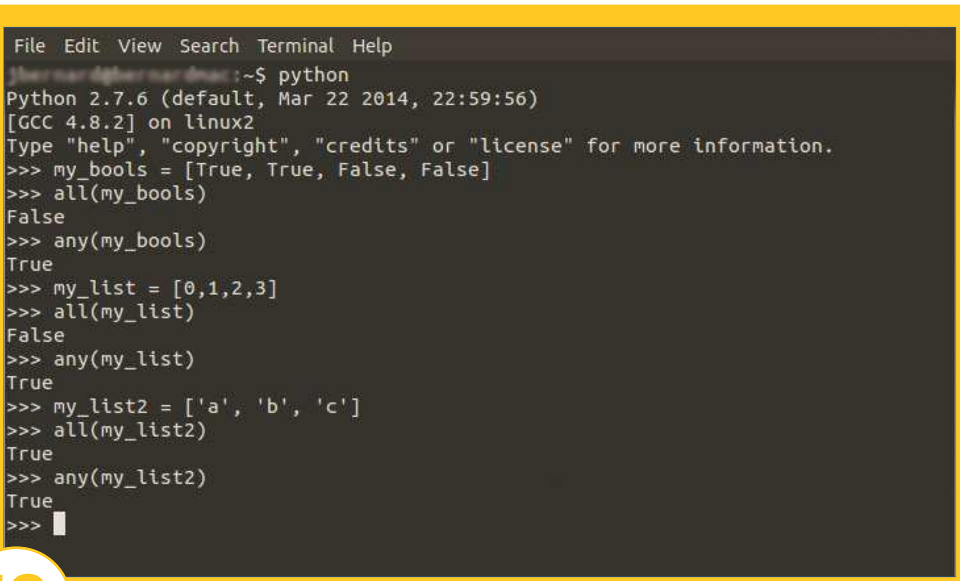
Where the command map returns a result for every element in an iterable, filter only returns a result if the function returns a True value. This means that you can create a new list of elements where only the elements that satisfy some condition are used. As an example, if your function checked that the values were numbers between 0 and 10, then it would create a new list with no negative numbers and no numbers above 10. This could be accomplished with a for loop, but this method is much cleaner. If the function provided to filter is 'None', then it is assumed to be the identity function. This means that only those elements that evaluate to True are returned as part of the new list. There are iterable versions of filter available in the itertools module.



```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> reduce(lambda a,b: a+b, range(3))
3
>>> reduce(lambda a,b: a+b, range(4))
6
>>> reduce(lambda a,b: a+b, range(5))
10
>>> reduce(lambda a,b: a*b, range(5))
0
>>> reduce(lambda a,b: a*b, range(1,5))
24
>>>
```

12 Reductions

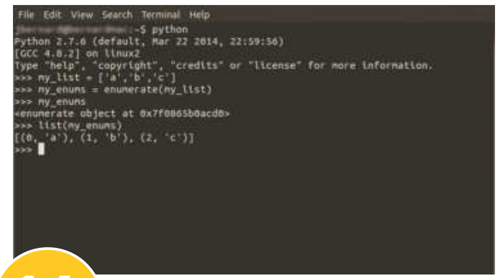
In many calculations, one of the computations you need to do is a reduction operation. This is where you take some list of values and reduce it down to a single value. In Python, you can use the command 'reduce(function, iterable)' to apply the reduction function to each pair of elements in the list. For example, if you apply the summation reduction operation to the list of the first five integers, you would get the result ((((1+2)+3)+4)+5). You can optionally add a third parameter to act as an initialisation term. It is loaded before any elements from the iterable, and is returned as a default if the iterable is actually empty. You can use a lambda function as the function parameter to reduce to keep your code as tight as possible. In this case, remember that it should only take two input parameters.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> my_bools = [True, True, False, False]
>>> all(my_bools)
False
>>> any(my_bools)
True
>>> my_list = [0,1,2,3]
>>> all(my_list)
False
>>> any(my_list)
True
>>> my_list2 = ['a', 'b', 'c']
>>> all(my_list2)
True
>>> any(my_list2)
True
>>> █
```

13 How true is a list?

In some cases, you may have collected a number of elements within a list that can be evaluated to True or False. For example, maybe you ran a number of possibilities through your computation and have created a list of which ones passed. You can use the command 'any(list)' to check to see whether any of the elements within your list are true. If you need to check whether all of the elements are True, you can use the command 'all(list)'. Both of these commands return a True if the relevant condition is satisfied, and a False if not. They do behave differently if the iterable object is empty, however. The command 'all' returns a True if the iterable is empty, whereas the command 'any' returns a False when given any empty iterable.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> my_list = ['a','b','c']
>>> my_enums = enumerate(my_list)
>>> my_enums
<enumerate object at 0x7f0865b0acd0>
>>> list(my_enums)
[(0, 'a'), (1, 'b'), (2, 'c')]
>>> █
```

14 Enumerating

Sometimes, we need to label the elements that reside within an iterable object with their indices so that they can be processed at some later point. You could do this by explicitly looping through each of the elements and building an enumerated list. The enumerate command does this in one line. It takes an iterable object and creates a list of tuples as the result. Each tuple has the 0-based index of the element, along with the element itself. You can optionally start the indexing from some other value by including an optional second parameter. As an example, you could enumerate a list of names with the command 'list(enumerate(names, start=1))'. In this example, we decided to start the indexing at 1 instead of 0.

15 Casting

Variables in Python don't have any type information, and so can be used to store any type of object. The actual data, however, is of one type or another. Many operators, like addition, assume that the input values are of the same type. Very often, the operator you are using is smart enough to make the type of conversion that is needed. If you have the need to explicitly convert your data from one type to another, there are a class of functions that can be used to do this conversion process. The ones you are most likely to use is 'abs', 'bin', 'bool', 'chr', 'complex', 'float', 'hex', 'int', 'long', 'oct', and 'str'. For the number-based conversion functions, there is an order of precedence where some types are a subset of others. For example, integers are "lower" than floats. When converting up, no changes in the ultimate value should happen. When converting down, usually some amount of information is lost. For example, when converting from float to integer, Python truncates the number towards zero.

16 What is this?

Everything in Python is an object. You can check to see what class this object is an instance of with the command 'isinstance(object, class)'. This command returns a Boolean value.

17 Is it a subclass?

The command 'issubclass(class1, class2)' checks to see if class1 is a subclass of class2. If class1 and class2 are the same, this is returned as True.

18 Global objects

You can get a dictionary of the global symbol table for the current module with the command 'globals()'.

19 Local objects

You can access an updated dictionary of the current local symbol table by using the command 'locals()'.

20 Variables

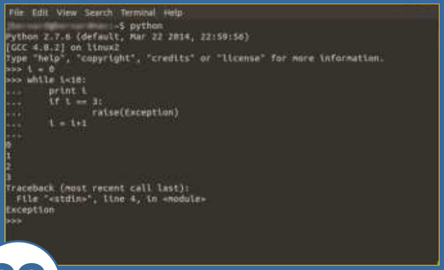
The command 'vars(dict)' returns writeable elements for an object. If you use 'vars()', it behaves like 'locals()'.

21 Making a global

A list of names can be interpreted as globals for the entire code block with the command 'global names'.

22 Nonlocals

In Python 3.X, you can access names from the nearest enclosing scope with the command 'nonlocal names' and bind it to the local scope.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> i = 0
>>> while i<10:
...     print i
...     if i == 3:
...             raise(Exception)
...     i = i+1
...
0
1
2
3
Traceback (most recent call last):
  File "<stdin>", line 4, in <module>
Exception
>>>
```

23 Raising an exception

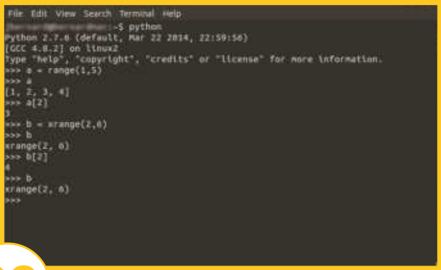
When you identify an error condition, you can use the 'raise' command to throw up an exception. You can include an exception type and a value.

24 Dealing with an exception

Exceptions can be caught in a try-except construction. If the code in the try block raises an exception, the code in the except block gets run.

25 Static methods

You can create a statis method, similar to that in Java or C++, with the command 'staticmethod(function_name)'.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> a = range(1,5)
>>> a
[1, 2, 3, 4]
>>> a[2]
3
>>> b = xrange(2,6)
>>> b
xrange(2, 6)
>>> b[2]
4
>>> b
xrange(2, 6)
>>>
```

26 Ranges

You may need a list of numbers, maybe in a 'for' loop. The command 'range()' can create an iterable list of integers. With one parameter, it goes from 0 to the given number. You can provide an optional start number, as well as a step size. Negative numbers count down.

27 Max and Min

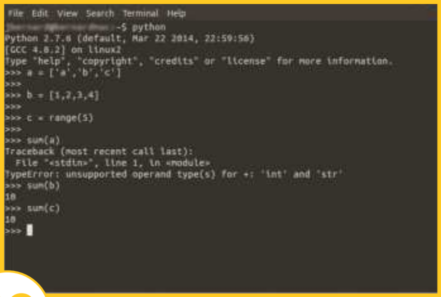
If you have a list of numbers (or anything else where it makes sense to talk about the largest and smallest elements), then you can find the maximum element with the max() function. Dually if you want to find the minimum element, use min().

28 Iterators

Iteration is a very Pythonic way of doing things. For objects which are not intrinsically iterable, you can use the command 'iter(object_name)' to essentially wrap your object and provide an iterable interface for use with other functions and operators.

29 Sorted lists

You can use the command 'sorted(list1)' to sort the elements of a list. You can give it a custom comparison function, and for more complex elements you can include a key function that pulls out a ranking property from each element for comparison.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> a = ['a','b','c']
>>>
>>> b = [1,2,3,4]
>>>
>>> c = range(5)
>>>
>>> sum(a)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: unsupported operand type(s) for +: 'int' and 'str'
>>> sum(b)
10
>>> sum(c)
10
>>> 
```

30 Summing items

Above, we saw the general reduction function reduce. A specific type of reduction operation, summation, is common enough to warrant the inclusion of a special case, the command 'sum(iterable_object)'. You can include a second parameter here that will provide a starting value.

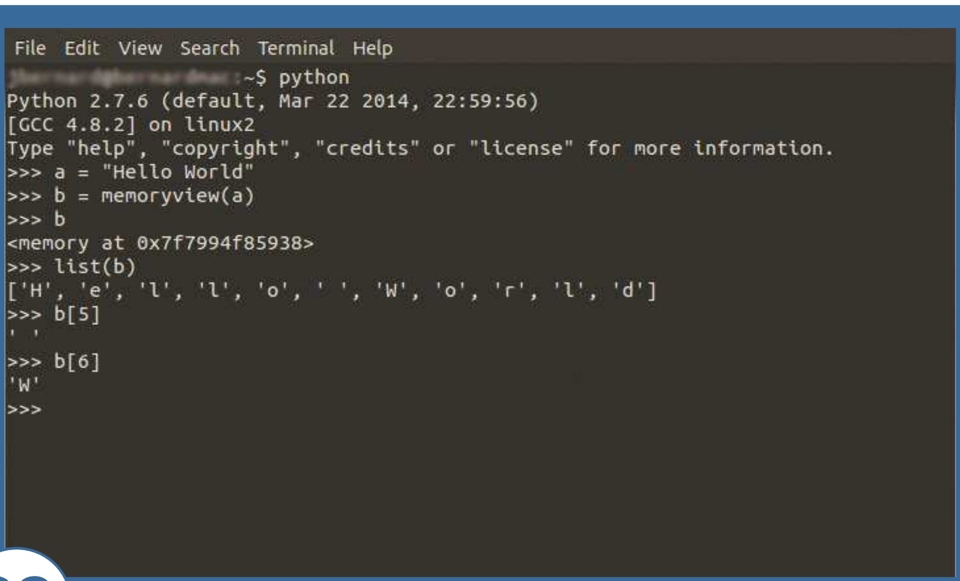
31 With modules

The 'with' command provides the ability to wrap a code block with methods defined by a context manager. This can help clean up code and make it easier to read what a given piece of code is supposed to be doing months later. A classic example of using 'with' is when dealing with files. You could use something like 'with open("myfile.txt", "r") as f:'. This will open the file and prepare it for reading. You can then read the file in the code block with 'data=f.read()'. The best part of doing this is that the file will automatically be closed when the code block is exited, regardless of the reason. So, even if the code block throws an exception, you don't need to worry about closing the file as part of your exception handler. If you have a more complicated 'with' example, you can create a context manager class to help out.

32 Printing

The most direct way of getting output to the user is with the print command. This will send text out to the console window. If you are using version 2.X of Python, there are a couple of ways you can use the print command. The most common way had been simply call it as 'print "Some text"'. You can also use print with the same syntax that you would use for any other function. So, the above example would look like 'print("Some text")'. This is the only form available in version 3.X. If you use the function syntax, you can add extra parameters that give you finer control over this output. For example, you can give the parameter 'file=myfile.txt' and get the output from the print command being dumped into the given text file. It also will accept any object that has some string representation available.

"A classic example of using 'with' is when dealing with files. The best part of doing this is that the file will automatically be closed when the code block is exited, regardless of the reason"



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> a = "Hello World"
>>> b = memoryview(a)
>>> b
<memory at 0x7f7994f85938>
>>> list(b)
['H', 'e', 'l', 'l', 'o', ' ', 'W', 'o', 'r', 'l', 'd']
>>> b[5]
' '
>>> b[6]
'W'
>>>
```

33 Memoryview

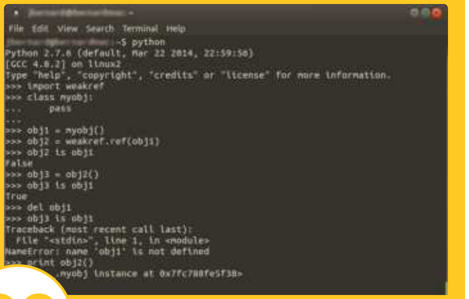
Sometimes, you need to access the raw data of some object, usually as a buffer of bytes. You can copy this data and put it into a bytearray, for example. But this means that you will be using extra memory, and this might not be an option for large objects. The command 'memoryview(object_name)' wraps the object handed in to the command and provides an interface to the raw bytes. It gives access to these bytes an element at a time. In many cases, elements are the size of one byte. But, depending on the object details, you could end up with elements that are larger than that. You can find out the size of an element in bytes with the property 'itemsize'. Once you have your memory view created, you can access the individual elements as you would get elements from a list (mem_view[1], for example).

34 Files

When dealing with files, you need to create a file object to interact with it. The file command takes a string with the file name and location and creates a file object instance. You can then call the file object methods like ‘open’, ‘read’ and ‘close’, to get data out of the file. If you are doing file processing, you can also use the ‘readline’ method. When opening a file, there is an explicit ‘open()’ command to simplify the process. It takes a string with the file name, and an optional parameter that is a string which defines the mode. The default is to open the file as read-only (‘r’). You can also open it for writing (‘w’) and appending (‘a’). After opening the file, a file object is returned so that you can further interact with it. You can then read it, write to it, and finally close it.

35 Yielding

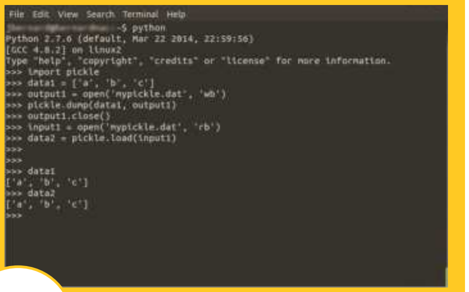
In many cases, a function may need to yield the context of execution to some other function. This is the case with generators. The preferred method for a generator is that it will only calculate the next value when it is requested through the method ‘next()’. The command ‘yield’ saves the current state of the generator function, and return execution control to the calling function. In this way, the saved state of the generator is reloaded and the generator picks up where it left off in order to calculate the next requested value. In this way, you only need to have enough memory available to store the bare minimum to calculate the next needed value, rather than having to store all of the possible values in memory all at once.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> import weakref
>>> class myobj:
...     pass
...
>>> obj1 = myobj()
>>> obj2 = weakref.ref(obj1)
>>> obj2 is obj1
False
>>> obj3 = obj2()
>>> obj3 is obj1
True
>>> del obj1
>>> obj3 is obj1
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'obj1' is not defined
>>> print obj2()
<__main__.myobj instance at 0x7fc788fe5f38>
```

36 Weak references

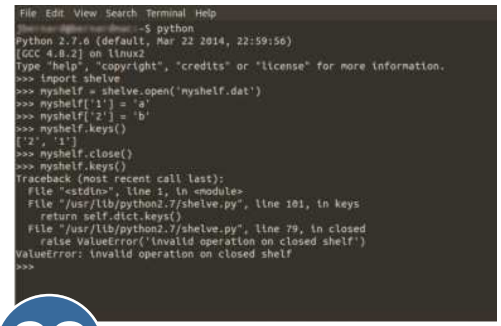
You sometimes need to have a reference to an object, but still be able to destroy it if needed. A weak reference is one which can be ignored by the garbage collector. If the only references left to n object are weak references, then the garbage collector is allowed to destroy that object and reclaim the space for other uses. This is useful in cases where you have caches or mappings of large datasets that don’t necessarily have to stay in memory. If an object that is weakly referenced ends up being destroyed and you try to access it, it will appear as a None. You can test for this condition and then reload the data if you decide that this is a necessary step.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> import pickle
>>> data1 = ['a', 'b', 'c']
>>> output1 = open('mypickle.dat', 'wb')
>>> pickle.dump(data1, output1)
>>> output1.close()
>>> input1 = open('mypickle.dat', 'rb')
>>> data2 = pickle.load(input1)
>>>
>>>
>>> data1
['a', 'b', 'c']
>>> data2
['a', 'b', 'c']
>>>
```

37 Pickling data

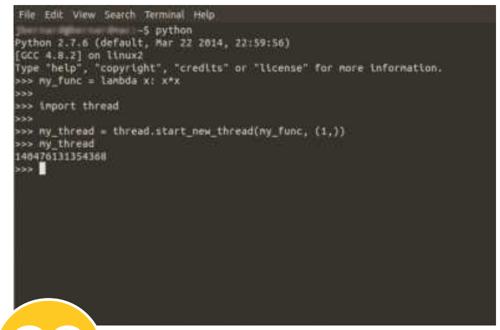
There are a few different ways of serialising memory when you need to checkpoint results to disk. One of these is called pickling. Pickle is actually a complete module, not just a single command. To store data on to the hard drive, you can use the dump method to write the data out. When you want to reload the same data at some other point in the future, you can use the load method to read the data in and unpickle it. One issue with pickle is its speed, or lack of it. There is a second module, cPickle, that provides the same basic functionality. But, since it is written in C, it can be as much as 1000 times faster. One thing to be aware of is that pickle does not store any class information for an object, but only its instance information. This means that when you unpickle the object, it may have different methods and attributes if the class definition has changed in the interim.



```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> import shelve
>>> myshelf = shelve.open('myshelf.dat')
>>> myshelf['1'] = 'a'
>>> myshelf['2'] = 'b'
>>> myshelf.keys()
['2', '1']
>>> myshelf.close()
>>> myshelf.keys()
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "/usr/lib/python2.7/shelve.py", line 101, in keys
    return self.dict.keys()
  File "/usr/lib/python2.7/shelve.py", line 79, in closed
    raise ValueError('invalid operation on closed shelf')
ValueError: invalid operation on closed shelf
>>>
```

38 Shelving data

While pickling allows you save data and reload it, sometimes you need more structured object permanence in your Python session. With the shelve module, you can create an object store where essentially anything that can be pickled can be stored there. The backend of the storage on the drive can be handled by one of several systems, such as dbm or gdbm. Once you have opened a shelf, you can read and write to it using key value pairs. When you are done, you need to be sure to explicitly close the shelf so that it is synchronised with the file storage. Because of the way the data may be stored in the backing database, it is best to not open the relevant files outside of the shelve module in Python. You can also open the shelf with writeback set to True. If so, you can explicitly call the sync method to write out cached changes.



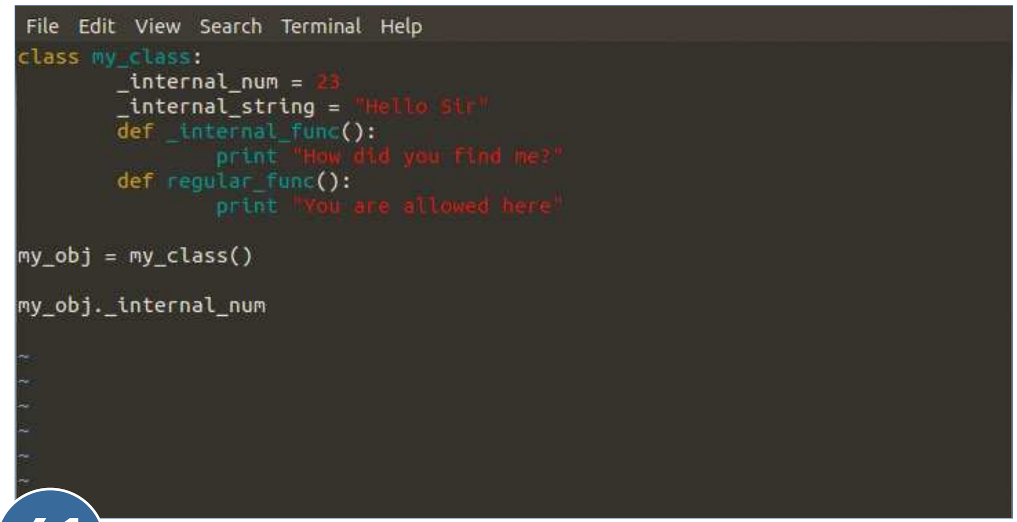
```
File  Edit  View  Search  Terminal  Help
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> my_func = lambda x: x*x
>>>
>>> import thread
>>>
>>> my_thread = thread.start_new_thread(my_func, (1,))
>>> my_thread
140476131354368
>>> █
```

39 Threads

You can do multiple threads of execution within Python. The ‘thread()’ command can create a new thread of execution for you. It follows the same techniques as those for POSIX threads. When you first create a thread, you need to hand in a function name, along with whatever parameters said function needs. One thing to keep in mind is that these threads behave just like POSIX threads. This means that almost everything is the responsibility of the programmer. You need to handle mutex locks (with the methods ‘acquire’ and ‘release’), as well as create the original mutexes with the method ‘allocate_lock’. When you are done, you need to ‘exit’ the thread to ensure that it is properly cleaned up and no resources get left behind. You also have fine-grained control over the threads, being able to set things like the stack size for new threads.

40 Inputting data

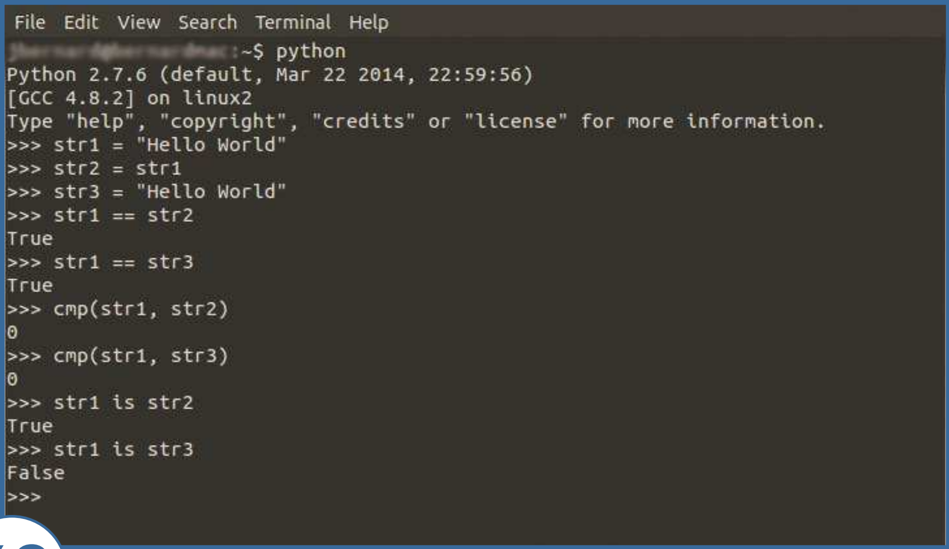
Sometimes, you need to collect input from an end user. The command 'input()' can take a prompt string to display to the user, and then wait for the user to type a response. Once the user is done typing and hits the enter key, the text is returned to your program. If the readline module was loaded before calling input, then you will have enhanced line editing and history functionality. This command passes the text through eval first, and so may cause uncaught errors. If you have any doubts, you can use the command 'raw_input()' to skip this problem. This command simply returns the unchanged string inputted by the user. Again, you can use the readline module to get enhanced line editing.



```
class my_class:
        _internal_num = 23
        _internal_string = "Hello Sir"
        def _internal_func():
                print "How did you find me?"
        def regular_func():
                print "You are allowed here"

my_obj = my_class()

my_obj._internal_num

~
~
~
~
~
~
```

41 Internal variables

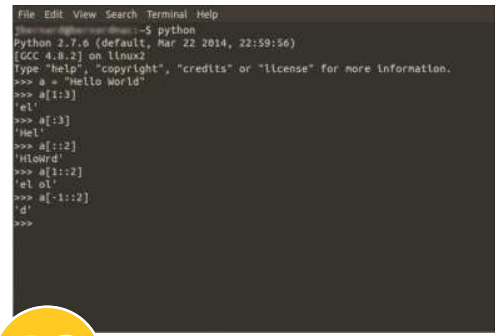
For people coming from other programming languages, there is a concept of having certain variables or methods be only available internally within an object. In Python, there is no such concept. All elements of an object are accessible. There is a style rule, however, that can mimic this type of behaviour. Any names that start with an underscore are expected to be treated as if they were internal names and to be kept as private to the object. They are not hidden, however, and there is no explicit protection for these variables or methods. It is up to the programmer to honour the intention from the author the class and not alter any of these internal names. You are free to make these types of changes if it becomes necessary, though.



```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> str1 = "Hello World"
>>> str2 = str1
>>> str3 = "Hello World"
>>> str1 == str2
True
>>> str1 == str3
True
>>> cmp(str1, str2)
0
>>> cmp(str1, str3)
0
>>> str1 is str2
True
>>> str1 is str3
False
>>>
```

42 Comparing objects

There are several ways to compare objects within Python, with several caveats. The first is that you can test two things between objects: equality and identity. If you are testing identity, you are testing to see if two names actually refer to the same instance object. This can be done with the command 'cmp(obj1, obj2)'. You can also test this condition by using the 'is' keyword. For example, 'obj1 is obj2'. If you are testing for equality, you are testing to see whether the values in the objects referred to by the two names are equal. This test is handled by the operator '==', as in 'obj1 == obj2'. Testing for equality can become complex for more complicated objects.

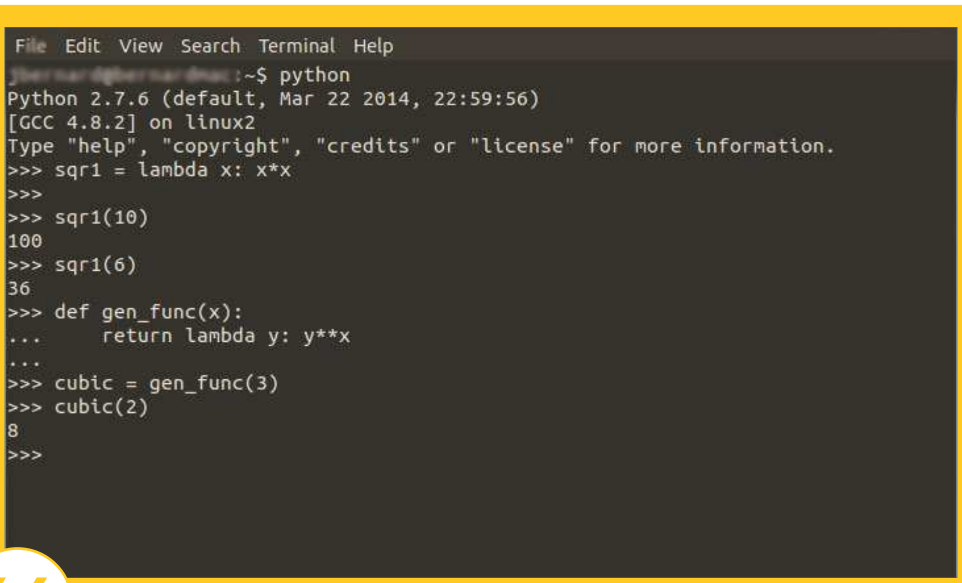


```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> a = "Hello World"
>>> a[1:3]
'el'
>>> a[:3]
'Hel'
>>> a[::2]
'HloWrd'
>>> a[1::2]
'el ol'
>>> a[-1::2]
'd'
>>>
```

43 Slices

While not truly a command, slices are too important a concept not to mention in this list of essential commands. Indexing elements in data structures, like lists, is one of the most common things done in Python. You can select a single element by giving a single index value. More interestingly, you can select a range of elements by giving a start index and an end index, separated by a colon. This gets returned as a new list that you can save in a new variable name. You can even change the step size, allowing you to skip some number of elements. So, you could grab every odd element from the list 'a' with the slice 'a[1::2]'. This starts at index 1, continues until the end, and steps through the index values 2 at a time. Slices can be given negative index values. If you do, then they start from the end of the list and count backwards.

“Python is an interpreted language, which means that the source code that you write needs to be compiled into a byte code format. This byte code then gets fed into the actual Python engine”



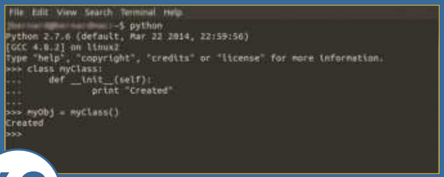
```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> sqr1 = lambda x: x*x
>>>
>>> sqr1(10)
100
>>> sqr1(6)
36
>>> def gen_func(x):
...     return lambda y: y**x
...
>>> cubic = gen_func(3)
>>> cubic(2)
8
>>>
```

44 Lambda expressions

Since objects, and the names that point to them, are truly different things, you can have objects that have no references to them. One example of this is the lambda expression. With this, you can create an anonymous function. This allows you use functional programming techniques within Python. The format is the keyword ‘lambda’, followed by a parameter list, then a colon and the function code. For example, you could build your own function to square a number with ‘lambda x: x*x’. You can then have a function that can programmatically create new functions and return them to the calling code. With this capability, you can create function generators to have self-modifying programs. The only limitation is that they are limited to a single expression, so you can’t generate very complex functions.

45 Compiling code objects

Python is an interpreted language, which means that the source code that you write needs to be compiled into a byte code format. This byte code then gets fed into the actual Python engine to step through the instructions. Within your program, you may have the need to take control over the process of converting code to byte code and running the results. Maybe you wish to build your own REPL. The command ‘compile()’ takes a string object that contains a collection of Python code, and returns an object that represents a byte code translation of this code. This new object can then be handed in to either ‘eval()’ or ‘exec()’ to be actually run. You can use the parameter ‘mode=’ to tell compile what kind of code is being compiled. The ‘single’ mode is a single statement, ‘eval’ is a single expression and ‘exec’ is a whole code block.



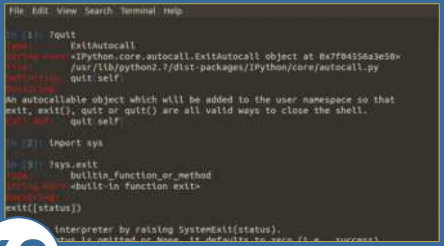
```
[redacted]:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> class myClass:
...     def __init__(self):
...             print "Created"
...
>>> myObj = myClass()
Created
>>>
```

46 __init__ method

When you create a new class, you can include a private initialisation method that gets called when a new instance of the class is created. This method is useful when the new object instance needs some data loaded in the new object.

47 __del__ method

When an instance object is about to be destroyed, the __del__ method is called. This gives you the chance to do any kind of cleanup that may be required. This might be closing files, or disconnecting network connections. After this code is completed, the object is finally destroyed and resources are freed.



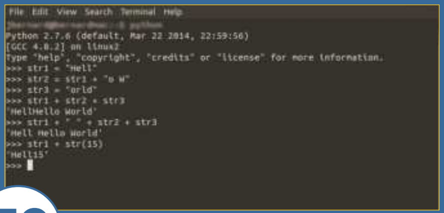
```
In [1]: ?quit
            ExitAutocall
            <IPython.core.autocall.ExitAutocall object at 0x7f04556a3e50>
            /usr/lib/python2.7/dist-packages/IPython/core/autocall.py
            quit self

An autocallable object which will be added to the user namespace so that
exit, exit(), quit or quit() are all valid ways to close the shell.
            quit self

In [2]: import sys

In [3]: ?sys.exit
            builtin_function_or_method
            <built-in function exit>

exit([status])

     interpreter by raising SystemExit(status).
```

48 Exiting your program

There are two pseudo-commands available to exit from the Python interpreter: ‘exit()’ and quit()’. They both take an optional parameter which sets the exit code for the process. If you want to exit from a script, you are better off using the exit function from the sys module (‘sys.exit(exit_code)’.

49 Return values

Functions may need to return some value to the calling function. Because essentially no name has a type, this includes functions. So functions can use the ‘return’ command to return any object to the caller.



```
[redacted]
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> str1 = "Hell"
>>> str2 = str1 + "o W"
>>> str3 = "orld"
>>> str1 + str2 + str3
'HellHello World'
>>> str1 + " " + str2 + str3
'Hell Hello World'
>>> str1 + str(15)
'Hell15'
>>> 
```

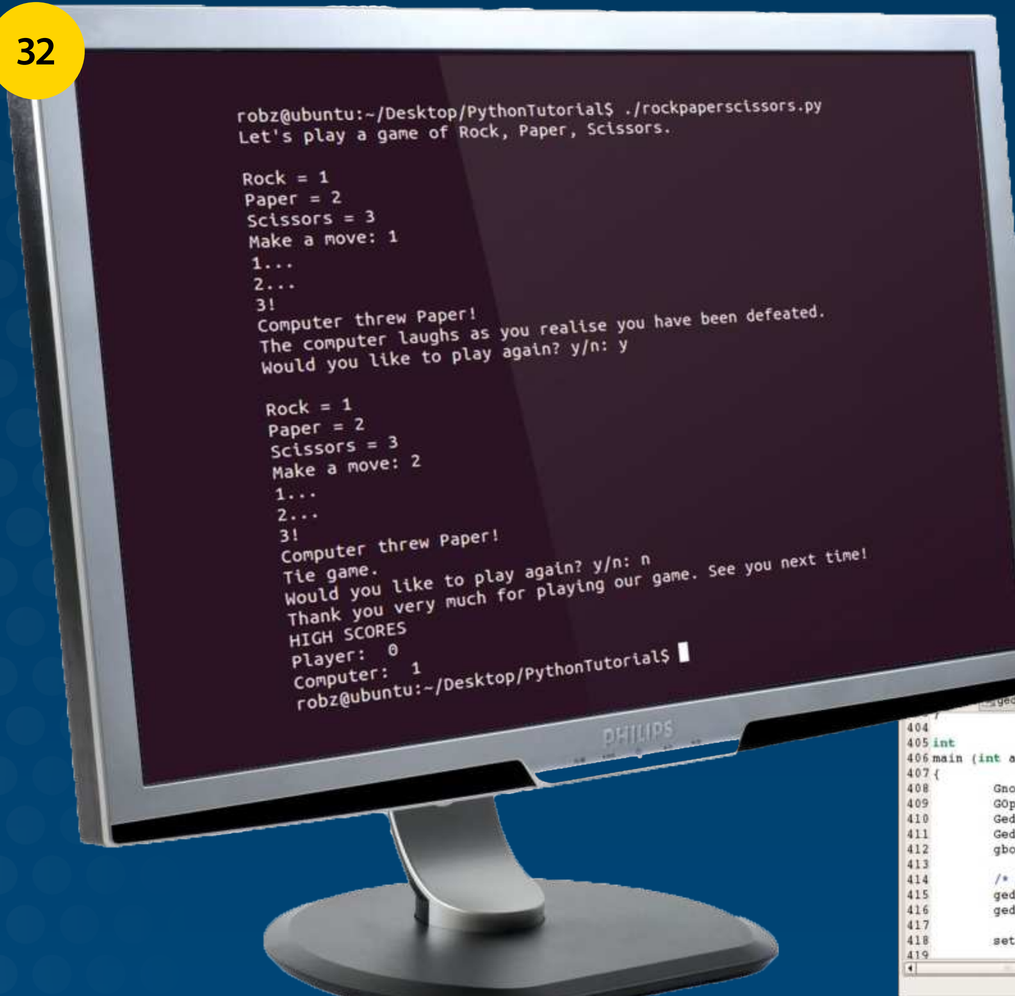
50 String concatenation

We will finish with what most lists start with – string concatenation. The easiest way to build up strings is to use the ‘+’ operator. If you want to include other items, like numbers, you can use the ‘str()’ casting function to convert it to a string object.

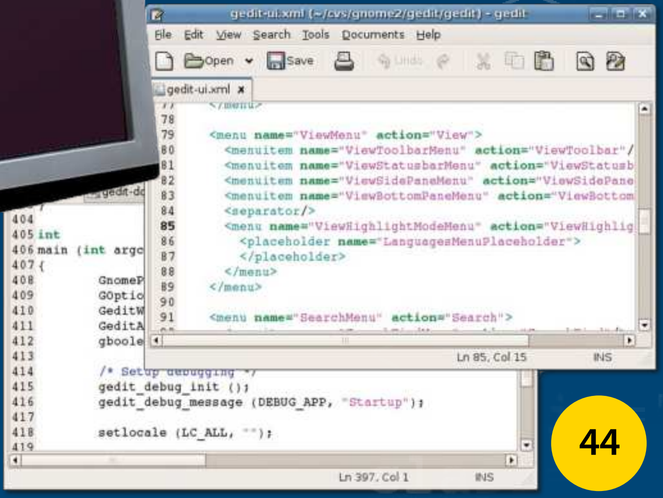
Python Essentials

"Python is one of the most popular programming languages"

32



```
robz@ubuntu:~/Desktop/PythonTutorials$ ./rockpaperscissors.py
Let's play a game of Rock, Paper, Scissors.

Rock = 1
Paper = 2
Scissors = 3
Make a move: 1
1...
2...
3!
Computer threw Paper!
The computer laughs as you realise you have been defeated.
Would you like to play again? y/n: y

Rock = 1
Paper = 2
Scissors = 3
Make a move: 2
1...
2...
3!
Computer threw Paper!
Tie game.
Would you like to play again? y/n: n
Thank you very much for playing our game. See you next time!
HIGH SCORES
Player:  0
Computer:  1
robz@ubuntu:~/Desktop/PythonTutorials$
```



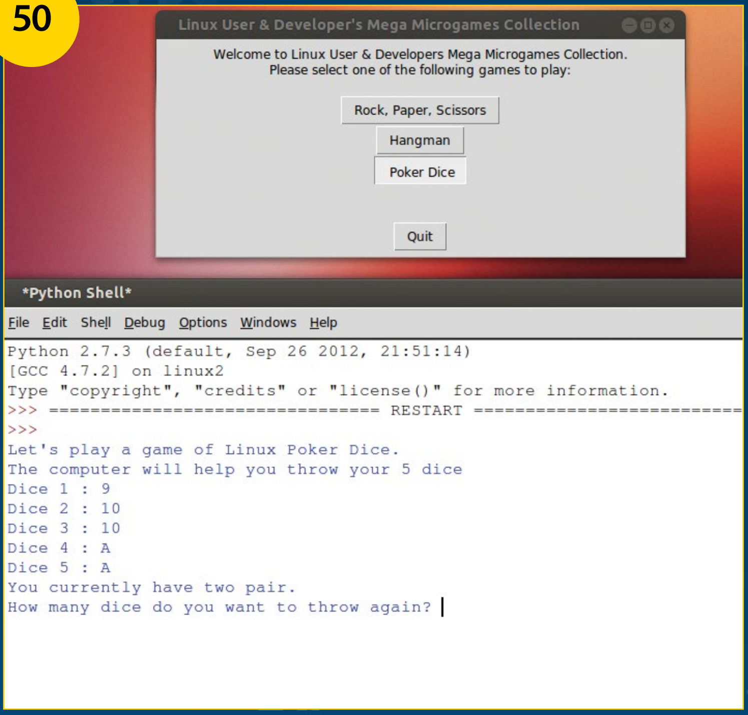
gedit-ui.xml (~/cvs/gnome2/gedit/gedit) - gedit
File Edit View Search Tools Documents Help
Open Save Undo
gedit-ui.xml

```
  <menu name="ViewMenu" action="View">
    <menuitem name="ViewToolbarMenu" action="ViewToolbar"/
    <menuitem name="ViewStatusbarMenu" action="ViewStatusb
    <menuitem name="ViewSidePaneMenu" action="ViewSidePane
    <menuitem name="ViewBottomPaneMenu" action="ViewBottom
    <separator/>
    <menu name="ViewHighlightModeMenu" action="ViewHighlig
      <placeholder name="LanguagesMenuPlaceholder">
      </placeholder>
    </menu>
  </menu>

  <menu name="SearchMenu" action="Search">
```

```
int
main (int argc
{
        GnomeP
        GOptio
        GeditW
        GeditA
        gboole

        /* Setup debugging */
        gedit_debug_init ();
        gedit_debug_message (DEBUG_APP, "Startup");

        setlocale (LC_ALL, "");
```

44

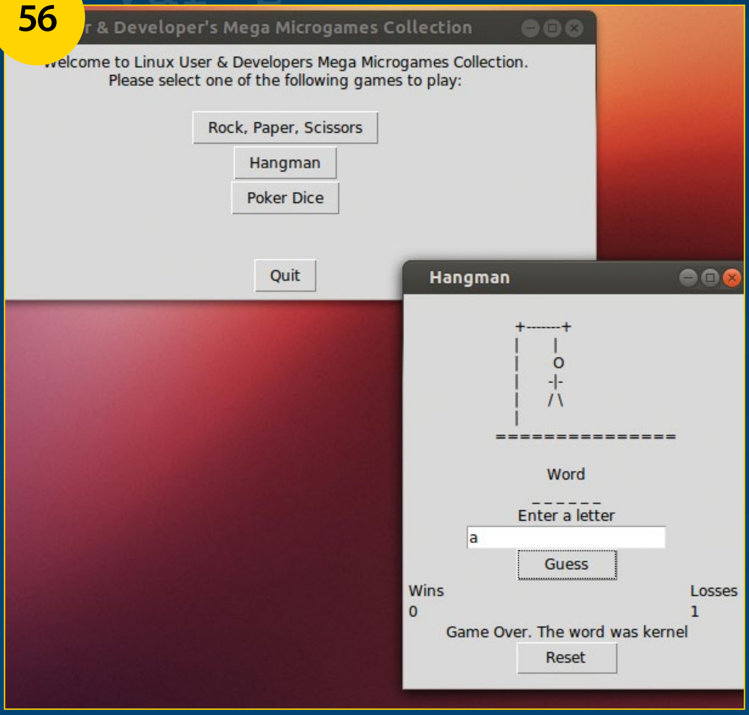
50


Linux User & Developer's Mega Microgames Collection
Rock, Paper, Scissors
Hangman
Poker Dice
Quit
Python Shell
File Edit Shell Debug Options Windows Help

Welcome to Linux User & Developers Mega Microgames Collection.
Please select one of the following games to play:

```
Python 2.7.3 (default, Sep 26 2012, 21:51:14)
[GCC 4.7.2] on linux2
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ==========================
>>>
Let's play a game of Linux Poker Dice.
The computer will help you throw your 5 dice
Dice 1 : 9
Dice 2 : 10
Dice 3 : 10
Dice 4 : A
Dice 5 : A
You currently have two pair.
How many dice do you want to throw again?
```

56



welcome to Linux User & Developers Mega Microgames Collection.
Please select one of the following games to play:

```
 +-------+
 |       |
 |       O
 |      -|-
 |      / \
 |
===============
```

Word

_ _ _ _ _ _

Enter a letter

a

Wins 0

Losses 1

Game Over. The word was kernel

50 Python tips

Python is a programming language that lets you work more quickly and integrate your systems more effectively. Today, Python is one of the most popular programming languages in the open source space. Look around and you will find it running everywhere, from various configuration tools to XML parsing. Here is the collection of 50 gems to make your Python experience worthwhile…

Basics

01 Running Python scripts

On most of the UNIX systems, you can run Python scripts from the command line.

```
$ python mypyprog.py
```

02 Running Python programs from Python interpreter

The Python interactive interpreter makes it easy to try your first steps in programming and using all Python commands. You just issue each command at the command prompt (>>>), one by one, and the answer is immediate.

Python interpreter can be started by issuing the command:

```
$ python
user@ubuntu:~$ python
Python 3.10.4 (main, Apr 2 2022,
09:04:19)
[GCC 11.2.0] on linux
Type "help", "copyright", "credits"
or "license" for more information.
>>> <type commands here>
```

In this article, all the code starting at the >>> symbol is meant to be given at the Python prompt. It is also important to remember that Python takes tabs very seriously – so if you are receiving any error that mentions tabs, correct the tab spacing.

03 Dynamic typing

In Java, C++, and other statically typed languages, you must specify the data type of the function return value and each function argument. Python is a dynamically typed language, you never have to explicitly specify the data type of anything. Based on what value you assign, Python will keep track of the data type internally.

04 Python statements

Python uses carriage returns to separate statements, and a colon and indentation to separate code blocks. Most of the compiled programming languages, such as C and C++, use semicolons to separate statements and curly brackets to separate code blocks.

05 == and = operators

Python uses '==' for comparison and '=' for assignment. Python does not support inline assignment, so there's no chance of accidentally assigning the value when you actually want to compare it.

06 Concatenating strings

You can use '+' to concatenate strings.

```
>>> print('py'+'thon')
python
```

07 The __init__ method

The __init__ method is run as soon as an object of a class is instantiated. The method is useful to do any initialization you want to do with your object. The __init__ method is analogous to a constructor in C++, C# or Java.

Example:

```
class Person:
   def __init__(self, name):
      self.name = name
   def sayHi(self):
     print('Hello, my name is', self.
name)
p = Person('Inego')
p.sayHi()
```

Output:

```
[~/src/python $:] python initmethod.py
Hello, my name is Inego
```

08 Modules

To keep your programs manageable as they grow in size, you may want to break them up into several files. Python allows you to put multiple function definitions into a file and use them as a module that can be imported into other scripts and programs. These files must have a .py extension.

Example:

```
# file my_function.py
def minmax(a,b):
 if a <= b:
 min, max = a, b
 else:
 min, max = b, a
 return min, max
Module Usage
import my_function
x,y = my_function.minmax(25, 6.3)
```

09 Module defined names

Example:

The built-in function 'dir()' can be used to find out which names a module defines. It returns a sorted list of strings.

```
>>> import time
>>> dir(time)
['__doc__', '__file__', '__name__',
'__package__', 'accept2dyear',
'altzone', 'asctime', 'clock',
'ctime', 'daylight', 'gmtime',
'localtime', 'mktime', 'sleep',
'strftime', 'strptime', 'struct_
time', 'time', 'timezone', 'tzname',
'tzset']
```

10 Module internal documentation

You can see the internal documentation (if available) of a module name by looking at .__doc__.

Example:

```
>>> import time
>>> print(time.clock.__doc__)
clock() -> floating point number
```

This example returns the CPU time or real time since the start of the process or since the first call to clock(). This has as much precision as the system records.

11 Passing arguments to a Python script

Python lets you access whatever you have passed to a script while calling it. The 'command line' content is stored in the sys.argv list.

```
import sys
print(sys.argv)
```

12 Loading modules or commands at startup

You can load predefined modules or commands at the startup of any Python script by using the environment variable $PYTHONSTARTUP. You can set environment variable $PYTHONSTARTUP to a file which contains the instructions load necessary modules or commands .

13 Converting a string to date object

You can use the function 'DateTime' to convert a string to a date object.

Example:

```
from DateTime import DateTime
dateobj = DateTime(string)
```

14 Converting a list to a string for display

You can convert a list to string in either of the following ways.

1st method:

```
>>> mylist = ['spam', 'ham', 'eggs']
>>> print(', '.join(mylist))
spam, ham, eggs
```

2nd method:

```
>>> print('\n'.join(mylist))
spam
ham
eggs
```

15 Tab completion in Python interpreter

You can achieve auto completion inside Python interpreter by adding these lines to your .pythonrc file (or your file for Python to read on startup):

```
import rlcompleter, readline
readline.parse_and_bind('tab: complete')
```

This will make Python complete partially typed function, method and variable names when you press the Tab key.

16 Python documentation tool

You can pop up a graphical interface for searching the Python documentation using the command:

```
$ pydoc -g
```

You will need python-tk package for this to work.

17 Python documentation server

You can start an HTTP server on the given port on the local machine. This will give you a nice-looking access to all Python documentation, including third-party module documentation.

```
$ pydoc -p <portNumber>
```

18 Python development software

There are plenty of tools to help with Python development. Here are a few important ones:

IDLE: The Python built-in IDE, with autocompletion, function signature popup help, and file editing.

IPython: Another enhanced Python shell with tab-completion and other features.

Eric3: A GUI Python IDE with autocompletion, class browser, built-in shell and debugger.

WingIDE: Commercial Python IDE with free licence available to open-source developers everywhere.

»

Built-in modules

19 Executing functions at the time of Python interpreter termination

You can use 'atexit' module to execute functions at the time of Python interpreter termination.

Example:

```
def sum():
        print(4+5)
def message():
        print("Executing Now")
import atexit
atexit.register(sum)
atexit.register(message)
```

Output:

```
Executing Now
9
```

20 Converting from integer to binary, hexadecimal and octal

Use bin(), hex() and oct() to convert from integer to binary, decimal and octal format respectively.

Example:

```
>>> bin(24)
'0b11000'
>>> hex(24)
'0x18'
>>> oct(24)
'030'
```

21 Converting any charset to UTF-8

You can use the following function to convert any charset to UTF-8.

```
data.decode("input_charset_here").
encode('utf-8')
```

22 Removing duplicates from lists

If you want to remove duplicates from a list, just put every element into a dict as a key (for example with 'none' as value) and then check dict.keys().

```
from operator import setitem
def distinct(l):
    d = {}
    map(setitem, (d,)*len(l), l, [])
    return d.keys()
```

23 Do-while loops

Since Python has no do-while or do-until loop constructs (yet), you can use the following method to achieve similar results:

```
while True:
    do_something()
    if condition():
        break
```

24 Detecting system platform

To execute platform-specific functions, it is very useful to detect the platform on which the Python interpreter is running. You can use 'sys.platform' to find out the current platform.

Example:

On Ubuntu Linux

```
>>> import sys
>>> sys.platform
'linux2'
```

On Mac OS X Snow Leopard

```
>>> import sys
>>> sys.platform
'darwin'
```

25 Disabling and enabling garbage collection

Sometimes you may want to enable or disable the garbage collector at runtime. You can use the 'gc' module to enable or disable the garbage collection.

Example:

```
>>> import gc
>>> gc.enable
<built-in function enable>
>>> gc.disable
<built-in function disable>
```

26 Using C-based modules for better performance

Many Python modules ship with counterpart C modules. Using these C modules will give a significant performance boost in complex applications.

Example:

```
cPickle instead of Pickle, cStringIO
instead of StringIO .
```

27 Calculating maximum, minimum and sum out of any list or iterable

You can use the following built-in functions.

max: Returns the largest element in the list.

min: Returns the smallest element in the list.

sum: This function returns the sum of all elements in the list. It accepts an optional second argument: the value to start with when summing (defaults to 0).

28 Representing fractional numbers

Fraction instance can be created using the following constructor:

```
Fraction([numerator [,denominator]])
```

29 Performing math operations

These work on integer and float numbers, except complex numbers. For complex numbers, a separate module is used, called 'cmath'.

For example:

```
import math
math.acos(x): Return arc cosine of x.
math.cos(x): Returns cosine of x.
math.factorial(x) : Returns x
factorial.
```

30 Working with arrays

The 'array' module provides an efficient way to use arrays in your programs. The 'array' module defines the following type:

```
array(typecode [, initializer])
```

Once you have created an array object, say myarray, you can apply a bunch of methods to it. Here are a few important ones:

```
myarray.count(x): Returns the number
of occurrences of x in a.
myarray.extend(x): Appends x at the
end of the array.
myarray.reverse(): Reverse the order
of the array.
```

31 Sorting items

The following functions order lists.

```
import bisect
bisect.insort(list, item [, low [,
high]])
```

Inserts item into list in sorted order. If item is already in the list, the new entry is inserted to the right of any existing entries.

```
bisect.insort_left(list, item [, low
[, high]])
```

Inserts item into list in sorted order. If item is already in the list, the new entry is inserted to the left of any existing entries.

32 Using regular expression-based search

You can use the function 're.search()' with a regexp-based expression. Check out the example below.

Example:

```
>>> import re
>>> s = "Kunal is a bad boy"
>>> if re.search("K", s): print
"Match!" # char literal
...
Match!
>>> if re.search("[@A-Z]", s): print
"Match!" # char class
... # match either at-sign or capital
letter
Match!
>>> if re.search("\d", s): print
"Match!" # digits class
...
```

33 Working with bzip2 (.bz2) compression format

You can use the module 'bz2' to read and write data using the bzip2 compression algorithm.

```
bz2.compress() :  For bz2
compression
bz2.decompress() : For bz2
decompression
```

Example:

```
# File: bz2-example.py
import bz2
MESSAGE = "Kunal is a bad boy"
compressed_message = bz2.
compress(MESSAGE)
decompressed_message = bz2.
decompress(compressed_message)
print "original:", repr(MESSAGE)
print "compressed message:",
repr(compressed_message)
print "decompressed message:",
repr(decompressed_message)
```

Output:

```
[~/src/python $:] python bz2-
example.py
original: 'Kunal is a bad boy'
compressed message: 'BZh91AY&SY\xc4\
x0fG\x98\x00\x00\x02\x15\x80@\x00\
x00\x084%\x8a  \x00"\x00\x0c\x84\r\
x03C\xa2\xb0\xd6s\xa5\xb3\x19\x00\
xf8\xbb\x92)\xc2\x84\x86 z<\xc0'
decompressed message: 'Kunal is a
bad boy'
```

34 Using SQLite database with Python

SQLite is fast becoming a very popular embedded database because of its zero configuration needed, and superior levels of performance. You can use the module 'sqlite3' in order to work with SQLite databases.

Example:

```
>>> import sqlite3
>>> connection = sqlite.connect('test.
db')
>>> curs = connection.cursor()
>>> curs.execute('''create table item
... (id integer primary key, itemno
text unique,
... scancode text, descr text, price
real)''')
<sqlite3.Cursor object at 0x1004a2b30>
```

35 Working with zip files

You can use the module 'zipfile' to work with zip files.

```
zipfile.ZipFile(filename [, mode [,
compression [,allowZip64]]])
```

Open a zip file, where the file can be either a path to a file (a string) or a file-like object.

```
zipfile.close()¶
```

Close the archive file. You must call 'close()' before exiting your program or essential records will not be written.

```
zipfile.extract(member[, path[,
pwd]])
```

Extract a member from the archive to the current working directory; 'member' must be its full name (or a zipinfo object). 'path' specifies a different directory to extract to. 'member' can be a filename or a zipinfo object. 'pwd' is the password used for encrypted files.

36 Using UNIX-style wildcards to search for filenames

You can use the module 'glob' to find all the pathnames matching a pattern according to the rules used by the UNIX shell. *, ?, and character ranges expressed with [] will be matched.

Example:

```
>>> import glob
>>> glob.glob('./[0-9].*')
['./1.gif', './2.txt']
>>> glob.glob('*.gif')
['1.gif', 'card.gif']
>>> glob.glob('?.gif')
['1.gif']
```

37 Performing basic file operations (copy, delete and rename)

You can use the module 'shutil' to perform basic file operation at a high level. This module works with your regular files and so will not work with special files like named pipes, block devices, and so on.

```
shutil.copy(src,dst)
```

Copies the file src to the file or directory dst.

```
shutil.copymode(src,dst)
```

Copies the file permissions from src to dst.

```
shutil.move(src,dst)
```

Moves a file or directory to dst.

```
shutil.copytree(src, dst, symlinks
[,ignore]])
```

Recursively copy an entire directory at src.

```
shutil.rmtree(path [, ignore_errors
[, onerror]])
```

Deletes an entire directory.

38 Executing UNIX commands from Python

This is not available in Python 3 – instead you need to use the module 'subprocess'.

Example:

```
>>> import commands
>>> commands.getoutput('ls')
'bz2-example.py\ntest.py'
```

39 Reading environment variables

You can use the module 'os' to gather operating-system-specific information:

Example:

```
>>> import os
>>> os.path <module 'posixpath'
from '/usr/lib/python2.6/posixpath.
pyc'>>>> os.environ {'LANG': 'en_
IN', 'TERM': 'xterm-color', 'SHELL':
'/bin/bash', 'LESSCLOSE':
'/usr/bin/lesspipe %s %s',
'XDG_SESSION_COOKIE':
'925c4644597c791c704656354adf56d6-
1257673132.347986-1177792325',
'SHLVL': '1', 'SSH_TTY': '/dev/
pts/2', 'PWD': '/home/kunal',
'LESSOPEN': '| /usr/bin
lesspipe
......}
>>> os.name
'posix'
>>> os.linesep
'\n'
```

»

40 Sending email

You can use the module 'smtplib' to send email using an SMTP (Simple Mail Transfer Protocol) client interface.

```
smtplib.SMTP([host [, port]])
```

Example (send an email using Google Mail SMTP server):

```
import smtplib
# Use your own to and from email
address
fromaddr = 'from@gmail.com'
toaddrs  = 'to@gmail.com'
msg = 'I am a Python geek. Here is
the proof.!'
# Credentials
# Use your own credentials and
enable 'less secure apps' in Gmail
username = 'from@gmail.com'
password = 'xxxxxxxx'
# The actual mail send
server = smtplib.SMTP('smtp.gmail.
com:587')
# Google Mail uses secure
connection for SMTP connections
server.starttls()
server.login(username,password)
server.sendmail(fromaddr, toaddrs,
msg)
server.quit()
```

41 Accessing FTP server

'ftplib' is a fully fledged client FTP module for Python. To establish an FTP connection, you can use the following function:

```
ftplib.FTP([host [, user [, passwd
[, acct [, timeout]]]]])
```

Example:

```
host = "ftp.redhat.com"
username = "anonymous"
password = "kunaldeo@gmail.com"
import ftplib
import urllib2
ftp_serv = ftplib.
FTP(host,username,password)
# Download the file
u = urllib2.urlopen ("ftp://
ftp.redhat.com/pub/redhat/linux/
README")
# Print the file contents
print (u.read())
```

Output:

```
$ python ftpclient.py
```

Older versions of Red Hat Linux have been moved ftp://archive.download.redhat.com/pub/redhat/linux/

42 Launching a webpage with the default web browser

The 'webbrowser' module provides a convenient way to launch webpages using the default web browser.

Example (launch google.co.uk with system's default web browser):

```
>>> import webbrowser
>>> webbrowser.open('http://google.
co.uk')
True
```

43 Creating secure hashes

The 'hashlib' module supports a plethora of secure hash algorithms.

Example (create hex digest of the given text):

```
>>> import hashlib
# sha1 Digest
>>> hashlib.sha1("MI6 Classified
Information 007").hexdigest()
'e224b1543f229cc0cb935a1eb9593
18ba1b20c85'
# sha224 Digest
>>> hashlib.sha224("MI6 Classified
Information 007").hexdigest()
'3d01e2f741000b0224084482f905e9b7b97
7a59b480990ea8355e2c0'
# sha256 Digest
>>> hashlib.sha256("MI6 Classified
Information 007").hexdigest()
'2fdde5733f5d47b672fcb39725991c89
b2550707cbf4c6403e fdb33b1c19825e'
# sha384 Digest
>>> hashlib.sha384("MI6 Classified
Information 007").hexdigest()
'5c4914160f03dfbd19e14d3ec1e74bd8b99
dc192edc138aaf7682800982488daaf540be
9e0e50fc3d3a65c8b6353572d'
# sha512 Digest
>>> hashlib.sha512("MI6 Classified
Information 007").hexdigest()
'a704ac3dbef6e8234578482a31d5ad29d25
2c822d1f4973f49b850222edcc0a29bb89077
8aea807a0a48ee4ff8bb18566140667fbaf7
3a1dc1ff192febc713d2'
# MD5 Digest
>>> hashlib.md5("MI6 Classified
Information 007").hexdigest()
'8e2f1c52ac146f1a999a670c826f7126'
```

44 Seeding random numbers

You can use the module 'random' to generate a wide variety of random numbers. The most used one is 'random.seed([x])'. It initialises the basic random number generator. If x is omitted or None, current system time is used; current system time is also used to initialise the generator when the module is first imported.

45 Working with CSV (comma-separated values) files

CSV files are very popular for data exchange over the web. Using the module 'csv', you can read and write CSV files.

Example:

```
import csv
# write stocks data as comma-
separated values
writer = csv.writer(open('stocks.
csv', 'wb', buffering=0))
writer.writerows([
('GOOG', 'Google, Inc.', 505.24, 0.47,
0.09),
('YHOO', 'Yahoo! Inc.', 27.38, 0.33,
1.22),
('CNET', 'CNET Networks, Inc.', 8.62,
-0.13, -1.49)
])
# read stocks data, print status
messages
stocks = csv.reader(open('stocks.
csv', 'rb'))
status_labels = {-1: 'down', 0:
'unchanged', 1: 'up'}
for ticker, name, price, change, pct
in stocks:
    status = status_
labels[cmp(float(change), 0.0)]
    print('%s is %s (%s%%)' % (name,
status, pct))
```

46 Installing third-party modules using setup tools

'setuptools' is a Python package which lets you download, build, install, upgrade and uninstall packages very easily.

You can install third party modules using the Pip package manager. Use the command 'sudo apt install python3-pip' to install Pip and avail yourself of its voluminous repositories.

Third-party modules

Example (installing simplejson using setuptools):

```
$ pip install simplejson
Collecting simplejson
Downloading simplejson-3.17.6-cp310-
cp310-manylinux_2_5_x86_64.manylinux1_
x86_64.manylinux_2_12_x86_64.
manylinux_2010_x86_64.whl (137kB)
Installing collected packages:
simplejson
Successfully installed
simplejson-3.17.6
Processing dependencies for simplejson
Finished processing dependencies for
simplejson
```

47 Logging messages to the systemd journal

You can use the module ‘syslog’ to write to the system log. This is useful for noting progress, errors or anything else your program might do. The ‘syslog’ module acts as an interface to UNIX syslog library routines. Most distributions now use systemd’s journal for logging, and we use the ‘journalctl’ command to look at that. The -b and -e switches jump to the latest journal entries for the current boot.

Example:

```
import syslog
syslog.syslog(‘mygeekapp: started
logging’)
for a in [‘a’, ‘b’, ‘c’]:
  b = ‘mygeekapp: I found the letter
’ + a
  syslog.syslog(b)
syslog.syslog(‘mygeekapp: the script
goes to sleep now, bye,bye!’)
```

Output:

```
$ python mylog.py
$ journalctl -b -e
Nov  8 17:22:34 ubuntu python[31169]:
mygeekapp: started logging
Nov  8 17:22:34 ubuntu python[31169]:
mygeekapp: I found the letter a
Nov  8 17:22:34 ubuntu python[31169]:
mygeekapp: I found the letter b
Nov  8 17:22:34 ubuntu python[31169]:
mygeekapp: I found the letter c
Nov  8 17:22:34 ubuntu python[31169]:
mygeekapp: the script goes to sleep
now, bye,bye!
```

48 Converting HTML documents to PDF

‘PyPDF’ is a very popular module for PDF generation from Python. It can render a PDF from either a web page or an html string.

Perform the following steps to install pydf

```
$ sudo pip install python-pdf
```

For a successful installation, you should see a similar message:

```
Collecting python-pdf
  Downloading python_pdf-0.39-py36-none-
any.whl (16.8 MB)
Installing collected packages: python-
pdf
Successfully installed python-pdf-0.39
```

Example:

```
>>> import pydf
>>> pdf = pydf.generate_pdf(‘<h1>this is
an html string’)
# open file for writing in binary mode
>>> with open(‘test_doc.pdf’,‘wb’) as f:
# write out PDF
>>> f.write(pdf)
```

The ‘generate_pdf’ function can take a whole lot of optional arguments, covering everything from DPI and quality settings to margin sizes. See the documentation at https://pypi.org/project/python-pdf for more information.

Under the hood Pydf uses the wkhtmltopdf library to do the conversion. And if you want you can pass any of the more exotic options for that library to Pydf too. One problem with wkhtmltopdf is speed. It can only generate one document per process, so if you have lots of documents they are generated one by one, each in a separate process which takes time to start and end.

To work around this, it’s possible to use asynchronous I/O to spawn multiple processes and parallelise PDF output. The Pydf module has a class ‘AsyncPydf()’ for handling this use case. Again, see the documentation for more details on this.

49 Using Twitter API

You can connect to Twitter using the ‘Python-Twitter’ module.

Perform the following steps to install Python-Twitter:

```
$ git clone git://github.com/bear/
python-twitter
$ cd python-twitter
$ make dev
```

Example (fetching followers list):

```
>>> import twitter
# Use you own twitter account here
>>> mytwi = twitter.Api(consumer_
key=...,consumer_secret=...,access_
token_key=...,access_token_secret_=...)
>>> friends = mytwi.GetFriends()
>>> print [u.name for u in friends]
[u’Matt Legend Gemmell’, u’jono wells’,
u’The MDN Big Blog’, u’Manish Mandal’,
u’iH8sn0w’, u’IndianVideoGamer.com’,
u’FakeAaron Hillegass’, u’ChaosCode’,
u’nileshp’, u’Frank Jennings’,..’]
```

Note that in order to use most features of Python-Twitter you’ll need to generate an Access Token and API key for your twitter account. You’ll find instructions for doing this at https://dev.twitter.com/oauth/overview/application-owner-access-tokens . This will give you the 4 magic numbers for ‘twitter.Api’.

50 Fetching the latest news

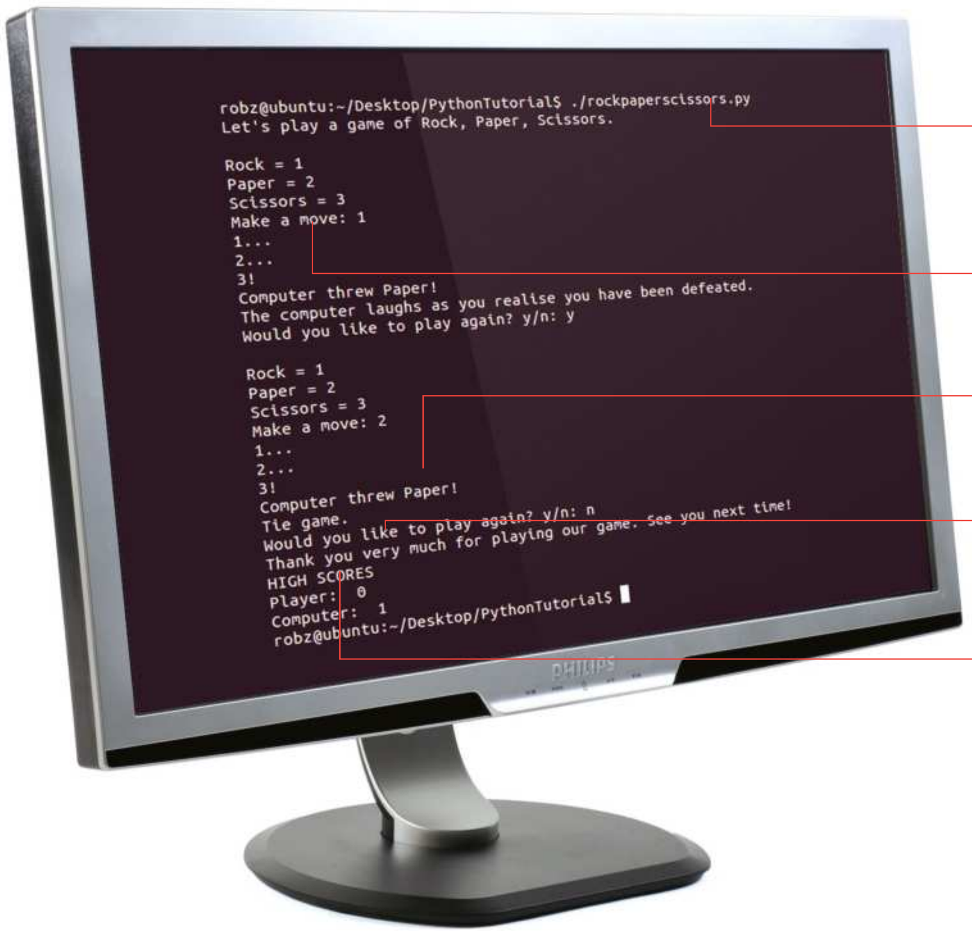
You can use a wrapper for the https://newsapi.org service to get headlines straight from Python. As with the Twitter module above, you’ll need to set up an API key before it will work. See https://pypi.org/project/news-python for more information.

Perform the following steps to install it:

```
$ pip install news-python
```

Example:

```
import news_python

news = news_python.Global(key=“API-KEY”)
news_content = news.get_
news(query=“linux”, source=“cnn”)

print(f“Title: {news_content.title}\n”
f“URL: {news_content.url}\n”
f“Author: {news_content.author}”)
```



```
robz@ubuntu:~/Desktop/PythonTutorial$ ./rockpaperscissors.py
Let's play a game of Rock, Paper, Scissors.

 Rock = 1
 Paper = 2
 Scissors = 3
 Make a move: 1
 1...
 2...
 3!
 Computer threw Paper!
 The computer laughs as you realise you have been defeated.
 Would you like to play again? y/n: y

 Rock = 1
 Paper = 2
 Scissors = 3
 Make a move: 2
 1...
 2...
 3!
 Computer threw Paper!
 Tie game.
 Would you like to play again? y/n: n
 Thank you very much for playing our game. See you next time!
 HIGH SCORES
 Player:  0
 Computer:  1
robz@ubuntu:~/Desktop/PythonTutorial$ 
```

Allow the Python script to run in a terminal, and outside the IDE
Human input in the form of integers is used for comparing moves and, ultimately, playing the game
Use deduction to determine one of three outcomes
Loop the code over again and start from the beginning
Append to integer variables to keep track of scores and more

Code a game of rock, paper, scissors

Learn how to do some basic Python coding by following our breakdown of a simple rock, paper, scissors game

Resources

Python 3: www.python.org/download

IDLE: www.python.org/idle

This tutorial will guide you through making a rock, paper, scissors game in Python. The code applies the lessons from the masterclass – and expands on what was included there – and doesn't require any extra Python modules to run, like Pygame.

Rock, paper, scissors is the perfect game to show off a little more about what exactly Python can do. Human input, comparisons, random selections and a whole host of loops are used in making a working version of the game. It's also easy enough to adapt and expand as you see fit, adding rules and results, and even making a rudimentary AI if you wish.

For this particular tutorial, we also recommend using IDLE. IDLE is a great Python IDE that is easily obtainable in most Linux distributions and is available by default on Raspbian for Raspberry Pi. It helps you by highlighting any problems there might be with your code and allows you to easily run it to make sure it's working properly.

01 This section imports the extra Python functions we'll need for the code – they're still parts of the standard Python libraries, just not part of the default environment

02 The initial rules of the game are created here. The three variables we're using and their relationship is defined. We also provide a variable so we can keep score of the games

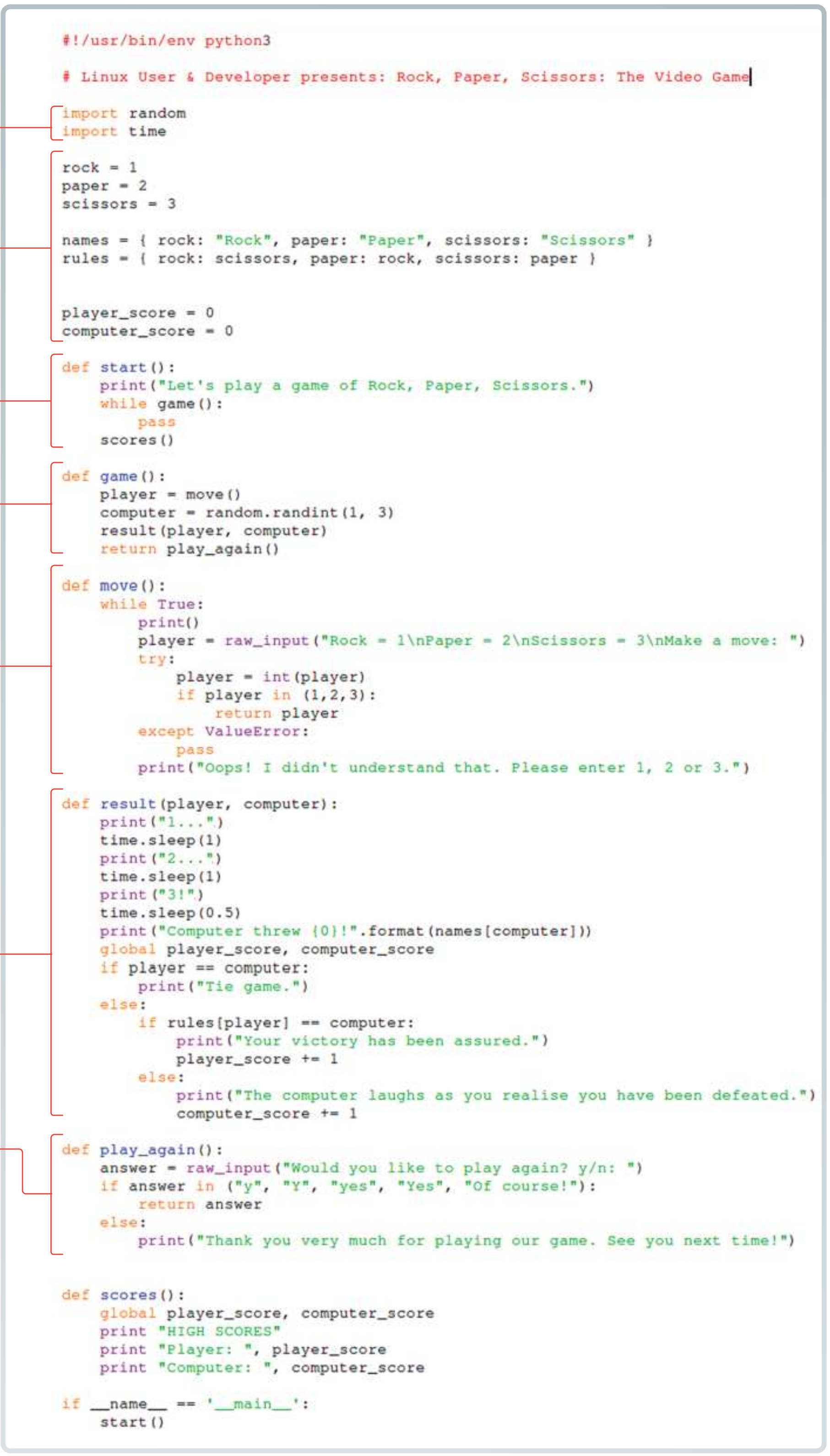
03 We begin the game code by defining the start of each round. The end of each play session comes back through here, whether we want to play again or not

04 The game is actually contained all in here, asking for the player input, getting the computer input and passing these on to get the results. At the end of that, it then asks if you'd like to play again

05 Player input is done here. We give the player information on how to play this particular version of the game and then allow their choice to be used in the next step. We also have something in place in case they enter an invalid option

06 There are a few things going on when we show the results. First, we're putting in a delay to add some tension, appending a variable to some printed text, and then comparing what the player and computer did. Through an if statement, we choose what outcome to print, and how to update the scores

07 We now ask for text input on whether or not someone wants to play again. Depending on their response, we go back to the start, or end the game and display the results



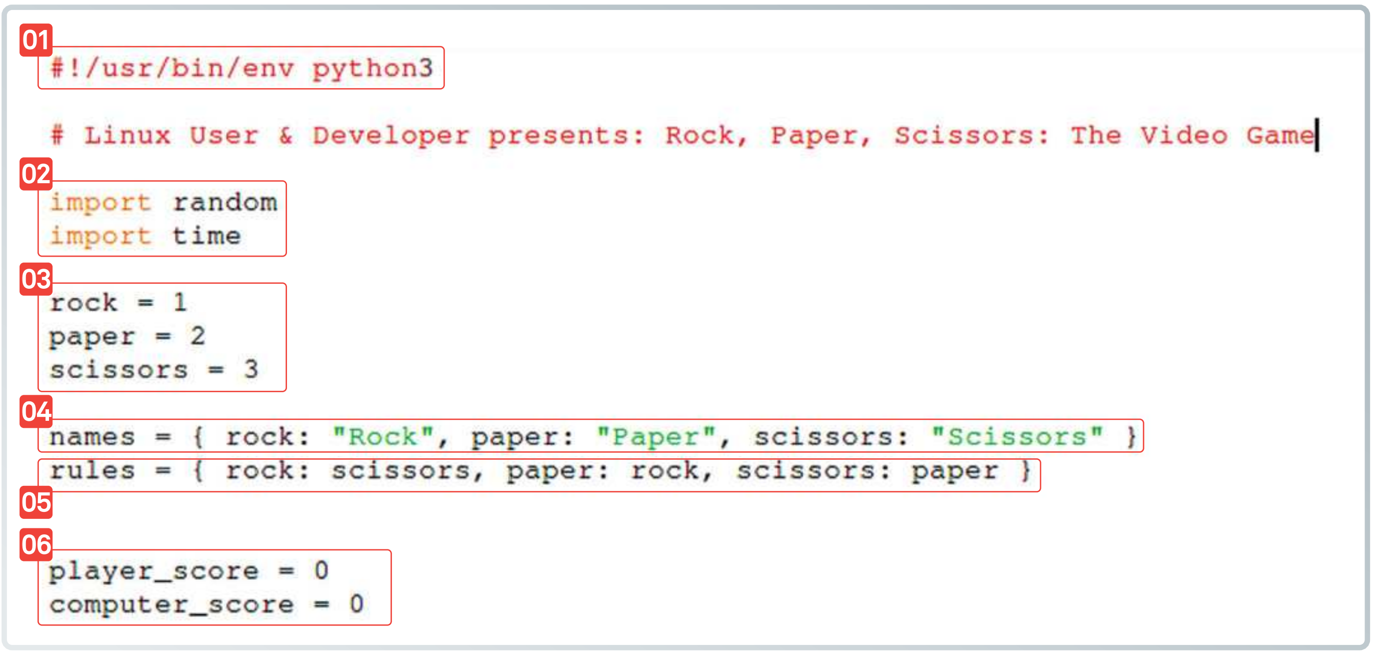
```python
#!/usr/bin/env python3

# Linux User & Developer presents: Rock, Paper, Scissors: The Video Game

import random
import time

rock = 1
paper = 2
scissors = 3

names = { rock: "Rock", paper: "Paper", scissors: "Scissors" }
rules = { rock: scissors, paper: rock, scissors: paper }


player_score = 0
computer_score = 0

def start():
    print("Let's play a game of Rock, Paper, Scissors.")
    while game():
        pass
    scores()

def game():
    player = move()
    computer = random.randint(1, 3)
    result(player, computer)
    return play_again()

def move():
    while True:
        print()
        player = raw_input("Rock = 1\nPaper = 2\nScissors = 3\nMake a move: ")
        try:
            player = int(player)
            if player in (1,2,3):
                return player
        except ValueError:
            pass
        print("Oops! I didn't understand that. Please enter 1, 2 or 3.")

def result(player, computer):
    print("1...")
    time.sleep(1)
    print("2...")
    time.sleep(1)
    print("3!")
    time.sleep(0.5)
    print("Computer threw {0}!".format(names[computer]))
    global player_score, computer_score
    if player == computer:
        print("Tie game.")
    else:
        if rules[player] == computer:
            print("Your victory has been assured.")
            player_score += 1
        else:
            print("The computer laughs as you realise you have been defeated.")
            computer_score += 1

def play_again():
    answer = raw_input("Would you like to play again? y/n: ")
    if answer in ("y", "Y", "yes", "Yes", "Of course!"):
        return answer
    else:
        print("Thank you very much for playing our game. See you next time!")

def scores():
    global player_score, computer_score
    print "HIGH SCORES"
    print "Player: ", player_score
    print "Computer: ", computer_score

if __name__ == '__main__':
    start()
```

The breakdown

01 We need to start with the path to the Python interpreter here. This allows us to run the program inside a terminal or otherwise outside of a Python-specific IDE like IDLE. Note that we're also using Python 3 rather than Python 2 for this particular script, which needs to be specified in the code to make sure it calls upon the correct version from the system.

02 We're importing two extra modules on top of the standard Python code so we can use some extra functions throughout the code. We'll use the random module to determine what move the computer will throw, and the time module to pause the running of the code at key points. The time module can also be used to utilise dates and times, either to display them or otherwise.

03 We're setting each move to a specific number so that once a selection is made by the player during the game, it will be equated to that specific variable. This makes the code slightly easier later on, as we won't need to parse any text for this particular function. If you so wish, you can add additional moves, and this will start here.



01

```
#!/usr/bin/env python3

# Linux User & Developer presents: Rock, Paper, Scissors: The Video Game
```

02

```
import random
import time
```

03

```
rock = 1
paper = 2
scissors = 3
```

04

```
names = { rock: "Rock", paper: "Paper", scissors: "Scissors" }
rules = { rock: scissors, paper: rock, scissors: paper }
```

05

06

```
player_score = 0
computer_score = 0
```

04 Here we specify the rules for the game, and the text representations of each move for the rest of the code. When called upon, our script will print the names of any of the three moves, mainly to tell the player how the computer moved. These names are only equated to these variables when they are needed – this way, the number assigned to each of them is maintained while it's needed.

05 Similar to the way the text names of the variables are defined and used only when needed, the rules are done in such a way that when comparing the results, our variables are momentarily modified. Further down in the code we'll explain properly what's happening, but basically after determining whether or not there's a tie, we'll see if the computer's move would have lost to the player move. If the computer move equals the losing throw to the player's move, you win.

06 Very simply, this creates a variable that can be used throughout the code to keep track of scores. We need to start it at zero now so that it exists, otherwise if we defined it in a function, it would only exist inside that function. The code adds a point to the computer or player depending on the outcome of the round, although we have no scoring for tied games in this particular version.

Python modules

There are other modules you can import with basic Python. Some of the major ones are shown to the right. There are also many more that are included as standard with Python.

string	Perform common string operations
datetime and **calendar**	Other modules related to time
math	Advanced mathematical functions
json	JSON encoder and decoder
pydoc	Documentation generator and online help system

07 Here we define the actual beginning of the code, with the function we've called 'start'. It's quite simple, printing our greeting to the player and then starting a while loop that will allow us to keep playing the game as many times as we wish. The pass statement allows the while loop to stop once we've finished, and could be used to perform a number of other tasks if so wished. If we do stop playing the game, the score function is then called upon – we'll go over what that does when we get to it.

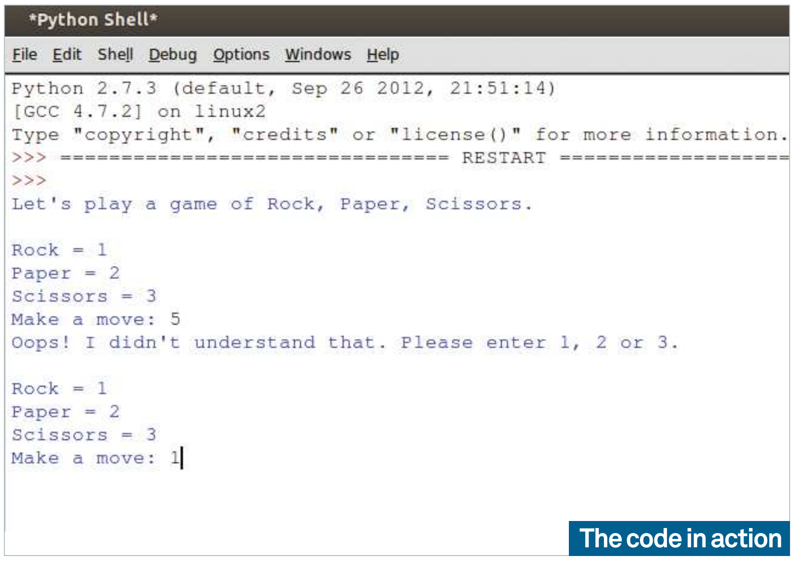
08 We've kept the game function fairly simple so we can break down each step a bit more easily in the code. This is called upon from the start function, and first of all determines the player move by calling upon the move function below. Once that's sorted, it sets the computer move. It uses the random module's randint function to get an integer between one and three (1, 3). It then passes the player and computer move, stored as integers, onto the result function which we use to find the outcome.

07
```
def start():
    print("Let's play a game of Rock, Paper, Scissors.")
    while game():
        pass
    scores()
```

08
```
def game():
    player = move()
    computer = random.randint(1, 3)
    result(player, computer)
    return play_again()
```

09
```
def move():
    while True:
        print()
        player = raw_input("Rock = 1\nPaper = 2\nScissors = 3\nMake a move: ")
```

10
```
        try:
            player = int(player)
            if player in (1,2,3):
                return player
        except ValueError:
            pass
        print("Oops! I didn't understand that. Please enter 1, 2 or 3.")
```



```
Python 2.7.3 (default, Sep 26 2012, 21:51:14)
[GCC 4.7.2] on linux2
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ==================
>>>
Let's play a game of Rock, Paper, Scissors.

Rock = 1
Paper = 2
Scissors = 3
Make a move: 5
Oops! I didn't understand that. Please enter 1, 2 or 3.

Rock = 1
Paper = 2
Scissors = 3
Make a move: 1
```

The code in action

09 We start the move function off by putting it into a while loop. The whole point of move is to obtain an integer between one and three from the player, so the while loop allows us to account for the player making an unsupported entry. Next, we are setting the player variable to be created from the player's input with raw_input. We've also printed instruction text to go along with it. The '\n' we've used in the text adds a line break; this way, the instructions appear as a list.

10 The try statement is used to clean up code and handle errors or other exceptions. We parse what the player entered by turning it into an integer using int(). We use the if statement to check if it is either 1, 2, or 3 – if it is, move returns this value back up to the game function. If it throws up a ValueError, we use except to do nothing. It prints an error message and the while loop starts again. This will happen until an acceptable move is made.

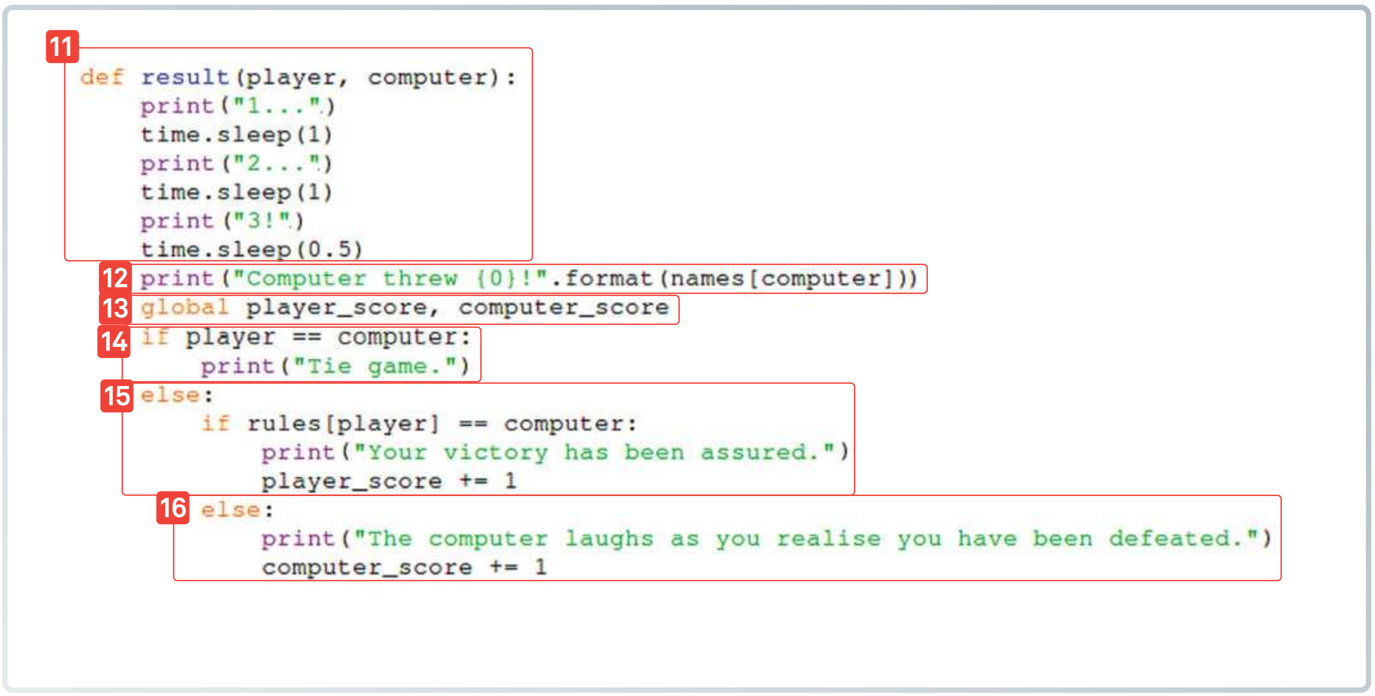
»

«

11 The result function only takes the variables player and computer for this task, which is why we set that in result(player, computer). We're starting off by having a countdown to the result. The printed numbers are self-explanatory, but we've also thrown in sleep from the time module we imported. Sleep pauses the execution of the code by the number of seconds in the brackets. We've put a one-second pause between counts, then half a second after that to show the results.

12 To print out what the computer threw, we're using string.format(). The {0} in the printed text is where we're inserting the move, which we have previously defined as numbers. Using names[computer], we're telling the code to look up what the text version of the move is called from the names we set earlier on, and then to insert that where {0} is.

13 Here we're simply calling the scores we set earlier. Using the global function allows for the variable to be changed and used outside of the variable, especially after we've appended a number to one of their scores.

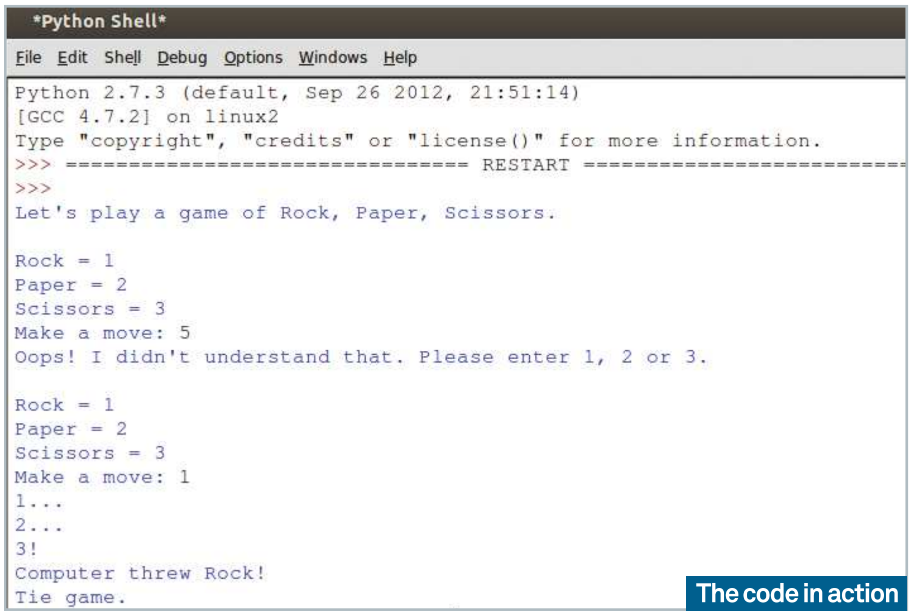


```
11
def result(player, computer):
    print("1...")
    time.sleep(1)
    print("2...")
    time.sleep(1)
    print("3!")
    time.sleep(0.5)
12  print("Computer threw {0}!".format(names[computer]))
13  global player_score, computer_score
14  if player == computer:
        print("Tie game.")
15  else:
        if rules[player] == computer:
            print("Your victory has been assured.")
            player_score += 1
16      else:
            print("The computer laughs as you realise you have been defeated.")
            computer_score += 1
```

14 The way we're checking the result is basically through a process of elimination. Our first check is to see if the move the player and computer used were the same, which is the simplest part. We put it in an if statement so that if it's true, this particular section of the code ends here. It then prints our tie message and goes back to the game function for the next step.

15 If it's not a tie, we need to keep checking, as it could still be a win or a loss. Within the else, we start another if statement. Here, we use the rules list from earlier to see if the losing move to the player's move is the same as the computer's. If that's the case, we print the message saying so, and add one to the player_score variable from before.

16 If we get to this point, the player has lost. We print the losing message, give the computer a point and it immediately ends the result function, returning to the game function.



```
Python 2.7.3 (default, Sep 26 2012, 21:51:14)
[GCC 4.7.2] on linux2
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ==========================
>>>
Let's play a game of Rock, Paper, Scissors.

Rock = 1
Paper = 2
Scissors = 3
Make a move: 5
Oops! I didn't understand that. Please enter 1, 2 or 3.

Rock = 1
Paper = 2
Scissors = 3
Make a move: 1
1...
2...
3!
Computer threw Rock!
Tie game.
```

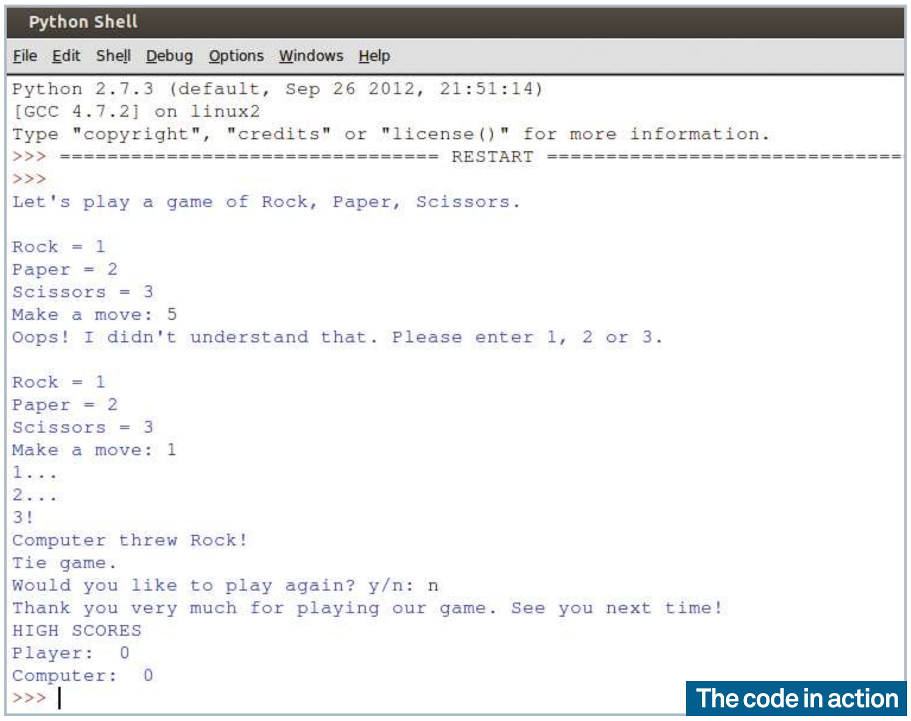
The code in action

17 The next section of game calls upon a play_again function. Like the move function, we have human input, asking the player if they would like to play again via a text message with raw_input, with the simple 'y/n' suggestion in an attempt to elicit an expected response.

18 Giving users an option of y/n like we have should expect a response in kind. The if statement checks to see if any of our defined positive responses have been entered. As Python doesn't differentiate between upper or lower case, we've made sure that it accepts both y and Y. If this is the case, it returns a positive response to game, which will start it again.

19 If we don't get an expected response, we will assume the player does not want to play again. We'll print a goodbye message, and that will end this function. This will also cause the game function to move onto the next section and not restart.

```
17
def play_again():
    answer = raw_input("Would you like to play again? y/n: ")
18
    if answer in ("y", "Y", "yes", "Yes", "Of course!"):
        return answer
19
    else:
        print("Thank you very much for playing our game. See you next time!")

20
def scores():
    global player_score, computer_score
    print "HIGH SCORES"
    print "Player: ", player_score
    print "Computer: ", computer_score
21
if __name__ == '__main__':
    start()
```



```
Python 2.7.3 (default, Sep 26 2012, 21:51:14)
[GCC 4.7.2] on linux2
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>>
Let's play a game of Rock, Paper, Scissors.

Rock = 1
Paper = 2
Scissors = 3
Make a move: 5
Oops! I didn't understand that. Please enter 1, 2 or 3.

Rock = 1
Paper = 2
Scissors = 3
Make a move: 1
1...
2...
3!
Computer threw Rock!
Tie game.
Would you like to play again? y/n: n
Thank you very much for playing our game. See you next time!
HIGH SCORES
Player:  0
Computer:  0
>>>
```

The code in action

ELIF

IF also has the ELIF (else if) operator, which can be used in place of the second IF statement we employed. It's usually used to keep code clean, but performs the same function.

20 Going back to the start function, after game finishes we move onto the results. This section calls the scores, which are integers, and then prints them individually after the names of the players. This is the end of the script, as far as the player is concerned. Currently, the code won't permanently save the scores, but you can have Python write it to a file to keep if you wish.

21 The final part allows for the script to be used in two ways. Firstly, we can execute it in the command line and it will work fine. Secondly, we can import this into another Python script, perhaps if you wanted to add it as a game to a collection. This way, it won't execute the code when being imported.

This section imports the extra Python functions we'll need for the code – they're still parts of the standard Python libraries, just not part of the default environment

We're again providing variables so we can keep score of the games played, and they're updated each round

Our very basic graphics involve ASCII art of the game's stages, printed out after every turn

Code listing

```
#!/usr/bin/env python3

from random import *

player_score = 0
computer_score = 0

def hangedman(hangman):
    graphic = [
    “”””
        +-------+
        |
        |
        |
        |
        |
     ==============
    “”””,
    “”””
        +-------+
        |       |
        |       O
        |
        |
        |
    ===============
    “”””,
    “”””
```

```
    “”””,
    “”””
        +-------+
        |       |
        |       O
        |      -|-
        |      / \
        |
    ===============
    “”””]

    print(graphic[hangman])
    return
```

Program a game of Hangman

Learn how to do some more Python coding by following our breakdown of a simple Hangman game

One of the best ways to get to know Python is by building lots of simple projects so you can understand a bit more about the programming language. This time round, we're looking at Hangman, a multi-round game relying on if and while loops and dealing with strings of text in multiple ways. We'll be using some of the techniques we implemented last time as well, so we can build upon them.

Hangman still doesn't require the Pygame set of modules, but it's a little more advanced than rock-paper-scissors. We're playing around with a lot more variables this time. However, we're still looking at comparisons, random selections and human input, along with splitting up a string, editing a list and even displaying rudimentary graphics.

You should continue to use IDLE for these tutorials. As we've mentioned before, its built-in debugging tools are simple yet effective and it can be used on any Linux system, as well as the Raspberry Pi.

Resources

Python 3: www.python.org/download

IDLE: www.python.org/idle

The actual game starts here, with a while loop to let you continually play the game until you decide otherwise, then ending the program

The game rules are decided here, as well as the setup for the word and keeping track of tries and incorrect answers

Each round of the game is played here, asking for an input, then telling you if you were correct or not. It prints out the graphic and changes any variables that need to be updated, especially incorrect and correct guesses

After each round, the code checks if you've won or lost yet – the win condition being that you guessed the word, or losing if you've made six guesses

The human input for the game takes the letter and turns it into something the code can use. It's verified in the previous block of code and then referred back to if you've entered an unsupported or already used character

The same class as last time, which allows you to select whether or not you wish to play again

Upon quitting the game, scores are given for the duration of the play session. We also end the script with the if __name__ code like before

Code listing continued

```
def start():
    print (“Let’s play a game of Linux Hangman.”)
    while game():
        pass
    scores()

def game():
    dictionary = [“gnu”,”kernel”,”linux”,”mageia”,”penguin”,”ubuntu”]
    word = choice(dictionary)
    word_length = len(word)
    clue = word_length * [“_”]
    tries = 6
    letters_tried = “”
    guesses = 0
    letters_right = 0
    letters_wrong = 0
    global computer_score, player_score

    while (letters_wrong != tries) and (“”.join(clue) != word):
        letter=guess_letter()
        if len(letter)==1 and letter.isalpha():
            if letters_tried.find(letter) != -1:
                print(“You’ve already picked”, letter)
            else:
                letters_tried = letters_tried + letter
                first_index=word.find(letter)
                if  first_index == -1:
                    letters_wrong +=1
                    print “Sorry,”,letter,”isn’t what we’re looking for.”
                else:
                    print(”Congratulations,”,letter,”is correct.”)
                    for i in range(word_length):
                        if letter == word[i]:
                            clue[i] = letter
        else:
            print(“Choose another.”)

        hangedman(letters_wrong)
        print(“ ”.join(clue))
        print(“Guesses: ”, letters_tried)

        if letters_wrong == tries:
            print(“Game Over.”)
            print(“The word was”,word)
            computer_score += 1
            break
        if “”.join(clue) == word:
            print(“You Win!”)
            print(“The word was”,word)
            player_score += 1
            break
    return play_again()

def guess_letter():
    print()
    letter = raw_input(“Take a guess at our mystery word:”)
    letter.strip()
    letter.lower()
    print()
    return letter

def play_again():
    answer = raw_input(“Would you like to play again? y/n: “)
    if answer in (“y”, “Y”, “yes”, “Yes”, “Of course!”):
        return answer
    else:
        print(“Thank you very much for playing our game. See you next time!”)

def scores():
    global player_score, computer_score
    print (“HIGH SCORES”)
    print (“Player: ”, player_score)
    print (“Computer: ”, computer_score)

    if __name__ == ‘__main__’:
    start()
```

CODE HIGHLIGHTING

IDLE automatically highlights the code to make reading your work that little bit easier. It also allows you to change these colours and highlighting in IDLE's Preferences, in case you're colour blind or are just used to a different colour scheme in general.

I see ASCII

Here's a close-up of the seven stages we've used for Hangman's graphics. You can change them yourself, but you need to make sure the quote marks are all in the correct place so that the art is considered a text string to be printed out.

```
“””
       +-------+
       |
       |
       |
       |
       |
  ==============
“””,
“””
       +-------+
       |       |
       |       O
       |
       |
       |
===============
“””,
“””
       +-------+
       |       |
       |       O
       |       |
       |
       |
===============
“””,
“””
       +-------+
       |       O
       |      -|
       |
       |
       |
===============
“””,
“””
       +-------+
       |       |
       |       O
       |      -|-
       |
       |
===============
“””,
“””
       +-------+
       |       |
       |       O
       |      -|-
       |      /
       |
===============
“””,
“””
       +-------+
       |       |
       |       O
       |      -|-
       |      / \
       |
===============
“””]
```

```
01 #!/usr/bin/env python3

02 from random import *

03 player_score = 0
   computer_score = 0

04 def hangedman(hangman):
       graphic = [
       “””

           +-------+
           |
           |
           |
           |
           |
      ==============
       “””,
       “””

05 def start():
       print(“Let’s play a game of Linux Hangman.”)
       while game():
           pass
       scores()
```

THE RULES

Although we've moved some of the rules to the 'game' function, you can always put them back here and call upon them using the global variable, as we would do with the scores. For the words, you could also create a separate file and import them like the random module.

01 We begin by using this line to enter the path to the Python interpreter. This allows us to run the program inside a terminal or otherwise outside of a Python-specific IDE like IDLE. Note that we're also using Python 3 for this particular script, as it is installed by default on most Linux systems and will therefore ensure compatibility.

02 We're importing the 'random' module slightly differently this time, importing the actual names of the functions from random rather than just the module itself. This allows us to use the functions without having syntax like random.function. The asterisk imports all the functions from random, although you can switch that for specific names of any of random's functions. We'll be using the random function to select a word for the player to guess.

03 Very simply, this creates a variable that can be used throughout the code to keep track of scores. We need to start it at zero now so that it exists; otherwise if we defined it in a function, it would only exist inside that function. The code adds a point to the computer or player depending on the outcome of the round.

04 Our simple graphics consist of a series of ASCII hanging man stages. We're storing these in a function as a list of separate string objects so we can call upon them by passing on the number of incorrect guesses to it. There are seven graphics in all, like in the pen-and-paper version. We also include the print command with the function, so when it's called it will completely handle the selection and display of the hanging man, with the first one being printed after the first letter is guessed.

05 Here we define the actual beginning of the code, with the function we've called 'start'. It's quite simple, printing our greeting to the player and then starting a while loop that will allow us to keep playing the game as many times as we wish. The pass statement allows the while loop to stop once we've finished, and could be used to perform a number

```
06 def game():
       dictionary = ["gnu","kernel","linux","mageia","penguin","ubuntu"] 07
       word = choice(dictionary)
       word_length = len(word)
       clue = word_length * ["_"]
08     tries = 6
       letters_tried = ""
       guesses = 0
       letters_right = 0
       letters_wrong = 0
       global computer_score, player_score

09     while (letters_wrong != tries) and ("".join(clue) != word):
           letter=guess_letter() 10
           if len(letter)==1 and letter.isalpha():
               if letters_tried.find(letter) != -1:
                   print("You've already picked", letter)
```

of other tasks if so wished. If we do stop playing the game, the score function is then called upon –we'll go over what that does when we get to it.

06 We have put a majority of the game code in the 'game' function this time around, as there's not as much that needs to be split up. You can split it up further if you wish, using the style of code from last issue, if it would make the code cleaner for you or help you understand the building blocks a bit more.

07 The first four lines quickly set up the word for the player to guess. We've got a small selection of words in a list here. However, these can be imported via HTML or expanded upon. Choice is used to select a random element from the list, which comes from the random module we imported. Finally, we ascertain how long the string is of the word to guess, and then create the clue variable with a number of underscores of that length. This is used to display the word as you build it up from guesses.

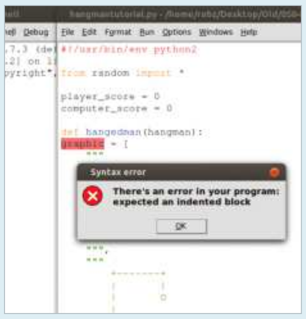
08 We start to set up the rules and the individual variables to keep track of during the game. There can only be six incorrect guesses before the hanging man is fully drawn, or in our case displayed, so we set the tries variable to six. We'll keep track of the letters through letters_tried to make sure that not only will the player know, but also the code for when it's checking against letters already played. Finally, we create empty variables for the number of guesses made, letters correct and letters incorrect, to make the code slightly easier. We also import the global scores here.

09 We're starting a while loop to perform the player selection and check the status of the game. This loop continues until the player wins or loses. It starts by checking if all the tries have been used up by seeing if letters_wrong is not equal to tries. As each try will only add one point to wrong, it will never go above six. It then concatenates 'clue' and sees if it's the same as the word the computer selected. If both these statements are true, it goes on to the next turn.

10 We call upon the function we're using to input a letter and give it the variable 'letter'. We check what it returns by first of all making sure it's only a single letter, with len(letter), then by using isalpha to see if it's one of the 26 letters of the alphabet. If these conditions are satisfied, we start a new if statement to make sure it's a new guess, and tell the player if it's already been chosen so they can start again. If all this is acceptable, we move on to the next section of the code to see if it's a correct guess or not.

INDENTATIONS

While IDLE will keep track of the indents in the code, if you're using a text editor to write some Python, you'll have to make sure you're using them correctly. Python is very sensitive to whether or not indents are used correctly, and it does aid in readability as well.



```
#!/usr/bin/env python2

from random import *

player_score = 0
computer_score = 0

def hangedman(hangman):
graphic = [
"""
```

Syntax error

There's an error in your program:
expected an indented block

CONTINUATION

This code is still part of the game function we started on the previous page, so make sure your indentations are in alignment if you're not using an IDE. If you plan to split this code up, we'd suggest starting with the word selection and results.

```
11      else:
            letters_tried = letters_tried + letter
            first_index=word.find(letter)
            if  first_index == -1:
                letters_wrong +=1
                print(“Sorry,”,letter,”isn’t what we’re looking for.”)
            else:
                print”Congratulations,”,letter,”is correct.”  12
13              for i in range(word_length):
                    if letter == word[i]:
                        clue[i] = letter
    else:
        print(“Choose another.”) 14

    hangedman(letters_wrong)
    print (“ ”.join(clue))
    print (“Guesses: ”, letters_tried)

15  if letters_wrong == tries:
        print(“Game Over.”)
        print(“The word was”,word)
        computer_score += 1
        break
    if “”.join(clue) == word:
        print(“You Win!”)
        print(“The word was”,word)
        player_score += 1
        break
return play_again()  16
```

11 If it's a new letter that we find acceptable, the first thing we do is add it to the list of letters tried. This is done simply by adding the strings together. We then use the find command to search the word string for the letter entered, which will then return a number of the placement of the letter in the string. If it doesn't find the letter, it returns a -1 value, which we use in the next if statement to see if the first_index variable is -1. If so, it adds one to the number of letters_wrong and then prints a message to let the player know that it was an incorrect guess.

12 If we've got this far and the letter is not incorrect, than we can only assume it is correct. Through this simple process of elimination, we first print out a message to let the player know that they've been successful and then make a record of it.

13 We're going to start a small loop here so we can update the clue with the correct letter we've added. We use the range function to tell the code how many times we wish to iterate over the clue by using the word_length variable. We then check to see which letter in the word has been guessed correctly and change that specific part of the clue to be that letter so it can be printed out for the player to see, and for us to check whether or not the game is over.

14 We end the original if statement by telling the player to choose again if they did not enter a supported input. Before we go on to the next round of choices, we print out the hanging man graphic as it stands, by calling the graphic in the list that corresponds to the number of incorrect guesses that have been made. We then print how the clue currently looks, with a space in between each character, and then print the number of guesses that have been made.

15 Here we check to see if the game is over again, first of all comparing the letters_wrong to the number of tries. If that's true, we print a message that the game has ended and reveal the mystery of the hidden word. We increase the computer's score and break the loop. The next loop checks to see if the full clue concatenated is the same as the original word – if that's the case, we print the win message, the full word and add one point to the player score before breaking the loop again. This can also be done with ifs and elifs to avoid using breaks.

```
17  def guess_letter():
        print()
        letter = raw_input("Take a guess at our mystery word:")
        letter.strip()
        letter.lower()
        print()
        return letter

18  def play_again():
        answer = raw_input("Would you like to play again? y/n: ")
19      if answer in ("y", "Y", "yes", "Yes", "Of course!"):
            return answer
20      else:
            print("Thank you very much for playing our game. See you next time!")

21  def scores():
        global player_score, computer_score
        print("HIGH SCORES")
        print("Player: ", player_score)
        print("Computer: ", computer_score)

22      if __name__ == '__main__':
        start()
```

16 We end the entire game function loop by calling upon return again, which we will then pass all the way up to the start function once it's finished.

17 The human input function first of all prints out a raw_input message. Once the player enters the letter, the function parses it to be used with the rest of the code. Firstly, strip is used to remove any white space from the input given, as we've not given it any extra parameters. We then convert it into lower-case letters, as Python will not be able to correctly compare an upper-case character with a lower-case alternative. We then print the selection for the record and return it up to the game function.

18 The last part of the game function is to ask the player if they wish to try again. The play_again function takes a human input with a simple message and then analyses the input so it knows what to send back.

19 Giving users an option of y/n like we have should expect a response in kind. The if statement checks to see if any of our defined positive responses have been entered. Since Python differentiates between upper and lower case, we've made sure it accepts both y and Y. If this is the case, it returns a positive response to game, which will start it again.

20 If we don't get an expected response, we will assume the player does not want to play again. We'll print a goodbye message and that will end this function. This will also cause the start function to move onto the next section and not restart.

21 Going all the way back to the start function, after game finishes we move onto the results. This section is quite simple – it calls the scores, which are integers, and then prints them individually after the names of the players. This is the end of the script, as far as the player is concerned. Currently, the code will not permanently save the scores, but you can have Python write it to a file to keep if you wish.

HOMEWORK

Now that you've finished with the code, why not make your own changes? Increase the word count; create different, selectable word categories; or even let people guess the full word. You have all the tools to do this in the current code and last month's tutorial.

22 The final part of the code allows for the script to be used in two ways. Firstly, we can execute it in the command line and it will work fine. Secondly, we can import this into another Python script, perhaps if you wanted to add it as a game to a collection. This way, it will not execute the code when being imported.

Play poker dice using Python

Put on your poker face and get ready to gamble as you hone your programming skill with a bit of poker dice

So you've learnt how to program rock, paper, scissors and guessed your way to victory at hangman. Now it's time to head to Las Vegas and play our cards right. Or in this case, virtual dice, as we continue with our Python game tutorials and introduce you to some poker dice.

We're again using some of the lessons we've already learnt, including random number generation, list creation and modification, human input, rule setting, scoring and more. But we'll also be adding some new skills in this tutorial. Namely, we'll be creating and appending lists with random numbers, and using functions multiple times in one block of code to cut down on bloat.

Again, we recommend using IDLE, and we're using Python 2 to ensure compatibility with a wider variety of distros, including the Raspberry Pi. So, we hope luck is a lady for you and that the odds are ever in your favour – just keep those fingers crossed that you don't roll a snake eyes (we are coding in Python, after all)!

Resources

Python 3: www.python.org/download

IDLE: www.python.org/idle

The Start

Here we're doing some minor setups so we can get our code to run with some extra modules not included with the basics

The Rules

We're setting names for each dice roll so they can be properly identified to the player – much more interesting than numbers

The Score

Again we've got some basic variables set up so we can keep score of the games if we want to

The Script

The game is handled here, passing the player onto the next function to actually play, and handling the end of the session as well

The Game

We access the full game loop via here, and the function that allows us to play again if we're so inclined

The Throw

The initial hand is dealt, so to speak, at the start of the throws function. This function handles all the decision making in the game, while passing off the dice rolls to another function

The Hand

We've also got a special function so we can inform the player exactly what style of hand they have

The Decision

There are two rounds in this version of poker dice, and you can select how many dice you wish to re-roll in this small while loop that makes sure you're also using a correct number

Code listing

```
#!/usr/bin/env python3

import random
from itertools import groupby

nine = 1
ten = 2
jack = 3
queen = 4
king = 5
ace = 6

names = { nine: "9", ten: "10", jack: "J", queen: "Q", king: "K", ace: "A" }

player_score = 0
computer_score = 0

def start():
    print("Let's play a game of Linux Poker Dice.")
    while game():
        pass
    scores()

def game():
    print ("The computer will help you throw your 5 dice")
    throws()
    return play_again()

def throws():
    roll_number = 5
    dice = roll(roll_number)
    dice.sort()
    for i in range(len(dice)):
        print("Dice",i + 1,":",names[dice[i]])

    result = hand(dice)
    print ("You currently have", result)

    while True:
      rerolls = input("How many dice do you want to throw again? ")
        try:
            if rerolls in (1,2,3,4,5):
                break
        except ValueError:
            pass
        print ("Oops! I didn't understand that. Please enter 1, 2, 3, 4 or 5.")
```

The Re-roll
We're doing the second set of rolls and starting the end of the game here by calling on the same function as before, but we're also aware that choosing no re-rolls means the end of the game

The Dice
Here we're finding out which dice the player wants to re-roll, and also making sure that they enter a valid number. Just so they know they're doing something, we print something after every turn

Second Hand
We change and display the new dice hand to end the game. Again, we make sure to tell the player what the actual hand they have is

The Rolls
The function we reuse to roll our virtual six dice using a simple while loop. This allows us to keep the codebase smaller

The Analysis
There are eight possible types of hands in poker dice, and we can use a bit of logic to work out all but one of them without checking against all 7,776 outcomes – in fact, we only specifically have to check for two

The Question
Our simple 'play again' function that parses player input so we can restart or end the script

The End
Scores are displayed at the end of the script, and the very final part allows us to import this into other Python scripts as a module

Code listing continued

```
    if rerolls == 0:
        print("You finish with", result)
    else:
        roll_number = rerolls
        dice_rerolls = roll(roll_number)
        dice_changes = range(rerolls)
        print("Enter the number of a dice to reroll: ")
        iterations = 0
        while iterations < rerolls:
            iterations = iterations + 1
            while True:
                selection = input("")
                try:
                    if selection in (1,2,3,4,5):
                        break
                except ValueError:
                    pass
                print("Oops! I didn't understand that. Please enter 1, 2, 3, 4 or 5.")
            dice_changes[iterations-1] = selection-1
            print("You have changed dice", selection)

        iterations = 0
        while iterations < rerolls:
            iterations = iterations + 1
            replacement = dice_rerolls[iterations-1]
            dice[dice_changes[iterations-1]] = replacement

        dice.sort()
        for i in range(len(dice)):
            print("Dice",i + 1,":",names[dice[i]])

        result = hand(dice)
        print("You finish with", result)
def roll(roll_number):
    numbers = range(1,7)
    dice = range(roll_number)
    iterations = 0
    while iterations < roll_number:
        iterations = iterations + 1
        dice[iterations-1] = random.choice(numbers)
    return dice

def hand(dice):
    dice_hand = [len(list(group)) for key, group in groupby(dice)]
    dice_hand.sort(reverse=True)
    straight1 = [1,2,3,4,5]
    straight2 = [2,3,4,5,6]

    if dice == straight1 or dice == straight2:
        return "a straight!"
    elif dice_hand[0] == 5:
        return "five of a kind!"
    elif dice_hand[0] == 4:
        return "four of a kind!"
    elif dice_hand[0] == 3:
        if dice_hand[1] == 2:
            return "a full house!"
        else:
            return "three of a kind."
    elif dice_hand[0] == 2:
        if dice_hand[1] == 2:
            return "two pair."
        else:
            return "one pair."
    else:
        return "a high card."

def play_again():
    answer = raw_input("Would you like to play again? y/n: ")
    if answer in ("y", "Y", "yes", "Yes", "Of course!"):
        return answer
    else:
        print "Thank you very much for playing our game. See you next time!"

def scores():
    global player_score, computer_score
    print("HIGH SCORES")
    print("Player: ", player_score)
    print("Computer: ", computer_score)

if __name__ == '__main__':
    start()
```

EXTRA FUNCTIONS

Splitting up actions into functions makes it easier to not only perform them multiple times, but reduce the amount of code. On larger projects, this can aid with speed.

01
```
#!/usr/bin/env python3
```
02
```
import random
from itertools import groupby
```
03
```
nine = 1
ten = 2
jack = 3
queen = 4
king = 5
ace = 6

names = { nine: “9”, ten: “10”, jack: “J”, queen: “Q”, king: “K”, ace: “A” }
```
04
```
player_score = 0
computer_score = 0
```
05
```
def start():
    print(“Let’s play a game of Linux Poker Dice.”)
    while game():
        pass
    scores()
```
06
```
def game():
    print(“The computer will help you throw your 5 dice”)
    throws()
    return play_again()
```

RECYCLING

There are a few variables that have duplicates throughout the code – while we’ve been careful to make sure they work where we want them to, it’s not the best code conduct. The names of the variables don’t specifically matter – it’s just best to label them in a way you understand for bug fixing and others to read.

01 Begin
As before, we use this line to enter the path to the Python interpreter. This allows us to run the program inside a terminal or otherwise outside of a Python-specific IDE like IDLE. Note that we’re also using Python 3 for this script.

02 Importing
As well as importing the random module for our dice throws, we need to get the groupby function so we can order the dice in a way that is more readable and also easier for analysis when telling the player what hand they have.

03 Cards
While we’re using random numbers for the dice rolls, unless we assign the correct cards to each number, the player won’t know what they’ve rolled and what constitutes a better hand. We set each card to a number and then equate what these should be printed out as.

04 Scores
As usual, we have the empty scores for the player and computer so we can update these as we go. While it’s not specifically used in this version of the code, it’s easy enough to expand on it and add your own simple computer roll, or limited AI for both rolls.

05 Start
We’re starting the interactive part of the code with the ‘start’ function. It prints a greeting to the player, then starts a while loop that’ll allow us to replay the game as many times as we wish. The pass statement allows the while loop to stop once we’ve finished. If we do stop playing the game, the score function is then called upon.

06 Game
Like our Rock, Paper, Scissors code, def game pawns the rest of the game onto other functions, with its main function allowing us to keep repeating the game by passing the player through to the play_again function.

07 Throws
For our first throw, we want to have five random dice. We’ve set a variable here to pass on to our throwing function, allowing us to reuse it later with a different number that the player chooses. We get five random numbers in a list returned from the function, and we order it using sort to make it a bit more readable for the player and also later on for the hand function.

08 Dice display
We print out each dice, numbering them so the player knows which dice is which, and also giving it the name we set at the start of the script. We’re doing this with a loop that repeats itself the number of times as the dice list is long using the range(len(dice)) argument. The i is increased each turn, and it prints out that specific number of the dice list.

09 Current hand
We want to find the type of hand the player has multiple times during the game, so set a specific function to find out. We pass the series of dice we have on to this function, and print.

10 Throw again
Before we can throw the dice for the second round, we need to know which dice the

```
07  def throws():
        roll_number = 5
        dice = roll(roll_number)
        dice.sort()
08      for i in range(len(dice)):
            print(“Dice”,i + 1,”:”,names[dice[i]])

09      result = hand(dice)
        print(“You currently have”, result)

10      while True:
            rerolls = input(“How many dice do you want to throw again? “)
            try:
                if rerolls in (1,2,3,4,5):
                    break
            except ValueError:
                pass
            print(“Oops! I didn’t understand that. Please enter 1, 2, 3, 4 or 5.”)
11      if rerolls == 0:
            print(“You finish with”, result)
12      else:
            roll_number = rerolls
            dice_rerolls = roll(roll_number)
            dice_changes = range(rerolls)
            print(“Enter the number of a dice to reroll: “)
            iterations = 0
            while iterations < rerolls:
                iterations = iterations + 1
                while True:
                    selection = input(“”)
                    try:
                        if selection in (1,2,3,4,5):
                            break
                    except ValueError:
                        pass
13                  print(“Oops! I didn’t understand that. Please enter 1, 2, 3, 4 or 5.”)
                dice_changes[iterations-1] = selection - 1
                print(“You have changed dice”, selection)
```

INDENTATIONS

Watch the indentations again as we split the else function. The following page’s code is on the same level as roll roll_number, dice_rerolls and dice_changes in the code.

WHITE SPACE

The big if function at the end of throws doesn’t have many line breaks between sections – you can add these as much as you want to break up the code into smaller chunks visually, aiding debugging.

player wants to roll again. We start this by asking them how many re-rolls they want to do, which allows us to create a custom while loop to ask the user which dice to change that iterates the correct number of times.

We also have to make sure it’s a number within the scope of the game, which is why we check using the try function, and print out a message which tells the user if and how they are wrong.

11 Stick

One of the things we’ve been trying to do in these tutorials is point out how logic can cut down on a lot of coding by simply doing process of eliminations or following flow charts. If the user wants to re-roll zero times, then that means they’re happy with their hand, and it must be the end of the game. We print a message to indicate this and display their hand again.

12 The re-rolls

Here’s where we start the second roll and the end of the game, using a long else to the if statement we just started. We first of all make sure to set our variables – updating roll_number to pass onto the roll function with the re-roll number the user set, and creating the list that’s the exact length of the new set of rolls we wish to use thanks to range(rerolls).

13 Parse

We ask the player to enter the numbers of the dice they wish to re-roll. By setting an iterations variable, we can have the while loop last the same number of times as we want re-rolls by comparing it to the reroll variable itself. We check each input to make sure it’s a number that can be used, and add the valid choices to the dice_changes list. We use iterations-1 here as Python lists begin at 0 rather than 1. We also print out a short message so the player knows the selection was successful.

»

```
14  iterations = 0
    while iterations < rerolls:
        iterations = iterations + 1
        replacement = dice_rerolls[iterations-1]
        dice[dice_changes[iterations-1]] = replacement

15  dice.sort()
    for i in range(len(dice)):
        print("Dice",i + 1,":",names[dice[i]])

    result = hand(dice)
    print("You finish with", result)

16 def roll(roll_number):
17     numbers = range(1,7)
       dice = range(roll_number)
       iterations = 0
18     while iterations < roll_number:
           iterations = iterations + 1
           dice[iterations-1] = random.choice(numbers)
       return dice
```

HIGHER OR LOWER

Which hand is best? What are the odds of getting certain hands in the game? Some of the answers are surprising, as the poker hands they're based on trump the differing odds the dice produce. We've ranked hands from highest to lowest.

Five of a Kind	6/7776
Four of a Kind	150/7776
Full House	300/7776
Straight	240/7776
Three of a Kind	1200/7776
Two Pairs	1800/7776
One Pair	3600/7776
High Card	480/7776

14 New dice

We're resetting and reusing the iterations variable to perform a similar while loop to update the rolls we've done to the original dice variable. The main part of this while loop is using the iterations-1 variable to find the number from dice_changes list, and using that to change that specific integer in the dice list with the number from the replacement list. So if the first item on the dice_changes list is two, then the second item on the dices list is changed to the number we want to replace it with.

15 Sorting

We're ending the throw function in basically the same way we ended the first throw. First of all, we re-sort the dice list so that all the numbers are in ascending order. Then we print out the final cards that the dice correspond to, before again passing it onto the hand function so that we can fully determine the hand that the player has. We print out this result and that ends the function, sending the whole thing back to the game function to ask if you want to play again.

16 Dice rolling

The roll function is used twice in the code for both times that we roll the dice. Being able to use the same code multiple times means we can cut down on bloat in the rest of the script, allowing it to run a little faster, as we've explained. It also means in this case that we can use it again if you want to change the game to three rounds, or modify it for real poker.

17 Number of rolls

We begin the whole thing by bringing over the roll_number variable into the function – this is because while in the original roll it will always be five, the second roll could between one and the full five dice. We create a list with the number of entries we need for each roll, and again set an iterations variable for the upcoming while loop.

18 Remember

Much like the while loops in the rest of the code so far, we're keeping it going until iterations is the same as roll_number. Each entry in the dice list is replaced with a random number using the random.choice function and keeping it in the range of the numbers variable, which is one to six for each side of the dice. After this is done, we return the dice variable to the throw function that makes up the majority of the game.

19 Hand analysis

While not technically a hand of cards, the poker terminology still applies. We start in this function by setting up a few things. The first part uses the groupby function we imported – this is used in this case to count the numbers that make up the dice variable. If there are three twos, a four and a five, it will return [3, 1, 1]. We're using this to ascertain what kind of hand the player has. As the output of this groupby won't be in any specific order, we use the sort function again to sort it; however, this time we use the reverse=TRUE argument to make the analysis easier again.

20 Straights

Straights and high cards are odd ones out in poker dice, as they do not rely on being able to count any repetitions in the cards. There are, however, only two hands that create a straight in poker dice, so we have created two lists here that contain them. We can then check first to see if the dice make these hands, and then if all other checks fail, it has to be a high card.

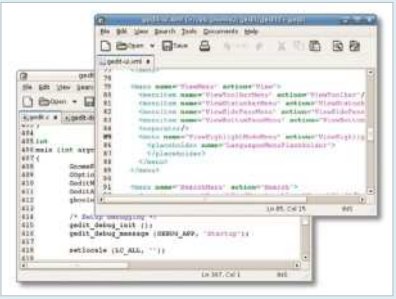
21 Your hand

While seemingly lengthy, this a fairly simple if statement. As we stated before, we check to see if it's one of the two straight hands. As there are no flushes or royal straight flushes in poker dice, we don't have to worry about those. We then check to see if the first item in the list is five, which can only result in five of a kind; similarly, if the first item is four then the hand must be four of a kind. If the first number is three, then it can be either a full house or three of a kind,

```
19  def hand(dice):
        dice_hand = [len(list(group)) for key, group in groupby(dice)]
        dice_hand.sort(reverse=True)
20      straight1 = [1,2,3,4,5]
        straight2 = [2,3,4,5,6]

21      if dice == straight1 or dice == straight2:
            return "a straight!"
        elif dice_hand[0] == 5:
            return "five of a kind!"
        elif dice_hand[0] == 4:
            return "four of a kind!"
        elif dice_hand[0] == 3:
            if dice_hand[1] == 2:
                return "a full house!"
            else:
                return "three of a kind."
        elif dice_hand[0] == 2:
            if dice_hand[1] == 2:
                return "two pair."
            else:
                return "one pair."
        else:
            return "a high card."

22  def play_again():
        answer = raw_input("Would you like to play again? y/n: ")
        if answer in ("y", "Y", "yes", "Yes", "Of course!"):
            return answer
        else:
            print("Thank you very much for playing our game. See you next time!")

23  def scores():
        global player_score, computer_score
        print("HIGH SCORES")
        print("Player: ", player_score)
        print("Computer: ", computer_score)

24  if __name__ == '__main__':
        start()
```

TEXT EDITORS

Instead of the IDE we've suggested, you should also try coding in a text editor. Some of them are a little more lightweight and format code similar to the way the IDE does, separating functions and strings by colours etc. Some of the ones we'd recommend are the classic gedit, a popular text editor from GNOME desktops; Geany, which has a few IDE-esque features written into it; TEA, a multifunctioning text editor and project manager; and Jedit, a text editor that lives in the command line for minimum resource usage. These can also be used with multiple programming languages, so you can get used to them with Python, then make the switch.



HOMEWORK

There is currently no scoring in place for this version of the game. Try adding a computer player, or create a rule set that requires a certain hand or higher. You could even make it two-player.

so we nest an if statement. Again, we do this for pairs, where that could be one or two pairs. If all else fails then, by a process of elimination, it can only be a high card. We give each outcome a text string to send back to the throw function so that it can be printed.

22 Play again

As before, we ask the player for raw input with the text offering another game. Instead of parsing it, we assume the player will choose a specified yes response based on the text, and if none of these versions is received, we print out the message thanking them for playing the game. This ends the game function.

23 Final scores

Going all the way back to the start function, after the game finishes we move onto the results. This section is quite simple – it calls the scores, which are integers, and then prints them individually after the names of the players. This is the end of the script, as far as the player is concerned. Currently, the code will not permanently save the scores, but you can have Python write it to a file to keep if you wish.

24 Modules

The final part of the code allows for the script to be used in two ways. Firstly, we can execute it in the command line and it will work just fine. Secondly, we can import this into another Python script, perhaps if you wanted to add it as a game to a collection. This last piece of code will prevent our script being executed when imported by another module – it will only do so when being run directly.

Create a graphical interface for Python games

Bring everything together with a Python GUI and take the next step in programming your own software

The three basic games we have made in Python so far have all run in the command line or via IDLE, a Python IDE. While this allowed us to show off different ways to use Python code, we haven't actually shown you how to present it yet. In this tutorial, we will take all three games and put them all into one neatly unified graphical interface.

To this end, we'll be making use of the small line of code we added at the bottom of each previous tutorial so we can import them as modules into our main graphical script. We'll also modify the existing code to add some graphical elements. To do all this we'll be using Tkinter, a default module available in Python that allows you to create windows and frames with fairly simple code.

All you need for this tutorial is an up-to-date copy of Python, from your distro's repository or the website, and the IDLE development environment. This will also work great on Raspberry Pi distros, such as Raspbian.

Resources

Python 3: www.python.org/download

IDLE: www.python.org/idle

The start
Here we're doing some minor setup, including getting a new module that helps us create a simple graphical interface

The imports
We're importing the three games we created in past issues so we can call upon or use them

The window
Create a graphical window and give it a name so we can add some functions to it

The frame
Define the dimensions of the window and give a rough guide to placement of the objects within

The welcome
Print a message in the window and place it in a specific orientation. This works a little differently to print

The button
The focus of this month's tutorial is making Rock-Paper-Scissors work in a graphical interface, so we're calling a new function we're creating

The interface
Creating and formatting buttons to start the other two tutorial games in the command line or shell

The exit
Here we create a button that quits the window and ends the script. We've also placed it specifically at the bottom of the window

The loop
The mainloop allows the main window to continue to work and be updated without exiting the program unless specified

Main Interface Code Listing

```
#!/usr/bin/env python3

#Linux User & Developer presents: Mega Microgrames Collection

from tkinter import *

import rockpaperscissors
import hangman
import pokerdice

root = Tk()
root.title ("Linux User & Developer's Mega Microgames Collection")

mainframe = Frame(root, height = 200, width = 500)
mainframe.pack_propagate(0)
mainframe.pack(padx = 5, pady = 5)

intro = Label(mainframe, text = """Welcome to Linux User & Developers Mega
Microgames Collection.
Please select one of the following games to play:
""")
intro.pack(side = TOP)

rps_button = Button(mainframe, text = "Rock, Paper, Scissors", command =
rockpaperscissors.gui)
rps_button.pack()

hm_button = Button(mainframe, text = "Hangman", command = hangman.start)
hm_button.pack()

pd_button = Button(mainframe, text = "Poker Dice", command = pokerdice.start)
pd_button.pack()

exit_button = Button(mainframe, text = "Quit", command = root.destroy)
exit_button.pack(side = BOTTOM)

root.mainloop()
```

New imports
Import new modules that allow us to create the GUI part of Rock, Paper, Scissors, as well as removing the modules we no longer need

New interface
Our new main function allows us to call the majority of the game script when the rps_button is pressed. This contains the game components and the graphical components

New start
We've changed the start function so that it no longer goes to the score function after it's finished. We've also removed the score function, as we track that differently so it can be displayed properly

New game
We've changed the game function so that it now takes the input from our graphical interface. We use a new variable to do this that works with the GUI, otherwise it works roughly the same as before

New results
The result function remains largely unchanged, only now it sends the outcome message to a variable we use for the interface, and generally uses the new GUI's variables

New window
We create the game window with a slightly different method due to already having a 'mainloop' root window. We're also giving it a name so you can identify it properly

New variables
Our new variables are set up so they can interact with both the game code and the interface code properly. We've also made sure to have a default selection for the player so that the code runs properly

New frame
Determine the size and layout of the window for the game using a slightly different method than before. We've also allowed for elements to be anchored in certain positions around the window

New choice
Here we place radio buttons in a specific configuration in the window, giving the user the choice of three moves. This is then passed along to the variable and used by the game code

New move
Here we allow for the computer's move to be displayed under the 'Computer' label

New button
Pressing the Play button we've put here runs the game script, prints out the scores and finally a message based on the outcome

New ending
We've changed this so that the main script begins with gui now rather than the start function

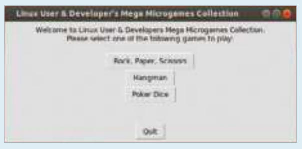
Modified RPS Code Listing

```
#!/usr/bin/env python3

# Linux User & Developer presents: Rock, Paper, Scissors: The Video Game: The Module

from tkinter import *
from ttk import *
import random

def gui():

    rock = 1
    paper = 2
    scissors = 3

    names = { rock: "Rock", paper: "Paper", scissors: "Scissors" }
    rules = { rock: scissors, paper: rock, scissors: paper }

    def start():
        while game():
            pass

    def game():
        player = player_choice.get()
        computer = random.randint(1, 3)
        computer_choice.set(names[computer])
        result(player, computer)

    def result(player, computer):
        new_score = 0
        if player == computer:
            result_set.set("Tie game.")
        else:
            if rules[player] == computer:
                result_set.set("Your victory has been assured.")
                new_score = player_score.get()
                new_score += 1
                player_score.set(new_score)
            else:
                result_set.set("The computer laughs as you realise you have been defeated.")
                new_score = computer_score.get()
                new_score += 1
                computer_score.set(new_score)

    rps_window = Toplevel()
    rps_window.title ("Rock, Paper, Scissors")

    player_choice = IntVar()
    computer_choice = StringVar()
    result_set = StringVar()
    player_choice.set(1)
    player_score = IntVar()
    computer_score = IntVar()

    rps_frame = Frame(rps_window, padding = '3 3 12 12', width = 300)
    rps_frame.grid(column=0, row = 0, sticky=(N,W,E,S))
    rps_frame.columnconfigure(0, weight=1)
    rps_frame.rowconfigure(0,weight=1)

    Label(rps_frame, text='Player').grid(column=1, row = 1, sticky = W)
    Radiobutton(rps_frame, text ='Rock', variable = player_choice, value = 1).grid(column=1,
    row=2, sticky=W)
    Radiobutton(rps_frame, text ='Paper', variable = player_choice, value = 2).grid(column=1,
    row=3, sticky=W)
    Radiobutton(rps_frame, text ='Scissors', variable = player_choice, value =
    3).grid(column=1, row=4, sticky=W)

    Label(rps_frame, text='Computer').grid(column=3, row = 1, sticky = W)
    Label(rps_frame, textvariable = computer_choice).grid(column=3, row=3, sticky = W)

    Button(rps_frame, text="Play", command = start).grid(column = 2, row = 2)

    Label(rps_frame, text = "Score").grid(column = 1, row = 5, sticky = W)
    Label(rps_frame, textvariable = player_score).grid(column = 1, row = 6, sticky = W)

    Label(rps_frame, text = "Score").grid(column = 3, row = 5, sticky = W)
    Label(rps_frame, textvariable = computer_score).grid(column = 3, row = 6, sticky = W)

    Label(rps_frame, textvariable = result_set).grid(column = 2, row = 7)

if __name__ == '__main__':
    gui()
```

```
01  #!/usr/bin/env python3

    #Linux User & Developer presents: Mega Micrograms Collection

02  from tkinter import *

    import rockpaperscissors
03  import hangman
    import pokerdice

04  root = Tk()
    root.title (“Linux User & Developer’s Mega Microgames Collection”)

    mainframe = Frame(root, height = 200, width = 500)
05  mainframe.pack_propagate(0)
    mainframe.pack(padx = 5, pady = 5)

    intro = Label(mainframe, text = “””Welcome to Linux User & Developers Mega Microgames Collection.
06  Please select one of the following games to play:
    “””)
    intro.pack(side = TOP)

07  rps_button = Button(mainframe, text = “Rock, Paper, Scissors”, command = rockpaperscissors.gui)
    rps_button.pack()

08  hm_button = Button(mainframe, text = “Hangman”, command = hangman.start)
    hm_button.pack()

    pd_button = Button(mainframe, text = “Poker Dice”, command = pokerdice.start)
    pd_button.pack()

    exit_button = Button(mainframe, text = “Quit”, command = root.destroy)
09  exit_button.pack(side = BOTTOM)

    root.mainloop()
```

MAIN WINDOW

The main interface window that this code creates is fairly basic, but contains the functions we require. The window exit button will do the same job as the Quit button, and the Hangman and Poker Dice buttons run the old scripts in the Python shell.



Linux User & Developer's Mega Microgames Collection

Welcome to Linux User & Developers Mega Microgames Collection.
Please select one of the following games to play:

01 First line
We use this line to enter the path to the Python interpreter. This lets us run the program inside a terminal or otherwise outside of a Python-specific IDE like IDLE. Note that we're also using Python 3 for this particular script.

02 Import graphics
Tkinter is the graphical interface we're using and while it's a standard Python function, you'll need to import the module so you can use it. We've used the 'from [module] import *' method so that we can use the functions from it without having to add Tkinter at the beginning.

03 Import games
We're importing the modules for the three games. We added the line at the bottom of each script so we can do this. To make sure to differentiate the functions in each game, we will have to specify [module].[function] so there are no errors in the code.

04 Root window
Using the Tk() function creates the window we're going to be placing everything into. We've decided to call it root for now; however, you can call it anything you like, as long as you're consistent with it. We've also named it using the title command from Tkinter and a string of text.

05 Main frame
The first line has us set the variable mainframe as a Frame in the interface. We've attached it to root, the main window, and given it a minimum height and width in pixels. We use pack_propogate to create the window, and then make sure it's the size that we've defined. We've then used pack to pad the borders, allowing the contents of the window to not touch the sides of it.

06 Introductions
We create the intro variable as a label that lives in the main frame. We give it text to introduce the interface, using the triple quote marks to have it go across multiple lines and format better. We then use pack to display it, and tell Tkinter to put it at the top of the interface.

07 Rock, Paper, Scissors
We create a button for the Rock, Paper, Scissors game using the Button function. We attach to it the main frame, give it a label using

10
```
#!/usr/bin/env python3

# Linux User & Developer presents: Rock, Paper, Scissors: The Video Game: The Module

from tkinter import *
from ttk import *
import random
```

11
```
def gui():
```

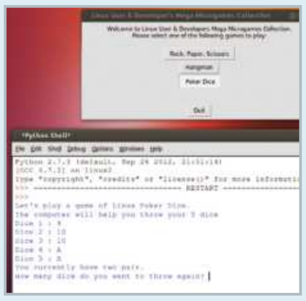
12
```
    rock = 1
    paper = 2
    scissors = 3

    names = { rock: "Rock", paper: "Paper", scissors: "Scissors" }
    rules = { rock: scissors, paper: rock, scissors: paper }
```

13
```
    def start():
        while game():
            pass
```

14
```
    def game():
        player = player_choice.get()
        computer = random.randint(1, 3)
        computer_choice.set(names[computer])
        result(player, computer)
```

PYTHON SHELL

Our other code will run in the shell or via a command line in the same way as before when the buttons are pressed.


Linux User & Developer's Mega Microgames Collection
Welcome to Linux User & Developers Mega Microgames Collection.
Please select one of the following games to play:
Rock, Paper, Scissors
Hangman
Poker Dice
Quit
Python Shell
File Edit Shell Debug Options Windows Help

```
Python 2.7.3 (default, Sep 26 2012, 21:51:14)
[GCC 4.7.2] on linux2
Type "copyright", "credits" or "license()" for more informati
>>> ================================ RESTART ================
>>>
Let's play a game of Linux Poker Dice.
The computer will help you throw your 5 dice
Dice 1 : 9
Dice 2 : 10
Dice 3 : 10
Dice 4 : A
Dice 5 : A
You currently have two pair.
How many dice do you want to throw again?
```

text that appears on the button, and then have it run a command. In this case, we use the modified rockpapershotgun.py code that has a gui function, hence rockpapershotgun.py. We then use pack to place it in the window

08 Other games

For the other two games, the code is mostly the same; however, we call upon the start function in both of them. In the final interface, this will cause the games to run in the shell or command line as they've been running before.

09 Break the loop

The exit button works similarly to the other buttons we've created, but instead it uses the command root.destroy. This ends the loop that we've created with root.mainloop(), which allows the interface code to continue looping, allowing us to continually use it. We place the exit button at the bottom of the window with 'side = BOTTOM'.

10 Game code

Nothing much has changed in the start of this code, other than a few import changes. The code for running it in the command line is still there, and with a few modifications the code will run independently of the main interface. We've removed the time module, as we no longer need it, and imported not only the Tkinter module, but the ttk module. The ttk module allows us to arrange the GUI in a grid, which will be slightly easier to use and understand.

11 Game interface

One of the biggest changes we're making to this script is having it all contained in one function, 'def gui'. The interface code needs to be put into a function, otherwise it will be run during import. While we've chosen to put the entirety of the code in a function, you can also try just having the graphical interface code in one. All our variables are kept in here so that they still work properly.

12 Game variables

The variables are staying the same so that we can do the same comparisons we made in the original code. We've put them into the function itself so that they don't affect the other imported code into the main interface – and so that when calling just this function, we don't need to use global to bring them in.

13 Start function

We've removed the part that calls the score function from the start function, as we have the interface handle the scoring now. It still calls upon the game function, though, putting it into a loop so it can be used continuously. This function is called by the interface to begin the game by setting a computer move and then comparing it to the player's choice.

14 Game function

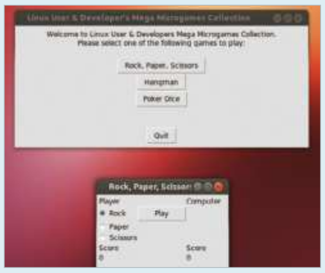
The game function has had a few modifications to make sure it works with the interface. First of all, the player variable is retried using get() on the special variable we've created to contain the player choice. We do a similar thing for the computer, using 'set' to change the variable in our interface-friendly computer_choice value. We still use the name variable to set the text that goes into computer_choice. This then passes the player and computer variables along in the same way we did before.

»

```
15  def result(player, computer):
        new_score = 0
16      if player == computer:
            result_set.set("Tie game.")
        else:
            if rules[player] == computer:
17              result_set.set("Your victory has been assured.")
                new_score = player_score.get()
                new_score += 1
                player_score.set(new_score)
            else:
                result_set.set("The computer laughs as you realise you have been defeated.")
18              new_score = computer_score.get()
                new_score += 1
                computer_score.set(new_score)

19  rps_window = Toplevel()
    rps_window.title ("Rock, Paper, Scissors")

    player_choice = IntVar()
    computer_choice = StringVar()
20  result_set = StringVar()
    player_choice.set(1)
    player_score = IntVar()
    computer_score = IntVar()
```

GAME WINDOW

In its default state, the game window will have rock selected and no message will be displayed. Once the player makes a move, the message will be displayed at the bottom and the computer's move will be printed. There's no quit button on this menu, but clicking the window exit will bring you back to the main interface.


Linux User & Developer's Mega Microgames Collection

Welcome to Linux User & Developers Mega Microgames Collection.
Please select one of the following games to play:

15 Result function

The result function still takes the same two variables as before, which we set in the game function. While technically we can use the variables set up for the interface, these are not pure integers and can cause an error if not handled correctly. With that in mind, we've created an empty new_score variable that we can use to effectively clean the interface value before adding it back into it.

16 Tie

The logic for determining the result is the same as before. We first do the easy check – whether or not the numeric value for the player and computer variable is the same. What changes this time is that, instead of printing the text, we send the "Tie game" message to our result variable using the set function from Tkinter.

17 Win

The if statement continues by seeing if the player has won. Like before, we use the rules we set to make the comparison for the code to make. We set the result_set like we did in the tie game, with a different message to the user. Finally, we set the new_score variable to be the current player score, using the get function to obtain it, plus one to the score, and then use set again to put it back into the player_score variable. We can't use += with the player_score variable, as it is not a standard variable.

18 Lose

This part of the overall if statement works in the same way as before, by assuming that if it isn't a tie or a win, it's a loss. Like the new version of the win code, it then uses set to change the message that will be displayed to the player, and calls upon and changes the computer score by putting it through the new_score variable.

19 New window

As the original window is part of the mainloop, we cannot have the window be created using Tk() like in the main interface code. As this window is coming off it, though, we instead create it using Toplevel(). This allows the window to run separately and on top of the main window. We've also given it a name, which will not change the main window's name in the process.

20 Interface variables

Here is the reason we had to call and change the variables in a different manner. For Tkinter, we need to let the interface know whether or not a variable is an integer or a text value. IntVar and StringVar allow for these respectively. We've also set the player_choice variable to be one, which we have already set as the choice for rock. This means there will at least be a default choice when the game is started, and it won't cause an error.

21 Game frame

We've created the frame for our interface items slightly differently. Instead of using the pack command in the main interface, we're using grid to make sure they're orientated in such a way that makes sense for the user. Padding does just that, setting up values to make sure the items in the frame don't touch the edge of the window. Using the .grid command, we then create this frame. The row and column variables allow for rows and columns to be included in the structure of

21
```
rps_frame = Frame(rps_window, padding = '3 3 12 12', width = 300)
rps_frame.grid(column=0, row = 0, sticky=(N,W,E,S))
rps_frame.columnconfigure(0, weight=1)
rps_frame.rowconfigure(0,weight=1)
```

22
```
Label(rps_frame, text='Player').grid(column=1, row = 1, sticky = W)
Radiobutton(rps_frame, text ='Rock', variable = player_choice, value = 1).grid(column=1, row=2,
sticky=W)
Radiobutton(rps_frame, text ='Paper', variable = player_choice, value = 2).grid(column=1, row=3,
sticky=W)
Radiobutton(rps_frame, text ='Scissors', variable = player_choice, value = 3).grid(column=1,
row=4, sticky=W)
```

23
```
Label(rps_frame, text='Computer').grid(column=3, row = 1, sticky = W)
Label(rps_frame, textvariable = computer_choice).grid(column=3, row=3, sticky = W)
```

24
```
Button(rps_frame, text="Play", command = start).grid(column = 2, row = 2)
```

25
```
Label(rps_frame, text = "Score").grid(column = 1, row = 5, sticky = W)
Label(rps_frame, textvariable = player_score).grid(column = 1, row = 6, sticky = W)

Label(rps_frame, text = "Score").grid(column = 3, row = 5, sticky = W)
Label(rps_frame, textvariable = computer_score).grid(column = 3, row = 6, sticky = W)

Label(rps_frame, textvariable = result_set).grid(column = 2, row = 7)
```

26
```
if __name__ == '__main__':
    gui()
```

the window, and the sticky allows us to justify items with specific directions – in this case top, left, right and bottom justification. Finally, we then make sure each column and row is treated equally by giving them the same weighting, and starting from zero.

22 Player's choice

We create a label for the player's move and assign it to a grid location, on the first row, on the first column. We also justify it to the left using 'sticky = W'. We then add the radio buttons for the player's move, each on the same column but the following row down. We give each choice a name, then assign it to the player_choice variable. We then make each choice have a numerical value that corresponds to the moves we've determined in the first set of rules.

23 Computer's move

We display the computer move here. First of all, we label what this is and then create a second label to display the actual move. We do this by adding the textvariable option to Label, and using the computer_choice variable we updated earlier in the game function. This merely prints the text from the names list and justifies this to the left.

24 Press Play

The running of the code all hinges on the Play button. It's very simple: we put it in the row between the Player and Computer move as part of our three-column system; and it runs the start function using the command option. Due to the loop of the interface, we can keep pressing this without needing to be asked to play again. Simply exiting the window will go back to the main interface window as well, meaning we do not need a specific quit button.

25 Running score

We have two sets of scores to display – one for the player and the other for the computer. We label these the same way we've done with labelling the Player and Computer move, having them on a lower row but still in the relevant columns. Below that, we use the textvariable option again to get the numerical score we assigned to the separate score variable. Finally, we create another label to display the message for the game's outcome

26 End game

The final part of the code allows for the script to be used by the main window, and also allows for it to run on its own when used in the command line or shell. You'll need to perform some modifications to make it run on its own, such as making it the mainloop and not a Toplevel window. However, it will run just fine from both without the need to be launched from the main interface.

Bring graphics to simple Python games

Complete your trio of games with a graphical interface for the hangman and poker dice code

We have now created a simple selector for the trio of Python games we made previously. This interface was able to launch a GUI for our rock, paper, scissors game, and run the other two in the terminal. Now, we're going to convert the hangman and poker dice codes to work in a similar way to rock, paper, scissors.

The trick with hangman comes in allowing for a different type of input, text, and the ability to have multiple rounds of the game. Tkinter allows for text entry, and we rely a lot less on 'while' loops to play the game in its entirety. Poker Dice needs to keep the dice analysis code, and the option to change specific dice using checkboxes.

We'll be modifying a large amount of the original code to fit in with the new graphical scheme. This mainly involves cutting specific parts and having the Tkinter-specific code handle these itself. The code listings on these pages include the modified code – we'll discuss the graphical part on the following pages.

Resources

Python 2: www.python.org/download

IDLE: www.python.org/idle

1 Imported
Here we're doing a minor setup, including getting the Tkinter module that helps us create a simple graphical interface

2 Words
We're keeping our variables that determine the word to guess here so it can be easily accessed anywhere in the code

3 Function
Like last time, we're putting the majority of our original code into a new function, gui

4 Analysis
We select the word and analyse it before continuing on with the rest of the code

5 Graphics
The hangedman function is largely unchanged, albeit with new code to display our ASCII graphics on the interface

6 Guesses
We check the number of mistakes made, and call the guess_letter function to check the letter entered

Hangman Code Listing

```
   from tkinter import *
01 from ttk import *
   from random import *
   word = 0
02 word_length = 0
   clue = 0

03 def gui():
       global word, word_length, clue
       dictionary = [“gnu”,”kernel”,”linux”,”magei
   a”,”penguin”,”ubuntu”]
04     word = choice(dictionary)
       word_length = len(word)
       clue = word_length * [“_”]
       tries = 6

       def hangedman(hangman):
           graphic = [
           “””
               +--------+
               |        |
               |        O
05             |       -|-
               |       / \
               |
           ===============
           “””]
           graphic_set = graphic[hangman]
           hm_graphic.set(graphic_set)

       def game():
           letters_wrong = incorrect_guesses.get()
           letter=guess_letter()
06         first_index=word.find(letter)
           if  first_index == -1:
               letters_wrong +=1
               incorrect_guesses.set(letters_
               wrong)
           else:
               for i in range(word_length):
                   if letter == word[i]:
                       clue[i] = letter
           hangedman(letters_wrong)
           clue_set = “ “.join(clue)
           word_output.set(clue_set)
           if letters_wrong == tries:
               result_text = “Game Over. The word
   was “ + word
               result_set.set(result_text)
               new_score = computer_score.get()
               new_score += 1
               computer_score.set(new_score)
           if “”.join(clue) == word:
               result_text = “You Win! The word
   was “ + word
               result_set.set(result_text)
               new_score = player_score.get()
               new_score += 1
               player_score.set(new_score)

       def guess_letter():
           letter = letter_guess.get()
           letter.strip()
           letter.lower()
           return letter

       def reset_game():
           global word, word_length, clue
           incorrect_guesses.set(0)
           hangedman(0)
           result_set.set(“”)
           letter_guess.set(“”)
           word = choice(dictionary)
           word_length = len(word)
           clue = word_length * [“_”]
           new_clue = “ “.join(clue)
           word_output.set(new_clue)

   if __name__ == ‘__main__’:
       gui()
```

1 More imports
We've added the new imported modules we need to make Tkinter work and keep the rest the same

2 Dice list
The list that holds the dice is kept outside the main function so that it can be accessed everywhere

3 Rolls
Same goes for the roll function. It doesn't specifically need to be inside the gui function anyway

4 Decisions
The checkboxes in the graphical code we're going to create later will give us numbers we can analyse for the code. We retrieve these numbers and check them to find out which dice the user wishes to re-roll

5 Hands
Finally, our hand analysis function is the last part of the original code that is kept outside the gui function. Both this and the above function pass the necessary details back up the chain to then be added into the new graphical elements of the new interface

6 No dice
If no dice have been selected to re-roll, the hand output is changed to show a final message

7 Re-roll
This part is almost the same as before – a new set of dice are rolled and then inserted into the list of dice like before, then re-sorted to make the hand analysis easier

8 More functions
The new gui function is the main change to the Poker Dice code, and as before includes the Tkinter elements and other parts of the original code

9 Game start
A simple function that we can use to activate the re-rolls of the dice

10 New hand
The new dice are named, analysed, and everything is then set for the gui to display the final outcome

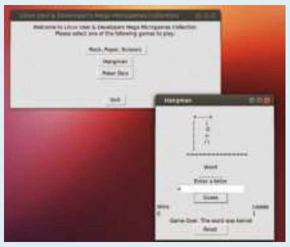
11 Reset
Like with the hangman code, we have a function to reset all the variables, allowing you to start the game again

Poker Dice Code Listing

```
01
from tkinter import *
from ttk import *
import random
from itertools import groupby
02
dice = 0

03
def roll(roll_number):
        numbers = range(1,7)
        dice = range(roll_number)
        iterations = 0
        while iterations < roll_number:
            iterations = iterations + 1
            dice[iterations-1] = random.
choice(numbers)
        return dice

04
def hand(dice):
    dice_hand = [len(list(group)) for key,
group in groupby(dice)]
    dice_hand.sort(reverse=True)
    straight1 = [1,2,3,4,5]
    straight2 = [2,3,4,5,6]
    if dice == straight1 or dice ==
straight2:
        return "a straight!"
    elif dice_hand[0] == 5:
        return "five of a kind!"
    elif dice_hand[0] == 4:
        return "four of a kind!"
    elif dice_hand[0] == 3:
        if dice_hand[1] == 2:
            return "a full house!"
        else:
            return "three of a kind."
    elif dice_hand[0] == 2:
        if dice_hand[1] == 2:
            return "two pair."
        else:
            return "one pair."
    else:
        return "a high card."

05
def gui():
    global dice
    dice = roll(5)
    dice.sort()
    nine = 1
    ten = 2
    jack = 3
    queen = 4
    king = 5
    ace = 6
    names = { nine: "9", ten: "10", jack:
"J", queen: "Q", king: "K", ace: "A" }
    result = "You have " + hand(dice)

06
    def game():
        throws()

    def throws():
07
        global dice
        dice1_check = dice1.get()
        dice2_check = dice2.get()
        dice3_check = dice3.get()
        dice4_check = dice4.get()
        dice5_check = dice5.get()
        dice_rerolls = [dice1_check,
dice2_check, dice3_check, dice4_check,
dice5_check]
08
        for i in range(len(dice_rerolls)):
            if 0 in dice_rerolls:
                dice_rerolls.remove(0)
        if len(dice_rerolls) == 0:
            result = "You finish with " +
hand(dice)
            hand_output.set(result)
09
        else:
            roll_number = len(dice_rerolls)
            number_rerolls = roll(roll_num-
ber)
            dice_changes = range(len(dice_
rerolls))
            iterations = 0
            while iterations < roll_number:
                iterations = iterations + 1
                dice_changes[iterations-1]
= number_rerolls[iterations-1]
            iterations = 0
            while iterations < roll_number:
                iterations = iterations + 1
                replacement = number_
rerolls[iterations-1]
                dice[dice_
changes[iterations-1]] = replacement
            dice.sort()
            new_dice_list = [0,0,0,0,0]
            for i in range(len(dice)):
                new_dice_list[i] =
names[dice[i]]
            final_dice = " ".join(new_dice_
list)
10
            dice_output.set(final_dice)
            final_result = "You finish with
" + hand(dice)
            hand_output.set(final_result)

11
    def reset_game():
        global dice
        dice = roll(5)
        dice.sort()
        for i in range(len(dice)):
            empty_dice[i] =  names[dice[i]]
        first_dice = " ".join(empty_dice)
        dice_output.set(first_dice)
        result = "You have " + hand(dice)
        hand_output.set(result)

if __name__ == '__main__':
    gui()
    #!/usr/bin/env python3

01  from tkinter import *
    from ttk import *
    from random import *
    word = 0
02  word_length = 0
    clue = 0

03  def gui():
        global word, word_length, clue
        dictionary = ["gnu","kernel","linux","mageia","penguin","ubuntu"]
        word = choice(dictionary)
04      word_length = len(word)
        clue = word_length * ["_"]
        tries = 6

        def hangedman(hangman):
            graphic = [
            """
                +--------+
                |        |
05              |        O
                |       -|-
                |       / \
                |
            ===============
            """]
            graphic_set = graphic[hangman]
            hm_graphic.set(graphic_set)

        def game():
06          letters_wrong = incorrect_guesses.get()
            letter=guess_letter()
            first_index=word.find(letter)
            if  first_index == -1:
                letters_wrong +=1
07              incorrect_guesses.set(letters_wrong)
            else:
                for i in range(word_length):
                    if letter == word[i]:
                        clue[i] = letter
            hangedman(letters_wrong)
08          clue_set = " ".join(clue)
            word_output.set(clue_set)
            if letters_wrong == tries:
                result_text = "Game Over. The word was " + word
                result_set.set(result_text)
                new_score = computer_score.get()
                new_score += 1
                computer_score.set(new_score)
09          if "".join(clue) == word:
                result_text = "You Win! The word was " + word
                result_set.set(result_text)
                new_score = player_score.get()
                new_score += 1
                player_score.set(new_score)
```

YOU LOSE

When you've run out of guesses, the game stops. From here, you can also reset the game to play again if you wish.



01 First lines

As usual, we start off each program with the code that lets us run it in the command line, followed by importing the necessary modules: **random**, to determine the word to use; **tkinter**, for the majority of the graphical code; and **ttk**, for the grid code we'll be using to align the different elements.

02 Global variables

We have kept these three variables outside of the **gui** function so they can be accessed at all points in the code. Python 2 does not allow you to call upon global variables when you're in a nested function, whereas in Python 3 this could have gone into the gui function.

03 Graphical function

We're putting all the working code into the gui function so it can be activated from the main interface. This means we can import the Hangman code into the interface without the game window popping up, and only run it when we activate the gui function from here.

04 Random word

We bring in the three variables with **global** so we can modify them throughout the code, and then set the word. As before, a random item from the list of words is selected with choice, the length is ascertained, and the clue to display is set.

05 The hanged man

The main difference this time for the Hangman graphics is that instead of printing these out, we're going to display them in the interface. When the function is called and the graphic selected, it's placed in the variable we've set up in the interface code that we're using to display the result.

06 Games begin

All the analysis of the letter we've entered is done in this function. To that end, we start by obtaining the incorrect guesses so far from the variable we've set up so the interface can access it if we want it to. The letter from the entry field in the interface is then obtained and cleaned up so it can be used with the rest of the code.

07 Check the letter

This section of the code is again largely unchanged – the letter is taken and compared to the word with **find** to see if it matches with one of the letters. The if statement then adds one to the incorrect guess variable, or updates the clue variable to add the letter in the right spot.

08 Update interface

These three lines set the graphic for this round, join the current clue together as a string, and then set it on the variable for the interface to read.

09 Update scores

Exactly as before, we check to see if the player has won or lost yet. In the event of either, a message is displayed to signify this, and the wins and losses score is updated using **set**.

10
```
    def guess_letter():
        letter = letter_guess.get()
        letter.strip()
        letter.lower()
        return letter

    def reset_game():
        global word, word_length, clue
        incorrect_guesses.set(0)
        hangedman(0)
        result_set.set("")
        letter_guess.set("")
        word = choice(dictionary)
        word_length = len(word)
        clue = word_length * ["_"]
        new_clue = " ".join(clue)
        word_output.set(new_clue)
```

11
```
    hm_window = Toplevel()
    hm_window.title ("Hangman")
```

12
```
    incorrect_guesses = IntVar()
    incorrect_guesses.set(0)
    player_score = IntVar()
    computer_score = IntVar()
    result_set = StringVar()
    letter_guess = StringVar()
    word_output = StringVar()
    hm_graphic = StringVar()
```

13
```
    hm_frame = Frame(hm_window, padding = '3 3 12 12', width = 300)
    hm_frame.grid(column=0, row = 0, sticky=(N,W,E,S))
    hm_frame.columnconfigure(0, weight=1)
    hm_frame.rowconfigure(0,weight=1)
```

14
```
    Label(hm_frame, textvariable = hm_graphic).grid(column=2, row = 1)
    Label(hm_frame, text='Word').grid(column=2, row = 2)
    Label(hm_frame, textvariable = word_output).grid(column=2, row = 3)

    Label(hm_frame, text='Enter a letter').grid(column=2, row = 4)
```

15
```
    hm_entry = Entry(hm_frame, exportselection = 0, textvariable = letter_guess).grid(column = 2, row = 5)
    hm_entry_button = Button(hm_frame, text = "Guess", command = game).grid(column = 2, row = 6)
```

16
```
    Label(hm_frame, text = "Wins").grid(column = 1, row = 7, sticky = W)
    Label(hm_frame, textvariable = player_score).grid(column = 1, row = 8, sticky = W)
    Label(hm_frame, text = "Losses").grid(column = 3, row = 7, sticky = W)
    Label(hm_frame, textvariable = computer_score).grid(column = 3, row = 8, sticky = W)
    Label(hm_frame, textvariable = result_set).grid(column = 2, row = 9)
    replay_button = Button(hm_frame, text = "Reset", command = reset_game).grid(column = 2, row = 10)

if __name__ == '__main__':
    gui()
```

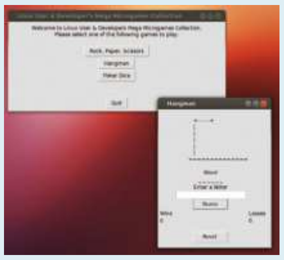
ORIGINAL INTERFACE

You'll also need the interface code from the earlier tutorial, which already works with the modified Rock, Paper, Scissors code. The way it was left off means it won't work with the new code, so you'll have to change the command in each button from **[game].start** to **[game].gui**.

```
[illegible]
```

THE HANGMAN GUI

Press the updated Hangman button to launch a new window. Here we have the initial graphic, word clue and entry for the player to interact with. The scores are set to zero, and no result message is displayed as no games have been played yet.



10 Sanitise input

The **guess_letter** function purely gets the letter from the player input variable, strips it of any formatting, makes it lower case, and then returns it back to the game function. This is so the letter can be used properly.

11 New window

We use the **Toplevel** command from Tkinter like last month to separate the loops of the main interface and game window. We then use **title** to call it Hangman.

12 Interface variables

Tkinter only works with specific variables – we've created all the ones we need or can use here. IntVars take integers, while StringVars take strings. We've used **get** and **set** throughout the code with these to get and set values.

" The frame is set up as before "

13 Framed window

The frame is set up the same way as last time. We pad the frame from the edge of the window, set a grid, give it sticky points at compass points, and allow for setting objects with specific row and column points.

14 Clue to Hangman

These labels are fairly straightforward – we're either giving them fixed text, or telling them to use a specific **textvariable** so they can be updated as we play the game.

15 Text entry

Entry here sets a text box we will add the letters to. The **exportselection** option makes it so selecting the letter won't immediately copy it to the clipboard, and the **textvariable** selection is where the code stores the letter added. The button activates the **game** function, analysing the letter the player entered.

16 Results and reset

The rest of the code is similar to what we've done already: labels to display fixed text and the scores/result text that change. The button that activates the **reset** function is also put at the bottom here. The final two lines allow us to import the module into the interface code.

»

17 Start over
The usual array of command-line compatibility and module importing here. The **groupby** function is specifically imported here for dice analysis.

18 Outside dice
For Poker Dice, there's only one variable to show at any one time, the dice. Again, due to the nested functions, and because we're using Python 2, we need to call it with **global** from here to make sure the game can be reset properly.

19 Dice rolls
The **roll** function has been removed from the **gui** function so as not to create any code errors with some of its variables. It can be easily called within the nested functions. It hasn't changed at all from the original code.

20 Hand of dice
Like **roll**, nothing has changed for the **hand** function. It's simply now placed outside the **gui** function for the exact same reasons. It also means that you can easily import this function into another script if you wish.

21 GUI start
As we've mentioned last month and in the Hangman code, we put all the GUI code into a function so that we can call on it when we want to. In this case, pressing the Poker Dice button on the main interface activates **pokerdice.gui**, which is this function.

22 First roll
As the window opens, we immediately make the first roll. This is then sorted, each number is attributed to a card, and then the result is created to be displayed in the main window. This is similar to how it worked before, but instead it's now entered into the StringVars for the interface towards the end of the script

23 Start game
When we activate the button that starts **game**, it immediately sends us to the rest of the code. This would also work if you had the button go to the **throws** function instead; however, you can add other functions to this part if you wish.

24 Dice selection
The first thing we do is find out what checkboxes have been ticked by the player. We then put these in a list so we can change out the correct dice numbers. We've also brought in **dice** so we can check against that what the current dice rolls are.

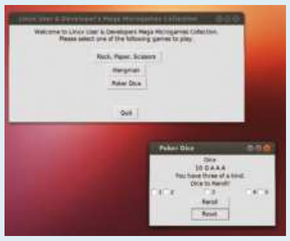
17
```
#!/usr/bin/env python3

from tkinter import *
from ttk import *
import random
from itertools import groupby
```
18
```
dice = 0
```
19
```
def roll(roll_number):
    numbers = range(1,7)
    dice = range(roll_number)
    iterations = 0
    while iterations < roll_number:
        iterations = iterations + 1
        dice[iterations-1] = random.choice(numbers)
    return dice
```
20
```
def hand(dice):
  dice_hand = [len(list(group)) for key, group in groupby(dice)]
  dice_hand.sort(reverse=True)
  straight1 = [1,2,3,4,5]
  straight2 = [2,3,4,5,6]
  if dice == straight1 or dice == straight2:
    return "a straight!"
  elif dice_hand[0] == 5:
    return "five of a kind!"
  elif dice_hand[0] == 4:
    return "four of a kind!"
  elif dice_hand[0] == 3:
    if dice_hand[1] == 2:
      return "a full house!"
    else:
      return "three of a kind."
  elif dice_hand[0] == 2:
    if dice_hand[1] == 2:
      return "two pair."
    else:
      return "one pair."
  else:
    return "a high card."
```
21
```
def gui():
  global dice
```
22
```
  dice = roll(5)
  dice.sort()
  nine = 1
  ten = 2
  jack = 3
  queen = 4
  king = 5
  ace = 6
  names = { nine: "9", ten: "10", jack: "J", queen: "Q", king: "K",
ace: "A" }
  result = "You have " + hand(dice)
```
23
```
  def game():
    throws()
```
24
```
  def throws():
    global dice
    dice1_check = dice1.get()
    dice2_check = dice2.get()
    dice3_check = dice3.get()
    dice4_check = dice4.get()
    dice5_check = dice5.get()
    dice_rerolls = [dice1_check, dice2_check, dice3_check, dice4_
check, dice5_check]
```

EXTRA GAME FUNCTIONS

We mentioned that the **game** function doesn't necessarily need to be used right now. You can either clean up the code and remove it, or add extra functions, such as being able to choose a random new selection of dice, or making it two-player. Experiment with what you want to do!

THE POKER DICE GUI

Two things are being printed out on the initial window. The first set of dice, ordered in the way we did last time, and the current hand. The checkboxes activate a specific number that is used when re-rolling dice with the Reroll button.



```
        for i in range(len(dice_rerolls)):
            if 0 in dice_rerolls:                                    25
                dice_rerolls.remove(0)
        if len(dice_rerolls) == 0:
            result = "You finish with " + hand(dice)                 26
            hand_output.set(result)
        else:
            roll_number = len(dice_rerolls)
            number_rerolls = roll(roll_number)
            dice_changes = range(len(dice_rerolls))
            iterations = 0                                           27
            while iterations < roll_number:
                iterations = iterations + 1
                dice_changes[iterations-1] = number_rerolls[iterations-1]
            iterations = 0
            while iterations < roll_number:
                iterations = iterations + 1
                replacement = number_rerolls[iterations-1]
                dice[dice_changes[iterations-1]] = replacement
            dice.sort()
            new_dice_list = [0,0,0,0,0]
            for i in range(len(dice)):
                new_dice_list[i] =  names[dice[i]]
            final_dice = " ".join(new_dice_list)
            dice_output.set(final_dice)
            final_result = "You finish with " + hand(dice)           28
            hand_output.set(final_result)

    def reset_game():
        global dice
        dice = roll(5)
        dice.sort()
        for i in range(len(dice)):
            empty_dice[i] =  names[dice[i]]
        first_dice = " ".join(empty_dice)
        dice_output.set(first_dice)
        result = "You have " + hand(dice)
        hand_output.set(result)

    pd_window = Toplevel()
    pd_window.title ("Poker Dice")
    dice_output = StringVar()
    empty_dice = [0,0,0,0,0]
    for i in range(len(dice)):
        empty_dice[i] =  names[dice[i]]
    first_dice = " ".join(empty_dice)
    dice_output.set(first_dice)
    hand_output = StringVar()
    hand_output.set(result)                                          29
    dice1 = IntVar()
    dice2 = IntVar()
    dice3 = IntVar()
    dice4 = IntVar()
    dice5 = IntVar()
    result_set = StringVar()
    player_score = IntVar()
    computer_score = IntVar()

    pd_frame = Frame(pd_window, padding = '3 3 12 12', width = 300)
    pd_frame.grid(column=0, row = 0, sticky=(N,W,E,S))
    pd_frame.columnconfigure(0, weight=1)
    pd_frame.rowconfigure(0,weight=1)
    Label(pd_frame, text='Dice').grid(column=3, row = 1)
    Label(pd_frame, textvariable = dice_output).grid(column=3, row = 2)
    Label(pd_frame, textvariable = hand_output).grid(column=3, row = 3)

    Label(pd_frame, text='Dice to Reroll?').grid(column=3, row = 4)
    reroll1 = Checkbutton(pd_frame, text = "1", variable = dice1, onvalue = 1, offvalue
= 0).grid(column=1, row = 5)
    reroll2 = Checkbutton(pd_frame, text = "2", variable = dice2, onvalue = 2, offvalue
= 0).grid(column=2, row = 5)
    reroll3 = Checkbutton(pd_frame, text = "3", variable = dice3, onvalue = 3, offvalue
= 0).grid(column=3, row = 5)                                         30
    reroll4 = Checkbutton(pd_frame, text = "4", variable = dice4, onvalue = 4, offvalue
= 0).grid(column=4, row = 5)
    reroll5 = Checkbutton(pd_frame, text = "5", variable = dice5, onvalue = 5, offvalue
= 0).grid(column=5, row = 5)
    pd_reroll_button = Button(pd_frame, text = "Reroll", command = game).grid(column =
3, row = 6)
    replay_button = Button(pd_frame, text = "Reset", command = reset_game).grid(column
= 3, row = 7)

if __name__ == '__main__':
    gui()
```

ONE WINDOW

The way we've made these Tkinter interfaces is to have the games launch in a separate window. You can have them all running in one window, though, by replacing the labels and buttons of the original interface by putting them as different functions or classes. Make sure to add a quit button to the games that lets you go back to the main page.

"The check buttons are new"

25 Dice to re-roll

If a checkbox isn't selected, we have it set to give a zero value. We want to remove these from the list so that the correct dice are changed, so we use the **for** loop to check each part of the list, and then use the **remove** function when the element does equal zero.

26 Early finish

If no dice have been selected to re-roll, the list will contain all 0s, which will then be removed. The length of this list will then also be zero, meaning we can use that to end the game if the player hits Reroll without selecting any dice.

27 New dice

This **else** function works roughly the same as before. We start by getting the necessary information for how many dice to roll, and a list to put the re-rolls. We then roll as many new dice as we need with the first **while** loop

28 Game over

We use the same kind of **while** loop to replace the new numbers into the original list, much like last time. Then the dice are re-sorted, analysed, joined as a string and then set into the interface's variable. The final hand message is also create and set.

29 Graphical variables

As we're rolling the dice as soon as we launch the game, but the interface code doesn't start until the end, you can see that after creating the necessary variables, we also then set them. Of note, the dice have to be made into a string separately with the **for** loop before adding to the variable.

30 Check buttons

The main new addition to this code is the check buttons with **Checkbutton**. You can set an on and off value, with default off being 0. We've made it so that the check buttons return the same number as the dice they're changing, which we explained how we used earlier in the code. The **variable** option sets whatever the outcome is to the specific Tkinter variable.

Embed Python in C

Here, we will learn how to use Python code within your usual C program to get the best of both worlds

There are times, within a C program, when you may want to execute some piece of Python code. Maybe you want to be able to run user code within your program, for example. This means you can enable users to use plug-ins to extend your program's functionality. The way we can do this is by embedding Python within the C program.

We will look at how to embed, how to run your Python code, and how to interact with the Python interpreter you've set up. This is functionality built into Python itself, so you don't need to install anything extra on your Raspberry Pi, aside from the development package for Python and GCC. You will need to install them with the command:

```
sudo apt-get install python-dev gcc
```

You should now have all of the tools you need to compile your code.

The first step is to start the interpreter. To access the functions you need, you will have to add the following line to the head of your C source code file:

```
#include <Python.h>
```

You can now start to embed Python. The first function you need is void Py_Initialize(). The only other functions that can be called, before you initialise the interpreter, are Py_SetProgramName(), Py_SetPythonHome(), PyEval_InitThreads(), PyEval_ReleaseLock() and PyEval_AcquireLock(). Once this function finishes, you can start to interact with this interpreter. This starts up the interpreter, and loads the core modules __builtin__, __main__ and sys. But what about other modules? You can set the search path, where the interpreter will look to find modules, by using the function void Py_SetPythonHome(char *home). If you need the information, you can find the current module path with the function char* Py_GetPythonHome().

It does not set sys.argv, however. You need to use the function void PySys_SetArgvEx(int argc, char **argv, int updatepath). This way, you can access any command line arguments that your Python code needs. You can check to see whether the interpreter is properly initialised by using the function int Py_IsInitialized(). It returns an integer for either true (nonzero) or false (zero). The simplest way to use your new interpreter is to use the function int PyRun_SimpleString(const char *command). This function takes a string that contains some arbitrary bit of code. If you have multiple lines of code that you want to run, you can use newline characters to separate lines. For example, you can print out the sine of an angle with:

```
PyRun_SimpleString("import math\na =
math.sin(45)\nprint('The sine of 45 is ' +
a)");
```

This function is a simplified version of int PyRun_SimpleStringFlags(const char *command, PyCompilerFlags *flags). This not only takes the command string, but also takes a struct of compiler flags for the Python compiler. You will need to check the development documentation online to see the details for these compiler flags. Let's say that you have a more complicated bit of code to execute. There are equivalent functions to work with Python script files. The simplified version is int PyRun_SimpleFile(FILE *fp, const char *filename). You actually hand in two references to your script. The first is a file handle that you get from the C function fopen() to open your script file, and the seconde is the name of the script you just opened. You will need to open your script file with the read permission. You also now need to worry about whether your program will have the correct file permissions on the file system to open this script. Proper coding means you should check this call to fopen() to verify that it completed and gave you a valid file handle. This simplified version doesn't use any compiler flags, and closes the file handle after the function returns. The full version of the function is int PyRun_SimpleFileExFlags(FILE *fp, const char *filename, int closeit, PyCompilerFlags *flags). If closeit is true, then the file handle is closed. If the script is something you will want to run several times, set closeit to false so the file handle remains open. You can set any flags for the Python interpreter in the flags struct, similar to the PyRun_SimpleStringFlags() function call. If this simple way of running code isn't powerful enough, there are ways of interacting with the interpreter in a more direct fashion. The first step is learning how to send data back and forth between the Python interpreter and the main body of your C program. The basic workflow is to convert your C variables to their Python equivalents, then call the Python functions you wish to use, and convert the Python results back into their equivalents within C. Python is an object-oriented language, so the core of communicating with the interpreter happens with the Py_Object construct. This provides the base for all the other types of objects you can use to communicate with Python. For example, create a Python string object with:

```
PyObject *pName;
pName = PyString_FromString("print('Hello
World')");
```

You can then use this Python object when using Python functions. . You can also get access to Python functions from your C code. You store a reference to the function in a PyObject, just as with data objects. The first step is to get the dictionary of the function names for the module in question with:

```
my_module = PyImport_AddModule("__
main__");
my_dict = PyModule_GetDict(my_module);
```

Once you have the dictionary, you can get a reference to specific function with:

```
my_func = PyDict_GetItemString(my_dict,
func_name);
```

After doing this you will find that where func_name is a string containing the function you want access to, you can then run the function with a command like:

Extend your Python

Find out how to digitally sign a release APK and upload it to an app store of your choice

With the Python interpreter, you aren't just limited to what is already available; you can extend the available functionality by defining your own Python objects, with their own methods and data, within your C code. These newly-created objects can then be called from within the Python interpreter. They are defined as static objects, with code like:

```
static PyObject* my_func(PyObject *self,
PyObject *args) {
        ...
   }
```

The new PyObject contains the executable code for the methods to be used for your new object. You also need to create a method definition to be able to register the details with the Python interpreter. You do this by creating a PyMethodDef array:

```
static PyMethodDef my_methods[] = {
   {"my_method", my_func, METH_VARARGS,
          "This is my method"},
     {NULL, NULL, 0, NULL}
          };
```

Once you have finished these two parts, you are almost ready to start using your new module code. You need to initialise it with the function:

```
Py_InitModule("my_module", my_methods);
```

Now, you can import this new module in your Python code, just like any other module installed on your system. Within your Python code, you can write::

```
import my_module
my_module.my_method()
```

One thing to be aware of is that this level of control also gives you a huge level of responsibility. For example, you will need to start worrying about things like reference counts for objects. The garbage collector for the interpreter needs to know when an object is okay to delete. You need to increment the reference count each time something points to your newly created object. Every time a reference is removed, you need to decrement the counter.

You can also create multiple sub-interpreters within a single program. You can create a new sub-interpreter with the function Py_NewInterpreter(). This way, you can have multiple Python threads running concurrently, and mostly independently. When you are done, you can shut them down with the function Py_EndInterpreter(). There is no limit to what you can do with all of this power.

```
PyObject_CallObject(my_func, NULL);
```

With this access, you should be able to do just about anything you wish in Python.

Up to now, we have been specifically looking at code interacting with the Python interpreter. But there are occasions when you want to allow the end user to have access to the interpreter. In these cases, you probably want to give your user access to a full Python console. You can do just such a thing with the function call Py_Main(argc, argv), where you hand in the argc and argv that you have from the C side of your program. This is fine for a console-based program, but for a GUI program, you need to create some kind of terminal window to allow the user to interact with the Python interpreter. This console will automatically continue to run until the user explicitly quits from Python. The last thing you need to do is to clean up after the interpreter. You can do this with the function void Py_Finalize(). The major issue with this function is that it destroys objects in a random order. If they depend on other objects, they may not be able to get cleaned up correctly. If you then try and re-initialise the interpreter again, it may fail due to an unclean finalisation step.

Now that you have your program written, you need to compile it. You need to include flags to tell the compiler where to find everything. Luckily, you can get these from Python itself. The flags needed for compiling are available with the command python-config --cflags. You also need to know where to find the libraries to link in, which are available with python-config --ldflags. After completing all of this you will have access to Python anywhere, even within another program.

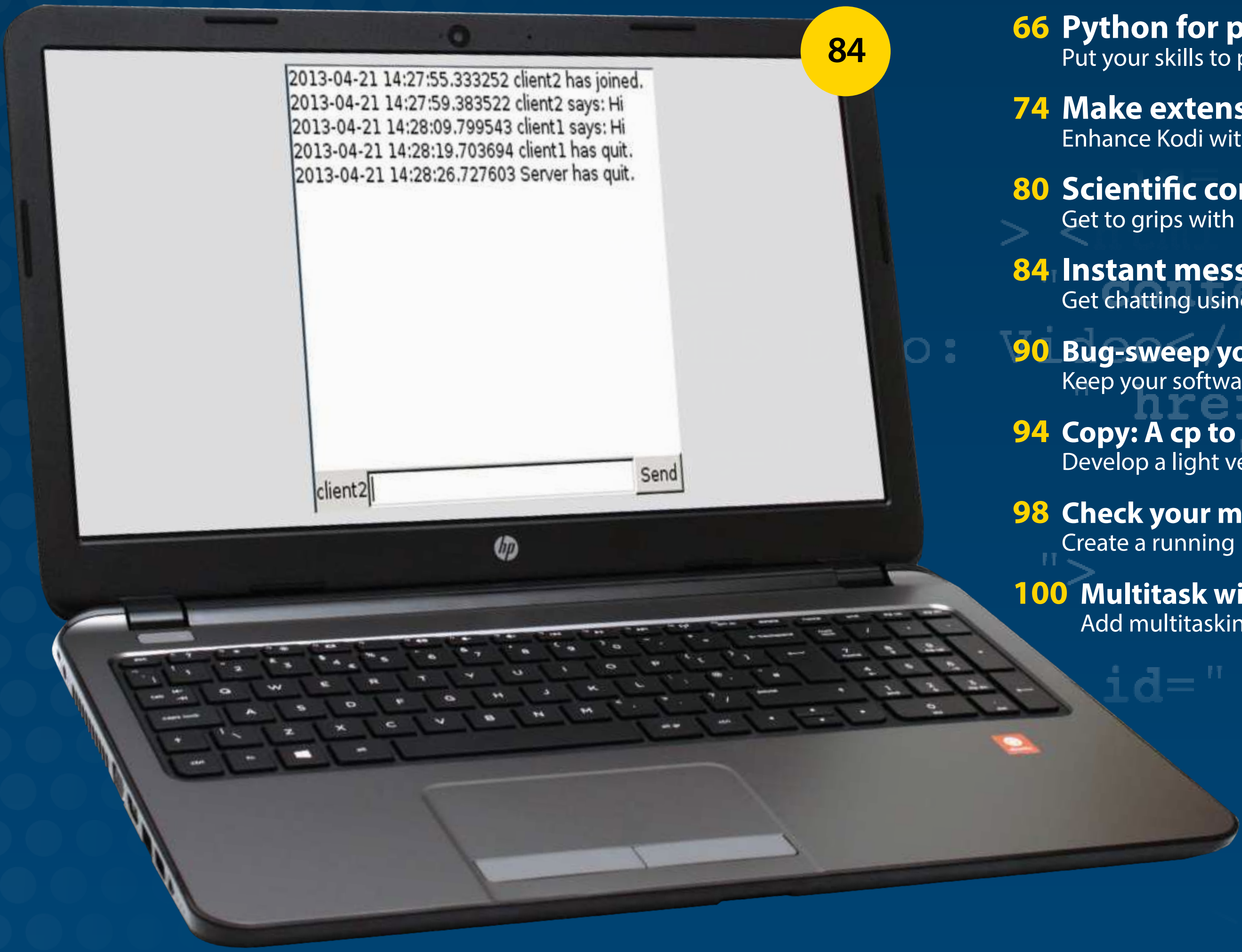
Code listing

```
# A simple way to run Python code
#include <Python.h>

int main(int argc, char *argv[]) {
  Py_SetProgramName(argv[0]);
  # Initialize the Python
interpreter
  Py_Initialize();
  # Run your Python code
  PyRun_SimpleString("from time
import time,ctime\n"
                    "print 'Today
is',ctime(time())\n");
  # Don't forget to clean up
  Py_Finalize();
  return 0;
}
-----------------------------------
# You can create an interactive
Python console
#include <Python.h>
int main(int argc, char *argv[]) {
  Py_Initialize();
  Py_Main(argc, argv);
  Py_Finalize();
}
-----------------------------------
# You can even run a script file
#include <Python.h>

int main(int argc, char *argv[]) {
  FILE *fp;
  Py_Initialize();
  fp = fopen("my_script.py", "r");
  PyRun_SimpleFile(fp, "my_script.
py");
  Py_Finalize();
  fclose(fp);
}
```

WHY PYTHON

It's the official language of the Raspberry Pi. Read the docs at python.org/doc

Work with Python



```
2013-04-21 14:27:55.333252 client2 has joined.
2013-04-21 14:27:59.383522 client2 says: Hi
2013-04-21 14:28:09.799543 client1 says: Hi
2013-04-21 14:28:19.703694 client1 has quit.
2013-04-21 14:28:26.727603 Server has quit.
```

"Most Linux distributions have a Python interpreter included in order to run system scripts"

74

Add-on Information

LUD Reddit Viewer

Type: Media sources
Author: LUD
Version: 0.0.1
Rating:
Summary: LUD Ent Example

Description
LUD Example Addon to demonstrate XBMC Extension System. Orig
AddonScriptorDE.

80

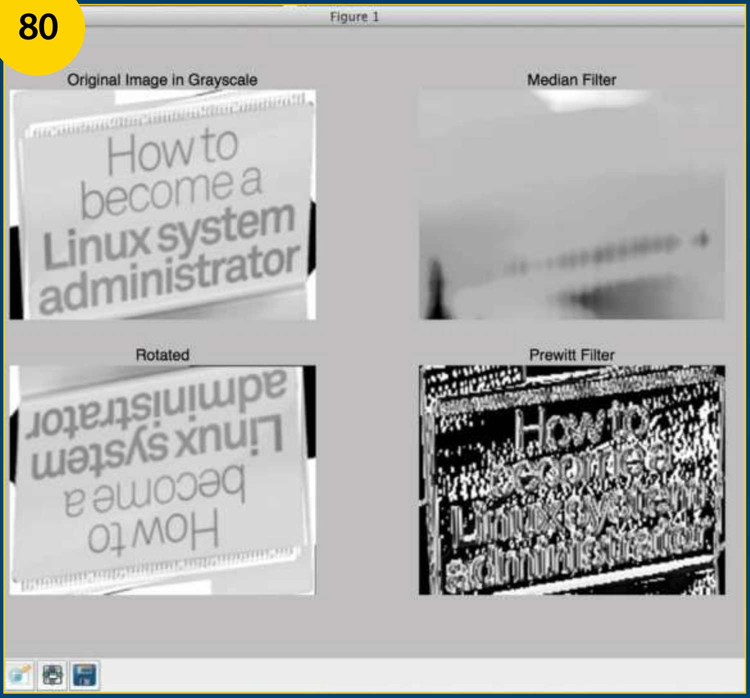


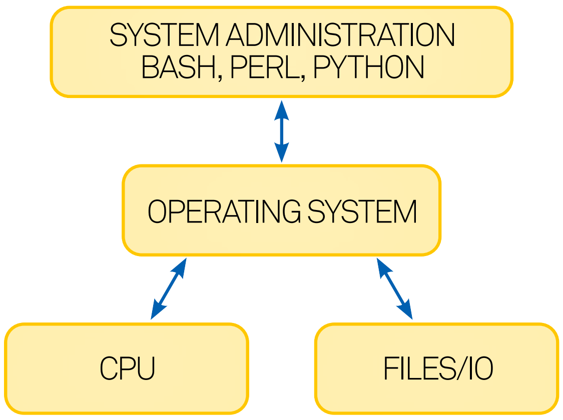
Figure 1
Original Image in Grayscale
Median Filter
Rotated
Prewitt Filter
How to become a Linux system administrator

PYTHON FOR PROFESSIONALS

Python is relied upon by web developers, engineers and academic researchers across the world. Here's how to put your Python skills to professional use

System administration

Get the most out of Python in handling all of the day-to-day upkeep that keeps your system healthy



Left Python scripts enable you to instruct and interact with your operating system

System administration tasks are some of the most annoying things that you need to deal with when you have to maintain your own system. Because of this, system administrators have constantly been trying to find ways to automate these types of tasks to maximise their time. They started with basic shell scripts, and then moved on to various scripting languages. For a long time, Perl had been the language of choice for developing these types of maintenance tools. However, Python is now growing in popularity as the language to use. It has reached the point where most Linux distributions have a Python interpreter included in order to run system scripts, so you shouldn't have any excuse for not writing your own scripts.

Because you will be doing a lot system level work, you will have most need of a couple of key Python modules. The first module is 'os'. This module provides the bulk of the interfaces to interacting with the underlying system. The usual first step is to look at the environment your script is running in to see what information might exist there to help guide your script. The following code gives you a mapping object where you can interact with the environment variables active right now:

```
import os
os.environ
```

You can get a list of the available environment variables with the function "os.environs.keys()", and then access individual variables with "os.environs[key]". These environment variables are used when you spawn a subprocess, as well. So you will want to change values, like the PATH or the current working directory, in order for you to run these subprocesses correctly. While there is a "putenv" function that edits these values for you, it unfortunately does not exist on all systems. So the better way to do this is to edit the values directly within the environs mapping.

Another category of tasks you may want to automate is when working with files. For example, you can get the current working directory with code like

```
cwd = os.getcwd()
```

You can then get a list of the files in this directory with

```
os.listdir(cwd)
```

You can move around the file system with the function "os.chdir(new_path)". Once you've found the file you are interested in, you can open it with "os.open()" and open it for reading, writing and/or appending. You can then read or write to it with the functions "os.read()" and "os.write()". Once done, you can close the file with "os.close()".

Running subprocesses from Python

The underlying philosophy of Unix is to build small, specialised programs that do one job extremely well. You then chain these together to build more complex behaviours. There is no reason why you shouldn't use the same philosophy within your Python scripts. There are several utility programs available to use with very little work on your part. The older way of handling this was through using functions like "popen()" and "spawnl()" from the os module, but a better way of running other programs is by using the subprocess module instead. You can then launch a program, like ls, by using:

```
import subprocess
subprocess.run(['ls', '-l'])
```

This provides you with a long file listing for the current directory. The function "run()" was introduced in Python 3.5 and is the suggested way of handling this. If you have an older version, or if you require more control than that, then you can employ the underlying "popen()" function that we mentioned earlier instead. If you want to get the output, you can use the following:

```
cmd_output = subprocess.run(['ls', '-l'],
stdout=subprocess.PIPE)
```

The variable "cmd_output" is a CompletedProcess object that contains the return code and a string holding the stdout output.

Scheduling with cron

Once you have your script all written up, you may want to schedule them to run automatically without your intervention. On Unix systems, you can have cron run your script on whatever schedule is necessary. The utility "crontab -l" lists the current contents of your cron file, and "crontab -e" lets you edit the scheduled jobs that you want cron to run.

Web development

Python has several frameworks available for all of your various web development tasks. We will look at some of the more popular ones

With the content and the bulk of the computing hosted on a server, a web application can better guarantee a consistent experience for the end user. The popular Django framework provides a very complete environment of plugins and works on the DRY principle (Don't Repeat Yourself). Because of this, you should be able to build your web application very quickly. Since Django is built on Python, you should be able to install it with "sudo pip install Django". Most distributions should have a package for Django, too. Depending on what you want to do with your app, you may need to install a database like MySQL or postgresql to store your application data.

There are Django utilities available to automatically generate a starting point for your new project's code:

```
django-admin startproject newsite
```

This command creates a file named "manage.py" and a subdirectory named "newsite". The file "manage.py" contains several utility functions you can use to administer your new application. The newly created subdirectory contains the files "__init__.py", "settings.py", "urls.py" and "wsgi.py". These files and the subdirectory they reside in comprise a Python package that gets loaded when your web site is started up. The core configuration for your site can be found in the file "settings.py". The URL declarations, basically a table of contents for your site, are stored in the file "urls.py". The file "wsgi.py" contains an entry point for WSGI-compatible web servers.

Once your application is done, it should be hosted on a properly configured and hardened web server. But, this is inconvenient if you are in the process of developing your web application. To help you out, Django has a web server built into the framework. You can start it up by changing directory to the "newsite" project directory and running the following command:

```
python manage.py runserver
```

This will start up a server listening to port 8000 on your local machine. Because this built in server is designed to be used for development, it automatically reloads your Python code for each request. This means that you don't need to restart the server to see your code changes.

All of these steps get you to a working project. You are now ready to start developing your applications. Within the "newsite" subdirectory, you can type:

```
python manage.py startapp newapp
```

This will create a new subdirectory named "newapp", with the files "models.py", "tests.py" and "views.py", among others. The simplest possible view consists of the code:

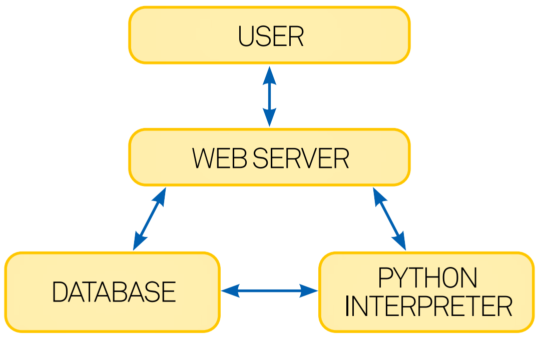
```
from django.http import HttpResponse
def index(request):
 return HttpResponse("Hello world")
```

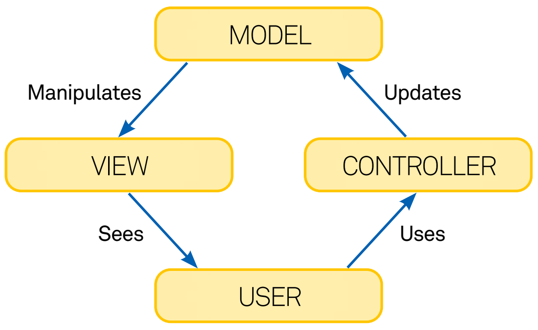
This isn't enough to make it available, however. You will also need to create a URLconf for the view. If the file "urls.py" doesn't exist yet, create it and then add the code:

```
from django.conf.urls import url
from . Import views
 urlpatterns = [ url(r'^$', views.index,
   name='index'), ]
```

The last step is to get the URL registered within your project. You can do this with the code

```
from django.conf.urls import include, url
from django.contrib import admin
urlpatterns = [ url(r'^newapp/',
include('newapp.urls')),
```





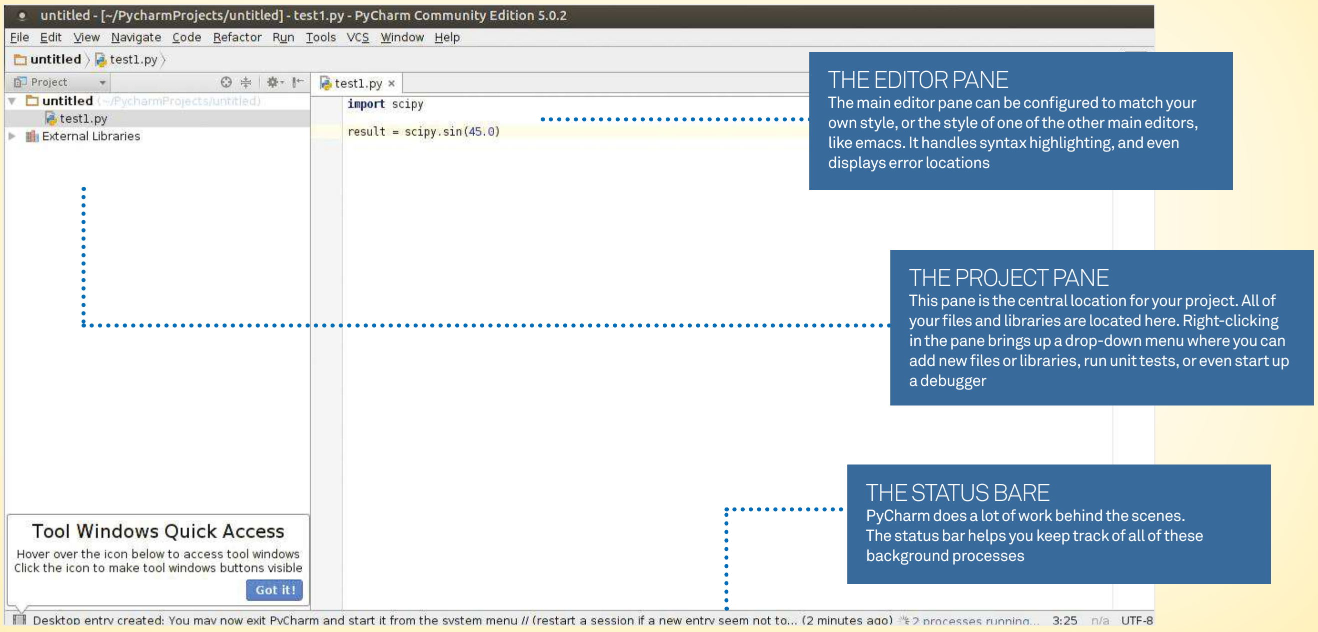
Left Python interpreters work with your databases to power a web server

Bottom The Model-View-Controller architecture is often used for UIs

Virtual environments

When you start developing your own applications, you may begin a descent into dependency hell. Several Python packages depend on other Python packages. This is its strength, but also its weakness. Luckily, you have virtualenv available to help tame this jungle. You can create new virtual environments for each of your projects. Thankfully with this, you can be sure to capture all of the dependencies for your own package.

Using the PyCharm IDE


untitled - [~/PycharmProjects/untitled] - test1.py - PyCharm Community Edition 5.0.2
File Edit View Navigate Code Refactor Run Tools VCS Window Help
untitled test1.py
Project
untitled (~/PycharmProjects/untitled)
test1.py
External Libraries
test1.py ×
Tool Windows Quick Access
Hover over the icon below to access tool windows
Click the icon to make tool windows buttons visible
Got it!

```
import scipy

result = scipy.sin(45.0)
```

```
Desktop entry created: You may now exit PyCharm and start it from the system menu // (restart a session if a new entry seem not to... (2 minutes ago)   2 processes running...   3:25   n/a   UTF-8
```

THE EDITOR PANE
The main editor pane can be configured to match your own style, or the style of one of the other main editors, like emacs. It handles syntax highlighting, and even displays error locations

THE PROJECT PANE
This pane is the central location for your project. All of your files and libraries are located here. Right-clicking in the pane brings up a drop-down menu where you can add new files or libraries, run unit tests, or even start up a debugger

THE STATUS BARE
PyCharm does a lot of work behind the scenes. The status bar helps you keep track of all of these background processes

```
url(r'^admin', admin.site.urls), ]
```

This needs to be put in the "urls.py" file for the main project. You can now pull up your newly created application with the URL http://localhost:8000/newapp/.

The last part of many applications is the database side. The actual connection details to the database, like the username and password, are contained in the file "settings.py". This connection information is used for all of the applications that exist within the same project. You can create the core database tables for your site with this command:

```
python manage.py migrate
```

For your own applications, you can define the data model you need within the file "models.py". Once the data model is created, you can add your application to the INSTALLED_APPS section of the "settings.py" so that django knows to include it in any database activity. You initialize it with:

```
python manage.py makemigrations newapp
```

Once these migrations have been created, you need to apply them to the database by using the command:

```
python manage.py migrate
```

Any time you make changes to your model, you will need to run the makemigrations and migrate steps again.

Once you have your application finished, you can make the move to the final hosting server. Don't forget to check the available code within the Django framework before putting too much work into developing your own code.

Terminal development environments

When you are in the middle of developing your application, you may need to have several different terminal windows open in order to have a code editor open, a monitor on the server, and potentially testing output. If you are doing this on your own machine, this isn't an issue. But, if you are working remotely, you should look into using tmux. It can provide a much more robust terminal environment for you.

Other Python frameworks

While Django is one of the most popular frameworks around for doing web development, it is by no means the only one around. There are several others available that may prove to be a better fit for particular problem domains. For example, if you are looking for a really self-contained framework, you could look at web2py. Everything you need to be able to have a complete system, from databases to web servers to a ticketing system, are included as part of the framework. It is so self-contained that it can even run from a USB drive

If you need even less of a framework, there are several mini-frameworks that are available. For example, CherryPy is a purely Pythonic multi-threaded web server that you can embed within your own application. This is actually the server included with TurboGears and web2py. A really popular microframework is a project called flask. It includes integrated unit testing support, jinja2 templating and RESTful request dispatching.

One of the oldest frameworks around is zope, now up to version 3. This latest version was renamed BlueBream. Zope is fairly low-level, however. You may be more interested in looking at some of the other frameworks that are built on top of what is provided by zope. For example, pyramid is a very fast, easy to use framework that focuses on the most essential functions required by most web applications. To this end, it provides templating, the serving of static content, mapping of URLs to code, among other functions. It handles this while providing tools for application security.

If you are looking for some ideas, there are several open source projects that have been built using these frameworks, from blogs, to forums to ticketing systems. These projects can provide some best-practices when you go to construct your own application.

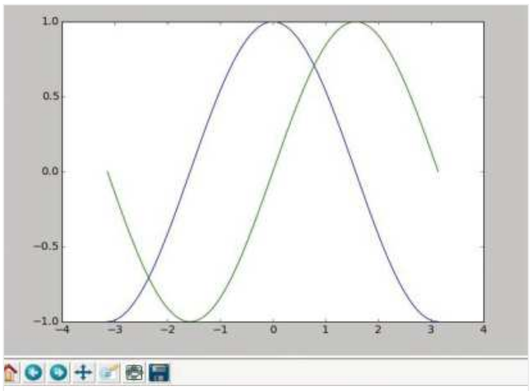
Computational science

Python is fast becoming the go-to language for computational science

Python has become one of the key languages used in science. There is a huge number of packages available to handle almost any task that you may have and, importantly, Python knows what it isn't good at. To deal with this, Python has been designed to easily incorporate code from C or FORTRAN. This way, you can offload any heavy computations to more efficient code.

The core package of most of the scientific code available is numpy. One of the problems in Python is that the object oriented nature of the language is the source of its inefficiencies. With no strict types, Python always needs to check parameters on every operation. Numpy provides a new datatype, the array, which helps solve some of these issues. Arrays can only hold one type of object, and because Python knows this it can use some optimisations to speed things up to almost what you can get from writing your code directly in C or FORTRAN. The classic example of the difference is the for loop. Lets say you wanted to scale a vector by some value, something like a*b. In regular Python, this would look like

```
for elem in b:
c.append(a * elem)
In numpy, this would look like:
  a*b
```



Left The numpy package makes it simple to visualise your data

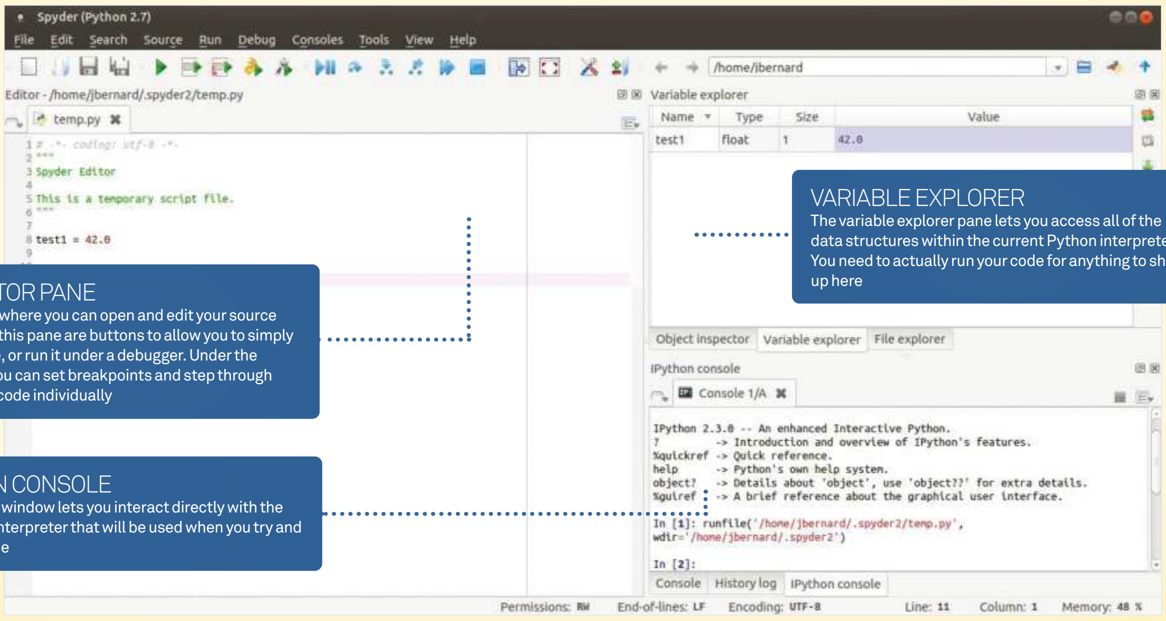
So, not only is it faster, it is also written in a shorter, clearer form. Along with the new datatype, numpy provides overloaded forms of all of the operators that are of most use, like multiplication or division. It also provides optimised versions of several functions, like the trig functions, to take advantage of this new datatype.

The largest package available, that is built on top of numpy, is scipy. Scipy provides sub-sections in several areas of science. Each of these sub-sections need to be imported individually after importing the main scipy package. For example, if you are doing work with differential equations, you can use the "integrate" section

Parallel Python

One of the really powerful parts of Ipython (or jupyter) is that it is built with a client/server model. This means that it is relatively easy to setup multiple machines to act as a server pool. You can then farm out multiple tasks to these other machines to get even more work done. While this doesn't run any particular function in parallel, it does let you run longer functions in the background while you work on something else.

Spyder, the IDE for scientists



```
# -*- coding: utf-8 -*-
"""
Spyder Editor

This is a temporary script file.
"""

test1 = 42.0
```

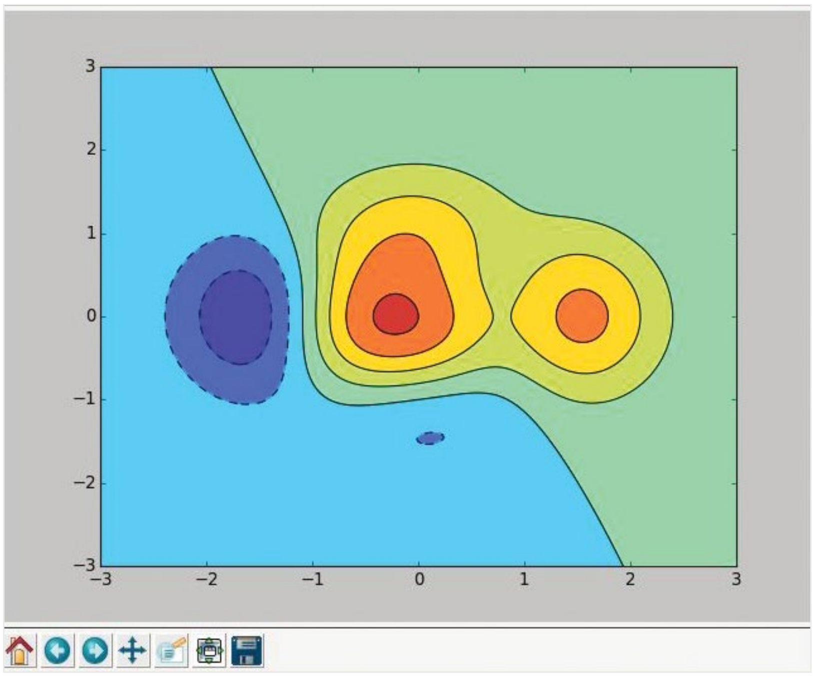
Name	Type	Size	Value
test1	float	1	42.0

```
IPython 2.3.0 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object', use 'object??' for extra details.
%guiref   -> A brief reference about the graphical user interface.

In [1]: runfile('/home/jbernard/.spyder2/temp.py',
wdir='/home/jbernard/.spyder2')

In [2]:
```

THE EDITOR PANE
This pane is where you can open and edit your source files. Above this pane are buttons to allow you to simply run the code, or run it under a debugger. Under the debugger, you can set breakpoints and step through each line of code individually

VARIABLE EXPLORER
The variable explorer pane lets you access all of the data structures within the current Python interpreter. You need to actually run your code for anything to show up here

IPYTHON CONSOLE
The console window lets you interact directly with the underlying interpreter that will be used when you try and run your code



Above The ability to generate complex plots is essential

to solve them with code that looks like

```
import scipy
import scipy.integrate
result = scipy.integrate.quad(lambda x:
sin(x), 0, 4.5)
```

Differential equations crop up in almost every scientific field. You can do statistical analysis with the "stats" section. If you want to do some signal processing, you can use the "signal" section and the "fftpack" section. This package is definitely the first stop for anyone wanting to do any scientific processing.

Once you have collected your data, you usually need to graph it, in order to get a visual impression of patterns within it. The primary package you can use for this is matplotlib. If you have ever used the graphics package in R before, the core design of matplotlib has borrowed quite a few ideas. There are two categories of functions for graphing, low-level and high-level. High-level functions try to take care of as many of the menial tasks, like creating a plot window, drawing axes, selecting a coordinate system, as possible. The low-level functions give you control over almost every part of a plot, from drawing individual pixels to controlling every aspect of the plot window. It also borrowed the idea of drawing graphs into a memory based window. This means that it can draw graphs while running on a cluster.

If you need to do symbolic math, you may be more used to using something like Mathematica or Maple. Luckily, you have sympy that can be used to do many of the same things. You can use Python to do symbolic calculus, or to solve algebraic equations. The one weird part of sympy is that you need to use the "symbols()" function to tell sympy what variables are valid to be considered in your equations. You can then start doing manipulations using these registered variables.

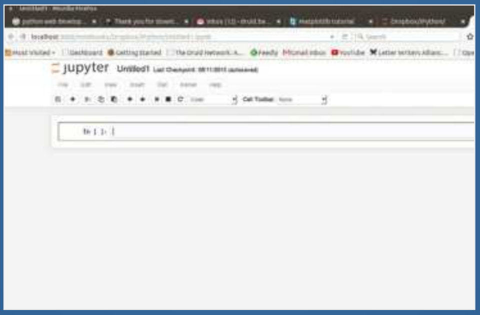
You may have large amounts of data that you need to work with and analyze. If so, you can use the pandas package to help deal with that. Pandas has support for several different file formats, like CSV files, Excel spreadsheets or HDF5. You can merge and join datasets, or do slicing or subsetting. In order to get the best performance out of the code, the heaviest lifting is done by Cython code that incorporates functions written in C. Quite a few ideas on how to manipulate your data was borrowed from how things are done in R.

You now have no reason not to start using Python for your scientific work. You should be able to use it for almost any problem that comes up!

Interactive science with jupyter

For a lot of scientific problems, you need to play with your data in an interactive way. The original way you would do this was to use the Ipython web notebook. This project has since been renamed Jupyter. For those who have used a program like Mathematica or Maple, the interface should seem very familiar. Jupyter starts a server process, by default on port 8888, and then will open a web browser where you can open a worksheet. Like most other programs of this type, the entries run in chronological order, not in the order that they happen on the worksheet. This can be a bit confusing at first, but it means that if you go to edit an earlier entry, all of the following entries need to be re-executed manually in order to propagate that change through the rest of the computations.

Jupyter has support for pretty printing math within the produced web page. You can also mix documentation blocks and code blocks within the same page. This means that you can use it to produce very powerful educational material, where students can read about some technique, and then actually run it and see it in action. By default, Jupyter will also embed matplotlib plots within the same worksheet as a results section, so you can see a graph of some data along with the code that generated it. This is huge in the growing need for reproducible science. You can always go back and see how any analysis was done and be able to reproduce any result at all.



Above Jupyter Notebook is a web application that is used for creating and sharing documents that contain live code and equations

The need for speed

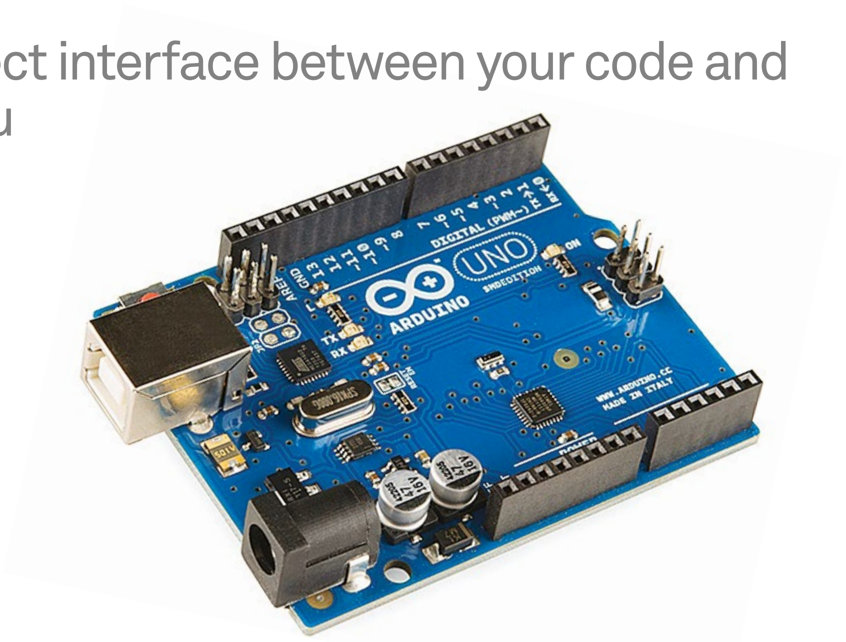
Sometimes you need as much speed as your are capable of pushing on your hardware. In these cases, you always have the option of using Cython. This lets you take C code from some other project, which has probably already been optimised, and use it within your own Python program. In scientific programming, you are likely to have access to code that has been worked on for decades and is highly specialised. There is no need to redo the development effort that has gone into it.

Robotics and electronics

Robotics is the most direct interface between your code and the real world around you

Robotics is the most direct way that your code can interact with the world around you. It can read actual sensor information and move real actuators and get real work done.

The first thing your robot needs is the ability to sense the world around it. The one sense that we as humans feel is most useful is sight. With web cameras being so cheap and easy to connect to hardware, vision is easy to give to your robot. The real problem is how to interpret this data. Luckily, you can use the OpenCV project to do just that. It is a vision package that can provide simple image gathering and processing, to extremely complex functions like face recognition and extraction of 3D objects. You can identify and track objects moving through your field of view. You can also use OpenCV to give you robot some reasoning capabilities, too. OpenCV includes a set of functions for machine learning, where you can do statistical classification or data clustering, and use it to feed decision trees or even neural networks.



Another important sense that you may want to use is sound. The jasper project is one that is developing a complete voice control system. This project would give you the structure you need to give your robot the ability to listen for and respond to your verbal commands. The project has gotten to the point where you can give it a command and the voice recognition software can translate this into text. You then need to build a mapping of what pieces of text correspond to what commands to execute.

There are lots of other sensors you could have, but this begins to leave the realm of store-bought hardware. Most other sensors, like temperature, pressure, orientation or location, need specialised hardware that needs to be interfaced to the computer brain for your robot. This

Arduino

In contrast to the Raspberry Pi, which runs a full OS from its SD card, the Arduino boards are microcontrollers rather than complete computers. Instead of running an OS, the Arduino platform executes code that is interpreted by its firmware. It is mainly used to interface with hardware such as motors and servos, sensors, and devices such as LEDs, and is incredibly capable in this regard. Arduinos are widely used in robotics projects and can be a powerful complement to the Pi.

Raspberry Pi

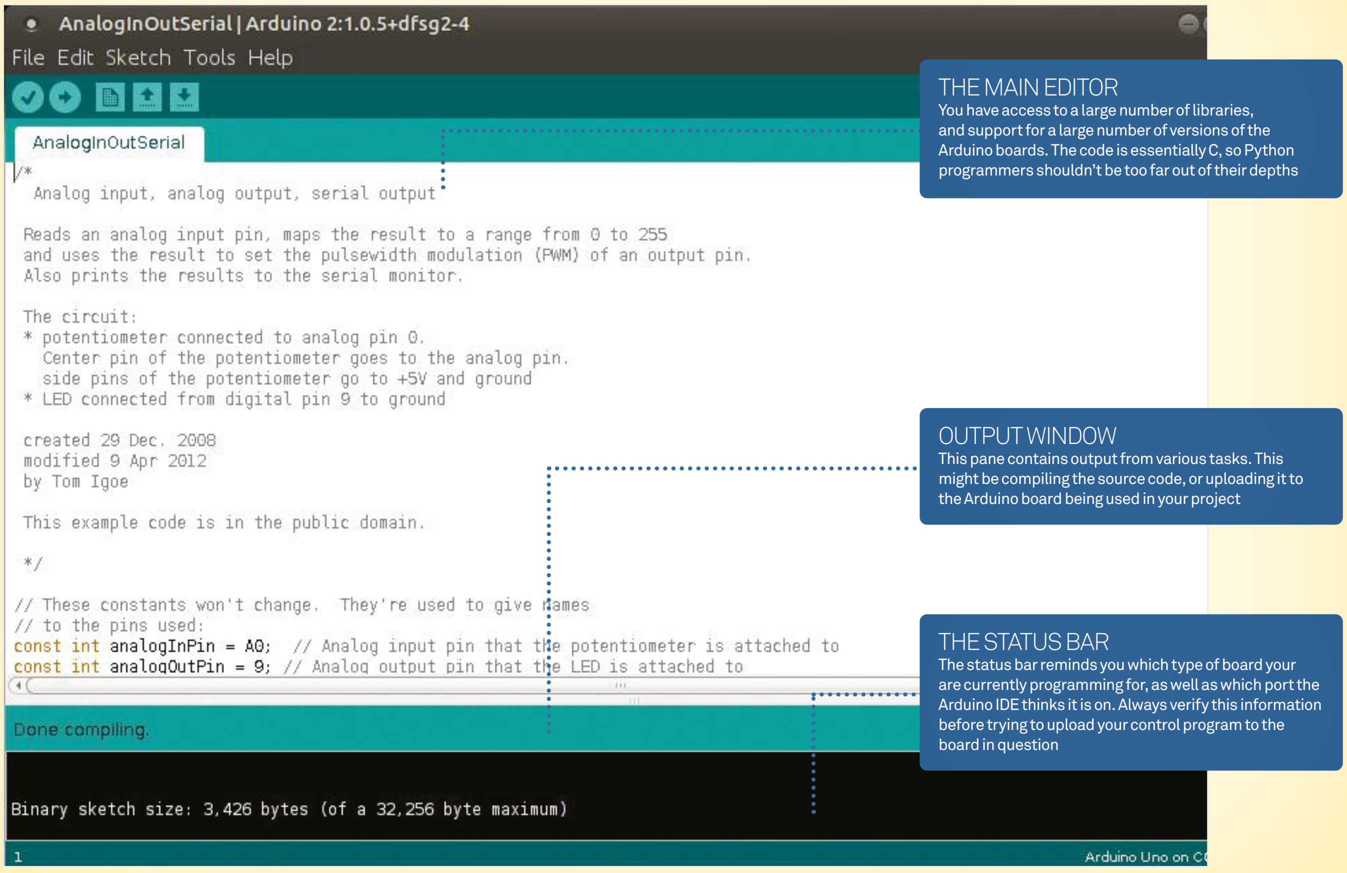
While we haven't discussed what kind of computer to use for your robotics project, you should consider the famous Raspberry Pi. This tiny computer should be small enough to fit into almost any robot structure that you might be building. Since it is already running Linux and Python, you should be able to simply copy your code development work to the Pi. It also includes its own IO bus so that you can have it read it's own sensors.

ROS – Robot Operating System

While you could simply write some code that runs on a standard computer and a standard Linux distribution, this is usually not optimal when trying to handle all of the data processing that a robot needs when dealing with events in realtime. When you reach this point, you may need to look at a dedicated operating system – the Robot Operating System (ROS). ROS is designed to provide the same type of interface between running code the computer hardware it is running on, with the lowest possible overhead. One of the really powerful features of ROS is that it is designed to facilitate communication between different processes running on the computer, or potentially over multiple computers connected over some type of network. Instead of each process being a silo that is protected from all other processes, ROS is more of a graph of processes with messages being passed between them all.

Because ROS is a complete operating system, rather than a library, it is wrong to think that you can use it in your Python code. It is better to think that you can write Python code that can be used in ROS. The fundamental design is to be as agnostic as possible. This means that interfaces to your code should be clean and not particularly care where they running or who is talking to them. Then, it can be used within the graph of processes running within ROS. There are standard libraries available that allow you to do coordinate transformations, useful for figuring out where sensors or limbs are in space. There is a library available for creating preemptible tasks for data processing, and another for creating and managing the types of messages that can be handed around the various processes. For extremely time-sensitive tasks, there is a plugin library that allows you to write a C++ plugin that can be loaded within ROS packages.

For low-level work, check out Arduinos


AnalogInOutSerial | Arduino 2:1.0.5+dfsg2-4
File Edit Sketch Tools Help
AnalogInOutSerial
Done compiling.
1
Arduino Uno on C

```
/*
  Analog input, analog output, serial output

 Reads an analog input pin, maps the result to a range from 0 to 255
 and uses the result to set the pulsewidth modulation (PWM) of an output pin.
 Also prints the results to the serial monitor.

 The circuit:
 * potentiometer connected to analog pin 0.
   Center pin of the potentiometer goes to the analog pin.
   side pins of the potentiometer go to +5V and ground
 * LED connected from digital pin 9 to ground

 created 29 Dec. 2008
 modified 9 Apr 2012
 by Tom Igoe

 This example code is in the public domain.

 */

// These constants won't change.  They're used to give names
// to the pins used:
const int analogInPin = A0;  // Analog input pin that the potentiometer is attached to
const int analogOutPin = 9; // Analog output pin that the LED is attached to
```

```
Binary sketch size: 3,426 bytes (of a 32,256 byte maximum)
```

THE MAIN EDITOR
You have access to a large number of libraries, and support for a large number of versions of the Arduino boards. The code is essentially C, so Python programmers shouldn't be too far out of their depths

OUTPUT WINDOW
This pane contains output from various tasks. This might be compiling the source code, or uploading it to the Arduino board being used in your project

THE STATUS BAR
The status bar reminds you which type of board your are currently programming for, as well as which port the Arduino IDE thinks it is on. Always verify this information before trying to upload your control program to the board in question

means it is time to get your soldering iron out. As for reading the data in, this is most often done over a basic serial connection. You can then use the pySerial module to connect to the serial port and read data off the connection. You can use:

```
import serial
```

to load the module and start communicating with your sensor. The problem is that this is a very low-level way to communicate. You, as the programmer, are responsible for all of the details. This includes communication speed, byte size, flow control; basically everything. So this will definitely be an area of your code where you should plan on spending some debugging time.

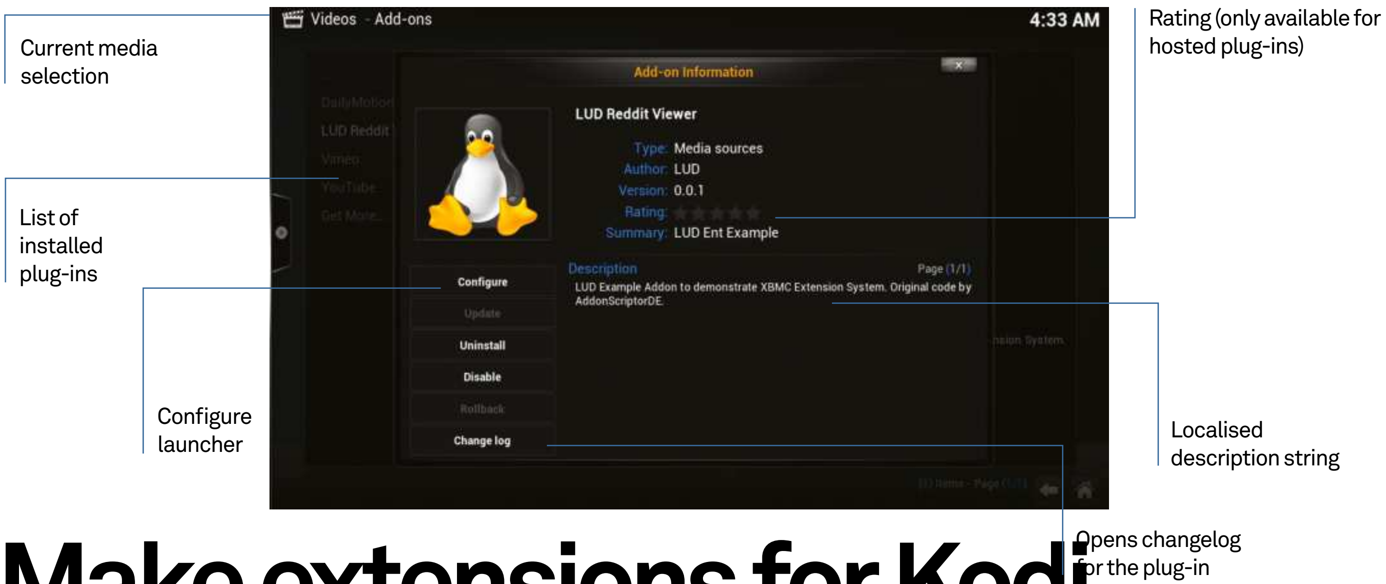
Now that you have all of this data coming in, what will you do with it? You need to be able to move actuators out in the world and have real effects. This could be motors for wheels or tracks, levers to shift objects, or potentially complete limbs, like arms or legs. While you could try and drive these types of electronic devices directly from the output ports of your computer, there usually isn't enough current available to provide the necessary power. So, you will need to have some off-board brains capable of handling the supplying of power to these devices. One of the most popular candidates for this task is the Arduino.

Luckily, the Arduino is designed to connect to the serial port of your computer, so you can simply use pySerial to talk to it. You can send commands to code that you have written and uploaded to the Arduino to handle the actual manipulations of the various actuators. The Arduino can talk back, however. This means that you can read feedback data to see what effect your movements have had. Did you end up turning your wheels as far as you wanted to? This means that you could also use the Arduino as an interface between your sensors and the computer, thus simplifying your Python code even more. There are loads of add-on modules available, too, that might be able to provide the sensing capabilities that you require straight out of the box. There are also several models of Arduino, so you may be able to find a specialised model that best fits your needs.

Now that you have all of this data coming in and the ability to act out in the real world, the last step is giving your robot some brains. This is where the state of the art unfortunately does not live up to the fantasy of R2-D2 or C-3P0. Most of your actual innovative coding work will likely take place in this section of the robot. The general term for this is artificial intelligence. There are several projects currently underway that you could use as a starting point to giving your robot some real reasoning capability, like SimpleAI or PyBrain.

Bypassing the GIL

For robotics work, you may need to run some code truly in parallel, on multiple CPUs. Python currently has the GIL, which means that there is a fundamental bottleneck built into the interpreter. One way around this is to actually run multiple Python interpreters, one for each thread of execution. The other option is to move from Cpython to either Jython or IronPython, as neither has a GIL.



LUD Reddit Viewer

Type: Media sources
Author: LUD
Version: 0.0.1
Rating:
Summary: LUD Ent Example

Description Page (1/1)
LUD Example Addon to demonstrate XBMC Extension System. Original code by AddonScriptorDE.

Make extensions for Kodi with Python

Python is the world's most popular easy-to-use open source language. Learn how to use it to build your own features for Kodi, the world's favourite FOSS media centre

Resources

Kodi 18: www.kodi.tv/download
Python 2.7x
Python IDE (optional)
Code on FileSilo

Kodi (formerly XBMC) is perhaps the most important thing that has ever happened in the open source media centre space. It started its life on the original Xbox videogames console and since then it has become the de facto software for multimedia aficionados. It also has been forked into many other successful media centre applications such as Boxee and Plex. Kodi has ultimately grown into a very powerful open source application with a solid community behind it. It supports almost all major platforms, including different hardware architectures. It is available for Linux, Windows, mac OS , Android, iOS and Raspberry Pi.

In these pages we will learn to build extensions for Kodi. Extensions are a way of adding features to Kodi without having to learn the core of XBMC or alter that core in any way. One additional advantage is that Kodi uses Python as its scripting language, and this can also be used to build the extensions. This really helps new developers to get involved in the project since Python is easy to learn compared to languages like C/C++ (from which the core of Kodi is made).

Kodi supports various types of extensions (or Add-ons): Plugins, Programs and Skins. Plugins add features to Kodi. Depending on the type of feature, a plug-in will appear in the relevant media section of Kodi. For example, a YouTube plug-in would appear in the Videos section. Scripts/Programs are like mini-applications for Kodi. They appear in the Programs section. Skins are important since Kodi is a completely customisable application – you can change the look and feel of just about every facet of the package. Depending upon which category your extension fits, you will have to create the extension directory accordingly. For example...

Plug-ins:

plugin.audio.ludaudi: An audio plug-in
plugin.video.ludvidi: A video plug-in
script.xxx.xxx: A program

In this tutorial we will build a Kodi plug-in called LUD Entertainer. This plug-in will provide a nice way to watch videos from Reddit from within Kodi. Our plug-in will show various content such as trailers and documentaries from Reddit. We'll also allow our users to add their own Subreddit. Each video can then be categorised as Hot, New, Top, Controversial etc. With this plug-in we will demonstrate how easy it is hook into XBMC's built-in method to achieve a very high-quality user experience.

Due to space limitations, we aren't able to print the full code here. We recommend downloading the complete code from FileSilo.

01 Preparing the directory structure

As we have mentioned previously, each Kodi extension type follows a certain directory naming convention. In this case we are building a video plug-in, so the plug-in directory name would be **plugin.video.ludlent**. But that's just the root directory name – we will need several other folders and files as well.

The following describes the directory structure of LUD Linux Entertainer:

```
plugin.video.ludent – Root Plugin directory
|-- addon.xml
|-- changelog.txt
|-- default.py
|-- icon.png
|-- LICENSE.txt
|-- README
`-- resources
  |-- lib
  `-- settings.xml
```

02 Creating addon.xml

An **addon.xml** file needs to be created in the root of the extension directory. The addon.xml file contains the primary metadata from a Kodi extension. It contains overview, credits, version information and dependencies information about the extension.

The root element of addon.xml is the **<addon>** element. It is defined as:

```
<addon id="plugin.video.
ludent" name="LUD HSW Viewer"
version="0.0.1" provider-
name="LUDK">
rest of the content is placed here
</addon>
```

Here, **id** is the identifier for the plug-in, so it should be unique among all the Kodi extensions, and id is also used for the directory name; **version** tells Kodi the extension version number, which helps in its ability to deliver automatic updates – Kodi follows the Major.Minor.Patch versioning convention; **name** is the English title of the plug-in.

Note: Steps 3 to 5 cover entries that need to be added within the **addon.xml** file.

03 Adding dependency information

Dependency inside an extension is managed using the **<requires>** element.

```
<requires>
<import addon="xbmc.python"
version="2.26.0"/>
<import addon="plugin.video.youtube"
version="3.0.0"/>
<import addon="plugin.video.vimeo"
version="2.3.0"/>
<import addon="plugin.video.
dailymotion_com" version="1.0.0"/>
</requires>
```

In the above code we have added a dependency to a library called **xbmc.python** version 2.26.0. Currently it is added as a mandatory dependency. To make the dependency optional you will need to add **optional="true"**; eg `<import addon="lud.special" version="0.1.0" optional="true" />`

In the above example we have added core dependency xbmc.python to 2.26.0 because it's the version shipped with Kodi version Leia 18.0 through 18.7 . If you were to add xbmc.python to 2.0 then it would only work in XBMC Eden 11.0 and not in the latest version.

Note that we're not using the latest version of Kodi here. Kodi 19 (released in 2021) switched to Python 3 for its plugin architecture so the code featured here will need to be tweaked to work there. Kodi 18 is still widely used and can be found on the Old Releases section of the website at https://mirrors.kodi.tv/releases , though it is no longer supported and should be considered end of life.

In addition to xbmc.python we are also adding some third-party plug-ins as dependencies, such as plugin.video.youtube. These plug-ins will be installed automatically when we install plugin.video.ludent.

04 Setting up the provider and entry point

Our extension is supposed to provide the video content for XBMC. In order to convey that, we have to set up the following element:

```
<extension point="xbmc.python.
pluginsource" library="default.py">
<provides>video</provides>
</extension>
```

Here, the **library** attribute sets up the plug-in entry point. In this example default.py will be executed when the user activates the plug-in. The **<provides>** elements sets up the media type it provides. This also gets reflected in the placement of the plug-in. Since ours is a video plug-in, it will show up in the Videos section of Kodi.

05 Setting up plug-in metadata

Metadata about the plug-in is provided in **<extension point="xbmc.addon.metadata">**. The following are the important elements...

<platform>: Most of the time, XBMC extensions are cross-platform compatible. However, if you depend on the native platform library that is only available on certain platforms then you will need to set the supported platforms here. Accepted values for the platform are: all, linux, osx, osx32, osx64, ios (Apple iOS) , windx (Windows DirectX), wingl (Windows OpenGL) and android.

<summary lang="en">: This gives a brief description of the plug-in. Our example sets the language attribute as English, but you can use other languages too.

<description>: A detailed description of the plug-in.

<website>: Webpage where the plug-in is hosted.

<source>: Source code repository URL. If you are hosting your plug-in on GitHub, you can mention the repository URL here.

<forum>: Discussion forum URL for your plug-in.

<email>: Author email. You can directly type email or use a bot-friendly email address like max at domain dot com.

06 Setting changelog, icon, fanart and licence

We need a few additional files in the plug-in directory...

changelog.txt: You should list the changes made to your plug-in between releases. The changelog is visible from the Kodi UI.

An example changelog:

```
0.0.1
- Initial Release
0.0.2
- Fixed Video Buffering Issue
```

icon.png: This will represent the plug-in in the Kodi UI. It needs to be a non-transparent PNG file of size 256x256.

fanart.jpg (optional): The fanart.jpg is rendered in the background if a user selects the plug-in in Kodi. The art needs to be rendered in HDTV formats, so its size can range from 1280x720 (720p) up to the maximum 1920x1080 (1080p).

»

License.txt: This file contains the licence of the distributed plug-in. The XBMC project recommends the use of the Creative Commons Attribution-ShareAlike 3.0 licence for skins, and GPL 2.0 for add-ons. However, most of the copyleft licences can be used.

Note: For the purpose of packaging, extensions/add-ons/themes/plug-ins are the same.

07 Providing settings for the plug-in

Settings can be provided by the file **resources/settings.xml**. These are great for user-configurable options.

Partial: resources/settings.xml

```
<settings>
<category label="30109">
<setting id="filter" type="bool"
label="30101" default="false"/>
<setting type="sep" />
<setting id="showAll" type="bool"
label="30106" default="false"/>
<setting id="showUnwatched"
type="bool" label="30107"
default="true"/>
<setting id="showUnfinished"
type="bool" label="30108"
default="false"/>
<setting type="sep" />
<setting id="forceViewMode"
type="bool" label="30102"
default="true"/>
<setting id="viewMode" type="number"
label="30103" default="504"/>
</category>
<category label="30110">
<setting id="cat_hot" type="bool"
label="30002" default="true"/>
<setting id="cat_new" type="bool"
label="30003" default="true"/>
</category>
</settings>
```

Here, **label** defines the language id string which will then be used to display the label. **id** defines the name which will be used for programmatic access. **type** defines the data type you want to collect; it also affects the UI which will be displayed for the element. **default** defines the default value for the setting. You should always use a default value wherever possible to provide a better user experience.

The following are a few important settings types that you can use…
text: Used for basic string inputs.
ipaddress: Used to collect internet addresses.
number: Allows you enter a number. XBMC will also provide an on-screen numeric keyboard for the input.
slider: This provides an elegant way to collect integer, float and percentage values. You can get the slider setting in the following format:

```
<setting label="21223" type="slider"
id="sideinput" default="10"
range="1,1,10" option="int" />
```

In the above example we are creating a slider with min range 1, max range 10 and step as 1. In the **option** field we are stating the data type we are interested in – we can also set option to "float" or "percent".

bool: Provides bool selection in the form of on or off.
file: Provides a way to input file paths. Kodi will provide a file browser to make the selection of file. If you are looking to make selection for a specific type of file you can use audio, video, image or executable instead of file.

folder: Provides a way to browse for a folder…

Example:
```
<setting label="12001" type="folder"
id="folder" source="auto"
option="writeable"/>
```
Here, **source** sets the start location for the folder, while **option** sets the write parameter for the application.

sep & lsep: sep is used to draw a horizontal line in the setting dialog; lsep is used for drawing a horizontal line with text. They do not collect any input but are there for building better user interface elements…

```
<setting label="21212" type="lsep"
/>
```

08 Language support

Language support is provided in the form of the **strings.xml** file located in **resources/languages/[language name]**. This approach is very similar to many large software projects, including Android, where static strings are never used.

resource/language/english/string.xml example:

```
<?xml version="1.0" encoding="utf-8"
standalone="yes"?>
<strings>
<string id="30001">Add subreddit</
string>
<string id="30002">Hot</string>
<string id="30003">New</string>
<string id="30004">Top</string>
<string id="30005">Controversial</
string>
<string id="30006">Hour</string>
<string id="30007">Day</string>
<string id="30008">Week</string>
<string id="30009">Month</string>
<string id="30010">Year</string>
</strings>
```

As you may have seen in the settings.xml example, all the labels are referring to string ids. You can have many other languages as well. Depending upon the language Kodi is running in, the correct language file will be loaded automatically.

Since XBMC Frodo (12.1), strings.xml has been deprecated. Kodi has since moved to a GNU gettext-based translation system; gettext uses PO files. You can use a tool called xbmc-xml2po to convert strings.xml into equivalent PO files.

09 Building default.py

Since our plug-in is small, it will all be contained inside **default.py**. If you are developing a more complex add-on then you can create supporting files in the same directory. If your library depends upon third-party libraries, you have two ways to go about it. You can either place the third-party libraries into the **resources/lib** folder; or bundle the library itself into a plug-in, then add that plug-in as the dependency in the **addon.xml** file.

Our plug-in works with **reddit.tv**. This is the website from Reddit which contains trending videos shared by its readers. Videos posted on Reddit are actually sourced from YouTube, Vimeo and Dailymotion.

We will be starting off default.py using the following imports:

```
import urllib
import urllib2
…
import xbmcplugin
import xbmcgui
import xbmcaddon
```

Apart from xbmcplugin, xbmcgui and xbmcaddon, the rest are all standard Python libraries which are available on PyPI (Python Package Index) via pip. You will not need to install any library yourself since the Python runtime for Kodi has all the components built in.

urllib and **urllib2** help in HTTP communication. **socket** is used for network I/O; **re** is used for regular expression matching; **sqlite3** is the Python module for accessing an SQLite embedded database; **xbmcplugin**, **xbmcgui** and **xbmcaddon** contain the XBMC-specific routine.

10 Initialising

During the initialisation process, we will be reading various settings from **settings.xml**. Settings can be read in the following way:

```
addon = xbmcaddon.Addon()
filterRating = int(addon.
getSetting("filterRating"))
filterVoteThreshold = int(addon.getS
etting("filterVoteThreshold"))
```

In order to read settings of type bool you will need to do something like:

```
filter = addon.getSetting("filter")
== "true"
```

We are also setting the main URL, plug-in handle and the user agent for it:

```
pluginhandle = int(sys.argv[1])
urlMain = "http://www.reddit.com"
userAgent = "Mozilla/5.0 (Windows NT
6.2; WOW64; rv:22.0) Gecko/20100101
Firefox/22.0"
opener = urllib2.build_opener()
opener.addheaders = [('User-Agent',
userAgent)]
```

11 Reading localised strings

As mentioned, XBMC uses **strings.xml** to serve up the text. In order to read those strings, you will need to use **getLocalizedString**.

```
translation = addon.
getLocalizedString
translation(30002)
```

In this example, **translation(30002)** will return the string "Hot" when it is running in an English environment.

idFile	idPath	strFilename	playCount	lastPlayed	dateAdded
1	1	plugin://plugin.		2013-08-06 23:47	
2	2	plugin://plugin.	1	2013-08-07 22:42	
3	2	plugin://plugin.	1	2013-08-08 00:09	
4	2	plugin://plugin.	1	2013-08-08 00:55	
5	2	plugin://plugin.	1	2013-08-08 00:58	

12 Building helper functions

In this step we will look at some of the important helper functions.

getDbPath(): This returns the location of the SQLite database file for videos. XBMC stores library and playback information in SQLite DB files. There are separate databases for videos and music, located inside the **.kodi/userdata/ Database** folder. We are concerned with the videos DB. It is prefixed with 'MyVideos'...

```
def getDbPath():
    path = xbmc.
translatePath("special://userdata/
Database")
    files = os.listdir(path)
    latest = ""
    for file in files:
        if file[:8] == 'MyVideos'
and file[-3:] == '.db':
            if file > latest:
                latest = file
    return os.path.join(path,
latest)
```

getPlayCount(url): Once we have the database location, we can get the play count using a simple SQL query. The MyVideo database contains a table called **files**, which keeps a record of all the video files played in Kodi by filename. In this case it will be URL.

```
dbPath = getDbPath()
conn = sqlite3.connect(dbPath)
c = conn.cursor()
```

```
def getPlayCount(url):
    c.execute('SELECT playCount FROM
files WHERE strFilename=?', [url])
    result = c.fetchone()
    if result:
        result = result[0]
        if result:
            return int(result)
        return 0
    return -1
```

The above table is an example of a files table.

addSubreddit(): Our plug-in allows users to add their own Subreddit. This function takes the Subreddit input from the user, then saves it in the **subreddits** file inside the addon data folder.

The following sets the subreddits file location:

```
subredditsFile = xbmc.
translatePath("special://profile/
addon_data/"+addonID+"/subreddits")
this translates into .xbmc/
userdata/addon_data/plugin.video.
ludent/subreddits
```

```
def addSubreddit():
    keyboard = xbmc.Keyboard('',
translation(30001))
    keyboard.doModal()
    if keyboard.isConfirmed() and
keyboard.getText():
        subreddit = keyboard.
getText()
        fh = open(subredditsFile,
'a')
        fh.write(subreddit+'\n')
        fh.close()
```

This function also demonstrates how to take a text input from the user. Here we are calling the Keyboard function with a text title. Once it detects the keyboard, it writes the input in the subreddits file with a newline character.

getYoutubeUrl(id): When we locate a YouTube URL to play, we pass it on to the YouTube plug-in (plugin.video.youtube) to handle the playback. To do so, we need to call it in a certain format...

```
def getYoutubeUrl(id):
    url = "plugin://plugin.
video.youtube/?path=/root/
video&action=play_video&videoid="
+ id
    return url
```

»

Similarly for Vimeo:

```
def getVimeoUrl(id):
    url = "plugin://plugin.video.
vimeo/?path=/root/video&action=play_
video&videoid=" + id
    return url
```

And for Dailymotion:

```
def getDailyMotionUrl(id):
    url = "plugin://plugin.video.
dailymotion_com/?url=" + id +
"&mode=playVideo"
    return url
```

Once we have the video URL resolved into the respective plug-in, playing it is very simple:

```
def playVideo(url):
    listitem = xbmcgui.
ListItem(path=url)
    xbmcplugin.
setResolvedUrl(pluginhandle, True,
listitem)
```

13 Populating plug-in content listing

xbmcplugin contains various routines for handling the content listing inside the plug-ins UI. The first step is to create directory entries which can be selected from the Kodi UI. For this we will use a function called **xbmcplugin.addDirectoryItem**.

For our convenience we will be abstracting addDirectoryItem to suit it to our purpose, so that we can set name, URL, mode, icon image and type easily.

```
def addDir(name, url, mode,
iconimage, type=""):
    u = sys.argv[0]+"?url="+urllib.
quote_plus(url)+"&mode="+str(mode)+"
&type="+str(type)
    ok = True
    liz = xbmcgui.ListItem(name,
iconImage="DefaultFolder.png",
thumbnailImage=iconimage)
    liz.setInfo(type="Video",
infoLabels={"Title": name})
    ok = xbmcplugin.
addDirectoryItem(handle=int(sys.
argv[1]), url=u, listitem=liz,
isFolder=True)
    return ok
```

On the same lines, we can build a function to place links as well...

```
def addLink(name, url, mode,
iconimage, description, date):
    u = sys.argv[0]+"?url="+urllib.
quote_plus(url)+"&mode="+str(mode)
    ok = True
    liz = xbmcgui.ListItem(name,
iconImage="DefaultVideo.png",
thumbnailImage=iconimage)
    liz.setInfo(type="Video",
infoLabels={"Title": name, "Plot":
description, "Aired": date})
    liz.setProperty('IsPlayable',
'true')
    ok = xbmcplugin.
addDirectoryItem(handle=int(sys.
argv[1]), url=u, listitem=liz)
    return ok
```

Based on the abstractions we have just created, we can create the base functions which will populate the content. But before we do that, let's first understand how Reddit works. Most of the Reddit content filters are provided through something called Subreddits. This allows you to view discussions related to a particular topic. In our plug-in we are interested in showing videos; we also want to show trailers, documentaries etc. We access these using Subreddits. For example, for trailers it would be **reddit.com/r/trailers**. For domains we can use **/domain**; for example, to get all the YouTube videos posted on Reddit, we will call **reddit.com/domain/youtube.com**. Now you may ask what is the guarantee that this Subreddit will only list videos? The answer is that it may not. For that reason we scrape the site ourselves to find videos. More on this in the next step.

The first base function we'll define is **index()**. This is called when the user starts the plug-in.

```
def index():
    defaultEntries = ["videos",
"trailers", "documentaries",
"music"]
    entries = defaultEntries[:]
    if os.path.
exists(subredditsFile):
        fh = open(subredditsFile,
'r')
        content = fh.read()
        fh.close()
        spl = content.split('\n')
        for i in range(0, len(spl),
1):
            if spl[i]:
                subreddit = spl[i]
                entries.
append(subreddit)
    entries.sort()
    for entry in entries:
        if entry in defaultEntries:
            addDir(entry.title(),
"r/"+entry, 'listSorting', "")
        else:
            addDirR(entry.title(),
"r/"+entry, 'listSorting', "")
    addDir("[ Vimeo.com ]",
"domain/vimeo.com", 'listSorting',
"")
    addDir("[ Youtu.be ]", "domain/
youtu.be", 'listSorting', "")
    addDir("[ Youtube.com
]", "domain/youtube.com",
'listSorting', "")
    addDir("[ Dailymotion.com
]", "domain/dailymotion.com",
'listSorting', "")
    addDir("[B]-
"+translation(30001)+" -[/B]", "",
'addSubreddit', "")
    xbmcplugin.
endOfDirectory(pluginhandle)
```

Here, the penultimate entry makes a call to addSubreddit. **listSorting** takes care of sorting out the data based on criteria such as Hot, New etc. It also calls in Reddit's JSON function, which returns nice easy-to-parse JSON data.

We have created a settings entry for all the sorting criteria. Based on what is set, we go ahead and build out the sorted list.

```
def listSorting(subreddit):
    if cat_hot:
        addDir(translation(30002),
urlMain+"/"+subreddit+"/hot/.
json?limit=100", 'listVideos', "")
    if cat_new:
        addDir(translation(30003),
urlMain+"/"+subreddit+"/new/.
json?limit=100", 'listVideos', "")
    if cat_top_d:
        addDir(translation(30004)+":
"+translation(30007),
urlMain+"/"+subreddit+"/
top/.json?limit=100&t=day",
'listVideos', "")
    xbmcplugin.
endOfDirectory(pluginhandle)
```

```
def listVideos(url):
    currentUrl = url
    xbmcplugin.setContent(pluginhandle, "episodes")
    content = opener.open(url).read()
    spl = content.split('"content"')
    for i in range(1, len(spl), 1):
        entry = spl[i]
        try:
            match = re.compile('"title": "(.+?)"', re.DOTALL).findall(entry)
            title = match[0].replace("&amp;", "&")
            match = re.compile('"description": "(.+?)"', re.DOTALL).
findall(entry)
            description = match[0]
            match = re.compile('"created_utc": (.+?),', re.DOTALL).findall(entry)
            downs = int(match[0].replace("}", ""))
            rating = int(ups*100/(ups+downs))
            if filter and (ups+downs) > filterVoteThreshold and rating <
filterRating:
                continue
            title = title+" ("+str(rating)+"%)"
            match = re.compile('"num_comments": (.+?),', re.DOTALL).
findall(entry)
            comments = match[0]
            description = dateTime+"  |  "+str(ups+downs)+" votes:
"+str(rating)+"% Up  |  "+comments+" comments\n"+description
            match = re.compile('"thumbnail_url": "(.+?)"', re.DOTALL).
findall(entry)
            thumb = match[0]
            matchYoutube = re.compile('"url": "http://www.youtube.com/
watch\\?v=(.+?)"', re.DOTALL).findall(entry)
            matchVimeo = re.compile('"url": "http://vimeo.com/(.+?)"', re.DOTALL).
findall(entry)
            url = ""
            if matchYoutube:
                url = getYoutubeUrl(matchYoutube[0])
            elif matchVimeo:
                url = getVimeoUrl(matchVimeo[0].replace("#", ""))
            if url:
                addLink(title, url, 'playVideo', thumb, description, date)
        except:
            pass
    match = re.compile('"after": "(.+?)"', re.DOTALL).findall(entry)
    xbmcplugin.endOfDirectory(pluginhandle)
    if forceViewMode:
        xbmc.executebuiltin('Container.SetViewMode('+viewMode+')')
```

14 Populating the episode view (listing videos)

At this point we have the URL in hand, which returns JSON data; now we need to extract the data out of it which will make sense to us.

By looking at the JSON data, you can see there's a lot of interesting information present here. For example, **url** is set to youtube.com/watch?v=n4rTztvVx8E; **title** is set to 'The Counselor – Official Trailer'. There also many other bits of data that we will use, such as ups, downs, num_comments, thumbnail_url and so on. In order to filter out the data that we need, we will use regular expressions.

There is one more thing to note: since we are not presenting directories any more but are ready to place content, we have to set the **xbmcplugin.setContent** to episodes mode.

In the code listed to the left here, we are opening the URL, then – based on regular expression matches – we are discovering the location title, description, date, ups, downs and rating. We are also locating video thumbnails and then passing them on to Kodi.

Later in the code, we also try to match the URL to a video provider. With our plug-in we are supporting YouTube, Vimeo and Dailymotion. If this is detected successfully, we call the helper functions to locate the Kodi plug-in based playback URL. During this whole parsing process, if any exception is raised, the whole loop is ignored and the next JSON item is parsed.

15 Installing & running the add-on

You can install the add-on using one of the following two methods:

- You can copy the plug-in directory to .kodi/addons.
- You can install the plug-in from the zip file. To do so, compress the add-on folder into a zip file using the command:

```
$ zip -r plugin.video.ludent.zip
plugin.video.ludent
```

To install the plug-in from the zip file, open Kodi, go to System then Add-ons, then click 'Install from zip file'. The benefit of installing from a zip file is that Kodi will automatically try to install all the dependent plug-ins as well.

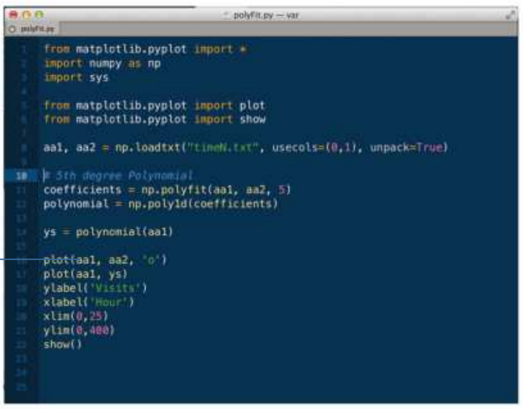
Once you have the plug-in installed, you can run it by going to the Videos Add-ons section of Kodi, selecting Get More… and then clicking on LUD Reddit Viewer.

You can access the settings dialog of the plug-in by right-clicking the LUD Reddit Viewer, then selecting 'Add-on settings'.

So, you have seen how robust and powerful Kodi's extension system is. In this example, we were able to leverage the full power of Python (including those magical regular expression matches) from within Kodi. Kodi itself also offers a robust UI framework, which provides a very professional look for our add-on.

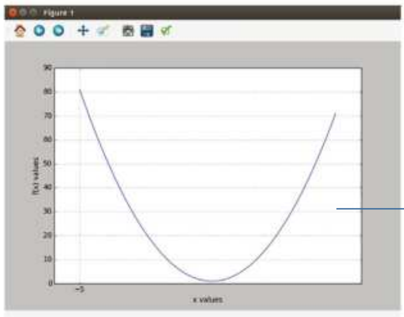
As powerful as it may seem, we have only built a video plug-in. Kodi's extension system also provides a framework for building fully fledged programs (called Programs). We will cover this in a later issue.

A simple Python program for Polynomial Fitting!

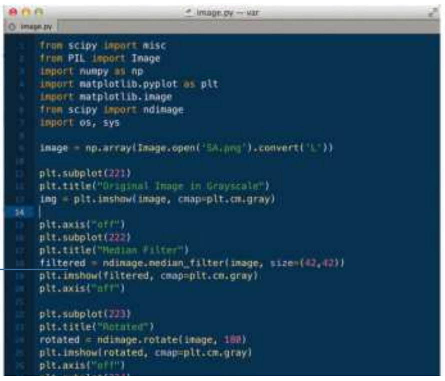


```
from matplotlib.pyplot import *
import numpy as np
import sys

from matplotlib.pyplot import plot
from matplotlib.pyplot import show

aa1, aa2 = np.loadtxt("timeN.txt", usecols=(0,1), unpack=True)

# 5th degree Polynomial
coefficients = np.polyfit(aa1, aa2, 5)
polynomial = np.poly1d(coefficients)

ys = polynomial(aa1)

plot(aa1, aa2, 'o')
plot(aa1, ys)
ylabel('Visits')
xlabel('Hour')
xlim(0,25)
ylim(0,400)
show()
```

Matplotlib generated output

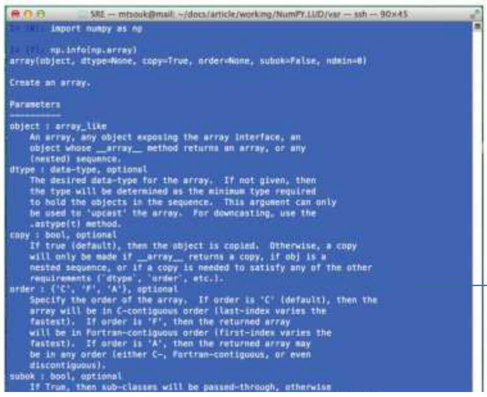


A Python script that uses SciPy to process an image



```
from scipy import misc
from PIL import Image
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.image
from scipy import ndimage
import os, sys

image = np.array(Image.open('SA.png').convert('L'))

plt.subplot(221)
plt.title("Original Image in Grayscale")
img = plt.imshow(image, cmap=plt.cm.gray)

plt.axis("off")
plt.subplot(222)
plt.title("Median Filter")
filtered = ndimage.median_filter(image, size=(42,42))
plt.imshow(filtered, cmap=plt.cm.gray)
plt.axis("off")

plt.subplot(223)
plt.title("Rotated")
rotated = ndimage.rotate(image, 180)
plt.imshow(rotated, cmap=plt.cm.gray)
plt.axis("off")
```

Finding help is easy



```
SRE — mtsouk@mail: ~/docs/article/working/NumPY.LUD/var — ssh — 90×45
         import numpy as np

         np.info(np.array)
array(object, dtype=None, copy=True, order=None, subok=False, ndmin=0)

Create an array.

Parameters
----------
object : array_like
    An array, any object exposing the array interface, an
    object whose __array__ method returns an array, or any
    (nested) sequence.
dtype : data-type, optional
    The desired data-type for the array.  If not given, then
    the type will be determined as the minimum type required
    to hold the objects in the sequence.  This argument can only
    be used to 'upcast' the array.  For downcasting, use the
    .astype(t) method.
copy : bool, optional
    If true (default), then the object is copied.  Otherwise, a copy
    will only be made if __array__ returns a copy, if obj is a
    nested sequence, or if a copy is needed to satisfy any of the other
    requirements (`dtype`, `order`, etc.).
order : {'C', 'F', 'A'}, optional
    Specify the order of the array.  If order is 'C' (default), then the
    array will be in C-contiguous order (last-index varies the
    fastest).  If order is 'F', then the returned array
    will be in Fortran-contiguous order (first-index varies the
    fastest).  If order is 'A', then the returned array may
    be in any order (either C-, Fortran-contiguous, or even
    discontiguous).
subok : bool, optional
    If True, then sub-classes will be passed-through, otherwise
```

Scientific computing with NumPy

Powerful calculations with NumPy, SciPy and Matplotlib

Resources

NumPy:
www.numpy.org

SciPy:
www.scipy.org

Matplotlib:
www.matplotlib.org

NumPy is the primary Python package for performing scientific computing. It has a powerful N-dimensional array object, tools for integrating C/C++ and Fortran code, linear algebra, Fourier transform, and random number capabilities, among other things. NumPy also supports broadcasting, which is a clever way for universal functions to deal in a meaningful way with inputs that do not have exactly the same form.

Apart from its capabilities, the other advantage of NumPy is that it can be integrated into Python programs. In other words, you may get your data from a database, the output of another program, an external file or an HTML page and then process it using NumPy.

This article will show you how to install NumPy, make calculations, plot data, read and write external files, and it will introduce you to some Matplotlib and SciPy packages that work well with NumPy.

NumPy also works with Pygame, a Python package for creating games, though explaining its use is beyond of the scope of this article.

It is considered good practice to try the various NumPy commands inside the Python shell before putting them into Python programs.

The examples in this article are using either Python shell or iPython.

01 Installing NumPy

Most Linux distributions have a ready-to-install package you can use. After installation, you can find out the NumPy version you are using by executing the following:

```
$ python
Python 3.10.4 (main, Apr 2 2022, 09:04:19)
[GCC 11.2.0] on linux
Type "help", "copyright", "credits" or
"license" for more information.
>>> numpy.version.version
```

```
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'numpy' is not defined
>>> import numpy
>>> numpy.version.version
'1.21.5'
>>>
```

Not only have you found the NumPy version, but you also now know that NumPy has been properly installed.

02 About NumPy

Despite its simplistic name, NumPy is a powerful Python package that is mainly for working with arrays and matrices. There are many ways to create an array but the simplest is by using the array() function:

```
>>> oneD = array([1,2,3,4])
```

The aforementioned command creates a one-dimensional array. If you want to create a two-dimensional array, you can use the array() function as follows:

```
>>> twoD = array([ [1,2,3],
...                [3,3,3],
...                [-1,-0.5,4],
...                [0,1,0]] )
```

You can also create arrays with more dimensions.

03 Making simple calculations using NumPy

Given an array named myArray, you can find the minimum and maximum values in it by executing the following commands:

```
>>> myArray.min()
>>> myArray.max()
```

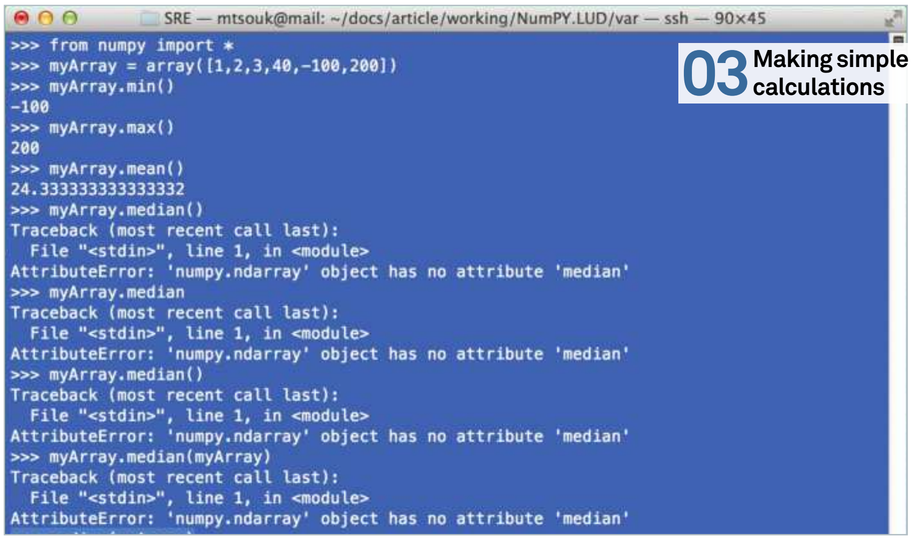
Should you wish to find the mean value of all array elements, run the next command:

```
>>> myArray.mean()
```

Similarly, you can find the median of the array by running the following command:

```
>>> median(myArray)
```

The median value of a set is an element that divides the data set into two subsets (left and right subsets) with the same number of elements. If the data set has an odd number of elements, then the median is part of the data set. On the other side, if the data set has an even number of elements, then the median is the mean value of the two centre elements of the sorted data set.


SRE — mtsouk@mail: ~/docs/article/working/NumPY.LUD/var — ssh — 90×45
03 Making simple calculations

```
>>> from numpy import *
>>> myArray = array([1,2,3,40,-100,200])
>>> myArray.min()
-100
>>> myArray.max()
200
>>> myArray.mean()
24.333333333333332
>>> myArray.median()
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: 'numpy.ndarray' object has no attribute 'median'
>>> myArray.median
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: 'numpy.ndarray' object has no attribute 'median'
>>> myArray.median()
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: 'numpy.ndarray' object has no attribute 'median'
>>> myArray.median(myArray)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: 'numpy.ndarray' object has no attribute 'median'
```

04 Using arrays with NumPy

NumPy not only embraces the indexing methods used in typical Python for strings and lists but also extends them. If you want to select a given element from an array, you can use the following notation:

```
>>> twoD[1,2]
```

You can also select a part of an array (a slice) using the following notation:

```
>>> twoD[:1,1:3]
```

Finally, you can convert an array into a Python list using the tolist() function.

05 Reading files

Imagine that you have just extracted information from an Apache log file using AWK and you want to process the text file using NumPy.

The following AWK code finds out the total number of requests per hour:

```
$ cat access.log | cut -d[ -f2 | cut -d]
-f1 | awk -F: '{print $2}' | sort -n | uniq
-c | awk '{print $2, $1}' > timeN.txt
```

The format of the text file (timeN.txt) with the data is the following:

```
00 191
01 225
02 121
03 104
```

Reading the timeN.txt file and assigning it to a new array variable can be done as follows:

```
aa = np.loadtxt("timeN.txt")
```

06 Writing to files

Writing variables to a file is largely similar to reading a file. If you have an array variable named aa1, you can easily save its contents into a file called aa1.txt by using the following command:

```
In [17]: np.savetxt("aa1.txt", aa1)
```

As you can easily imagine, you can read the contents of aa1.txt later by using the loadtxt() function.

07 Common functions

NumPy supports many numerical and statistical functions. When you apply a function to an array, the function is automatically applied to all array elements.

When working with matrices, you can find the inverse of a matrix AA by typing "AA.I". You can also find its eigenvalues by typing "np.linalg.eigvals(AA)" and its eigenvector by typing "np.linalg.eig(BB)".

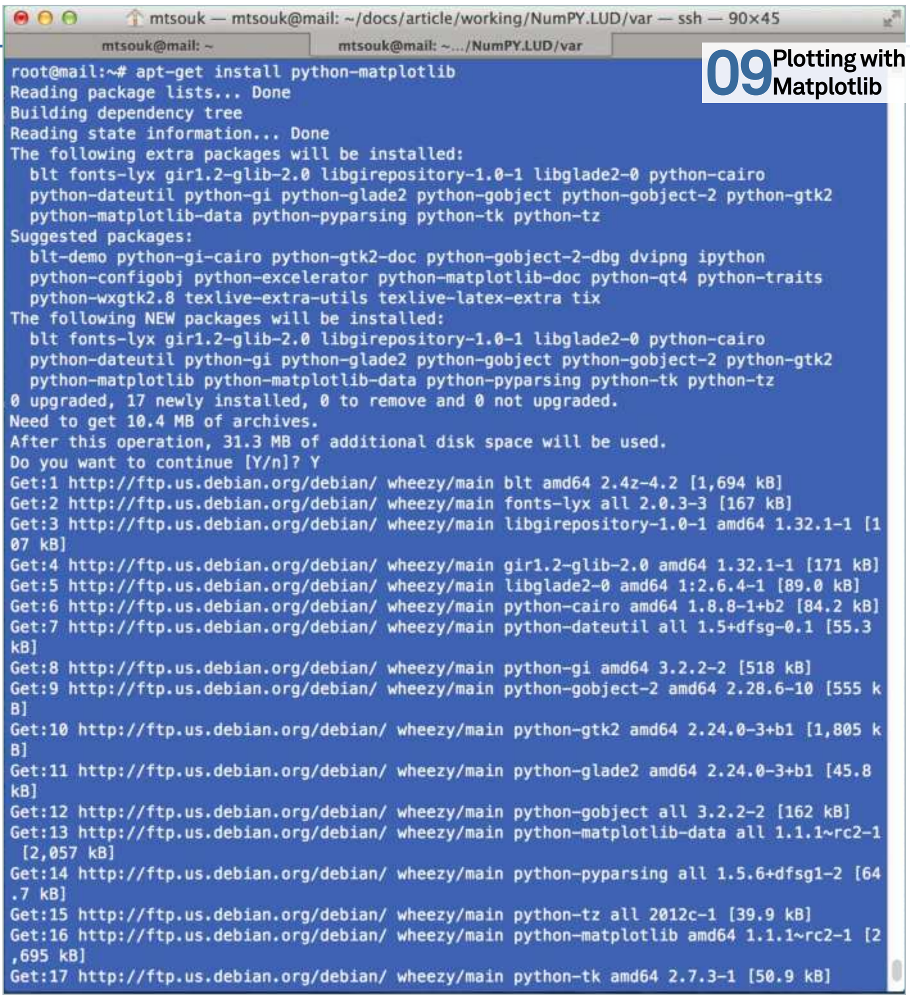
08 Working with matrices

A special subtype of a two-dimensional NumPy array is a matrix. A matrix is like an array except that matrix multiplication replaces element-by-element multiplication. Matrices are generated using the matrix (or mat) function as follows:

```
In [2]: AA = np.mat('0 1 1; 1 1 1; 1 1 1')
```

You can add two matrices named AA and BB by typing AA + BB. Similarly, you can multiply them by typing AA * BB.

»


mtsouk — mtsouk@mail: ~/docs/article/working/NumPY.LUD/var — ssh — 90×45
mtsouk@mail: ~
mtsouk@mail: ~.../NumPY.LUD/var
09 Plotting with Matplotlib

```
root@mail:~# apt-get install python-matplotlib
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following extra packages will be installed:
  blt fonts-lyx gir1.2-glib-2.0 libgirepository-1.0-1 libglade2-0 python-cairo
  python-dateutil python-gi python-glade2 python-gobject python-gobject-2 python-gtk2
  python-matplotlib-data python-pyparsing python-tk python-tz
Suggested packages:
  blt-demo python-gi-cairo python-gtk2-doc python-gobject-2-dbg dvipng ipython
  python-configobj python-excelerator python-matplotlib-doc python-qt4 python-traits
  python-wxgtk2.8 texlive-extra-utils texlive-latex-extra tix
The following NEW packages will be installed:
  blt fonts-lyx gir1.2-glib-2.0 libgirepository-1.0-1 libglade2-0 python-cairo
  python-dateutil python-gi python-glade2 python-gobject python-gobject-2 python-gtk2
  python-matplotlib python-matplotlib-data python-pyparsing python-tk python-tz
0 upgraded, 17 newly installed, 0 to remove and 0 not upgraded.
Need to get 10.4 MB of archives.
After this operation, 31.3 MB of additional disk space will be used.
Do you want to continue [Y/n]? Y
Get:1 http://ftp.us.debian.org/debian/ wheezy/main blt amd64 2.4z-4.2 [1,694 kB]
Get:2 http://ftp.us.debian.org/debian/ wheezy/main fonts-lyx all 2.0.3-3 [167 kB]
Get:3 http://ftp.us.debian.org/debian/ wheezy/main libgirepository-1.0-1 amd64 1.32.1-1 [1
07 kB]
Get:4 http://ftp.us.debian.org/debian/ wheezy/main gir1.2-glib-2.0 amd64 1.32.1-1 [171 kB]
Get:5 http://ftp.us.debian.org/debian/ wheezy/main libglade2-0 amd64 1:2.6.4-1 [89.0 kB]
Get:6 http://ftp.us.debian.org/debian/ wheezy/main python-cairo amd64 1.8.8-1+b2 [84.2 kB]
Get:7 http://ftp.us.debian.org/debian/ wheezy/main python-dateutil all 1.5+dfsg-0.1 [55.3
kB]
Get:8 http://ftp.us.debian.org/debian/ wheezy/main python-gi amd64 3.2.2-2 [518 kB]
Get:9 http://ftp.us.debian.org/debian/ wheezy/main python-gobject-2 amd64 2.28.6-10 [555 k
B]
Get:10 http://ftp.us.debian.org/debian/ wheezy/main python-gtk2 amd64 2.24.0-3+b1 [1,805 k
B]
Get:11 http://ftp.us.debian.org/debian/ wheezy/main python-glade2 amd64 2.24.0-3+b1 [45.8
kB]
Get:12 http://ftp.us.debian.org/debian/ wheezy/main python-gobject all 3.2.2-2 [162 kB]
Get:13 http://ftp.us.debian.org/debian/ wheezy/main python-matplotlib-data all 1.1.1~rc2-1
 [2,057 kB]
Get:14 http://ftp.us.debian.org/debian/ wheezy/main python-pyparsing all 1.5.6+dfsg1-2 [64
.7 kB]
Get:15 http://ftp.us.debian.org/debian/ wheezy/main python-tz all 2012c-1 [39.9 kB]
Get:16 http://ftp.us.debian.org/debian/ wheezy/main python-matplotlib amd64 1.1.1~rc2-1 [2
,695 kB]
Get:17 http://ftp.us.debian.org/debian/ wheezy/main python-tk amd64 2.7.3-1 [50.9 kB]
```

“ SciPy is built on top of NumPy and is more advanced ”

Fig 01

```
In [36]: from scipy.stats import poisson, lognorm
In [37]: mySh = 10;
In [38]: myMu = 10;
In [39]: ln = lognorm(mySh)
In [40]: p = poisson(myMu)
In [41]: ln.rvs((10,))
Out[41]:
array([  9.29393114e-02,   1.15957068e+01,   9.78411983e+01,
         8.26370734e-07,   5.64451441e-03,   4.61744055e-09,
         4.98471222e-06,   1.45947948e+02,   9.25502852e-06,
         5.87353720e-02])
In [42]: p.rvs((10,))
Out[42]: array([12, 11,  9,  9,  9, 10,  9,  4, 13,  8])
In [43]: ln.pdf(3)
Out[43]: 0.013218067177522842
```

09 Plotting with Matplotlib

The first move you should make is to install Matplotlib. As you can see, Matplotlib has many dependencies that you should also install.

The first thing you will learn is how to plot a polynomial function. The necessary commands for plotting the 3x^2-x+1 polynomial are the following:

```
import numpy as np
import matplotlib.pyplot as plt
myPoly = np.poly1d(np.array([3, -1, 1]).
astype(float))
x = np.linspace(-5, 5, 100)
y = myPoly(x)
plt.xlabel('x values')
plt.ylabel('f(x) values')
xticks = np.arange(-5, 5, 10)
yticks = np.arange(0, 100, 10)
plt.xticks(xticks)
plt.yticks(yticks)
plt.grid(True)
plt.plot(x,y)
```

The variable that holds the polynomial is myPoly. The range of values that will be plotted for x is defined using “x = np.linspace(-5, 5, 100)”. The other important variable is y, which calculates and holds the values of f(x) for each x value.

It is important that you start ipython using the “ipython --pylab=qt” parameters in order to see the output on your screen. If you are interested in plotting polynomial functions, you should experiment more, as NumPy can also calculate the derivatives of a function and plot multiple functions in the same output.

10 About SciPy

SciPy is built on top of NumPy and is more advanced than NumPy. It supports numerical integration, optimisations, signal processing, image and audio processing, and statistics. The example in **Fig. 01** (to the left) uses a small part of the scipy.stats package that is about statistics.

The example uses two statistics distributions and may be difficult to understand even if you know mathematics, but it is presented in order to give you a better taste of SciPy commands.

11 Using SciPy for image processing

Now we will show you how to process and transform a PNG image using SciPy.

The most important part of the code is the following line:

```
image = np.array(Image.open('SA.png').
convert('L'))
```

This line allows you to read a usual PNG file and convert it into a NumPy array for additional processing. The program will also separate the output into four parts and displays a different image for each of these four parts.

12 Other useful functions

It is very useful to be able to find out the data type of the elements in an array; it can be done using the dtype() function.

Similarly, the ndim() function returns the number of dimensions of an array.

When reading data from external files, you can save their data columns into separate variables using the following way:

```
In [10]: aa1,aa2 = np.loadtxt("timeN.txt",
usecols=(0,1), unpack=True)
```

The aforementioned command saves column 1 into variable aa1 and column 2 into variable aa2. The "unpack=True" allows the data to be assigned to two different variables. Please note that the numbering of columns starts with 0.

13 Fitting to polynomials

The NumPy polyfit() function tries to fit a set of data points to a polynomial. The data was found from the timeN.txt file, created earlier in this article.

The Python script uses a fifth degree polynomial, but if you want to use a different degree instead then you only have to change the following line:

```
coefficients = np.polyfit(aa1, aa2, 5)
```

14 Array broadcasting in NumPy

To close, we will talk more about array broadcasting because it is a very useful characteristic. First, you should know that array broadcasting has a rule: in order for two arrays to be considered for array broadcasting, "the size of the trailing axes for both arrays in an operation must either be the same size or one of them must be one."

Put simply, array broadcasting allows NumPy to "change" the dimensions of an array by filling it with data in order to be able to do calculations with another array. Nevertheless, you cannot stretch both dimensions of an array to do your job.

"Process and transform a PNG image using SciPy"

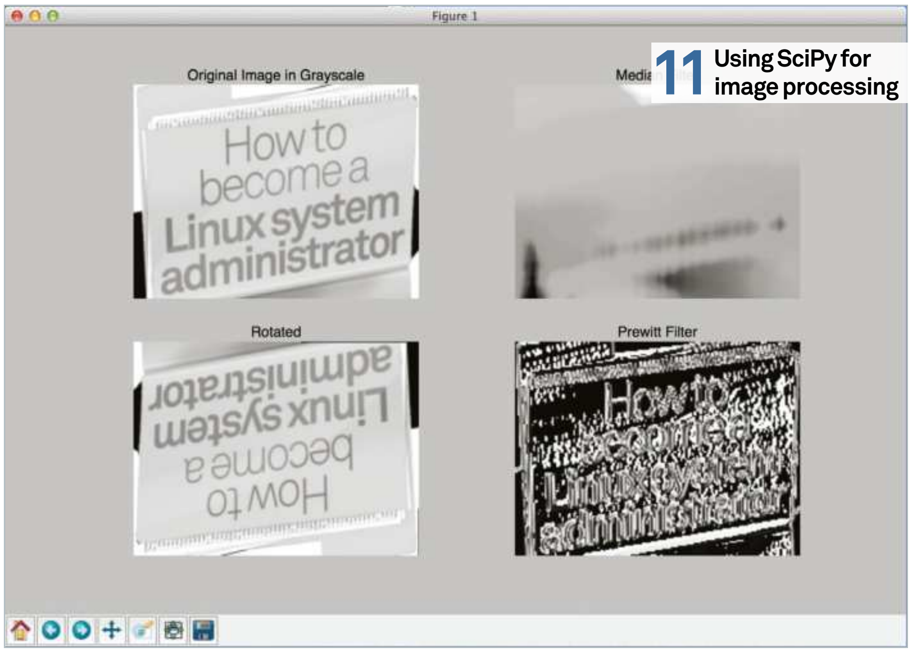
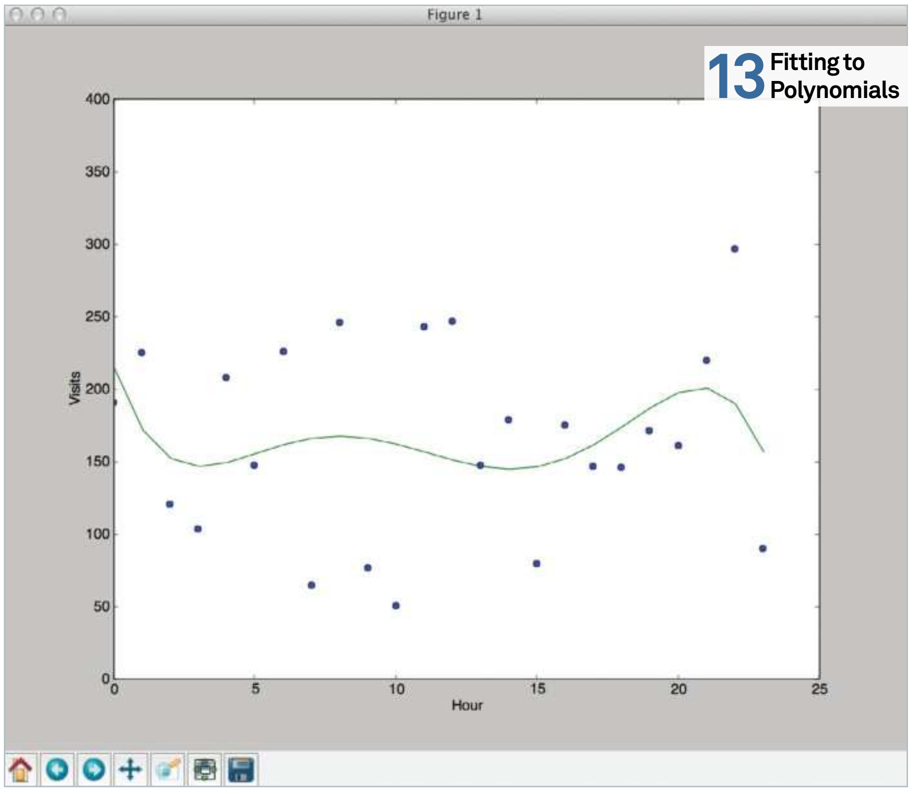
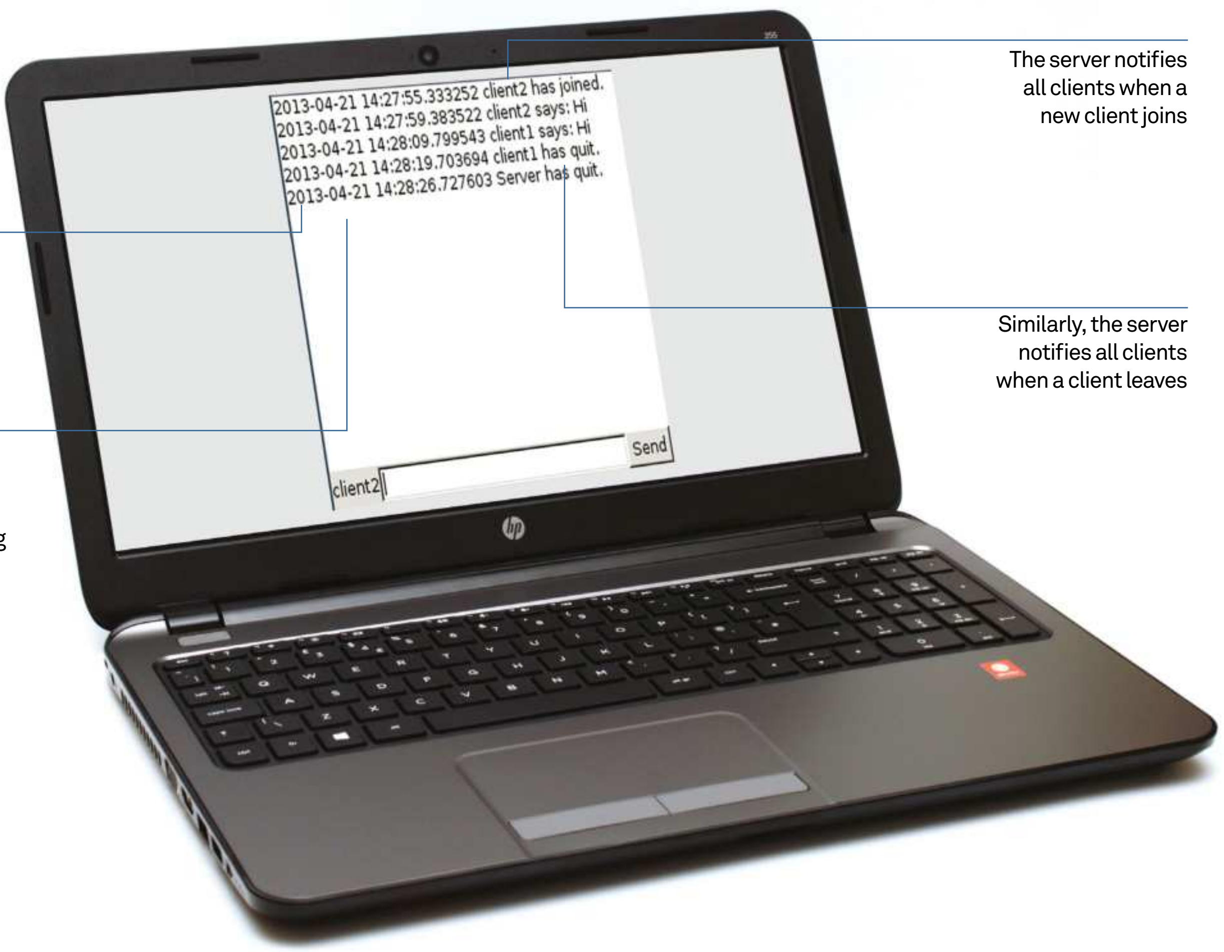


Figure 1
Original Image in Grayscale
Media
Rotated
Prewitt Filter
How to become a Linux system administrator

11 Using SciPy for image processing



13 Fitting to Polynomials



```
2013-04-21 14:27:55.333252 client2 has joined.
2013-04-21 14:27:59.383522 client2 says: Hi
2013-04-21 14:28:09.799543 client1 says: Hi
2013-04-21 14:28:19.703694 client1 has quit.
2013-04-21 14:28:26.727603 Server has quit.
```

The server notifies all clients when a new client joins

Each message has a time stamp prefixed to it

Similarly, the server notifies all clients when a client leaves

A client can detect when the server exits without crashing or hanging

Instant messaging with Python

How to program both the client – complete with a GUI – and server of a simple instant messenger in Python

Resources

A computer – running your favourite Linux distribution

Internet connection – to access documentation

Python 3.x, PyGTK and GObject – packages installed

Here we'll be implementing an instant messenger in Python with a client-server architecture. This means each client connects to the server, which relays any message that one client sends to all other clients. The server will also notify the other clients when someone joins or leaves the server. The instant messenger can work anywhere a TCP socket can: on the same computer with the loopback interface, across various computers on a LAN, or even over the internet if you were to configure your router correctly. However, our messages aren't encrypted, so we wouldn't recommend that. Writing an instant messenger is an interesting technical problem that covers a bunch of areas that you may not have come across while programming before:

• We'll be employing sockets, which are used to transmit data across networks.

• We'll also be using threading, which allows a program to do multiple things at once.

• We'll cover the basics of writing a simple graphical user interface with GTK, as well as how to interact with that from a different thread.

• Finally, we'll be touching on the use of regular expressions to easily analyse and extract data from strings.

Before getting started, you'll need to have a Python2.x interpreter installed, as well as the PyGTK bindings and the Python2 GObject bindings. The chances are that if you have a system with a fair amount of software on it, you will already have these packages, so it may be easier to wait and see if you're missing any libraries when you attempt to import them. All of the above packages are commonly used, so you should be able to install them using your distro's package manager.

01 The server

The server will do the following jobs:

- Listen for new clients
- Notify all clients when a new client joins
- Notify all clients when a client leaves
- Receive and deliver messages to all clients

We're going to write the server side of the instant messenger first, as the client requires it. There will be two code files, so it's a good idea to make a folder to keep them inside. You can create an empty file with the command `touch [filename]`, and mark that file as executable using `chmod +x [filename]`. This file is now ready to edit in your favourite editor.

```
$ mkdir Python-IM
$ cd Python-IM/
$ touch IM-Server.py
$ chmod +x IM-Server.py
```

02 Starting off

As usual, we need to start off with the line that tells the program loader what it needs to interpret the rest of the file with. In your advisor's case, that line is:

```
#!/usr/bin/env python3
```

On your system, it may need to be changed to `#!/usr/bin/env python3.7` or `#!/usr/bin/env python3.10` but usually the first variation will be fine.

After that, we've written a short comment about what the application does, and imported the required libraries. We've already mentioned what the **threading** and **socket** libraries are for. The **re** library is used for searching strings with regular expressions. The **signal** library is used for dealing with signals that will kill the program, such as SIGINT. SIGINT is sent when Ctrl+C is pressed. We handle these signals so that the program can tell the clients that it's exiting rather than dying unexpectedly. The **sys** library is used to exit the program. Finally, the **time** library is used to put a sensible limit on how frequently the body of while loops execute.

```
#!/usr/bin/env python3
# The server side of an instant
messaging application. Written as
part of a Linux User & Developer
tutorial by Liam Fraser in 2013.
import threading
import socket
import re
import signal
import sys
import time
```

03 The Server class

The **Server** class is the main class of our instant messenger server. The **initialiser** of this class accepts a port number to start listening for clients on. It then creates a socket, binds the socket to the specified port on all interfaces, and then starts to listen on that port. You can optionally include an IP address in the tuple that contains the port. Passing in a blank string like we have done causes it to listen on all interfaces. The value of 1 passed to the **listen** function specifies the maximum number of queued connections we can accept. This shouldn't be a problem as we're not expecting a bunch of clients to connect at the same time.

Now that we have a socket, we'll create an empty array that will be later used to store a collection of client sockets that we can echo messages to. The final part is to tell the signal library to run the **self.signal_handler** function, which we have yet to write, when a SIGINT or SIGTERM is sent to the application so that we can tidy up nicely.

```
class Server():
    def __init__(self, port):
# Create a socket and bind it to a
port
        self.listener = socket.
socket(socket.AF_INET, socket.SOCK_
STREAM)
        self.listener.bind((‘’,
port))
        self.listener.listen(1)
        print(“Listening on port
{0}”.format(port0)
# Used to store all of the client
sockets we have, for echoing
to them
        self.client_sockets = []
# Run the function self.signal_
handler when Ctrl+C is pressed
       signal.signal(signal.SIGINT,
self.signal_handler)
        signal.signal(signal.
SIGTERM, self.signal_handler)
```

04 The server's main loop

The server's main loop essentially accepts new connections from clients, adds that client's socket to the collection of sockets and then starts an instance of the **ClientListener** class, which we have yet to write, in a new thread. Sometimes, defining interfaces you are going to call before you've written them is good, because it can give an overview of how the program will work without worrying about the details. Note that we're printing information as we go along, to make debugging easier should we need to do it. Sleeping at the end of the loop is useful to make sure the **while** loop can't run quickly enough to hang the machine. However, this is unlikely to happen as the line that accepts new connections is blocking, which means that the program waits for a connection before moving on from that line. For this reason, we need to enclose the line in a **try** block, so that we can catch the socket error and exit when we can no longer accept connections. This will usually be when we've closed the socket during the process of quitting the program.

```
    def run(self):
        while True:
# Listen for clients, and create a
ClientThread for each new client
            print(“Listening for
more clients”)

            try:
                (client_socket,
client_address) = self.listener.
accept()
            except socket.error:
                sys.exit(“Could not
```

Useful documentation

Threading: docs.python.org/3/library/threading.html

Sockets: docs.python.org/3/library/socket.html

Regular expressions: docs.python.org/3/library/re.html

The signal handler: docs.python.org/3/library/signal.html

PyGTK: www.pygtk.org/pygtk2reference

GObject: www.pygtk.org/pygtk2reference/gobject-functions.html

```
accept any more connections")

            self.client_sockets.
append(client_socket)

            print("Starting client
thread for {0}".format(client_
address))
            client_thread =
ClientListener(self, client_socket,
client_address)
            client_thread.start()

            time.sleep(0.1)
```

05 The echo function

We need a function that can be called from a client's thread to echo a message to each client. This function is pretty simple. The most important part is that sending data to sockets is in a **try** block, which means that we can handle the exception if the operation fails, rather than having the program crash.

```
    def echo(self, data):
# Send a message to each socket in
self.client_socket
        print("echoing: {0}".
format(data))
        for socket in self.client_
sockets:
# Try and echo to all clients
            try:
                socket.sendall(data)
            except socket.error:
                print("Unable to send
message")
```

06 Finishing the Server class

The remainder of the **Server** class is taken up with a couple of simple functions; one to remove a socket from the collection of sockets, which doesn't need an explanation, and the **signal_handler** function that we talked about in the **initialiser** of the class. This function stops listening for new connections, and unbinds the socket from the port it was listening on. Finally, we send a message to each client to let them know that we are exiting. The signal will continue to close the program as expected once the signal_handler function has ended.

```
    def remove_socket(self, socket):
# Remove the specified socket from the
client_sockets list
        self.client_sockets.
remove(socket)
    def signal_handler(self, signal,
frame):
# Run when Ctrl+C is pressed
        print("Tidying up")
# Stop listening for new connections
        self.listener.close()
# Let each client know we are quitting
        self.echo("QUIT")
```

07 The client thread

The class that is used to deal with each client inherits the **Thread** class. This means that the class can be created, then started with `client_thread.start()`. At this point, the code in the **run** function of the class will be run in the background and the main loop of the **Server** class will continue to accept new connections.

We have to start by initialising the Thread base class, using the **super** keyword. You may have noticed that when we created a new instance of the **ClientListener** class in the server's main loop, we passed through the server's **self** variable. We do this because it's better for each instance of the ClientListener class to have its own reference to the server, rather than using the global one that we'll create later to actually start the application.

```
class ClientListener(threading.
Thread):
    def __init__(self, server,
socket, address):
# Initialise the Thread base class
        super(ClientListener,
self).__init__()
# Store the values that have been
passed to the constructor
        self.server = server
        self.address = address
        self.socket = socket
        self.listening = True
        self.username = "No
Username"
```

08 The client thread's loop

The loop that runs in the client thread is pretty similar to the one in the server. It keeps listening for data while **self.listening** is true, and passes any data it gets to a **handle_msg** function that we will write shortly. The value passed to the **socket.recv** function is the size of the buffer to use while receiving data.

```
    def run(self):
# The thread's loop to receive and
process messages
        while self.listening:
            data = ""
            try:
                data = self.socket.
recv(1024)
            except socket.error:
                "Unable to recieve
data"
            self.handle_msg(data)
            time.sleep(0.1)
# The while loop has ended
        print("Ending client thread
for {0}".format(self.address))
```

09 Tidying up

We need to have a function to tidy up the thread. We'll call this either when the client sends us a blank string (indicating that it's stopped listening on the socket) or sends us the string "QUIT". When this happens, we'll echo to every client that the user has quit.

```
    def quit(self):
# Tidy up and end the thread
        self.listening = False
        self.socket.close()
        self.server.remove_
socket(self.socket)
        self.server.echo("{0} has
quit.\n".format(self.username))
```

10 Handling messages

There are three possible messages our clients can send:

- QUIT
- USERNAME user
- Arbitrary string to be echoed to all clients

The client will also send a bunch of empty messages if the socket has been closed, so we will end their thread if that happens. The code should be pretty self-explanatory apart from the regular expression part. If someone sends the USERNAME message, then the server tells every client that a new user has joined. This is tested with a regular expression. **^** indicates the start of the string, **$** indicates the end, and the brackets containing **.*** extract whatever comes after "USERNAME ".

“We need to tell GObject that we’ll be using threading”

```
    def handle_msg(self, data):
# Print and then process the message
we’ve just recieved
        print("{0} sent: {1}".
format(self.address, data))
# Use regular expressions to test for
a message like "USERNAME liam"
        username_result =
re.search('^USERNAME (.*)$', data)
        if username_result:
            self.username =
username_result.group(1)
            self.server.echo("{0}
has joined.\n".format(self.
username))
        elif data == "QUIT":
# If the client has sent quit then
close this thread
            self.quit()
        elif data == "":
# The socket at the other end is
probably closed
            self.quit()
        else:
# It's a normal message so echo it to
everyone
            self.server.echo(data)
```

11 Starting the server

The code that actually starts the **Server** class is as follows. Note that you are probably best picking a high-numbered port as you need to be root to open ports <1024.

```
if __name__ == "__main__":
    # Start a server on port 59091
    server = Server(59091)
    server.run()
```

12 The client

Create a new file for the client as we did for the server and open it in your favourite editor. The client requires the same imports as the server, as well as the gtk, gobject and datetime libraries. One important thing we need to do is to tell GObject that we’ll be using threading, so we can call functions from other threads and have the main window, which is running in the main GTK thread, update.

```
#!/usr/bin/env python3
# The client side of an instant
messaging application. Written as
part of a Linux User & Developer
tutorial by Liam Fraser in 2013.

import threading
import gtk
import gobject
import socket
import re
import time
import datetime

# Tell gobject to expect calls from
multiple threads
gobject.threads_init()
```

13 The client graphical user interface

The user interface of the client isn’t the main focus of the tutorial, and won’t be explained in as much detail as the rest of the code. However, the code should be fairly straightforward to read and we have provided links to documentation that will help.

Our **MainWindow** class inherits the **gtk Window** class, so we need to start by initialising that using the **super** keyword. Then we create the controls that will go on the window, connect any events they have to functions, and finally lay out the controls how we want. The **destroy** event is raised when the program is closed, and the other events should be obvious.

GTK uses a packing layout, in which you use Vboxes and Hboxes to lay out the controls. V and H stand for vertical and horizontal. These controls essentially let you split a window up almost like a table, and will automatically decide the size of the controls depending on the size of the application. GTK doesn’t come with a control to enter basic information, such as the server’s IP address, port and your chosen username, so we’ve made a function called **ask_for_info**, which creates a message box, adds a text box to it and then retrieves the results. We’ve done this because it’s simpler and uses less code than creating a new window to accept the information.

```
class MainWindow(gtk.Window):
    def __init__(self):
# Initialise base gtk window class
        super(MainWindow, self).__
init__()
# Create controls
        self.set_title("IM Client")
        vbox = gtk.VBox()
        hbox = gtk.HBox()
        self.username_label = gtk.
Label()
        self.text_entry = gtk.
Entry()
        send_button = gtk.
Button("Send")
        self.text_buffer = gtk.
TextBuffer()
        text_view = gtk.
TextView(self.text_buffer)
# Connect events
        self.connect("destroy",
self.graceful_quit)
        send_button.
connect("clicked", self.send_
message)
# Activate event when user presses
Enter
        self.text_entry.
connect("activate", self.send_
message)
# Do layout
        vbox.pack_start(text_view)
        hbox.pack_start(self.
username_label, expand = False)
```

»

```
        hbox.pack_start(self.text_
entry)
        hbox.pack_end(send_button,
expand = False)
        vbox.pack_end(hbox, expand
= False)
# Show ourselves
        self.add(vbox)
        self.show_all()
# Go through the configuration
process
        self.configure()
    def ask_for_info(self,
question):
# Shows a message box with a text
entry and returns the response
        dialog = gtk.
MessageDialog(parent = self, type =
gtk.MESSAGE_QUESTION,

flags = gtk.DIALOG_MODAL |

gtk.DIALOG_DESTROY_WITH_PARENT,

buttons = gtk.BUTTONS_OK_CANCEL,

message_format = question)
        entry = gtk.Entry()
        entry.show()
        dialog.vbox.pack_end(entry)
        response = dialog.run()
        response_text = entry.
get_text()
        dialog.destroy()
        if response == gtk.RESPONSE_
OK:
            return response_text
        else:
            return None
```

14 Configuring the client

This code is run after we've added the controls to the main window, and asks the user for input. Currently, the application will exit if the user enters an incorrect server address or port; but this isn't a production system, so that's fine.

```
    def configure(self):
# Performs the steps to connect to
the server
# Show a dialog box asking for server
address followed by a port
        server = self.ask_for_
info("server_address:port")
# Regex that crudely matches an IP
address and a port number
        regex = re.search('^(\d+\.\
d+\.\d+\.\d+):(\d+)$', server)
        address = regex.group(1).
strip()
        port = regex.group(2).
strip()
# Ask for a username
        self.username = self.ask_
for_info("username")
        self.username_label.set_
text(self.username)
# Attempt to connect to the server
and then start listening
        self.network =
Networking(self, self.username,
address, int(port))
        self.network.listen()
```

15 The remainder of MainWindow

The rest of the **MainWindow** class has plenty of comments to explain itself, as follows. One thing to note is that when a client sends a message, it doesn't display it in the text view straight away. The server is going to echo the message to each client, so the client simply displays its own message when the server echoes it back. This means that you can tell if the server is not receiving your messages when you don't see a message that you send.

```
    def add_text(self, new_text):
# Add text to the text view
        text_with_timestamp = "{0}
{1}".format(datetime.datetime.now(),

new_text)
# Get the position of the end of
the text buffer, so we know where to
insert new text
        end_itr = self.text_buffer.
get_end_iter()
# Add new text at the end of the buffer
        self.text_buffer.insert(end_
itr, text_with_timestamp)
    def send_message(self, widget):
# Clear the text entry and send the
message to the server
# We don't need to display it as it
will be echoed back to each client,
including us.
        new_text = self.text_entry.
get_text()
        self.text_entry.set_text("")
        message = "{0} says: {1}\n".
format(self.username, new_text)
        self.network.send(message)
    def graceful_quit(self, widget):
# When the application is closed,
tell GTK to quit, then tell the
server we are quitting and tidy up
the network
        gtk.main_quit()
        self.network.send("QUIT")
        self.network.tidy_up()
```

"The server is going to echo the message to each client"

16 The client's Networking class

Much of the client's **Networking** class is similar to that of the server's. One difference is that the class doesn't inherit the **Thread** class – we just start one of its functions as a thread.

```
class Networking():
    def __init__(self, window,
username, server, port):
# Set up the networking class
        self.window = window
        self.socket = socket.
socket(socket.AF_INET, socket.SOCK_
STREAM)
        self.socket.connect((server,
port))
        self.listening = True
 # Tell the server that a new user has
joined
        self.send("USERNAME {0}".
format(username))

    def listener(self):
# A function run as a thread that
listens for new messages
        while self.listening:
            data = ""
            try:
                data = self.socket.
recv(1024)
            except socket.error:
                "Unable to recieve
data"
            self.handle_msg(data)
# Don't need the while loop to be
ridiculously fast
            time.sleep(0.1)
```

17 Running a function as a thread

The listener function above will be run as a thread. This is trivial to do. Enabling the **daemon** option on the thread means that it will die if the main thread unexpectedly ends.

```
    def listen(self):
# Start the listening thread
        self.listen_thread =
threading.Thread(target=self.
listener)
# Stop the child thread from keeping
the application open
        self.listen_thread.daemon =
True
        self.listen_thread.start()
```

18 Finishing the Networking class

Again, most of this code is similar to the code in the server's Networking class. One difference is that we want to add some things to the text view of our window. We do this by using the **idle_add** function of GObject. This allows us to call a function that will update the window running in the main thread when it is not busy.

```
    def send(self, message):
# Send a message to the server
        print "Sending: {0}".
format(message)
        try:
            self.socket.
sendall(message)
        except socket.error:
            print "Unable to send
message"

    def tidy_up(self):
# We'll be tidying up if either we are
quitting or the server is quitting
        self.listening = False
        self.socket.close()
# We won't see this if it's us
that's quitting as the window will
be gone shortly
        gobject.idle_add(self.
window.add_text, "Server has
quit.\n")

    def handle_msg(self, data):
        if data == "QUIT":
# Server is quitting
            self.tidy_up()
        elif data == "":
# Server has probably closed
unexpectedly
            self.tidy_up()
        else:
# Tell the GTK thread to add some
text when it's ready
            gobject.idle_add(self.
window.add_text, data)
```

19 Starting the client

The main window is started by initialising an instance of the class. Notice that we don't need to store anything that is returned. We then start the GTK thread by calling **gtk.main()**.

```
if __name__ == "__main__":
# Create an instance of the main
window and start the gtk main loop
    MainWindow()
    gtk.main()
```

20 Trying it out

You'll want a few terminals: one to start the server, and some to run clients. Once you've started the server, open an instance of the client and enter `127.0.0.1:port`, where 'port' is the port you decided to use. The server will print the port it's listening on to make this easy. Then enter a username and click OK. Here is an example output from the server with two clients. You can use the client over a network by replacing 127.0.0.1 with the IP address of the server. You may have to let the port through your computer's firewall if it's not working.

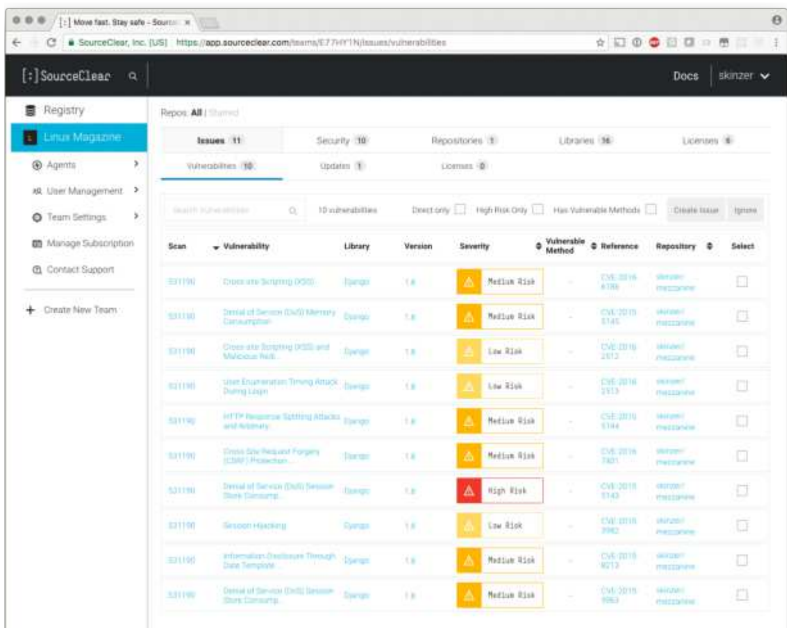
```
$ ./IM-Server.py
Listening on port 59091
Listening for more clients
Starting client thread for
('127.0.0.1', 38726)
('127.0.0.1', 38726) sent: USERNAME
client1
echoing: client1 has joined.
Listening for more clients
Starting client thread for
('127.0.0.1', 38739)
('127.0.0.1', 38739) sent: USERNAME
client2
echoing: client2 has joined.
Listening for more clients
('127.0.0.1', 38739) sent: client2
says: Hi
echoing: client2 says: Hi
('127.0.0.1', 38726) sent: client1
says: Hi
echoing: client1 says: Hi
('127.0.0.1', 38726) sent: QUIT
echoing: client1 has quit.
Ending client thread for
('127.0.0.1', 38726)
^CTidying up
echoing: QUIT
Could not accept any more
connections
('127.0.0.1', 38739) sent:
echoing: client2 has quit.
Ending client thread for
('127.0.0.1', 38739)
```

21 That's it!

So, it's not perfect and could be a little more robust in terms of error handling, but we have a working instant messenger server that can accept multiple clients and relay messages between them. More importantly, we have learned a bunch of new concepts and methods of working.

Bug-sweep your code with SourceClear

Keep your software projects safe – learn how to find and fix library-based security vulnerabilities quickly and easily



Scan	Vulnerability	Library	Version	Severity	Vulnerable Method	Reference	Repository	Select
[illegible]	Cross-site Scripting (XSS)	Django	1.6	Medium Risk	-	CVE-2016 [illegible]	skinzer/mezzanine	☐
[illegible]	Denial of Service (DoS) Memory Consumption	Django	1.6	Medium Risk	-	CVE-2015 [illegible]	skinzer/mezzanine	☐
[illegible]	Cross-site Scripting (XSS) and Malicious Redi...	Django	1.6	Low Risk	-	CVE-2016 [illegible]	skinzer/mezzanine	☐
[illegible]	User Enumeration Timing Attack During Login	Django	1.6	Low Risk	-	CVE-2016 [illegible]	skinzer/mezzanine	☐
[illegible]	HTTP Response Splitting Attacks and Arbitrary	Django	1.6	Medium Risk	-	CVE-2015 [illegible]	skinzer/mezzanine	☐
[illegible]	Cross Site Request Forgery (CSRF) Protection...	Django	1.6	Medium Risk	-	CVE-2016 [illegible]	skinzer/mezzanine	☐
[illegible]	Denial of Service (DoS) Session Store Consump...	Django	1.6	High Risk	-	CVE-2015 [illegible]	skinzer/mezzanine	☐
[illegible]	Session Hijacking	Django	1.6	Low Risk	-	CVE-2015 [illegible]	skinzer/mezzanine	☐
[illegible]	Information Disclosure Through Date Template	Django	1.6	Medium Risk	-	CVE-2015 [illegible]	skinzer/mezzanine	☐
[illegible]	Denial of Service (DoS) Session Store Consump...	Django	1.6	Medium Risk	-	CVE-2015 [illegible]	skinzer/mezzanine	☐

The average software project today relies on dozens – sometimes hundreds – of open source libraries. Are those libraries up to date? Are there any security vulnerabilities in the versions you're using? How would you even know?

SourceClear makes it easy to answer these questions and more, automatically. You'll get complete analysis of your open-source dependencies – security vulnerabilities, out-of-date libraries, and license reports.

To analyse your project, we'll be using the SourceClear command-line agent. By tapping into the native build and package managers that manage open-source dependencies, we'll start by gathering information on the full dependency graph. We'll then match up those libraries to the SourceClear Registry – the largest database in the world of open source security vulnerabilities – and help you triage the issues we might find.

Let's start by looking into a popular Python project and seeing what we can uncover.

Resources

Linux or OSX machine with internet access

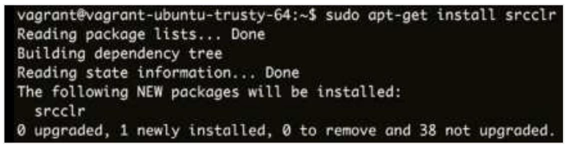
Python .x and pip installed on the local path
www.djangoproject.com/download

Git 1.9.3+

A free SourceClear.com account
https://www.sourceclear.com/

01 Install the SourceClear Agent

The SourceClear command-line interface (CLI) agent is a flexible utility that allows for easy scanning of your code projects for vulnerabilities in open-source. The tool can



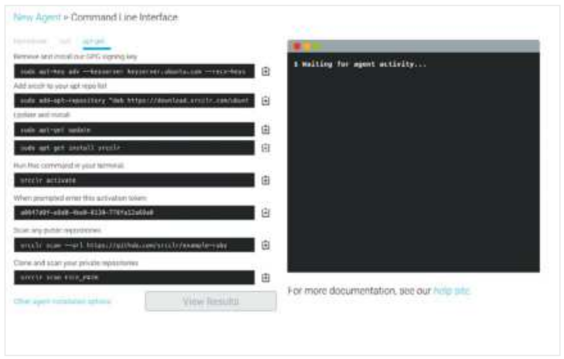
```
vagrant@vagrant-ubuntu-trusty-64:~$ sudo apt-get install srcclr
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  srcclr
0 upgraded, 1 newly installed, 0 to remove and 38 not upgraded.
```

be installed on nearly any Linux-based operating system by running one of the following sets of commands:

```
curl -sSL https://sourceclear.com/install | bash
```

Or, via apt-get if you prefer:

```
sudo apt-key adv --keyserver keyserver.ubuntu.com
--recv-keys DF7DD7A50B746DD4
sudo add-apt-repository "deb https://download.
srcclr.com/ubuntu stable/"
```


New Agent » Command Line Interface
apt-get
$ Waiting for agent activity...
For more documentation, see our help site.
View Results

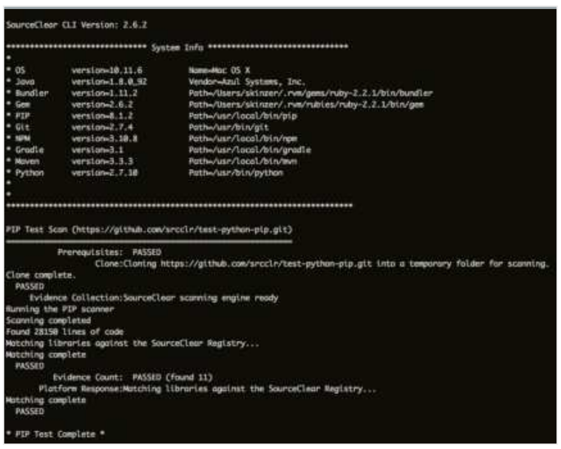
```
sudo apt-get update
sudo apt-get install srcclr
```

02 Activate your SourceClear Agent

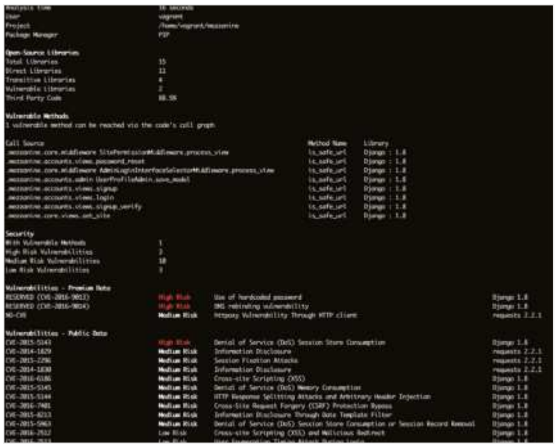
To activate your agent, we'll need your activation token. Log in to SourceClear.com. From the New Agent page, you can select your operating system (i.e. Linux). Copy your activation token by clicking on the clipboard to the right of the field. Next, go back to your terminal and run the following command, entering your activation token when prompted:

```
srcclr activate
```

This will create a configuration file with your API token in ~/.srcclr/agent.yml. If you wish to use this agent on another environment, you can copy the API token from this file and set it to the SRCCLR_API_TOKEN environment variable on another system without needing to activate the agent again.



```
SourceClear CLI Version: 2.6.2

****************************** System Info ******************************
*
* OS          version=10.11.6          Name=Mac OS X
* Java        version=1.8.0_92         Vendor=Azul Systems, Inc.
* Bundler     version=1.11.2           Path=/Users/skinzer/.rvm/gems/ruby-2.2.1/bin/bundler
* Gem         version=2.6.2            Path=/Users/skinzer/.rvm/rubies/ruby-2.2.1/bin/gem
* PIP         version=8.1.2            Path=/usr/local/bin/pip
* Git         version=2.7.4            Path=/usr/bin/git
* NPM         version=3.10.8           Path=/usr/local/bin/npm
* Gradle      version=3.1              Path=/usr/local/bin/gradle
* Maven       version=3.3.3            Path=/usr/local/bin/mvn
* Python      version=2.7.10           Path=/usr/bin/python
*
*
*************************************************************************

PIP Test Scan (https://github.com/srcclr/test-python-pip.git)
------------------------------------------------------------
         Prerequisites:  PASSED
                Clone:Cloning https://github.com/srcclr/test-python-pip.git into a temporary folder for scanning.
Clone complete.
  PASSED
    Evidence Collection:SourceClear scanning engine ready
Running the PIP scanner
Scanning completed
Found 28150 lines of code
Matching libraries against the SourceClear Registry...
Matching complete
  PASSED
         Evidence Count:  PASSED (found 11)
       Platform Response:Matching libraries against the SourceClear Registry...
Matching complete
  PASSED

* PIP Test Complete *
```



```
Analysis time                      16 seconds
User                               vagrant
Project                            /home/vagrant/mezzanine
Package Manager                    PIP

Open-Source Libraries
Total Libraries                    15
Direct Libraries                   11
Transitive Libraries               4
Vulnerable Libraries               2
Third Party Code                   88.5%

Vulnerable Methods
1 vulnerable method can be reached via the code's call graph

Call Source                                                                   Method Name    Library
 mezzanine.core.middleware.SitePermissionMiddleware.process_view              is_safe_url    Django : 1.8
 mezzanine.accounts.views.password_reset                                      is_safe_url    Django : 1.8
 mezzanine.core.middleware.AdminLoginInterfaceSelectorMiddleware.process_view is_safe_url    Django : 1.8
 mezzanine.accounts.admin.UserProfileAdmin.save_model                         is_safe_url    Django : 1.8
 mezzanine.accounts.views.signup                                              is_safe_url    Django : 1.8
 mezzanine.accounts.views.login                                               is_safe_url    Django : 1.8
 mezzanine.accounts.views.signup_verify                                       is_safe_url    Django : 1.8
 mezzanine.core.views.set_site                                                is_safe_url    Django : 1.8

Security
With Vulnerable Methods            1
High Risk Vulnerabilities          3
Medium Risk Vulnerabilities        18
Low Risk Vulnerabilities           7

Vulnerabilities - Premium Data
RESERVED (CVE-2016-9013)           High Risk     Use of hardcoded password                                   Django 1.8
RESERVED (CVE-2016-9014)           High Risk     DNS rebinding vulnerability                                 Django 1.8
NO-CVE                             Medium Risk   Httpoxy Vulnerability Through HTTP client                   requests 2.2.1

Vulnerabilities - Public Data
CVE-2015-5143                      High Risk     Denial of Service (DoS) Session Store Consumption           Django 1.8
CVE-2014-1829                      Medium Risk   Information Disclosure                                      requests 2.2.1
CVE-2015-2296                      Medium Risk   Session Fixation Attacks                                    requests 2.2.1
CVE-2014-1830                      Medium Risk   Information Disclosure                                      requests 2.2.1
CVE-2016-6186                      Medium Risk   Cross-site Scripting (XSS)                                  Django 1.8
CVE-2015-5145                      Medium Risk   Denial of Service (DoS) Memory Consumption                  Django 1.8
CVE-2015-5144                      Medium Risk   HTTP Response Splitting Attacks and Arbitrary Header Injection  Django 1.8
CVE-2016-7401                      Medium Risk   Cross-Site Request Forgery (CSRF) Protection Bypass         Django 1.8
CVE-2015-8213                      Medium Risk   Information Disclosure Through Date Template Filter         Django 1.8
CVE-2015-5963                      Medium Risk   Denial of Service (DoS) Session Store Consumption or Session Record Removal  Django 1.8
CVE-2016-2512                      Low Risk      Cross-site Scripting (XSS) and Malicious Redirect           Django 1.8
```

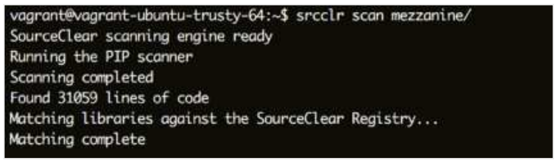
03 Test your environment

Let's ensure that your local environment is set up for scanning Python projects by running the following command:

```
srcclr test --pip
```

This command will display assorted system information that is used by the SourceClear CLI, and perform a scan of a test project that uses the specified package manager (pip in this case). The package manager information listed is only required if you wish to scan a project that uses libraries from the specific package manager. After running this command, you should now see output looking similar to the screenshot seen below.

" To demonstrate how SourceClear works, we'll start by analysing a public Python project called Mezzanine "



```
vagrant@vagrant-ubuntu-trusty-64:~$ srcclr scan mezzanine/
SourceClear scanning engine ready
Running the PIP scanner
Scanning completed
Found 31059 lines of code
Matching libraries against the SourceClear Registry...
Matching complete
```

04 Scan your Python project

To demonstrate how SourceClear works, we'll start by analysing a public Python project called Mezzanine (**https://github.com/stephenmcd/mezzanine**), which is a popular content management system built on Django.

We can scan projects like this by using their GitHub URL:

```
srcclr scan --url https://github.com/stephenmcd/
mezzanine
```

Specifying the GitHub URL will perform a shallow clone of the project, scan it, and then remove the project once finished. To scan projects you have locally, just use the path; for example:

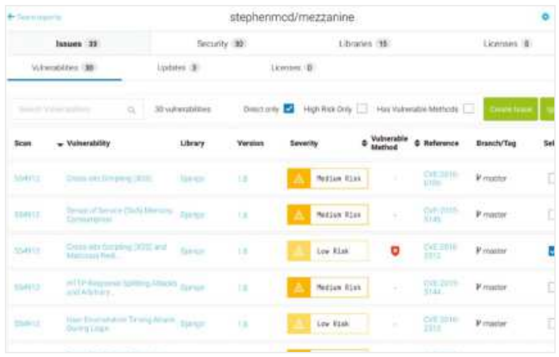
```
srcclr scan /path/to/mezzanine
```

05 View the scan report from standard output

After scanning the project, the output provides an overview of vulnerability and GPL licensing information. For this particular scan, the Django 1.8, requests 2.2.1, and Pillow 2.3.0 Python libraries are associated with 30 different vulnerabilities. In addition, the code in this particular project is actually using the vulnerable method associated with a Django 1.8 vulnerability.

06 Review the full scan results

The standard output from the SourceClear agent is helpful, but let's take a look at the full report online. Copy the Full Report Details URL at the bottom of the output and paste it into your browser. Once you've logged in, you can see the full details of this scan, including detailed vulnerability information, license information, and a searchable list of the open source libraries that are being used. All of the data can be filtered based on attributes of the library, license, or vulnerability (i.e. only high risk vulnerabilities, out of date libraries, and so on).



07 Fix a security issue

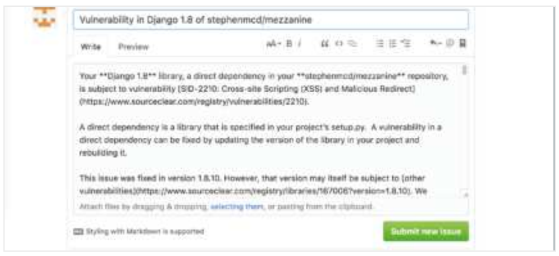
SourceClear integrates with JIRA and GitHub issues to help you track and fix vulnerabilities. In our report, we've identified a security issue that is not just part of this project, but one where the Mezzanine code directly calls the methods that are vulnerable. This is crucial to fix. We're going to create a GitHub issue for this vulnerable method by clicking the

»

Security automation made easy

Scanning projects from your laptop is a great way to get started, but automating the process helps the whole team. Adding security to your workflow can be made easy when you add SourceClear scanning inside your Continuous Integration environment. Just set up your activation token and add a post-build task. You can get environment-specific instructions over at **https://www.sourceclear.com/docs/**

checkbox next to the vulnerability and then selecting the Create Issue button.

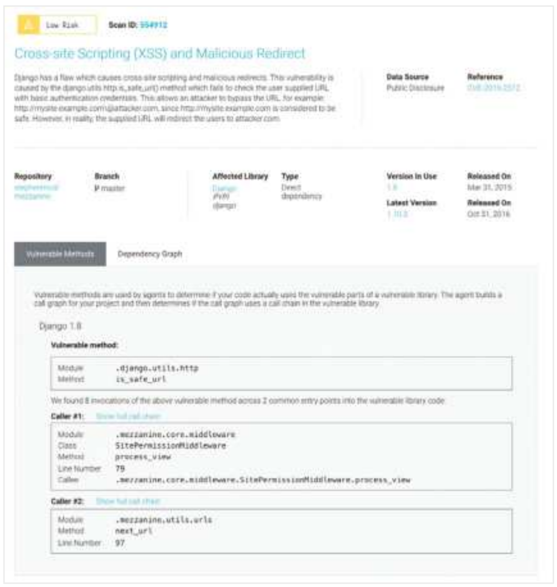

Vulnerability in Django 1.8 of stephenmcd/mezzanine

Your **Django 1.8** library, a direct dependency in your **stephenmcd/mezzanine** repository, is subject to vulnerability [SID-2210: Cross-site Scripting (XSS) and Malicious Redirect](https://www.sourceclear.com/registry/vulnerabilities/2210).

A direct dependency is a library that is specified in your project's setup.py. A vulnerability in a direct dependency can be fixed by updating the version of the library in your project and rebuilding it.

This issue was fixed in version 1.8.10. However, that version may itself be subject to [other vulnerabilities](https://www.sourceclear.com/registry/libraries/167006?version=1.8.10). We

Attach files by dragging & dropping, selecting them, or pasting from the clipboard.
Styling with Markdown is supported
Submit new issue



Scan ID: 554912

Cross-site Scripting (XSS) and Malicious Redirect

Django has a flaw which causes cross site scripting and malicious redirects. This vulnerability is caused by the django.utils.http is_safe_url() method which fails to check the user supplied URL with basic authentication credentials. This allows an attacker to bypass the URL, for example: http://mysite.example.com@attacker.com, since http://mysite.example.com is considered to be safe. However, in reality, the supplied URL will redirect the users to attacker.com.

Data Source	Reference
Public Disclosure	CVE-2016-2512

Repository	Branch	Affected Library	Type	Version In Use	Released On
stephenmcd/mezzanine	master	Django PyPI django	Direct dependency	1.8	Mar 31, 2015
				Latest Version	**Released On**
				1.10.3	Oct 31, 2016

Vulnerable methods are used by agents to determine if your code actually uses the vulnerable parts of a vulnerable library. The agent builds a call graph for your project and then determines if the call graph uses a call chain in the vulnerable library.

Django 1.8

Vulnerable method:

```
Module       .django.utils.http
Method       is_safe_url
```

We found 8 invocations of the above vulnerable method across 2 common entry points into the vulnerable library code.

Caller #1: Show full call chain

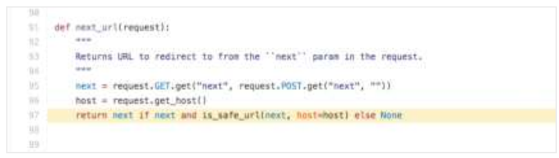
```
Module       .mezzanine.core.middleware
Class        SitePermissionMiddleware
Method       process_view
Line Number  79
Caller       .mezzanine.core.middleware.SitePermissionMiddleware.process_view
```

Caller #2: Show full call chain

```
Module       .mezzanine.utils.urls
Method       next_url
Line Number  97
```

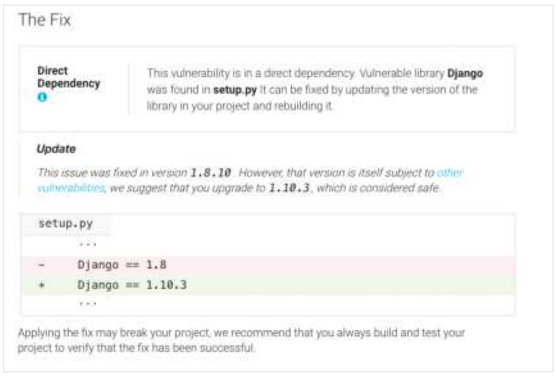
08 View vulnerability details

Now that we've identified the vulnerability, we want to fix it. SourceClear provides detailed information for the vulnerabilities. We can see this by going to the Issues tab within the scan report and clicking the vulnerability we want to fix. This will display a page with a description of the vulnerability, the library it is found in and the full call chain for any vulnerable methods that might be used and how to fix it.


```
90
91  def next_url(request):
92      """
93      Returns URL to redirect to from the ``next`` param in the request.
94      """
95      next = request.GET.get("next", request.POST.get("next", ""))
96      host = request.get_host()
97      return next if next and is_safe_url(next, host=host) else None
98
99
```

09 Look at the vulnerable code

Viewing the vulnerability fix information allows us to see exactly where in the code the vulnerable part is being used. In order to see how vulnerable caller #2, '**next_url**', is being used, we can go to line 97 within the **url.py** file. Sure enough, the vulnerable '**is_safe_url**' function is being used within the '**next_url**' function as shown in the screenshot.


The Fix

Direct Dependency

This vulnerability is in a direct dependency. Vulnerable library **Django** was found in **setup.py**. It can be fixed by updating the version of the library in your project and rebuilding it.

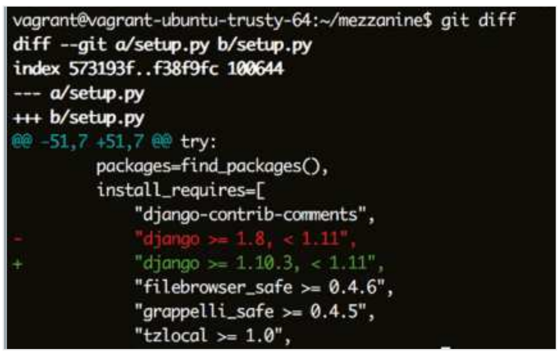
Update

This issue was fixed in version **1.8.10**. *However, that version is itself subject to other vulnerabilities, we suggest that you upgrade to* **1.10.3**, *which is considered safe.*

```
setup.py
        ...
-       Django == 1.8
+       Django == 1.10.3
        ...
```

Applying the fix may break your project, we recommend that you always build and test your project to verify that the fix has been successful.

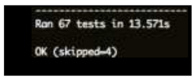
Using our understanding of where this vulnerability occurs in the code allows us to decide if altering the code itself to remove the vulnerability would be the best solution.


```
vagrant@vagrant-ubuntu-trusty-64:~/mezzanine$ git diff
diff --git a/setup.py b/setup.py
index 573193f..f38f9fc 100644
--- a/setup.py
+++ b/setup.py
@@ -51,7 +51,7 @@ try:
         packages=find_packages(),
         install_requires=[
             "django-contrib-comments",
-            "django >= 1.8, < 1.11",
+            "django >= 1.10.3, < 1.11",
             "filebrowser_safe >= 0.4.6",
             "grappelli_safe >= 0.4.5",
             "tzlocal >= 1.0",
```

10 Fix a vulnerability

Fixing this particular vulnerability by changing the code does not look to be the most feasible option in our case. Instead, we have the option of viewing the vulnerability fix information in SourceClear to see how to update the library in use to a version without any known vulnerabilities. The version that SourceClear is recommending to us is free of known vulnerabilities, so updating will only require that you specify a library version range greater than or equal to the suggested version.

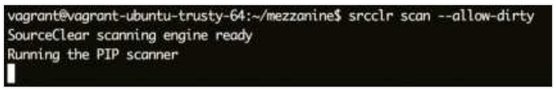
11 Apply the fix


```
-------------------------------
Ran 67 tests in 13.571s

OK (skipped=4)
```

Updating a library can be tricky, especially if the library is indirectly used in your code (i.e. library A depends on library B, which happens to be vulnerable). Fortunately the Django library is directly specified in the setup.py file within the project's root directory, which means we can simply update the version range for this particular library. As of November 2016, versions 1.10.3 or higher of Django do not have any known vulnerabilities.

12 Test your changes

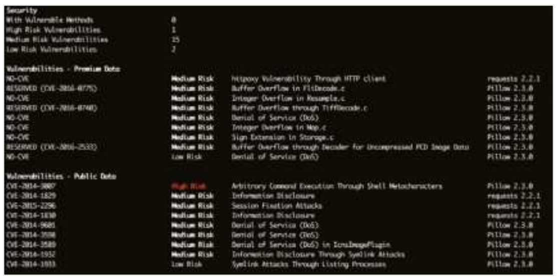
It is important to verify whether or not your project is compatible with a newer version of a library prior to committing changes. In this particular case, the version of Django we are updating to is below the highest version constraint (1.11), so the changes should not break the project. To be sure, you can use the Coverage Python library to run the tests for your project. As shown in the screenshot, the tests were successful, which means we can proceed with changes knowing that the project works as intended, assuming the appropriate test coverage is implemented.



```
vagrant@vagrant-ubuntu-trusty-64:~/mezzanine$ srcclr scan --allow-dirty
SourceClear scanning engine ready
Running the PIP scanner
```

13 Scan before committing

Once we have tested the fix, we can verify that the vulnerability fix worked prior to committing it to source control by running another SourceClear scan. SourceClear requires all code changes be associated with a commit in order for results to be sent and tracked in the web platform. By using the '**--allow-dirty**' argument, you can scan a project with uncommitted changes without sending the results to the web platform in order to verify that a vulnerability is fixed.



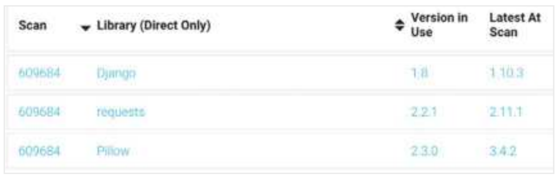
```
Security
With Vulnerable Methods                 0
High Risk Vulnerabilities               1
Medium Risk Vulnerabilities             15
Low Risk Vulnerabilities                2

Vulnerabilities - Premium Data
NO-CVE                    Medium Risk   Httpoxy Vulnerability Through HTTP client                    requests 2.2.1
RESERVED (CVE-2016-4775)  Medium Risk   Buffer Overflow in FliDecode.c                               Pillow 2.3.0
NO-CVE                    Medium Risk   Integer Overflow in Resample.c                               Pillow 2.3.0
RESERVED (CVE-2016-0740)  Medium Risk   Buffer Overflow through TiffDecode.c                         Pillow 2.3.0
NO-CVE                    Medium Risk   Denial of Service (DoS)                                      Pillow 2.3.0
NO-CVE                    Medium Risk   Integer Overflow in Map.c                                    Pillow 2.3.0
NO-CVE                    Medium Risk   Sign Extension in Storage.c                                  Pillow 2.3.0
RESERVED (CVE-2016-2533)  Medium Risk   Buffer Overflow through Decoder for Uncompressed PCD Image Data  Pillow 2.3.0
NO-CVE                    Low Risk      Denial of Service (DoS)                                      Pillow 2.3.0

Vulnerabilities - Public Data
CVE-2014-3007             High Risk     Arbitrary Command Execution Through Shell Metacharacters     Pillow 2.3.0
CVE-2014-1829             Medium Risk   Information Disclosure                                       requests 2.2.1
CVE-2015-2296             Medium Risk   Session Fixation Attacks                                     requests 2.2.1
CVE-2014-1830             Medium Risk   Information Disclosure                                       requests 2.2.1
CVE-2014-9601             Medium Risk   Denial of Service (DoS)                                      Pillow 2.3.0
CVE-2014-3598             Medium Risk   Denial of Service (DoS)                                      Pillow 2.3.0
CVE-2014-3589             Medium Risk   Denial of Service (DoS) in IcnsImagePlugin                   Pillow 2.3.0
CVE-2014-1932             Medium Risk   Information Disclosure Through Symlink Attacks               Pillow 2.3.0
CVE-2014-1933             Low Risk      Symlink Attacks Through Listing Processes                    Pillow 2.3.0
```

14 Verify the fix worked

After scanning with the '**--allow-dirty**' option, you can see an overview of the results and observe whether or not the vulnerabilities you intended to fix show up in the results. In this case, the output displays no vulnerabilities related to Django, which confirms that the changes were successful. Unfortunately, there are still vulnerable libraries being used in this code. Though the vulnerable methods for the libraries are not being used, we would still like to update to a non-vulnerable version to ensure that someone else contributing to the code does not use the vulnerable method.

15 Fix the rest of the vulnerabilities

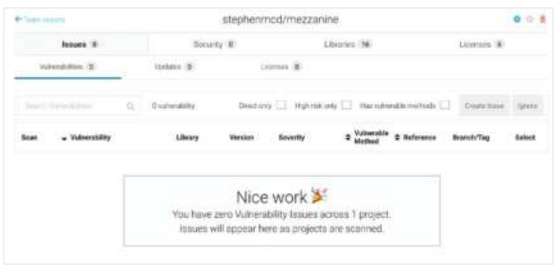
In the SourceClear dashboard, within the Issues section, you can select the Updates tab in order to view libraries that are out of date and are referenced directly by the dependency requirements file (setup.py, requirements.txt, pom.xml, etc). The remaining two vulnerable libraries, Pillow and requests, have version range requirements that do not specify an upper bound. This means we can simply update the constraints to be greater than or equal to the latest version displayed in the Latest at Scan column.



Scan	Library (Direct Only)	Version in Use	Latest At Scan
609684	Django	1.8	1.10.3
609684	requests	2.2.1	2.11.1
609684	Pillow	2.3.0	3.4.2

16 Update your libraries

Now that you know the versions to update to, you can change the version ranges so that they are greater than the specified Latest at Scan version. After updating the version ranges, you should run another scan with the '**--allow-dirty**' argument to ensure the fix was successful. Often you might find that version updates will cause more dependencies to be identified by SourceClear, because the library being updated might have another dependency it also depends on. SourceClear refers to these as 'transitive' dependencies.

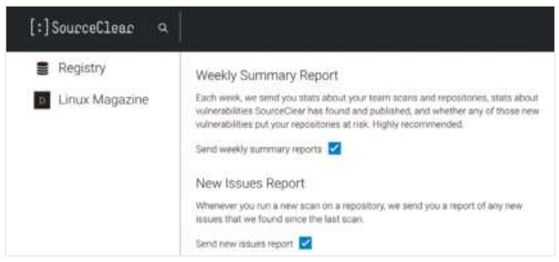


Nice work

You have zero Vulnerability Issues across 1 project.
Issues will appear here as projects are scanned.

17 Scan the committed changes to SourceClear

Finally, you will have identified and fixed all of the vulnerabilities associated with the project you are working on. By going into your Issues tab, you can see that your code is now free from known vulnerabilities. You can easily add SourceClear into your CI pipeline as well in order to automate this process, and keep your Issues tab up to date with vulnerability information.



Weekly Summary Report

Each week, we send you stats about your team scans and repositories, stats about vulnerabilities SourceClear has found and published, and whether any of those new vulnerabilities put your repositories at risk. Highly recommended.

Send weekly summary reports ✓

New Issues Report

Whenever you run a new scan on a repository, we send you a report of any new issues that we found since the last scan.

Send new issues report ✓

18 Notifications for future vulnerabilities

Security for your code is a constant battle, and it is important to make sure you are aware of any added vulnerable dependencies or newly identified vulnerabilities in your code. You can make sure you are notified by selecting the drop-down by your username in the top-right corner and choosing Notification Settings. You have the option to enable a weekly email summary of vulnerability information across all of your projects, or immediate notification emails when a new vulnerability is introduced to any of your projects, or both. Congratulations, your open source libraries are secure!

JSON output

Want to integrate SourceClear data into other security tools or dashboards? The SourceClear agent can produce scan data in JSON format – just use the '**--json**' argument when you run a scan. This data can be piped to a file or used in combination with a script to fail builds automatically when SourceClear identifies certain vulnerabilities or libraries.

Copy: A cp to call your own

Take inspiration from the common mocking bird and learn how to develop a light version of cp in Python 3 and safely copy files

Here, we'll be showing how to implement the cp command line utility in Python 3 – and our Python version will be called pycp.py. All operating systems offer at least one way to copy files and Linux is no exception. To understand how essential the cp command is, you should know that it is located inside /bin, which is available even if you boot your Linux machine in single user mode.

Using cp

The following output shows various uses of the cp utility:

```
$ ls -l /bin/cp
-rwxr-xr-x 1 root root 150824 Mar 14
2015 /bin/cp
$ cp /bin/cp .
$ ls -l cp
-rwxr-xr-x 1 mtsouk mtsouk 150824 Oct
19 22:09 cp
$ rm cp
$ cp /bin/cp /tmp/
$ ls -l cp
-rwxr-xr-x 1 mtsouk mtsouk 150824 Oct 19
22:09 cp
$ cp -n /bin/cp /tmp
$ cp -i /bin/cp /tmp
cp: overwrite '/tmp/cp'? y
```

The first command copies the cp executable into the current directory – as you can see, the new file belongs to the current user, whereas the original file belongs to the root user. The last cp command illustrates the use of the -i option of cp. You can check the man page of cp(1) to find more information about it as well as the other supported options.

Identifying files and directories

You'll need to find a way to differentiate between directories and regular files, which is the job of **fileORdir.py**:

```
#!/usr/bin/env python3

import os
import sys

if len(sys.argv) >= 2:
what = str(sys.argv[1])
else:
print('Not enough arguments!')
sys.exit(0)

if os.path.isdir(what):
print(what, 'is a directory!')
elif os.path.isfile(what):
print(what, 'is a file!')
```

The os.path.isdir() method tells whether its parameter is a directory or not whereas the os.path.isfile() tells whether its argument is a regular file or not. It should be noted here that although it looks redundant to perform both tests, this is the right way to do the job because Linux supports many more types of files including sockets, links and pipes. Executing fileORdir.py generates the following kind of output:

```
$ ./fileORdir.py .
. is a directory!
$ ./fileORdir.py /usr
/usr is a directory!
$ ./fileORdir.py /bin/cp
/bin/cp is a file!
```

This operation is important because if the second command line argument of cp is a directory, it means that you're going to create a copy of the original file, which is given as the first command line argument, into that directory. Additionally, if the first command line argument is a directory, then the Python script won't work.

Dealing with files

This part of the tutorial will present Python 3 methods that are related to files. It will enable you to add some extra features to **pycp.py.** The following Python 3 code, saved as **fileOperations.py,** shows some of the methods that explore file metadata:

```
#!/usr/bin/env python3

import sys
import os
import stat
from stat import *

if len(sys.argv) >= 2:
filename = str(sys.argv[1])
else:
print('Not enough arguments!')
sys.exit(0)

```

Quick tip

Systems programming is a special area of coding. When UNIX was first introduced, the only way to write systems software was by using C. Nowadays you can develop systems software using other programming languages including Python, Perl, Rust and Go.

```
fileMetadata = [(filename, os.
lstat(filename))]
for name, meta in fileMetadata:
if S_ISDIR(meta.st_mode):
print('It is a directory!')
else:
print('It is a regular file')
print(name, 'takes', meta.st_size,
'bytes')

print('File permissions:', stat.
filemode(os.
stat(filename).st_mode))
```

The difference between os.lstat() and os.stat(), which are both offered by Python 3, is that os.lstat() doesn't follow symbolic links, which makes it safer than os.stat(). Executing **fileOperations.py** generates the following kind of output:

```
$ ./fileOperations.py fileOperations.
py
It is a regular file
fileOperations.py takes 502 bytes
File permissions: -rwxr-xr-x
$ ./fileOperations.py .
It is a directory!
. takes 4096 bytes
File permissions: drwxr-xr-x
```

As you can see from the values of the "File permissions" part, regular files begin with a hyphen, whereas directories begin with the letter d.

This is cheating!

Python enables you to use external commands in your scripts with the help of the os.system() method. Therefore, you can implement file copying using the cp utility itself. The following code, saved in **cheating.py**, illustrates the technique:

```
#!/usr/bin/env python3

import os
import sys

if len(sys.argv) >= 3:
source = str(sys.argv[1])
destination = str(sys.argv[2])
else:
print('Not enough arguments!')
sys.exit(0)
os.system('cp '+ source + ' ' +
destination)
```

Nevertheless, this technique is not considered good practice and should be avoided.

File copies in Python 3

Most programming languages, including C, Perl and C++, offer more than one way to copy a file. Python 3 is no different.

Generally speaking, when you have many ways to perform a task you should use the most generic way. If all ways are generic, then you should choose the fastest one. If you don't know in advance which technique is the fastest, you can perform some tests to find out.

This section will present two ways to copy a file in Python 3. The first method is in the **copy1.py** file:

```
#!/usr/bin/env python3

from shutil import copyfile
import sys

if len(sys.argv) >= 3:
source = str(sys.argv[1])
destination = str(sys.argv[2])
else:
print('Not enough arguments!')
sys.exit(0)

try:
copyfile(source, destination)
except IOError as e:
errno, strerror = e.args
print("I/O error({0}): {1}".
format(errno,strerror))
```

The copyfile() function of the **shutil** module does the whole job for us. As this technique uses a single method, you have no control over it, which sometimes is a good thing, but it can sometimes be bad. The second method is included in the **copy2.py** file:

```
#!/usr/bin/env python3

import sys
if len(sys.argv) >= 3:
source = str(sys.argv[1])
destination = str(sys.argv[2])
else:
print('Not enough arguments!')
sys.exit(0)

size = 16384

try:
with open(source,'rb') as f1:
with open(destination,'wb') as f2:
while True:
buf = f1.read(size)
if buf:
n = f2.write(buf)
else:
break
except IOError as e:
errno, strerror = e.args
print("I/O error({0}): {1}".
format(errno,strerror))
```

This technique uses the write() method to copy data to the new file using a buffer variable named **buf**. Using a very small buffer, such as eight bytes, will jeopardise the performance of the script. The solution is to use relatively large buffers depending on the RAM of your machine.

Please note that both **copy1.py** and **copy2.py** use the "try" block to catch and handle potential errors during the copy operation. Although both techniques are good, the second one gives us more control over the process and might be more efficient; therefore, the presented Python 3 implementation of cp will use this technique.

Quick tip

You can find the source code on the LXFDVD or it's available from the Archives at linuxformat.com under issue LXF227, available to all.

The strace command line utility

The strace utility enables you to see what happens behind the scenes when you execute a program or a script. Strictly speaking, strace traces the system calls and signals of an executable program and displays them on your screen. Using strace against pycp.py displays the following type of information:

```
$ strace ./pycp.py pycp.py
anotherFile
...
stat("/usr/lib/python3.4/os.py",
{st_mode=S_
IFREG|0644, st_size=33763, ...}) = 0
...
open("./pycp.py", O_RDONLY) = 3
...
open("anotherFile", O_WRONLY|O_
CREAT|O_TRUNC|O_CLOEXEC, 0666) = 4
...
write(4, "#!/usr/bin/env python3\n\
nimport o"..., 2140) = 2140
close(4) = 0
close(3) = 0
...
```

The aforementioned output reveals that your pycp.py script is executed as C functions and C system calls because this is the only way to communicate with the Linux kernel. Nevertheless, writing the same program in C would have required many more lines of code and many more hours of debugging.

Quick tip

A C System Call is just a C function. What makes a System Call different from an ordinary C function is the fact that system calls implement functionality that is usually low level and connects the UNIX kernel with the rest of the world. At the end of the day, Python 3 commands related to file operations are translated into C system calls.

Processing options

The single most important thing to consider in the implementation of mycp.py is what you are going to do when the destination file already exists. Put simply, are you going to delete it or are you going to stop the copy process? The default behaviour of the cp utility is to delete the destination file unless you use the -n switch. Additionally, if you use the -i option, cp will ask you whether you want to delete the destination file or not. However, if you use both -n and -i, then -n will take precedence and -i will be ignored. The second task is to be able to tell whether the destination file is a directory because in this case you're going to put the new file inside that directory.

Here we process command line arguments and options related to file copying using the Python 3 code of **processOptions.py** for example:

```
#!/usr/bin/env python3

import os
import sys

iSwitch = 0;
nSwitch = 0;

if len(sys.argv) == 3:
source = str(sys.argv[1])
destination = str(sys.argv[2])
elif len(sys.argv) == 4:
source = str(sys.argv[1])
destination = str(sys.argv[2])
option1 = str(sys.argv[3])
if option1 == "-i":
iSwitch = 1;
if option1 == "-n":
nSwitch = 1;
elif len(sys.argv) >= 5:
source = str(sys.argv[1])
destination = str(sys.argv[2])
option1 = str(sys.argv[3])
option2 = str(sys.argv[4])
if (option1 == "-i" or option2 ==
"-i"):
iSwitch = 1;
if (option1 == "-n" or option2 ==
"-n"):
nSwitch = 1;
else:
print('Usage: ', sys.argv[0], 'source
destination [-in]')
sys.exit(0)

# If the source is not a file
if os.path.isfile(source) == False:
print(source, 'is not a file.
Exiting...')
sys.exit(0)

# If the destination is a directory
if os.path.isdir(destination):
destination = destination + '/' +
source
print('Copying to', destination)

# If the destination already exists
if os.path.isfile(destination):
print(destination, 'already exists!')
# If -n switch is OFF, check the -i
switch
if nSwitch == 0:
if iSwitch == 1:
answer = input('[y|n]: ')
if answer == 'y' or answer == 'Y':
print('Copying', source, 'to',
destination)
else:
print('Cannot overwrite', destination)
sys.exit(0)
# If -n switch is ON, stop program
execution
elif nSwitch == 1:
sys.exit(0)
else:
print('Copying', source, 'to',
destination)
```

"The most important thing to consider is what you are going to do when the destination file already exists"

To simplify the code, the source file must always come first and the destination file or directory must be second – this is explained in the usage message shown by the script.

Next, you should include any options you want. Executing **processOptions.py** generates the following kind of output:

```
$ ./processOptions.py
Usage:  ./processOptions.py source
destination [-in]
$ ./processOptions.py afile
Usage:  ./processOptions.py source
destination [-in]
$ ./processOptions.py afile anotherFile
afile is not a file. Exiting...
$ ./processOptions.py processOptions.py
newFile
Copying processOptions.py to newFile
$ mkdir test
$ ./processOptions.py processOptions.py
test
Copying to test/processOptions.py
Copying processOptions.py to test/
processOptions.py
```

```
$ touch test/processOptions.py
$ ./processOptions.py processOptions.
py
 test
Copying to test/processOptions.py
test/processOptions.py already exists!
$ ./processOptions.py processOptions.
py
 test -n
Copying to test/processOptions.py
test/processOptions.py already exists!
$ ./processOptions.py processOptions.
py
 test -i
Copying to test/processOptions.py
test/processOptions.py already exists!
[y|n]: y
Copying processOptions.py to test/
processOptions.py
$ ./processOptions.py processOptions.
py
 test -i
Copying to test/processOptions.py
test/processOptions.py already exists!
[y|n]: n
Cannot overwrite test/processOptions.
py
```

Although **processOptions.py** doesn't start the file copying operation, it's close to what we want to do – the code of **processOptions.py** will be used as the skeleton of **pycp.py**.

The final version

This is where all the previous details and code, come together to create the end result. The final version of the Python implementation of the cp utility, saved as **pycp.py**, is thus:

```
#!/usr/bin/env python3

import os
import sys

def fileCopy(source, destination):
size = 16384
try:
with open(source,'rb') as f1:
with open(destination,'wb') as f2:
while True:
buf = f1.read(size)
if buf:
n = f2.write(buf)
else:
break
except IOError as e:
errno, strerror = e.args
print("I/O error({0}): {1}".
format(errno,strerror))

def main():
iSwitch = 0;
nSwitch = 0;
if len(sys.argv) == 3:
source = str(sys.argv[1])
destination = str(sys.argv[2])
elif len(sys.argv) == 4:
source = str(sys.argv[1])
destination = str(sys.argv[2])
option1 = str(sys.argv[3])
if option1 == "-i":
iSwitch = 1;
if option1 == "-n":
nSwitch = 1;
elif len(sys.argv) >= 5:
source = str(sys.argv[1])
destination = str(sys.argv[2])
option1 = str(sys.argv[3])
option2 = str(sys.argv[4])
if (option1 == "-i" or option2 ==
 "-i"):
iSwitch = 1;
if (option1 == "-n" or option2 ==
"-n"):
nSwitch = 1;
else:
print('Usage: ', sys.argv[0], 'source
 destination [-in]')
sys.exit(0)

# If the source is not a file
if os.path.isfile(source) == False:
print(source, 'is not a file.
 Exiting...')
sys.exit(0)

# If the destination is a directory
if os.path.isdir(destination):
destination = destination + '/' +
 source

# If the destination already exists
if os.path.isfile(destination):
# If -n switch is OFF, check the -i
 switch
if nSwitch == 0:
if iSwitch == 1:
answer = input('[y|n]: ')
if answer == 'y' or answer == 'Y':
fileCopy(source, destination)
else:
# If -n switch is ON, stop program
 execution
elif nSwitch == 1:
sys.exit(0)
else:
fileCopy(source, destination)

if __name__ == '__main__':
main()
else:
print("This is a standalone program
 not a module!")
program not a module!")
```

Looking at both **pycp.py** and **processOptions.py** makes you understand their similarities but also shows their key differences – pycp.py is using two functions and the __name__ variable in its implementation.

When developing system tools, the testing phase is as crucial as the implementation phase because it verifies that your tool does its job. These tests need to be performed:

```
$ ./pycp.py pycp.py test/
$ ./pycp.py pycp.py /tmp/anotherFile
$ ./pycp.py pycp.py /tmp/anotherFile -i
...
$ ./pycp.py
Usage:  ./pycp.py source destination
 [-in]
```

About UNIX file permissions

Each Linux file has permissions associated with it. Look at the following output:

```
$ ls -l myCP.pl data.txt
-rw-r--r-- 1 mtsouk mtsouk 158 Oct 18
 10:35 data.txt
-rwxr-xr-x 1 mtsouk mtsouk 158 Apr 23
 2015 myCP.pl
```

The first column of the previous output of the ls command shows the permissions of each file. As you can see, the permissions of each file take 10 places, which can also be viewed as bits. Apart from the first bit, which is defined by Linux and declares the type of the entry, the remaining nine places can be collected into three groups with each one having three bits. The first set explains the permissions of the user, the second set is about the permissions of the main Linux group the user belongs to, and the last part is about the permissions of the rest of the users. If you're familiar with binary arithmetic, it's easy to understand that each set can take values from 000 up to 111, which in the decimal arithmetic system are values from 0 up to 7. So rw-r--r-- can be also written as 644 because rw- is considered as 110, which is equal to 6 and r-- is equal to 4. Similarly, rwxr-xr-x can be represented as 755.

There are various types of UNIX file permissions, including files that can't be modified or accessed by the current user as they belong to another user. If you have the right file permissions then you can change the current permissions of a file using the chmod command.

Check your mail

With Python, you can have your Raspberry Pi act as mail checker, giving you a running list on incoming email

Since the Raspberry Pi is such a small computer, it gets used in a lot of projects where you want to monitor a source of data. One such monitor you might want to create is a mail-checker that can display your current unread emails. This issue, we'll look at how to use Python to create your own mail-checking monitor to run on your Pi. We will focus mainly on the communications between the Pi and the mail server and not worry too much about how it might be displayed. That will be left as a further exercise.

To start with, most email servers use one of two different communication protocols. The older, simpler one was called POP (Post Office Protocol), and the newer one is called IMAP (Internet Message Access Protocol). We will cover both protocols to cover all of the situations that you might run into. We'll start with the older POP communications protocol. Luckily, there is support for this protocol as part of the standard library. In order to start using it, you will first need to import the poplib module, and then create a new POP3 object. For example, the following will create a connection to the POP server that is available through Gmail.

```
import poplib
my_pop = poplib.POP3_SSL(host='pop.
gmail.com')
```

You need to use the POP3_SSL class when connecting to Gmail because Google uses SSL for its connections. You'll also need to find the "allow insecure apps" option in your Gmail settings or you'll face an error. The POP communication protocol involves the client sending a series of commands to the server to interact with it. For example, you can get the welcome message from the server with the getwelcome() method:

```
my_pop.getwelcome()
```

The first things that you will want to communicate to the server are the username and password for the email account that you are interested in. Having the username in your code is not too much of a security issue, but the password is another matter. Unless you have a good reason to have it written out in your code, you should probably ask the end-user for it. Included within the standard library is the getpass module, which you can use to ask the end-user for their password in a safer fashion. You could use the following code, for example.

```
import getpass
my_pop.user('my_name@gmail.com')
my_pop.pass_(getpass.getpass())
```

You should now be fully logged in to your email account. Under POP, your account will be locked until you execute the quit() method of the connection. If you need a quick summary of what is on the server then you can execute the stat() method:

```
my_pop.stat()
```

This method returns a tuple consisting of the message count and the mailbox size. You can get an explicit list of messages with the list() method. You have two options for looking at the actual contents of these emails, depending on whether you want to leave the messages untouched or not. If you want to simply look at the first chunk of the messages, you can use the top() method. The following code will grab the headers and the first five lines of the first message in the list.

```
email_top = my_pop.top(1, 5)
```

This method will return a tuple consisting of the response text from the email server, a list of the headers and the number of requested lines, and the octet count for the message. The one problem with the top() method is that it is not always well implemented on every email server. In those cases, you can use the retr() method. It will return the entire requested message in the same form as that returned from top(). Once you have your message contents, you need to decide what you actually want to display. As an example, you might want to simply print out the subject lines for each message. You could do that with the following code.

```
for line in email_top[1]:
  if 'Subject' in i:
    print(i)
```

You need to explicitly do the search because the number of lines included in the headers varies from message to message. Once you are done, don't forget to execute the quit() method to close down your connection to the email server. One last thing to keep in mind is how long your email server will keep the connection alive. While running test code for this article, it would frequently time out. If you need to, you can use the noop() method as a keep-alive for the connection.

As mentioned previously, the second, newer, protocol for talking to email servers is IMAP. Luckily, there is a module included in the standard library that you can use, similar to the poplib module we looked at above, called imaplib. Also, as above, it contains two main classes to encapsulate the connection details. If you need an SSL connection, you can use IMAP4_SSL. Otherwise, you can use IMAP4 for

"Most email servers use one of two communication protocols"

unencrypted connections. Using Gmail as an example, you can create an SSL connection with the following code.

```
import imaplib
import getpass
my_imap = imaplib.IMAP4_SSL('imap.
gmail.com')
```

As opposed to poplib, imaplib has a single method to handle authentication. You can use the getpass module to ask for the password.

```
my_imap.login('my_username@gmail.com',
getpass.getpass())
```

IMAP contains the concept of a tree of mailboxes where all of your emails are organised. Before you can start to look at the emails, you need to select which mailbox you want to work with. If you don't give a mailbox name, the default is the inbox. This is fine since we only want to display the newest emails which have come in. Most of the interaction methods return a tuple that contains a status flag (either 'OK' or 'NO') and a list containing the actual data. The first thing that we need to do after selecting the inbox is to search for all of the messages available, as shown in the following example.

```
my_imap.select()
typ, email_list = my_imap.search(None,
'ALL')
```

The email_list variable contains a list of binary strings that you can use to fetch individual messages. You should check the value stored in the variable typ to be sure that it contains 'OK'. To loop through the list and select a particular email you can use the following code:

```
for num in email_list[0].split():
  typ, email_raw = my_imap.fetch(num,
'(RFC822)')
```

The variable email_raw contains the entire email body as a single escaped string. While you could parse it to pull out the pieces that you want to display in your email monitor, that kind of defeats the power of Python. Again, available in the standard library is a module called email that can handle all of those parsing issues. You will need to import the module in order to use it, as in the example here.

```
import email
email_mesg = email.message_from_
bytes(email_raw[0][1])
```

All of the sections of your email are now broken down into sections that you can pull out much more easily. Again, to pull out the subject line for a quick display, you can use the code:

```
subject_line = email_mesg.
get('Subject')
```

There are many different potential items that you could select out. To get the full list of available header items, you can use the keys method, as below:

```
email_mesg.keys()
```

Many times, the emails you get will come as multi-part messages. In these cases, you'll need to use the get_payload() method to extract any attached parts. It will come back as a list of further email objects. You then need to use the get_payload() method on those returned email objects to get the main body. The code might look like:

```
payload1 = email_mesg.get_payload()[0]
body1 = payload1.get_payload()
```

As with POP email connections, you may need to do something to keep the connection from timing out. If you do, you can use the noop() method of the IMAP connection object. This method acts as a keep-alive function. When you are all done, you need to be sure to clean up after yourself before shutting down. The correct way to do this is to close the mailbox you have been using first, and then log out from the server. An example is given here:

```
my_imap.logout()
my_imap.close()
```

You now should have enough information to be able to connect to an email server, get a list of messages, and then pull out the sections that you might want to display as part of your email monitor. For example, if you are displaying the information on an LCD, you might just want to have the subject lines scrolling past. If you are using a larger screen display, you might want to grab a section of the body, or the date and time, to include as part of the information.

What about sending emails?

In the main article, we have only looked at how to connect to an email server and how to read from it. But what if you need to be able to also send emails using code? Similar to poplib and imaplib, the Python standard library includes a module called smtplib. Again, similar to poplib and imaplib, you need to create an SMTP object for the connection, and then log in to the server. If you're using the GMail SMTP server, you could use the code

```
import smtplib
import getpass
my_smtp = smtplib.SMTP_
SSL('smtp.gmail.com')
my_smtp.login('my_email@gmail.
com', getpass.getpass())
```

This code asks the end user for their password, but if you aren't concerned about security, you could have it hard-coded into the code. Also, you only need to use the login() method for those servers that require it. If you are running your own SMTP server, you may have it set up to accept unauthenticated connections. Once you are connected and authenticated, you can now send emails out. The main method to do this is called sendmail(). As an example, the following code sends a 'Hello World' email to a couple of people.

```
my_smtp.sendmail('my_email@
gmail.com', ['friend1@email.
com', 'friend2@email.com'],
'This email\r\nsays\r\nHello
World')
```

The first parameter is the 'from' email address. The second parameter is a list of 'to' email addresses. If you only have one 'to' address, you can put it as a single string rather than a list. The last parameter is a string containing the body of the email. One thing to be aware of is that you will only get an exception if the email can't be sent to any of the 'to' email addresses. As long as the message can be sent to at least one of the addresses, it will return as completed. Once you have finished sending your emails, you can clean up with the code:

```
my_smtp.quit()
```

This cleans everything up and shuts down all active connections. So now your project can reply to incoming emails, too.

Multitask with your Pi

Learn how to add multitasking to your own Python code – perfect for those with multiple projects on the go

The majority of programmers will learn single-threaded programming as their first computational model. The basic idea is that instructions for the computer are processed sequentially, one after the other. This works well enough in most situations, but you will reach a point where you need to start multitasking. The classical situation for writing multi-threaded applications is to have them run on a multi-processor machine of some persuasion. In these cases, you would have some heavy, compute-bound process running on each processor. Since your Raspberry Pi is not a huge 16-core desktop machine, you might be under the assumption that you can't take advantage of using multiple threads of execution. This isn't true, though.

There are lots of problems that map naturally to the multiple thread model. You may also have IO operations that take a relatively large amount of time to complete. In these cases, it is well worth your programming effort to break your problem down into a multi-threaded model. Since Python is the language of choice for the Raspberry Pi, we will look at how you can add threads to your own Python code. For those of you who have looked into multi-threaded programming in Python, you may have run into the GIL (Global Interpreter Lock) before. This lock means that only one thread can actually be running at a time, so you don't get true parallel processing. But on the Raspberry Pi, this is actually okay.

The first bit of code we need is to import the correct module. For this article, we will be using the threading module. Once it is imported, you have access to all of the functions and objects that you would need to write your code. The first step is to create a new thread object with the constructor:

```
t = threading.Thread(target=my_func)
```

The Thread object takes some function that you have created, my_func in the above example, as the target code that needs to be run. When the thread object has finished its initialisation, it is alive but not running. You need to explicitly call the new thread's start() method. This will begin running the code within the function handed to the thread.

You can check to verify that this thread is alive and active by calling its is_alive() method. Normally, this new thread will run until the function exits normally. The other way a thread can exit is if an unhandled exception is raised. Depending on your experience of parallel programs, you may already have some ideas on what types of code you want to write. For example, in MPI programs, you typically have the same overall code running in multiple threads of execution. You use the thread's ID and a series of if or case statements to have each thread execute a different section of the code. To do something similar, you can use something like:

```
def my_func():
    id = threading.get_ident()
    if (id == 1):
       do_something()
  thread1 = threading.
Thread(target=my_func)thread1.
start()
```

This code works in Python 3, but the get_ident() function doesn't exist in Python 2. Threading is one of those modules that is a moving target when moving from one version of Python to another, so always check the documentation for the version of Python your are coding for.

Another common task in parallel programming is to farm out time-intensive IO into separate threads. This way, your main program can continue on with the core work and all of the computing resources are kept as busy as possible. But how do you figure out if the child thread is done yet or not? You can use the is_alive() function mentioned above, but what if you can't continue without the results from the child thread? In these cases, you can use the join() method of the thread object you are waiting on. This method blocks until the thread in question returns. You can include an optional parameter to have the method time-out after some number of seconds. This allows you to not get trapped into a thread that will never return due to some error or code bug.

Now that we have more than one thread of execution happening at the same time, we have a new set of issues to start worrying about. The first is accessing global data elements. What might happen if you have two different threads that want to read, or even worse write, to the same variable in global memory? You can have situations where changes to the value of variables can get out of sync with what you were expecting them to be.

These types of issues are called race conditions, because the different threads are racing with each other to see in what order their updates to variables will happen. There are two solutions to this type of problem. The first is to control access to these global variables and only allow one thread at a time to be able to work with them. The generic term describing this control is to use a mutex to control this access. A mutex is an object that a thread needs to lock before working with the associated variables. In the Python threading module, this object is called a lock. The first step is to create a new Lock object with:

```
lock = threading.Lock()
```

This new lock is created in an unlocked state, ready to be used. The thread interested in using it must call the acquire() method for the lock. If the lock is currently available then it changes state to the locked state and your thread can run the code that is meant to be protected. If the lock is currently in a locked state, then your thread will sit in a blocked state, waiting for the lock to become free. Once you are done with the protected code, you need to call the release() method to free the lock and make it available for the next thread. You could control a variable containing the sum of a series of results with:

Threads or processes?

What if you need to actually have truly parallel code, that has the ability to run on multiple cores? Because Python has the GIL, you need to move away from using threads and go to using separate processes to handle the different tasks. Luckily, Python includes a multiprocessing module that provides the process equivalent to the threading module. As with the threading module, you create a new process object and hand in a target function to be run. You then need to call the start() method to get it running. With threads, sharing data is trivial because memory is global and everybody can see everything.

However, different processes are in different memory scopes. In order to share data, we need to explicitly set up some form of communications. You can create a queue object where you can transfer objects. Processes can use the put() method to dump objects on the queue, and other processes can use the get() method to pull objects off. If you want a bit more control over who is talking to who, you can use pipes to create a two-way communication channel between two processes. When you use pipes and queues, you actually need to hand them in as arguments to your target function.

The other way you can share information is by creating a section of shared memory. You can create a single variable sharelocation with the Value object. If you have a number of variables you need to pass, you can put them in an Array object. As with pipes and queues, you will also need to pass them in as parameters to your target function. When you need to wait for the results from a process, you can use the join() method to get the main process to block until the sub-process finally finishes.

The processing module also includes the idea of a process pool that is different from the threading module. With a pool, you can pre-create a number of processes that can be used in a map function. This kind of construct is extremely useful if you are then going to be applying the same function to a number of different input values. For people who are actually using the concepts of mapping or applying functions from R, or Hadoop, this might turn out to be a bit more of an intuitive and beneficial model to use in your Python code.

```
lock.acquire()
sum_var += curr_val
lock.release()
```

This can lead to another common issue in parallel programs: deadlocks. These issues occur when you have multiple locks that are associated with different global variables. Say you have the variables A and B, and the associated locks lockA and lockB. If thread 1 tries to get lockA then lockB, while thread 2 tries to get lockB then lockA, you could have the situation where they each get their first requested lock, and then wait forever for the second requested lock.

The best way to avoid this type of bug is to code your program very carefully. Unfortunately, people are only human and messy code can creep in. You can try and catch this kind of bad behaviour by including the optional timeout parameter when you call the acquire() method. This tells the lock to only try and get the lock for some number of seconds. If the timeout is reached, the acquire method returns. You can tell whether or not it was successful by checking the returned value. If it was successful, acquire will return True. Otherwise, it will return False.

The second way you can deal with data access is by moving any variables that you can to within the local scope of the individual threads. The essential idea is that each thread would have its own local version of any required variables that nobody else can see. This is done by creating a local object. You can then add attributes to this local object and use them as local variables. Within the function being run by your thread, you would then have code that looks like:

```
my_local = threading.local()
my_local.x = 42
```

The last topic we will look at is synchronising your threads so that they can work together effectively. Bear in mind there will be certain times when a number of threads will need to talk to each other after working on their separate parts of a particular problem. The only way they can share their results is if they have all finished calculating their individual results. You can solve this problem by using a barrier, which each thread will stop at until all of the other threads have reached it. In Python 3, there is a barrier object that can be created for some number of threads. It will provide a point where threads will pause when they call the barrier's wait() method.

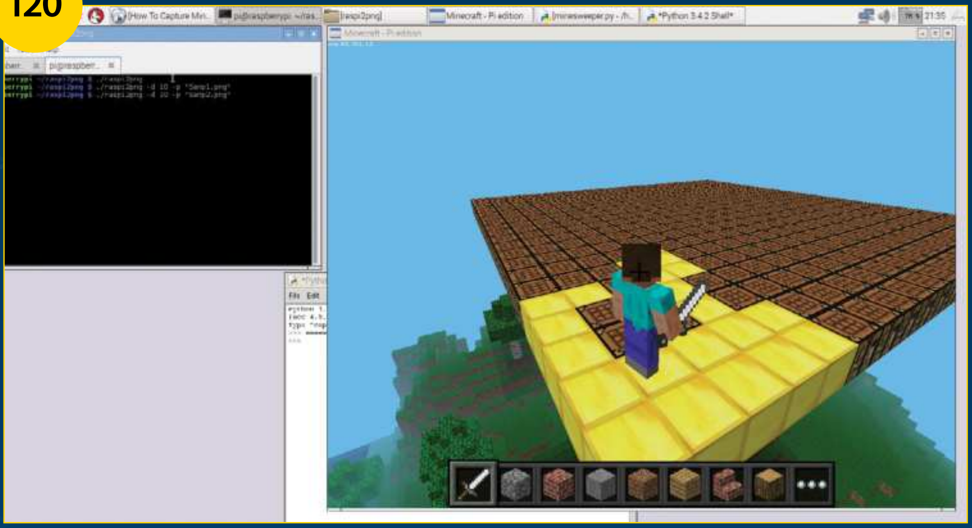
Because you actually need to explicitly tell the barrier object how many threads will be taking part in the barrier, this is another area where it is possible that you could actually be faced with the problem of having a bug. If you create five threads but create a barrier for ten threads, it will never actually be able to reach the point where all of the expected threads have reached the barrier. The other synchronisation tool is the timer object. A timer is a subclass of the thread class, and so takes a function to run after some amount of time has passed. As with a thread, you will need to call the timer's start() method in order to start the countdown to when the function gets executed. A new method, cancel(), will actually allow you to stop the countdown of the timer if it hasn't reached zero yet.

After following all of these steps you should now be able to have your code running even more efficiently by simply farming out any time intensive parts to other threads of execution. By following these steps in this way, the end result is that the main part of your program can remain as efficient and reactive as possible to interaction with the end user and you can also keep all parts of your Raspberry Pi as busy as possible.

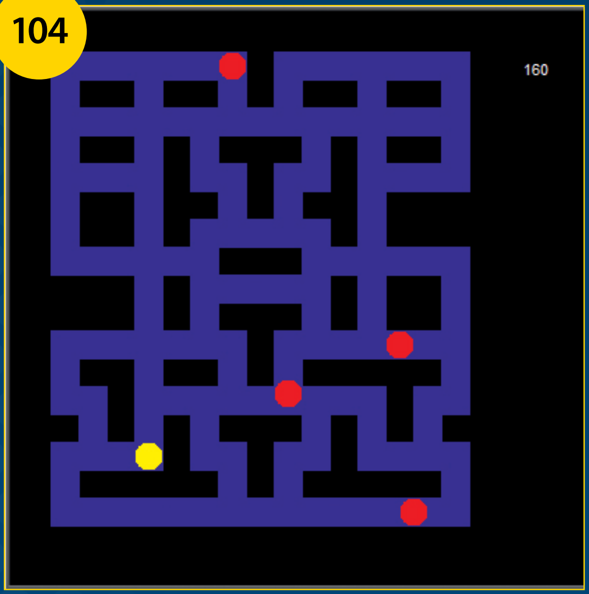
“Bear in mind there will be certain times when a number of threads will need to talk to each other after working on their separate parts of a particular problem”

Create with Python

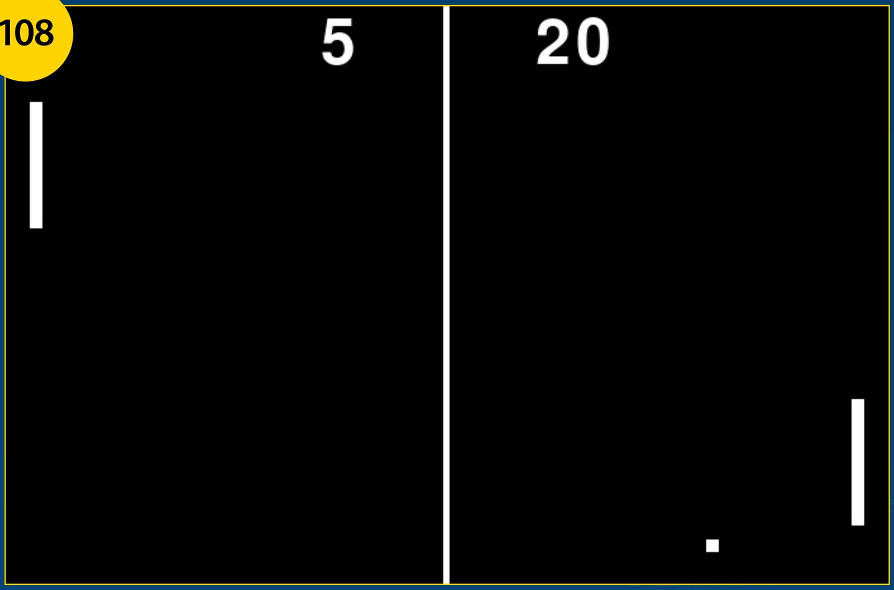
120



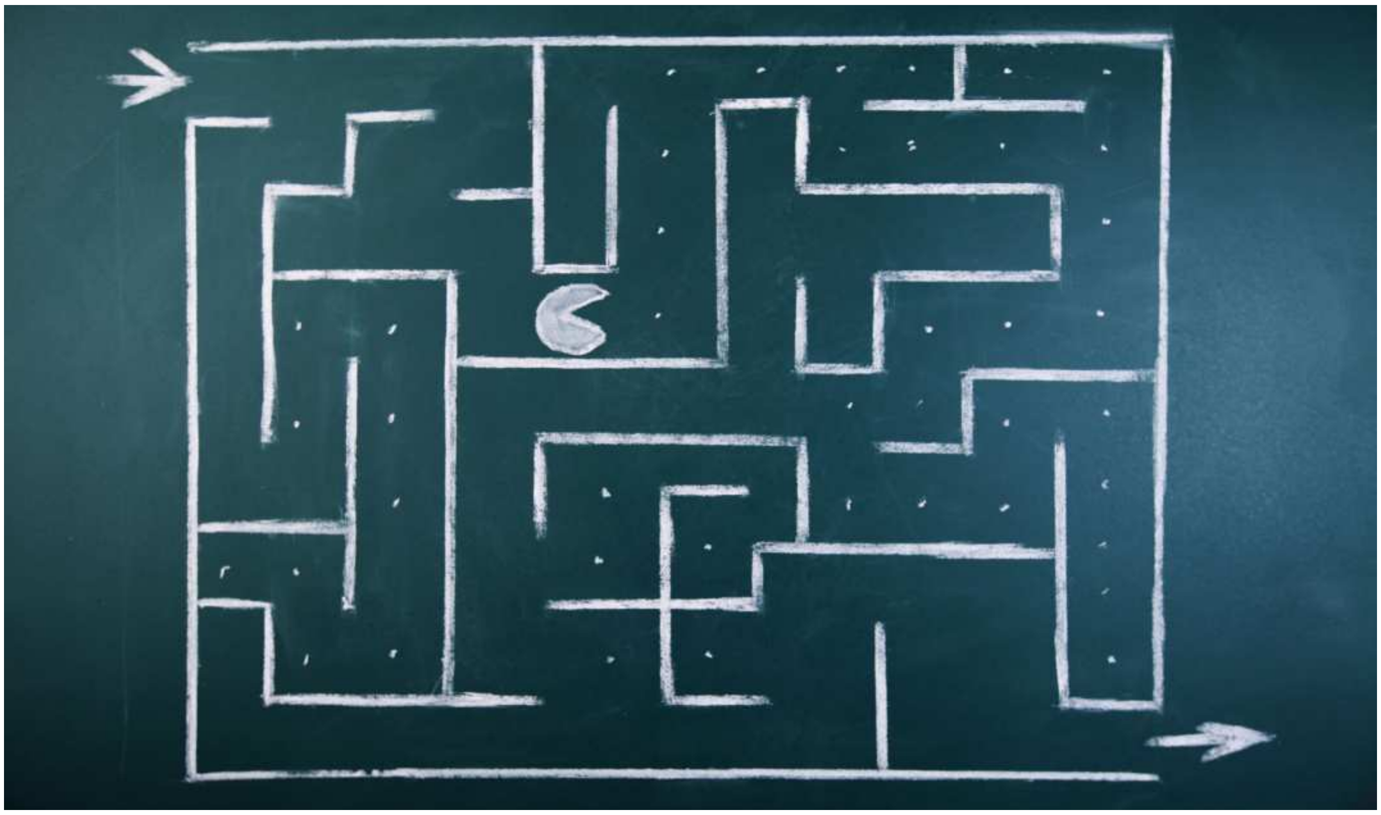
104



108



SCORE 0
LIVES 3
112



Creating Pac-Man style games in Python

Pac-Man has earned its place in video gaming history. Calvin Robinson shows how you create your own version of the iconic arcade title

The code
Download from linuxformat.com/archives

Pac-Man is arguably one of the most famous video game characters in the world. First shooting to fame in 1980 with the release of the arcade version, *Pac-Man* has seen many iterations, remakes and sequels over the years, but nothing compares to the original. It's a simple premise, really. Pac-Man is a yellow, disk-shaped, mainly feature-less character, who roams around a 2D environment collecting dots. The player has to collect all the dots in the room without being touched by any of the four enemy characters in the form of ghosts. Pinky, Blinky, Inky and Clyde are brightly coloured to stand out against the black background, being pink, red, cyan and orange, respectively. Pac-Man must avoid the ghosts and collect all the dots to progress to the next level.

Pac-Man can only move up, down, left or right, through the maze of dots, but does have some advantages in his arsenal. By collecting large 'power pellets' Pac-Man becomes energised and the ghosts all turn blue, enabling him to eat them on impact. The more blue ghosts you eat, the more points you get. As with all arcade games, the aim of the game is to get the highest score on the leader board.

Originally called *Puck Man* in Japan because of the main character looking like a hockey puck, *Pac-Man* was renamed for Western audiences to avoid any dodgy naming issues. It's fun and friendly, and potentially the first 'inclusive' video game, what with Pac-Man being designed to appeal to girls as well as boys, and to attract a younger audience.

Working in Python

Likewise, Python is an incredibly accessible programming language. In LXF262 we used Python to create a Lunar Lander Module game, and in LXF263 we created a side-scrolling game in Python. The original *Pac-Man* game was released between the two, Lunar Lander being 1979 and the first side-scroller being 1981. Python is perfect for our retro gaming projects. So let's begin…

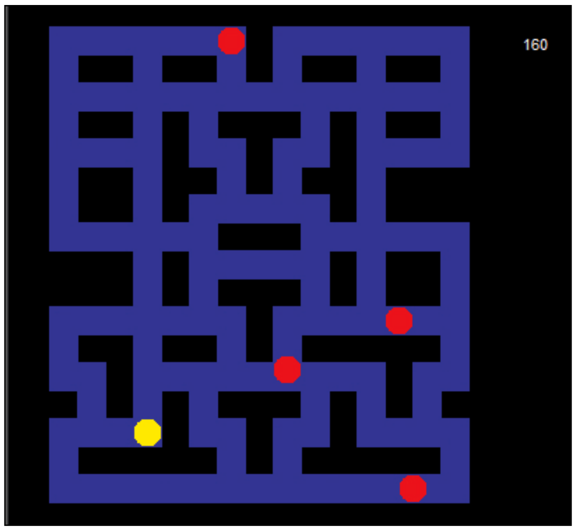
We will, of course, need Python installed. We'll use Python 3 for this tutorial. If you're on a Debian-based distro you can get set up with `sudo apt-get update`, followed by `sudo apt-get install python3`. We'll also be taking advantage of a vector graphics module **linuxformat.py** which can be found at the source code link on our Archives page at **www.linuxformat.com/archives**. Once downloaded or copied, ensure **linuxformat.py** is saved in the same directory as the Python project we're about to develop.

Start a new Python file. Using your favourite text editor create an empty file and save it in the same folder as linuxformat.py, which we'll be using as a reference module for vector graphics. When it comes to programming, there's no point reinventing the wheel every time. Start your new document off with a new modular imports:

```
from random import choice
from turtle import *
from linuxformat import vector
```

Next, we'll want to declare and initialise all of our global variables:

```
state = {'score': 0}
path = Turtle(visible=False)
writer = Turtle(visible=False)
aim = vector(5, 0)
pacman = vector(-40, -80)
ghosts = [[vector(-180, 160), vector(5, 0)],
[vector(-180, -160), vector(0, 5)],[vector(100, 160),
vector(0, -5)],[vector(100, -160), vector(-5, 0)],]
tiles = [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0,
             0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1,
1, 1, 0, 0, 0, 0,
               0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1,
0, 0, 1, 0, 0, 0, 0,
               0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 0, 0, 0, 0,
               0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1,
0, 0, 1, 0, 0, 0, 0,
               0, 1, 1, 1, 1, 0, 1,1, 0, 1, 1, 0, 1,
1, 1, 1, 0, 0, 0, 0,
               0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1,
0, 0, 0, 0, 0, 0, 0,
               0, 1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1,
0, 0, 0, 0, 0, 0, 0,
               0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1,
1, 1, 1, 0, 0, 0, 0,
               0, 0, 0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1,
0, 0, 1, 0, 0, 0, 0,
               0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1,
0, 0,1, 0, 0, 0, 0,
               0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1,
1, 1, 1, 0, 0, 0, 0,
               0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0,
               0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
0, 1, 1, 0, 0, 0, 0,
               0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1,
```



Above A vector based *Pac-Man* game developed in Python.

```
0, 1, 0, 0, 0, 0, 0,
               0, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1,
1, 1, 1, 0, 0, 0, 0,
               0, 1, 0, 0, 0,0, 0, 1, 0, 1, 0, 0, 0,
0, 0, 1, 0, 0, 0, 0,
               0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 0, 0, 0, 0,
               0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0,
               0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0,]
```

Here we're setting the spawn coordinates for our Pac-Man and all four ghosts and setting the score to start on zero. Aim sets the movement direction of Pac-Man on game launch, with (x,y). By default we're moving in a positive direction on the x-axis, which will take us right at the normal speed of 5. Stating zero for the y-axis means our Pac-Man won't be moving up or down on game start. We're also create a couple of Turtles which we'll use later: one for drawing the game world (Path) and the other for writing the score (Writer).

Quick tip

Speed up Pac-Man by increasing or decreasing the 'onkey' values, at the bottom of our code (x,y). Remember that positive numbers move right or up, and negatives move left or down.

Multiplayer Pac-Man and more!

We might want to make some improvements to take our *Pac-Man* game to the next level. Consider how we might change the level layout. Perhaps when the player has picked up all the dots, we could load in a second level. We could even make the levels automatically generated, therefore creating an unlimited amount of gameplay.

Some other alterations that might bring fun challenges to the game include: change where the player starts, by altering Pac-Man's spawn location; increase or decrease the number of ghosts in the game for different levels; and make the ghosts faster or slower as the player progresses through the levels.

If we really wanted to take things to the next level, we could introduce multiplayer. In the past, *Pac-Man* games have experimented with different forms of multiplayer. We might want to start out by introducing turn-based multiplayer, by developing a leader board. This would simply mean saving a player's score at the end of each game, and asking for their name once they've died. That's how classical arcade machines handled multiplayer. However, you might want to get really fancy and code another player character that's controlled by WASD instead of the arrow keys. Then you could have two Pac-Men active in the game at once, competing for dots and ghosts!

Quick tip
Have a play around with the colours in the World() function to create some funky-looking versions of Pac-Man.

Finally, we're creating the game world. Every 1 is a collectable dot or floor space, and a 0 is a black wall. Our game world is 20x20, so it may be easier to organise the above Python list by creating a new line every 20th value. We haven't done so here to save space in print, but it'll look a lot better in Python if you do – well, more recognisable to the human eye, anyway.

Turtly good

Time to put those Turtles to good use. Let's make a function to draw squares, which will be used to create squares (and rectangles) in our game, for the walls:

```
def square(x, y):
    path.up()
    path.goto(x, y)
    path.down()
    path.begin_fill()
    for count in range(4):
        path.forward(20)
        path.left(90)
    path.end_fill()
```

We'll also need a couple of functions to work out the maths. Even though *Pac-Man* is a relatively simple game, there's still an element of physics involved, mainly in collision detection and ensuring our Pac-Man doesn't walk through the walls and out of the game world.

```
def offset(point):
    x = (floor(point.x, 20) + 200) / 20
    y = (180 - floor(point.y, 20)) / 20
    index = int(x + y * 20)
    return index
```

This will return the offset. We'll also need to check if moves are valid:

```
def valid(point):
    index = offset(point)
    if tiles[index] == 0:
        return False
    index = offset(point + 19)
    if tiles[index] == 0:
        return False
    return point.x % 20 == 0 or point.y % 20 == 0
```

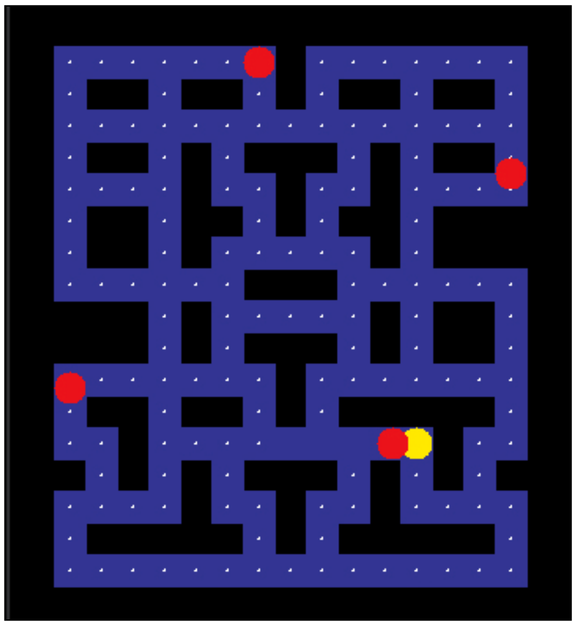
Let's use that Turtle again to draw our game world:

```
def world():
    bgcolor('black')
    path.color('blue')
    for index in range(len(tiles)):
        tile = tiles[index]
        if tile > 0:
            x = (index % 20) * 20 - 200
            y = 180 - (index // 20) * 20
            square(x, y)
            if tile == 1:
                path.up()
                path.goto(x + 10, y + 10)
                path.dot(2, 'white')
```

Of course we can change the colours to suit, but to start with we're using the traditional black and blue environment of the 1980 version of *Pac-Man*. That final colour (path.dot) is assigned to our dots on the path. You'll notice we're taking advantage of the square function we set up previously.

Our one major function, move, will be used to move both our Pac-Man and our ghosts around the game.

```
def move():
    writer.undo()
    writer.write(state['score'])
    clear()
    if valid(pacman + aim):
        pacman.move(aim)
    index = offset(pacman)
    if tiles[index] == 1:
        tiles[index] = 2
        state['score'] += 1
        x = (index % 20) * 20 - 200
        y = 180 - (index // 20) * 20
        square(x, y)
    up()
    goto(pacman.x + 10, pacman.y + 10)
    dot(20, 'yellow')
    for point, course in ghosts:
        if valid(point + course):
            point.move(course)
        else:
            options = [
                vector(5, 0),
                vector(-5, 0),
                vector(0, 5),
                vector(0, -5),
            ]
            plan = choice(options)
            course.x = plan.x
            course.y = plan.y

        up()
        goto(point.x + 10, point.y + 10)
        dot(20, 'red')
    update()
  for point, course in ghosts:
        if abs(pacman - point) < 20:
            return
    ontimer(move, 100)
```


Above A ghost colliding with Pac-Man ends the game.

Win, lose or draw?

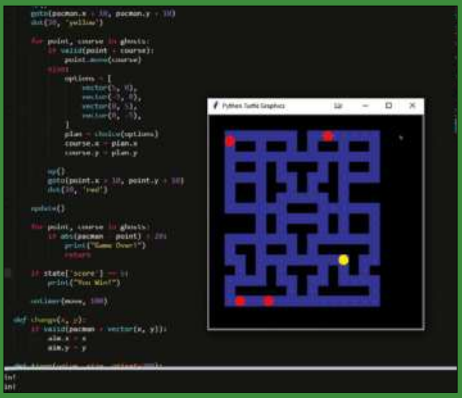
We'll probably need to consider adding a win and lose state to our game, so that our player experiences some closure by either winning or losing the game.

We already implemented collision detection in our Move() function, so the game freezes when Pac-Man collides with a ghost. However, nothing is currently communicated to the player. Look for the following code and insert a message. You'll see in this example we've printed "Game over!":

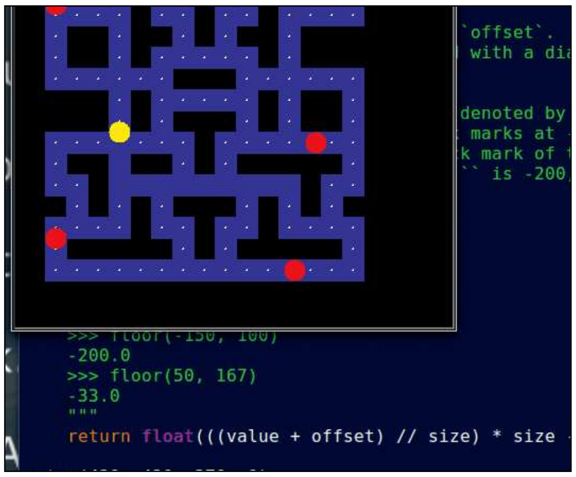
```
  for point, course in ghosts:
         if abs(pacman - point) < 20:
             print("Game Over!")
             return
```

We'll also need a way for players to win the game. For that, we'll need to implement a win state. Perhaps code the writer turtle to print You Won! when Pac-Man has collected all the dots, using a conditional statement, checking for the score to hit 160, which is the maximum number of dots in this level. One way would be to add the following code toward the bottom of the Move() function:

```
  if state['score'] == 160:
         print("You Win!")
```



```
    goto(pacman.x + 10, pacman.y + 10)
    dot(20, 'yellow')

    for point, course in ghosts:
        if valid(point + course):
            point.move(course)
        else:
            options = [
                vector(5, 0),
                vector(-5, 0),
                vector(0, 5),
                vector(0, -5),
            ]
            plan = choice(options)
            course.x = plan.x
            course.y = plan.y

        up()
        goto(point.x + 10, point.y + 10)
        dot(20, 'red')

    update()

    for point, course in ghosts:
        if abs(pacman - point) < 20:
            print("Game Over!")
            return

    if state['score'] == 16
        print("You Win!")

    ontimer(move, 100)

def change(x, y):
    if valid(pacman + vector(x, y)):
        aim.x = x
        aim.y = y
```



```
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`` is -200

>>> floor(-150, 100)
-200.0
>>> floor(50, 167)
-33.0
"""
return float(((value + offset) // size) * size
```

Above Type in the final few lines of code, before launching the game.

In this function we're drawing the scores first, then we're checking if a movement is valid before allowing it. The second `if` statement is what controls the eating of dots. If we wanted to take things a step further and introduce an animation, sound effect or other notification we would introduce it after `square(x,y)`. Try adding `print("munch")` as an example.

Movement is all well and good, but we'll need to be able to change the direction our Pac-Man is aiming in. We'll start be seeing if that direction is valid, thanks to our previous function, then we'll go ahead and switch the x and y accordingly:

```
def change(x, y):
    if valid(pacman + vector(x, y)):
        aim.x = x
        aim.y = y
```

Our last function is for the floor calculation, which takes into consideration the offset we made earlier:

```
def floor(value, size, offset=200):
    return float(((value + offset) // size) * size -
offset)
```

With this we can work out the floor value given its size and offset. To explain the floor function we can use a number line diagram:

```
-200  -100    0    100   200
<--|--x--|-----|--y--|--z--|-->
```

The number line shown has offset 200 denoted by the left-hand tick mark at -200 and size 100 denoted by the tick marks at -100, 0, 100, and 200. The floor of a value is the left-hand tick mark of the range where it lies. So for the points show above: floor(x) is -200, floor(y) is 0 and floor(z) is 100. Some examples would be `floor(10, 100) = 0.0` , `floor(120, 100) = 100.0` , `floor(-10, 100) = -100.0` , `floor(-150, 100) = -200.0` , `floor(50, 167) = -33.0` .

And finally, we can get our game going. We'll need to set a resolution, hide the Turtles, write the score, listen for keyboard presses (we're using lambda for this) and monitor the up, down, left and right keys for our aim changes. We'll then draw the world, start the move function and we're done!

```
setup(420, 420, 370, 0)
hideturtle()
tracer(False)
writer.goto(160, 160)
writer.color('white')
writer.write(state['score'])
listen()
onkey(lambda: change(5, 0), 'Right')
onkey(lambda: change(-5, 0), 'Left')
onkey(lambda: change(0, 5), 'Up')
onkey(lambda: change(0, -5), 'Down')
world()
move()
done()
```

Our version of *Pac-Man* is pretty basic, utilising 2D vector graphics and Python's turtle graphics to draw shapes and dots on our screen. This art style is very much in-line with the look and feel of the original incarnation of the game in the 1980. This simplistic artistic direction also meant we were able to code an entire game in a magazine article.

However, programming techniques and computers have moved on incredibly since the time of the first *Pac-Man* release and if we wanted to take things a step further we could introduce graphical sprites into our game. For instance, we might want a more accurate representation of our ghost antagonists in full colour, with features such as eyes.

Repl.it user Anurag Gowda has developed a relatively simple solution to take our Python game to the next level, by introducing said sprites. A sample of his code can be found at **https://repl.it/talk/share/Pacman/12194** which is fully forkable. Repl.it is an online IDE (Integrated Development Environment) that enables you to code Python on even the most basic of machines, using cloud resources instead of your local hardware. All you need is an Internet connection. Using a fork of Anurag's code on Repl.it you can code a visual *Pac-Man* in the cloud – fancy!

Quick tip

Credit to Grant Jenks of Free Python Games for the code reference. We wouldn't have been able to create a vector graphics based *Pac-Man* game, or indeed describe 'flooring' without his instruction.

Revisit the arcade classic Pong in Python

Calvin Robinson takes us through creating a contemporary homage to Pong – considered by many to be the very first arcade game

This series of building retro games in Python has so far seen us coding a lunar landing space module (LXF262), a side-scrolling platformer (LXF263), the famous pellet-munching, ghost-chasing Pac-Man (page 104), and in this tutorial we're going to develop our own version of *Pong*! To many, *Pong* is the original arcade game. It's certainly the first video game to become a commercial success. Released for arcades in 1972 and for the home in 1975, *Pong* has gained popularity worldwide and is now permanently memorialised in the Smithsonian Institute in Washingon, DC. Developed and self-published by Atari, *Pong* is a 2D table tennis simulation with arguably the most simplistic game design imaginable, while managing to achieve an incredibly addictive gaming experience.

What gameplay?

Gameplay mechanics in *Pong* are quite simple. It's essentially ping-pong seen from a basic bird's-eye view. The game makes use of vector graphics to display a rectangular shape for the players' pads and a square (or rough circle, depending on the processing power) for the ball.

In single-player mode, the player moves one paddle and the computer acts as a non-player character, controlling the second. The idea is to get the ball to pass the opponent's paddle on their side of the screen. You earn a point for each time the opponent misses a rally. Atari's Home Pong console was set up for two-player mode, with a paddle for each player. That's the version we're going to create today. Since we don't have hardware and we're programming this entirely in Python, we'll give each player two keys on either side of the keyboard: one for up, one for down.

Python offers us an accessible programming language with straightforward syntax. It's the perfect language for playing around with vector-based video games. Let's go!

Ping-pong Python

Without getting into any debates about version 2 versus version 3, we'll be using Python 3 for this tutorial. If you're running a Debian based Linux distro you can install Python in Terminal with the command `sudo apt-get install python3` after a quick update with `sudo apt-get update`, of course. We'll also be taking advantage of a vector graphics module **linuxformat.py** from last issue. This can be found on the disc, or via the source code link on our Archives page at **www.linuxformat.com/archives.** Once downloaded or copied, ensure **linuxformat.py** is saved in the same directory as the rest of the files we create in this tutorial.

Now that Python 3 is installed we can create a new Python file. Using your favourite text editor create an empty file and save it in the same folder as your linuxformat.py, which we'll be using as a reference module for vector graphics. To create the file you can use **touch pong.py** followed by **nano pong.py**, or open it directly through the Python IDLE.

We're going to take advantage of the PyGame toolset for this project. PyGame is a useful module designed to assist with, as the name would suggest, the development of games in Python. PyGame includes a sprite class with shapes such as the rectangle, which we'll certainly make use of. To install PyGame use `pip` in command line: `pip3 install pygame` should cover it. Remember to use `pip3` to install modules for Python3, rather than just `pip`, which can get messy with multiple installations of Python on a single machine.

When it comes to programming, there's no point re-inventing the wheel every time. Start off by importing the pygame module and initialising the game engine:

```
import pygame
pygame.init()
```

Let's declare those constant 'variables' and define the colours of our game world using RGB (red green blue) colour coding. It may seem counter-intuitive, but all zeros are black and the full 255 is white. It helps to think of it as the amount of light in that colour range, 255 being the maximum and 0 being none.

```
BLACK = (0,0,0)
WHITE = (255,255,255)
```

We'll want to set the dimensions of our game environment window. We're using a typical SVGA resolution of 800x600, but you may want to go lower res for a truly retro vibe. VGA for example, is 640x480.

```
size = (800,6500)
screen = pygame.display.set_mode(size)
pygame.display.set_caption("Pong")
```

We've also set the window title to Pong, but you may want to get more creative here.

Now that we have a display window with a resolution set and a coloured background and foreground set up, we can focus on the main loop of the program. Before we do, let's set the criteria for said loop:

```
carryOn = True
clock = pygame.time.Clock()
```

Here we've told the program that our Boolean `carryOn` is set to True. In a moment we'll design our loop to continue until we've changed the status of this Boolean to `False`. The clock controls the speed of our updates. We'll need to continuously observe user inputs and react to them in real time – for example, when the mouse or keyboard is pressed. When we monitor a change, we'll have to implement the appropriate game logic, such as moving the paddle or ball. After each change, we'll need to refresh the screen to ensure that the shapes and sprites are redrawn, and this is where the game clock will come in handy. We can set how often this screen refresh takes place – that's called the 'frame rate'. In our code below we've set the frame rate at 60 frames per second, which is standard for most video games. The higher the frame rate, the smoother the game's movement will appear on screen, but also the more computing resources are required to run it because the central processor has got more events to calculate and process in a shorter amount of time.

```
 while carryOn:
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
              carryOn = False
    screen.fill(BLACK)
    pygame.draw.line(screen, WHITE, [349, 0], [349, 
 500], 5)
    pygame.display.flip()
    clock.tick(60)
```

So while our `carryOn` bool is True we're checking if the user did anything (`pygame.event.get()`), and if what they did was click close (`if event.type == pygame.QUIT`) we'll switch the `carryOn` bool to False.

We haven't yet added the game logic – that'll all go in the middle here after the while loop. For now, we've done our drawing. The screen has been filled in black and we've drawn a white net across the screen. Then we've updated the screen with `pygame.display.flip()` and set the fps rate.

Quitters!

As always, we'll need a way to safely quit our program. After the main program loop it's best to include a `pygame.quit()` command.

For our paddles, we're going to create a new class. That way, we can spawn multiple objects of that class and they'll both carry the same properties. We'll need a paddle for each player, but they'll both have the same height, width, colour and so on. So it's pragmatic to use an Object Oriented approach here, rather than programming two separate entities. To implement Object Oriented Programming properly, we'll need to save our paddle class in its own file. Create a new Python file called **paddle.py**.

Quick tip

Try introducing a score limit to the game. With the addition of selection, an IF statement could be used to end the game once a player reaches a particular score count.

Above The original upright *Pong* cabinet from 1972.

Quick tip

Could we take things to the next level and create a four-player version of *Pong*, with a paddle on every side? It would be utter madness, but it sounds fun!

```
import pygame
BLACK = (0,0,0)
class Paddle(pygame.sprite.Sprite):
    def __init__(self, color, width, height):
        super().__init__()
        self.image = pygame.Surface([width, height])
        self.image.fill(BLACK)
        self.image.set_colorkey(BLACK)
         pygame.draw.rect(self.image, color, [0, 0,
width, height])
         self.rect = self.image.get_rect()
```

In our first class we're setting the basic parameters of height, width and colour, as well as the shape. There's not much to it, because we're inheriting **pygame**'s sprite class and building upon that. We don't, therefore, have to specify what a rectangle is or how to draw one.

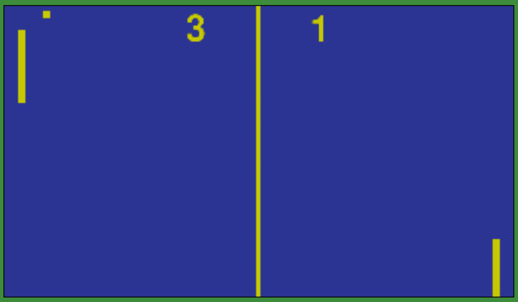
To control the movement of our paddles, we'll need a couple of methods: one for the x-axis and another for the y-axis. Keeping in mind a pixel check to ensure they never go off the screen:

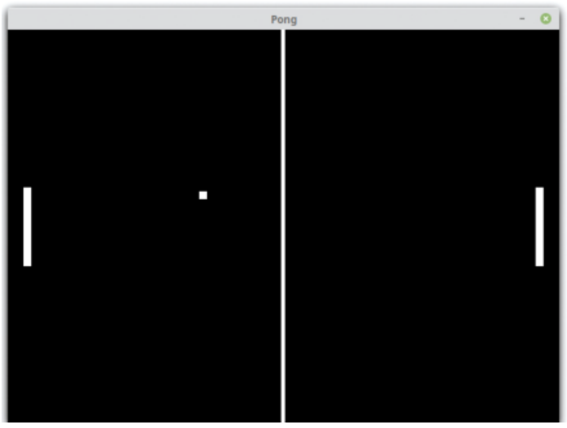
```
    def moveUp(self, pixels):
        self.rect.y -= pixels
        if self.rect.y < 0:
          self.rect.y = 0
```

Taking Pong to the next level

With *Pong* having been around for over 40 years, we've seen many iterations of what is essentially quite a basic game. Once our PyGame version of the game is fully functional, perhaps we could consider what steps we might take to improve our game? On the easier end of the spectrum we could change the colour scheme from black and white to something more contemporary. When *Pong* was first released, black and white were the only options available. By the time the Atari came out there were 128 colours in the PAL format. Eight-bit consoles introduced 256 colours, and we're now literally in the billions. Our game is designed in a VGA resolution, so if we were sticking to those retro/vintage aesthetics we'd only have 16 colours available to us. Try changing your *Pong* game to blue and yellow, for example. What effect would changing the frame rate have on the game? Does increasing or decreasing it affect gameplay? Could we implement a momentary speedup when the ball hits off a wall surface, and a temporary slowdown when the ball bounces off a paddle? That might provide a dramatic special effect. Likewise, we could change the speed of the ball itself.

To make the game difficult, if we were to introduce 'levels' we might want to set the paddles to a smaller size. And to make things go completely whack-mode we could change the angles that balls bounce off walls, or even introduce more balls by spawning more objects from the ball class.





Above *Pong* with working paddles and bouncing ball.

```
    def moveDown(self, pixels):
        self.rect.y += pixels
        if self.rect.y > 400:
          self.rect.y = 400
```

To implement our new class into our game, switch back to **pong.py** and import it as we would any other module, by adding `from paddle import Paddle` to the top of the code.

Creating instances of the paddle class is as simple as creating objects. By inserting the code shown below somewhere after defining our window, we're able to create two paddles: one for player A and the other for player B.

```
paddleA = Paddle(WHITE, 10, 100)
paddleA.rect.x = 20
paddleA.rect.y = 200
paddleB = Paddle(WHITE, 10, 100)
paddleB.rect.x = 670
paddleB.rect.y = 200
```

Immediately after that we'll want to create a list of all the sprites we're using, including these two paddles:

```
all_sprites_list = pygame.sprite.Group()
all_sprites_list.add(paddleA)
all_sprites_list.add(paddleB)
```

When we introduce additional sprites later we'll add them to this list. To ensure our sprites are drawn, we'll then call this list right before we flip (draw) our screen, with `all_sprites_list.draw(screen)`.

A good paddling

The final step of implementing our paddles class is setting up an event handler, to monitor for key presses. If player A is using S and W, and player B is using Up and Down on the keyboard, we'll need to add the following to our main program loop, `carryOn`:

```
keys = pygame.key.get_pressed()
    if keys[pygame.K_w]:
        paddleA.moveUp(5)
    if keys[pygame.K_s]:
        paddleA.moveDown(5)
    if keys[pygame.K_UP]:
        paddleB.moveUp(5)
    if keys[pygame.K_DOWN]:
        paddleB.moveDown(5)
```

We now have a working game environment and moveable paddles. The only thing missing is the ball. As with the paddle, we'll stick to an OOP approach. Create a new file called **ball.py**:

```
import pygame
from random import randint
BLACK = (0,0,0)
class Ball(pygame.sprite.Sprite):
    def __init__(self, color, width, height):
        super().__init__()
        self.image = pygame.Surface([width, height])
        self.image.fill(BLACK)
        self.image.set_colorkey(BLACK)
        pygame.draw.rect(self.image, color, [0, 0,
width, height])
        self.velocity = [randint(4,8),randint(-8,8)]
        self.rect = self.image.get_rect()
    def update(self):
        self.rect.x += self.velocity[0]
        self.rect.y += self.velocity[1]
   def bounce(self):
           self.velocity[0] = -self.velocity[0]
           self.velocity[1] = randint(-8,8)
```

Without delving too deep into the maths of it, we're implementing some basic collision detection by checking to see when a ball hits another surface and then bouncing it off in the opposite direction, at a 90 degree angle.

Back in our **pong.py** file we'll need to import the new module with `from ball import Ball` at the top of our code. We'll then need to add the ball settings below those of the paddle:

```
ball = Ball(WHITE,10,10)
ball.rect.x = 345
ball.rect.y = 195
```

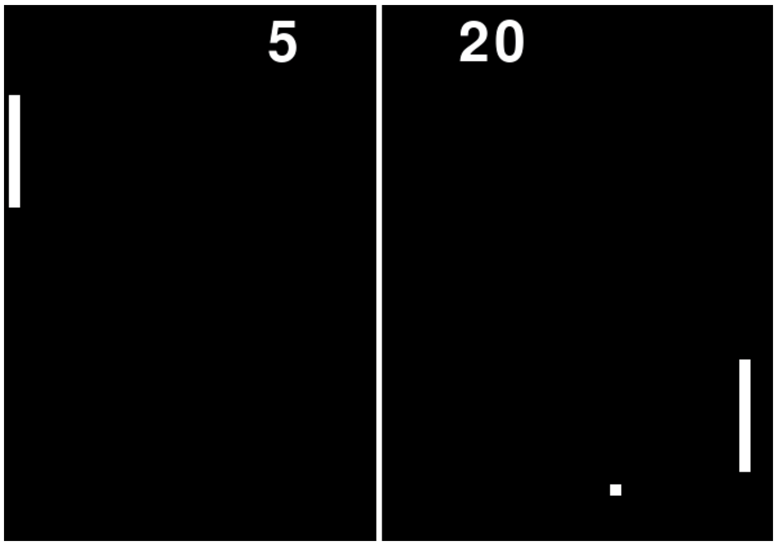
We made a list of sprites earlier, with an entry for paddleA and paddleB. We'll need to add a line for the ball, too: `all_sprites_list.add(ball)`.

Finally, after we've updated all the sprites we'll need to keep checking if our ball is bouncing off the walls. Add the following code to our `carryOn` loop:

```
    if ball.rect.x>=690:
        ball.velocity[0] = -ball.velocity[0]
    if ball.rect.x<=0:
        ball.velocity[0] = -ball.velocity[0]
    if ball.rect.y>490:
        ball.velocity[1] = -ball.velocity[1]
    if ball.rect.y<0:
        ball.velocity[1] = -ball.velocity[1]
```

That's the lot. Essentially, we now have a working game. Our paddles are controllable by two players and we have a moving ball that can bounce around the game environment. The only thing left to do is introduce a scoring system. After all, a game can't be properly called a game until there's a way for someone to win or lose!

Each player needs to bounce the ball past the opponent's paddle to score a point. Let's start off by declaring a variable for each player and initialising them at zero. Placing `scoreA = 0` and `scoreB = 0` with the rest of the variables should suffice.



Above Fully functioning retro *Pong*, developed with Python.

To add points to these new variables we'll need to make a slight alteration to the ball bouncing code in our `carryOn` loop. Immediately after `if ball.rect.x>=690:` insert `scoreA+=1` and after `if ball.rect.x<=0:` place `scoreB+=1`, leaving the rest as it is. That ought to do the trick.

Scores on the doors

Now that we've created scores and added them up, we need to display them on the screen. Right before `pygame.display.flip()`, insert the following:

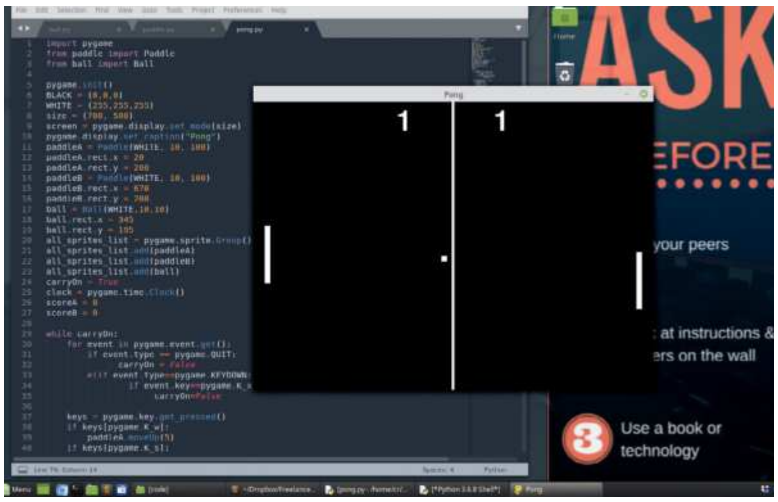
```
font = pygame.font.Font(None, 74)
    text = font.render(str(scoreA), 1, WHITE)
    screen.blit(text, (250,10))
    text = font.render(str(scoreB), 1, WHITE)
    screen.blit(text, (420,10))
```

Fire it up and give it a go. If all goes to plan, we should now have a working game of Pong.

We've included a full version of the game code on the the Archive pages on the *Linux Format* website.

Quick tip

Our game is a two-player experience, much like the original *Pong*. Consider how we might implement a non-player character to take over from player B if another person isn't available to play.



```
import pygame
from paddle import Paddle
from ball import Ball

pygame.init()
BLACK = (0,0,0)
WHITE = (255,255,255)
size = (700, 500)
screen = pygame.display.set_mode(size)
pygame.display.set_caption("Pong")
paddleA = Paddle(WHITE, 10, 100)
paddleA.rect.x = 20
paddleA.rect.y = 200
paddleB = Paddle(WHITE, 10, 100)
paddleB.rect.x = 670
paddleB.rect.y = 200
ball = Ball(WHITE,10,10)
ball.rect.x = 345
ball.rect.y = 195
all_sprites_list = pygame.sprite.Group()
all_sprites_list.add(paddleA)
all_sprites_list.add(paddleB)
all_sprites_list.add(ball)
carryOn = True
clock = pygame.time.Clock()
scoreA = 0
scoreB = 0

while carryOn:
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
              carryOn = False
        elif event.type==pygame.KEYDOWN:
                if event.key==pygame.K_x
                     carryOn=False

    keys = pygame.key.get_pressed()
    if keys[pygame.K_w]:
        paddleA.moveUp(5)
    if keys[pygame.K_s]:
```

Above Reduce the playing screen so that you can amend the Python code where necessary.

Part one: Program a Space Invaders clone

Write your own RasPi shooter in 300 lines of Python

Resources

Raspbian: www.raspberrypi.org/downloads
Python: www.python.org/doc
Pygame: www.pygame.org/docs

When you're learning to program in a new language or trying to master a new module, experimenting with a familiar and relatively simple project is a very useful exercise to help expand your understanding of the tools you're using. Our *Space Invaders* clone is one such example that lends itself perfectly to Python and the Pygame module – it's a simple game with almost universally understood rules and logic. While the Invaders meander their way down the screen towards you, it's your job to pick them off while dodging their random fire. When one wave is conquered, another faster, more aggressive wave appears. We've tried to use many features of Pygame, which is designed to make the creation of games and interactive applications easier. We've extensively used the Sprite class, which saves dozens of lines of extra code in making collision detection simple and updating the screen and its many actors a single-line command.

We hope you agree that this is an exciting game to play and a great tool to learn more about Python and Pygame, but our sensory system is far from overloaded here. Don't worry, as that will be covered in the next tutorial, adding animation and sound effects to our game to give it the spit and polish any self-respecting *Space Invaders*-inspired shooter demands…

01 Setting up dependencies

If you're looking to get a better understanding of programming games with Python and Pygame, we strongly recommend you copy the Pivaders code in this tutorial into your own program. It's great practice and gives you a chance to tweak elements of the game to suit you, be it a different ship image, changing the difficulty or the ways the alien waves behave. If you just want to play the game, that's easily achieved too, though. Either way, the game's only dependency is Pygame, which (if it isn't already) can be installed from the terminal by typing:

```
sudo apt-get install python-pygame
```

02 Downloading the project

For Pivaders we've used Git, a brilliant form of version control used to safely store the game files and retain historical versions of your code. Git should already be installed on your Pi; if not, you can acquire it by typing:

```
sudo apt-get install git
```

As well as acting as caretaker for your code, Git enables you to clone copies of other people's projects so you can work on them, or just use them. To clone Pivaders, go to your home folder in the terminal (`cd ~`), make a directory for the project (`mkdir pivaders`), enter the directory (`cd pivaders`) and type:

```
git pull https://github.com/russb78/
pivaders.git
```

```
#!/usr/bin/env python2

import pygame, random

BLACK = (0, 0, 0)
BLUE = (0, 0, 255)
WHITE = (255, 255, 255)
RED = (255, 0, 0)
ALIEN_SIZE = (30, 40)
ALIEN_SPACER = 20
BARRIER_ROW = 10
BARRIER_COLUMN = 4
BULLET_SIZE  = (5, 10)
MISSILE_SIZE = (5, 5)
BLOCK_SIZE = (10, 10)
RES = (800, 600)

class Player(pygame.sprite.Sprite):
  def __init__(self):
    pygame.sprite.Sprite.__init__(self)
    self.size = (60, 55)
    self.rect = self.image.get_rect()
    self.rect.x = (RES[0] / 2) - (self.size[0] / 2)
    self.rect.y = 520
    self.travel = 7
    self.speed = 350
    self.time = pygame.time.get_ticks()

  def update(self):
    self.rect.x += GameState.vector * self.travel
    if self.rect.x < 0:
      self.rect.x = 0
    elif self.rect.x > RES[0] - self.size[0]:
      self.rect.x = RES[0] - self.size[0]

class Alien(pygame.sprite.Sprite):
  def __init__(self):
    pygame.sprite.Sprite.__init__(self)
    self.size = (ALIEN_SIZE)
    self.rect = self.image.get_rect()
    self.has_moved = [0, 0]
    self.vector = [1, 1]
    self.travel = [(ALIEN_SIZE[0] - 7), ALIEN_SPACER]
    self.speed = 700
    self.time = pygame.time.get_ticks()

  def update(self):
    if GameState.alien_time - self.time > self.speed:
      if self.has_moved[0] < 12:
        self.rect.x += self.vector[0] * self.travel[0]
        self.has_moved[0] +=1
      else:
        if not self.has_moved[1]:
          self.rect.y += self.vector[1] * self.travel[1]
        self.vector[0] *= -1
        self.has_moved = [0, 0]
        self.speed -= 20
        if self.speed <= 100:
          self.speed = 100
      self.time = GameState.alien_time

class Ammo(pygame.sprite.Sprite):
  def __init__(self, color, (width, height)):
    pygame.sprite.Sprite.__init__(self)
    self.image = pygame.Surface([width, height])
    self.image.fill(color)
    self.rect = self.image.get_rect()
    self.speed = 0
    self.vector = 0

  def update(self):
    self.rect.y += self.vector * self.speed
    if self.rect.y < 0 or self.rect.y > RES[1]:
      self.kill()

class Block(pygame.sprite.Sprite):
  def __init__(self, color, (width, height)):
    pygame.sprite.Sprite.__init__(self)
    self.image = pygame.Surface([width, height])
    self.image.fill(color)
    self.rect = self.image.get_rect()
```

Clean clode Having all the most regularly used global variables clearly labelled here makes our code later on easier to read. Also, if we want to change the size of something, we only need to do it here and it will work everywhere.

Rain bullets The Ammo class is short and sweet. We only need a few initialising attributes and the update method checks if it's still on the screen. If not, it's destroyed.

```
class GameState:
  pass

class Game(object):
  def __init__(self):
    pygame.init()
    pygame.font.init()
    self.clock = pygame.time.Clock()
    self.game_font = pygame.font.Font(
    ‘data/Orbitracer.ttf’, 28)
    self.intro_font = pygame.font.Font(
    ‘data/Orbitracer.ttf’, 72)
    self.screen = pygame.display.set_mode([RES[0], RES[1]])
    self.time = pygame.time.get_ticks()
    self.refresh_rate = 20
    self.rounds_won = 0
    self.level_up = 50
    self.score = 0
    self.lives = 2
    self.player_group = pygame.sprite.Group()
    self.alien_group = pygame.sprite.Group()
    self.bullet_group = pygame.sprite.Group()
    self.missile_group = pygame.sprite.Group()
    self.barrier_group = pygame.sprite.Group()
    self.all_sprite_list = pygame.sprite.Group()
    self.intro_screen = pygame.image.load(
    ‘data/start_screen.jpg’).convert()
    self.background = pygame.image.load(
    ‘data/Space-Background.jpg’).convert()
    pygame.display.set_caption(‘Pivaders - ESC to exit’)
    pygame.mouse.set_visible(False)
    Player.image = pygame.image.load(
    ‘data/ship.png’).convert()
    Player.image.set_colorkey(BLACK)
    Alien.image = pygame.image.load(
    ‘data/Spaceship16.png’).convert()
    Alien.image.set_colorkey(WHITE)
    GameState.end_game = False
    GameState.start_screen = True
    GameState.vector = 0
    GameState.shoot_bullet = False

  def control(self):
    for event in pygame.event.get():
      if event.type == pygame.QUIT:
        GameState.start_screen = False
        GameState.end_game = True
      if event.type == pygame.KEYDOWN \
      and event.key == pygame.K_ESCAPE:
        if GameState.start_screen:
          GameState.start_screen = False
          GameState.end_game = True
          self.kill_all()
        else:
          GameState.start_screen = True
    self.keys = pygame.key.get_pressed()
    if self.keys[pygame.K_LEFT]:
      GameState.vector = -1
    elif self.keys[pygame.K_RIGHT]:
      GameState.vector = 1
    else:
      GameState.vector = 0
    if self.keys[pygame.K_SPACE]:
      if GameState.start_screen:
        GameState.start_screen = False
        self.lives = 2
        self.score = 0
        self.make_player()
        self.make_defenses()
        self.alien_wave(0)
      else:
        GameState.shoot_bullet = True

  def splash_screen(self):
    while GameState.start_screen:
      self.kill_all()
      self.screen.blit(self.intro_screen, [0, 0])
      self.screen.blit(self.intro_font.render(
      “PIVADERS”, 1, WHITE), (265, 120))
      self.screen.blit(self.game_font.render(
      “PRESS SPACE TO PLAY”, 1, WHITE), (274, 191))
```

Groups This long list of groups we're creating are essentially sets. Each time we create one of these items, it's added to the set so it can be tested for collisions and drawn with ease.

Control Taking care of keyboard input is the control method. It checks for key events and acts accordingly depending whether we're on the start screen or playing the game.

03 Testing Pivaders

With Pygame installed and the project cloned to your machine (you can also find the .zip on FileSilo – simply unpack it and copy it to your home directory to use it), you can take it for a quick test drive to make sure everything's set up properly. All you need to do is type `python pivaders.py` from within the pivaders directory in the terminal to get started. You can start the game with the space bar, shoot with the same button and simply use the left and right arrows on your keyboard to move your ship left and right.

04 Creating your own clone

Once you've racked up a good high score (anything over 2,000 points is respectable) and got to know our simple implementation, you'll get more from following along with and exploring the code and our brief explanations of what's going on. For those who want to make their own project, create a new project folder and use either IDLE or Leafpad (or perhaps install Geany) to create and save a .py file of your own.

05 Global variables & tuples

Once we've imported the modules we need for the project, there's quite a long list of variables in block capitals. The capitals denote that these variables are constants (or global variables). These are important numbers that never change – they represent things referred to regularly in the code, like colours, block sizes and resolution. You'll also notice that colours and sizes hold multiple numbers in braces – these are tuples. You could use square brackets (to make them lists), but we use tuples here since they're immutable, which means you can't reassign individual items within them. Perfect for constants, which aren't designed to change anyway.

06 Classes – part 1

A class is essentially a blueprint for an object you'd like to make. In the case of our **player**, it contains all the required info, from which you can make multiple copies (we create a player instance in the **make_player()** method halfway through the project). The great thing about the classes in Pivaders is that they inherit lots of capabilities and shortcuts from Pygame's Sprite class, as denoted by the **pygame.sprite.Sprite** found within the braces of the first line of the class. You can read the docs to learn more about the Sprite class via **www.pygame.org/docs/ref/sprite.html**.

07 Classes – part 2

In Pivader's classes, besides creating the required attributes – these are simply variables in classes – for the object (be it a player, an alien, some ammo or a block), you'll also notice all the classes have an **update()** method apart from the Block class (a method is a function within a class). The **update()** method is called in every loop through the main game (we've called ours **main_loop()**) and simply asks the iteration of the class we've created to move. In the case of a bullet from the Ammo class, we're asking it to move down the screen. If it goes off either the top or bottom of the screen, we destroy it (since we don't need it any more).

08 Ammo

What's most interesting about classes, though, is that you can use one class to create lots of different things. You could, for example, have a pet class. From that class you could create a cat (that meows) and a dog (that barks). They're different in many ways, but they're both furry and have four legs, so can be created from the same parent class. We've done exactly that with our Ammo class, using it to create both the player bullets and the alien missiles. They're different colours and they shoot in opposite directions, but they're fundamentally one and the same. This saves us creating extra unnecessary code and ensures consistent behaviour between objects we create.

We used widely available open source art and fonts to make the game

09 The game

Our final class is called **Game**. This is where all the main functionality of the game itself comes in, but remember, so far this is still just a list of ingredients – nothing can actually happen until a 'Game' object is created (right at the bottom of the code). The Game class is where the central mass of the game resides, so we initialise Pygame, set the imagery for our protagonist and extraterrestrial antagonist and create some GameState attributes that we use to control key aspects of external classes, like changing the player's vector (direction) and deciding if we need to return to the start screen, among other things.

10 The main loop

There are a lot of methods (class functions) in the Game class, and each is designed to control a particular aspect of either setting up the game or the gameplay itself. The actual logic that dictates what happens within any one round of the game is actually contained in the **main_loop()** method right at the bottom of the **pivaders.py** script and is the key to unlocking exactly what variables and functions you need for your game. Starting at the top of **main_loop()** and working line-by-line down to its last line, you can see exactly what's being evaluated 20 times every second when you're playing the game.

11 Main loop key logic – part 1

Firstly the game checks that the **end_game** attribute is false – if it's true, the entire loop in **main_loop()** is skipped and we go straight to **pygame.quit()**, exiting the game. This flag is set to true only if the player closes the game window or presses the Esc key when on the **start_screen**. Assuming end_game and start_screen are false, the main loop can start proper, with the **control()** method, which checks to see if the location of the player needs to change. Next we attempt to make an enemy missile and we use the **random** module to limit the number of missiles that can be created. Next we call the **update()** method for each and every actor on the screen using a simple **for** loop. This makes sure everyone's up to date and moved before we check collisions in **calc_collisions()**.

12 Main loop key logic – part 2

Once collisions have been calculated, we need to see if the game is still meant to continue. We do so with **is_dead()** and **defenses_breached()** – if either of these methods returns true, we know we need to return to the start screen. On the other hand, we also need to check to see if we've killed all the aliens, from within **win_round()**. Assuming we're not dead, but the aliens are, we know we can call the **next_round()** method, which creates a fresh batch of aliens and increases their speed around the screen. Finally, we refresh the screen so everything that's been moved, shot or killed can be updated or removed from the screen. Remember, the main loop happens 20 times a second – so the fact we don't call for the screen to update right at the end of the loop is of no consequence.

“A class is essentially a blueprint”

```
        pygame.display.flip()
        self.control()

    def make_player(self):
        self.player = Player()
        self.player_group.add(self.player)
        self.all_sprite_list.add(self.player)

    def refresh_screen(self):
        self.all_sprite_list.draw(self.screen)
        self.refresh_scores()
        pygame.display.flip()
        self.screen.blit(self.background, [0, 0])
        self.clock.tick(self.refresh_rate)

    def refresh_scores(self):
        self.screen.blit(self.game_font.render(
        “SCORE “ + str(self.score), 1, WHITE), (10, 8))
        self.screen.blit(self.game_font.render(
        “LIVES “ + str(self.lives + 1), 1, RED), (355, 575))

    def alien_wave(self, speed):
        for column in range(BARRIER_COLUMN):
            for row in range(BARRIER_ROW):
                alien = Alien()
                alien.rect.y = 65 + (column * (
                ALIEN_SIZE[1] + ALIEN_SPACER))
                alien.rect.x = ALIEN_SPACER + (
                row * (ALIEN_SIZE[0] + ALIEN_SPACER))
                self.alien_group.add(alien)
                self.all_sprite_list.add(alien)
                alien.speed -= speed

    def make_bullet(self):
        if GameState.game_time - self.player.time > self.player.speed:
            bullet = Ammo(BLUE, BULLET_SIZE)
            bullet.vector = -1
            bullet.speed = 26
            bullet.rect.x = self.player.rect.x + 28
            bullet.rect.y = self.player.rect.y
            self.bullet_group.add(bullet)
            self.all_sprite_list.add(bullet)
            self.player.time = GameState.game_time
        GameState.shoot_bullet = False

    def make_missile(self):
        if len(self.alien_group):
            shoot = random.random()
            if shoot <= 0.05:
                shooter = random.choice([
                alien for alien in self.alien_group])
                missile = Ammo(RED, MISSILE_SIZE)
                missile.vector = 1
                missile.rect.x = shooter.rect.x + 15
                missile.rect.y = shooter.rect.y + 40
                missile.speed = 10
                self.missile_group.add(missile)
                self.all_sprite_list.add(missile)

    def make_barrier(self, columns, rows, spacer):
        for column in range(columns):
            for row in range(rows):
                barrier = Block(WHITE, (BLOCK_SIZE))
                barrier.rect.x = 55 + (200 * spacer) + (row * 10)
                barrier.rect.y = 450 + (column * 10)
                self.barrier_group.add(barrier)
                self.all_sprite_list.add(barrier)

    def make_defenses(self):
        for spacing, spacing in enumerate(xrange(4)):
            self.make_barrier(3, 9, spacing)

    def kill_all(self):
        for items in [self.bullet_group, self.player_group,
        self.alien_group, self.missile_group, self.barrier_group]:
            for i in items:
                i.kill()
```

Refreshing the screen You need to carefully consider the way in which you update the screen. Blitting the background between actor movements is vital for clean animation.

Guns ’n’ ammo Bullets and missiles use the same parent class. We change a few key attributes originally initialised to create the behaviour we need; eg the vector for each is opposite.

Dead or alive Probably two of the most important questions are answered here – is the player dead or did you win the round?

```
    def is_dead(self):
        if self.lives < 0:
            self.screen.blit(self.game_font.render(
            “The war is lost! You scored: “ + str(
            self.score), 1, RED), (250, 15))
            self.rounds_won = 0
            self.refresh_screen()
            pygame.time.delay(3000)
            return True

    def win_round(self):
        if len(self.alien_group) < 1:
            self.rounds_won += 1
            self.screen.blit(self.game_font.render(
            “You won round “ + str(self.rounds_won) +
            “  but the battle rages on”, 1, RED), (200, 15))
            self.refresh_screen()
            pygame.time.delay(3000)
            return True

    def defenses_breached(self):
        for alien in self.alien_group:
            if alien.rect.y > 410:
                self.screen.blit(self.game_font.render(
                “The aliens have breached Earth defenses!”,
                1, RED), (180, 15))
                self.refresh_screen()
                pygame.time.delay(3000)
                return True

    def calc_collisions(self):
        pygame.sprite.groupcollide(
        self.missile_group, self.barrier_group, True, True)
        pygame.sprite.groupcollide(
        self.bullet_group, self.barrier_group, True, True)
        if pygame.sprite.groupcollide(
        self.bullet_group, self.alien_group, True, True):
            self.score += 10
        if pygame.sprite.groupcollide(
        self.player_group, self.missile_group, False, True):
            self.lives -= 1

    def next_round(self):
        for actor in [self.missile_group,
        self.barrier_group, self.bullet_group]:
            for i in actor:
                i.kill()
        self.alien_wave(self.level_up)
        self.make_defenses()
        self.level_up += 50

    def main_loop(self):
        while not GameState.end_game:
            while not GameState.start_screen:
                GameState.game_time = pygame.time.get_ticks()
                GameState.alien_time = pygame.time.get_ticks()
                self.control()
                self.make_missile()
                for actor in [self.player_group, self.bullet_group,
                self.alien_group, self.missile_group]:
                    for i in actor:
                        i.update()
                if GameState.shoot_bullet:
                    self.make_bullet()
                self.calc_collisions()
                if self.is_dead() or self.defenses_breached():
                    GameState.start_screen = True
                if self.win_round():
                    self.next_round()
                self.refresh_screen()
            self.splash_screen()
        pygame.quit()

if __name__ == ‘__main__’:
    pv = Game()
    pv.main_loop()
```

Main loop This is the business end of our application. This loop executes 20 times a second. It needs to be logical and easy for another coder to understand.

Start the game The very last thing we do is create a Game object and call the main loop. Besides our constants, this is the only code that sits outside a class.

Part two: Add animation and sound to Pivaders

After writing a Space Invaders clone in just 300 lines of Python, now we expand it to include animation and sound

Resources

Raspbian: www.raspberrypi.org/downloads

Python: www.python.org/doc

Pygame: www.pygame.org/docs

Art assets: opengameart.org

We had great fun creating our basic *Space Invaders* clone, Pivaders, for the previous tutorial. One of the key challenges with the project was keeping it to a manageable size – just 300 lines of Python. Without the use of Pygame's strong set of features, that goal would likely have been overshot at least twofold. Pygame's ability to group, manage and detect collisions thanks to the Sprite class really made a great difference to our project, not just in terms of length but in simplicity. If you missed the first part of the project, you can find the v0.1 code listing on GitHub via **git.io/cBVTBg**, while you can find version v0.2, including all the images, music and sound effects we used, over at **git.io/8QsK-w**.

Even working within the clearly defined framework Pygame offers, there are still a thousand ways we could have approached adding animation and sound. We could have created any one of a dozen classes to create and manage containers of individual images, or read in a sprite sheet (a single image full of smaller, separate images) which we could then draw (or blit) to the screen.

For the sake of simplicity and performance, we integrated a few animation methods into our Game class and opted to use a sprite sheet. Not only does it make it easy to draw to the screen, but it also keeps the asset count under control and keeps performance levels up, which is important for the Raspberry Pi.

01 Setting up dependencies

As we recommended with the last tutorial, you'll get much more from the exercise if you download the code we've made available online (**git.io/8QsK-w**) and use it for reference as you create your own animations and sound for your various Pygame projects. Regardless of whether you just want to simply preview and play or walk-through the code to get a better understanding of basic game creation, you're still going to need to satisfy some basic dependencies. The two key requirements here are Pygame and Git, both of which are installed by default on up-to-date Raspbian installations. If you're unsure if you have them, type the following at the command line:

```
sudo apt-get install python-pygame
git
```

Pivaders.py listing from line 86 (continued on next page)

```
class Game(object):
    def __init__(self):
        pygame.init()
        pygame.font.init()
        self.clock = pygame.time.Clock()
        self.game_font = pygame.font.Font(
        ‘data/Orbitracer.ttf’, 28)
        self.intro_font = pygame.font.Font(
        ‘data/Orbitracer.ttf’, 72)
        self.screen = pygame.display.set_mode([RES[0], RES[1]])
        self.time = pygame.time.get_ticks()
        self.refresh_rate = 20; self.rounds_won = 0
        self.level_up = 50; self.score = 0
        self.lives = 2
        self.player_group = pygame.sprite.Group()
        self.alien_group = pygame.sprite.Group()
        self.bullet_group = pygame.sprite.Group()
        self.missile_group = pygame.sprite.Group()
        self.barrier_group = pygame.sprite.Group()
        self.all_sprite_list = pygame.sprite.Group()
        self.intro_screen = pygame.image.load(
        ‘data/graphics/start_screen.jpg’).convert()
        self.background = pygame.image.load(
        ‘data/graphics/Space-Background.jpg’).convert()
        pygame.display.set_caption(‘Pivaders - ESC to exit’)
        pygame.mouse.set_visible(False)
        Alien.image = pygame.image.load(
        ‘data/graphics/Spaceship16.png’).convert()
        Alien.image.set_colorkey(WHITE)
        self.ani_pos = 5 # 11 images of ship
        self.ship_sheet = pygame.image.load(
        ‘data/graphics/ship_sheet_final.png’).convert_alpha()
        Player.image = self.ship_sheet.subsurface(
                self.ani_pos*64, 0, 64, 61)
        self.animate_right = False
        self.animate_left = False
        self.explosion_sheet = pygame.image.load(
        ‘data/graphics/explosion_new1.png’).convert_alpha()
        self.explosion_image = self.explosion_sheet.subsurface(0, 0, ↵
79, 96)
        self.alien_explosion_sheet = pygame.image.load(
        ‘data/graphics/alien_explosion.png’)
        self.alien_explode_graphics = self.alien_explosion_sheet. ↵
subsurface(0, 0, 94, 96)
        self.explode = False
        self.explode_pos = 0; self.alien_explode = False
        self.alien_explode_pos = 0
        pygame.mixer.music.load(‘data/sound/10_Arpanauts.ogg’)
        pygame.mixer.music.play(-1)
        pygame.mixer.music.set_volume(0.7)
        self.bullet_fx = pygame.mixer.Sound(
        ‘data/sound/medetix__pc-bitcrushed-lazer-beam.ogg’)
        self.explosion_fx = pygame.mixer.Sound(
        ‘data/sound/timgormly__8-bit-explosion.ogg’)
        self.explosion_fx.set_volume(0.5)
        self.explodey_alien = []
        GameState.end_game = False
        GameState.start_screen = True
        GameState.vector = 0
        GameState.shoot_bullet = False

    def control(self):
        for event in pygame.event.get():
            if event.type == pygame.QUIT:
                GameState.start_screen = False
                GameState.end_game = True
            if event.type == pygame.KEYDOWN \
            and event.key == pygame.K_ESCAPE:
                if GameState.start_screen:
                    GameState.start_screen = False
                    GameState.end_game = True
                    self.kill_all()
                else:
                    GameState.start_screen = True
        self.keys = pygame.key.get_pressed()
        if self.keys[pygame.K_LEFT]:
            GameState.vector = -1
            self.animate_left = True
            self.animate_right = False
        elif self.keys[pygame.K_RIGHT]:
            GameState.vector = 1
```

ship_sheet
We set the player image to be equal to one small segment of the sprite sheet by using the ‘ani_pos’ variable. Change the variable to change the picture

Set flags We’ve added ‘animate_left’ and ‘animate_right’ Boolean flags to the control method. When they’re true, the actual animation code is called via a separate method

```
            self.animate_right = True
            self.animate_left = False
        else:
            GameState.vector = 0
            self.animate_right = False
            self.animate_left = False

        if self.keys[pygame.K_SPACE]:
            if GameState.start_screen:
                GameState.start_screen = False
                self.lives = 2
                self.score = 0
                self.make_player()
                self.make_defenses()
                self.alien_wave(0)
            else:
                GameState.shoot_bullet = True
                self.bullet_fx.play()

    def animate_player(self):
        if self.animate_right:
            if self.ani_pos < 10:
                Player.image = self.ship_sheet.subsurface(
                    self.ani_pos*64, 0, 64, 61)
                self.ani_pos += 1
        else:
            if self.ani_pos > 5:
                self.ani_pos -= 1
                Player.image = self.ship_sheet.subsurface(
                    self.ani_pos*64, 0, 64, 61)

        if self.animate_left:
            if self.ani_pos > 0:
                self.ani_pos -= 1
                Player.image = self.ship_sheet.subsurface(
                    self.ani_pos*64, 0, 64, 61)
        else:
            if self.ani_pos < 5:
                Player.image = self.ship_sheet.subsurface(
                    self.ani_pos*64, 0, 64, 61)
                self.ani_pos += 1

    def player_explosion(self):
        if self.explode:
            if self.explode_pos < 8:
                self.explosion_image = self.explosion_sheet. ↵
subsurface(0, self.explode_pos*96, 79, 96)
                self.explode_pos += 1
                self.screen.blit(self.explosion_image, [self.player. ↵
rect.x -10, self.player.rect.y - 30])
            else:
                self.explode = False
                self.explode_pos = 0

    def alien_explosion(self):
        if self.alien_explode:
            if self.alien_explode_pos < 9:
                self.alien_explode_graphics = self.alien_explosion_ ↵
sheet.subsurface(0, self.alien_explode_pos*96, 94, 96)
                self.alien_explode_pos += 1
                self.screen.blit(self.alien_explode_graphics, ↵
[int(self. explodey_alien[0]) - 50 , int(self.explodey_alien[1]) - 60])
            else:
                self.alien_explode = False
                self.alien_explode_pos = 0
                self.explodey_alien = []

    def splash_screen(self):
        while GameState.start_screen:
            self.kill_all()
            self.screen.blit(self.intro_screen, [0, 0])
            self.screen.blit(self.intro_font.render(
            “PIVADERS”, 1, WHITE), (265, 120))
            self.screen.blit(self.game_font.render(
            “PRESS SPACE TO PLAY”, 1, WHITE), (274, 191))
            pygame.display.flip()
            self.control()
            self.clock.tick(self.refresh_rate / 2)

    def make_player(self):
        self.player = Player()
```

fx.play()
Having already loaded the sound effect we want when we shoot, we now just need to call it when we press the space bar

02 Downloading pivaders

Git is a superb version control solution that helps programmers safely store their code and associated files. Not only does it help you retain a full history of changes, it means you can 'clone' entire projects to use and work on from places like **github.com**. To clone the version of the project we created for this tutorial, go to your home folder from the command line (**cd ~**) and type:

```
git pull https://github.com/russb78/pivaders.git
```

This will create a folder called **pivaders** – go inside (**cd pivaders**) and take a look around.

03 Navigating the project

The project is laid out quite simply across a few subfolders. Within **pivaders** sits a licence, readme and a second pivaders folder. This contains the main game file, **pivaders.py**, which launches the application. Within the **data** folder you'll find subfolders for both graphics and sound assets, as well as the font we've used for the title screen and scores. To take pivaders for a test-drive, simply enter the pivaders subdirectory (**cd pivaders/pivaders**) and type:

```
python pivaders.py
```

Use the arrow keys to steer left and right and the space bar to shoot. You can quit to the main screen with the Esc key and press it again to exit the game completely.

04 Animation & sound

Compared with the game from last month's tutorial, you'll see it's now a much more dynamic project. The protagonist ship now leans into the turns as you change direction and corrects itself when you either press the opposite direction or lift your finger off the button. When you shoot an alien ship, it explodes with several frames of animation and should you take fire, a smaller explosion occurs on your ship. Music, lasers and explosion sound effects also accompany the animations as they happen.

05 Finding images to animate

Before we can program anything, it's wise to have assets set up in a way we can use them. As mentioned, we've opted to use sprite sheets; these can be found online or created with GIMP with a little practice. Essentially they're a mosaic made up of individual 'frames' of equally sized and spaced images representing each frame. Find ready-made examples at **opengameart.org**, as used here.

06 Tweaking assets

While many of the assets on sites like **opengameart.org** can be used as is, you may want to import them into an image-editing application like GIMP to configure them to suit your needs – as we did with our ship sheet asset to help us keep the code simple. We started with the central ship sprite and centred it into a new window. We set the size and width of the frame and then copy-pasted the other frames either side of it. We ended up with 11 frames of exactly the same size and width in a single document. Pixel-perfect precision on size and width is key, so we can just multiply it to find the next frame.

07 Loading the sprite sheet

Since we're inheriting from the **Sprite** class to create our **Player** class, we can easily alter how the player looks on screen by changing **Player.image**. First, we need to load our ship sprite sheet with **pygame.image.load()**. Since we made our sheet with a transparent background, we can append **.convert_alpha()** to the end of the line so the ship frames render correctly (without any background). We then use **subsurface** to set the initial **Player.image** to the middle ship sprite on the sheet. This is set by **self.ani_pos**, which has an initial value of 5. Changing this value will alter the ship image drawn to the screen: '0' would draw it leaning fully left, '11' fully to the right.

08 Animation flags

Down the list in the initialising code for the **Game** class, we set two flags for player animation: **self.animate_left** and **self.animate_right**. In the **Control** method of our Game class, we use these to 'flag' when we want animations to work using Boolean values. It allows us to 'automatically' animate the player sprite back to its resting state (otherwise the ship will continue to look as if it's flying left when it has stopped).

09 The animation method

These flags pop up again in the core animation code for the player: **animate_player()** within the Game class. Here we use nested **if** statements to control the animation and physically set the player image accordingly. Essentially it states that if the **animate_right** flag is **True** and if the current animation position is different to what we want, we incrementally increase the **ani_pos** variable and set the player's image accordingly. The **Else** statement then animates the ship sprite back to its resting state and the same logic is then applied in the opposite direction.

10 Animating explosions

The **player_explosion()** and **alien_explosion()** methods that come after the player animation block in the Game class are similar but simpler executions of essentially the same thing. As we only need to run through the same predefined set of frames (this time vertically), we only need to see if the **self.explode** and **self.alien_explode** flags are True before we increment the variables that change the image displayed. As the sprite sheet is vertical, the variables **alien_explode_pos** and **explosion_image** are set to a different part of **subsurface** than before.

11 Adding music to your project

Pygame makes it easy to add a musical score to a project. Just obtain a suitable piece of music in your preferred format (we found ours via **freemusicarchive.org**) and load it using the **Mixer** Pygame class. As it's already been initialised via **pygame.init()**, we can go ahead and load the music with this code:

```
pygame.mixer.music.load('data/sound/10_Arpanauts.ogg')
pygame.mixer.music.play(-1)
pygame.mixer.music.set_volume(0.7)
```

The music.play(-1) requests that the music should start with the app and continue to loop until it quits. If we replaced -1 with 5, the music would loop five times before ending. Learn more about the Mixer class via **www.pygame.org/docs/ref/mixer.html**.

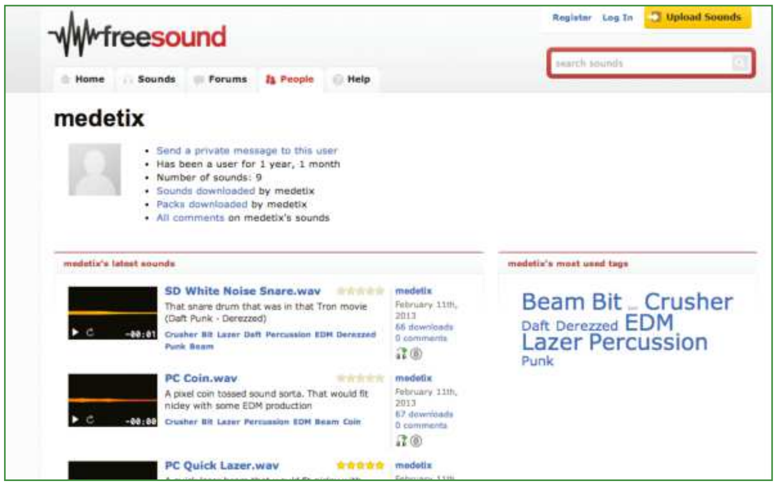
12 Using sound effects

Loading and using sounds is similar to how we do so for images in Pygame. First we load the sound effect using a simple assignment. For the laser beam, the initialisation looks like this:

```
self.bullet_fx = pygame.mixer.Sound(
    'data/sound/medetix__pc-bitcrushed-lazer-beam.ogg')
```

Then we simply trigger the sound effect at the appropriate time. In the case of the laser, we want it to play whenever we press the space bar to shoot, so we place it in the Game class's Control method, straight after we raise the **shoot_bullet** flag.

If you're struggling to find free and open sound effects, we recommend **www.freesound.org**.



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That snare drum that was in that Tron movie (Daft Punk - Derezzed)
Crusher Bit Lazer Daft Percussion EDM Derezzed Punk Beam

PC Coin.wav — medetix, February 11th, 2013, 67 downloads, 0 comments
A pixel coin tossed sound sorta. That would fit nicley with some EDM production
Crusher Bit Lazer Percussion EDM Beam Coin

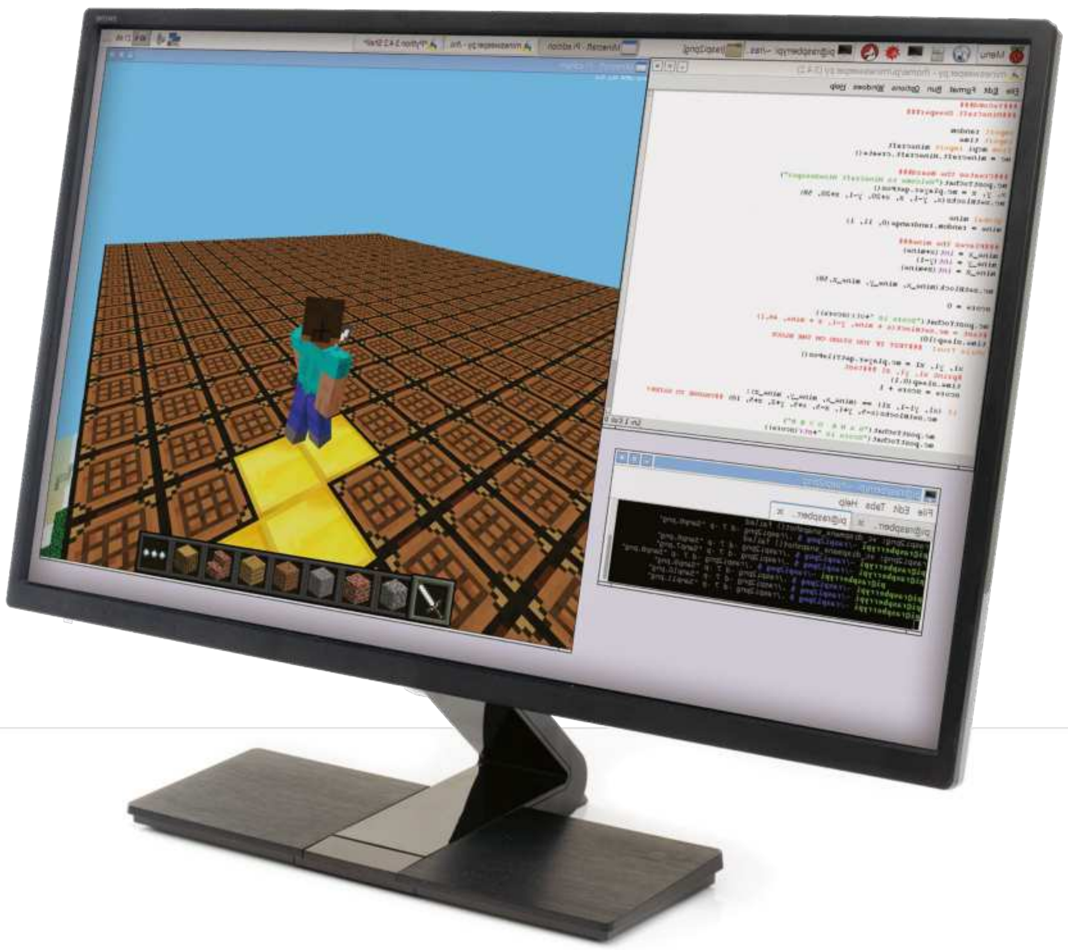
PC Quick Lazer.wav — medetix

medetix's most used tags

Beam Bit Crusher Daft Derezzed EDM Lazer Percussion Punk

Above The Freesound site is a good place to find free and open sound effects for projects

```
        self.player_group.add(self.player)
        self.all_sprite_list.add(self.player)

    def refresh_screen(self):
        self.all_sprite_list.draw(self.screen)
        self.animate_player()
        self.player_explosion()
        self.alien_explosion()
        self.refresh_scores()
        pygame.display.flip()
        self.screen.blit(self.background, [0, 0])
        self.clock.tick(self.refresh_rate)

    def refresh_scores(self):
        self.screen.blit(self.game_font.render(
        "SCORE " + str(self.score), 1, WHITE), (10, 8))
        self.screen.blit(self.game_font.render(
        "LIVES " + str(self.lives + 1), 1, RED), (355, 575))

    def alien_wave(self, speed):
        for column in range(BARRIER_COLUMN):
            for row in range(BARRIER_ROW):
                alien = Alien()
                alien.rect.y = 65 + (column * (
                ALIEN_SIZE[1] + ALIEN_SPACER))
                alien.rect.x = ALIEN_SPACER + (
                row * (ALIEN_SIZE[0] + ALIEN_SPACER))
                self.alien_group.add(alien)
                self.all_sprite_list.add(alien)
                alien.speed -= speed

    def make_bullet(self):
        if GameState.game_time - self.player.time > self.player.speed:
            bullet = Ammo(BLUE, BULLET_SIZE)
            bullet.vector = -1
            bullet.speed = 26
            bullet.rect.x = self.player.rect.x + 28
            bullet.rect.y = self.player.rect.y
            self.bullet_group.add(bullet)
            self.all_sprite_list.add(bullet)
            self.player.time = GameState.game_time
        GameState.shoot_bullet = False

    def make_missile(self):
        if len(self.alien_group):
            shoot = random.random()
            if shoot <= 0.05:
                shooter = random.choice([
                alien for alien in self.alien_group])
                missile = Ammo(RED, MISSILE_SIZE)
                missile.vector = 1
                missile.rect.x = shooter.rect.x + 15
                missile.rect.y = shooter.rect.y + 40
                missile.speed = 10
                self.missile_group.add(missile)
                self.all_sprite_list.add(missile)

    def make_barrier(self, columns, rows, spacer):
        for column in range(columns):
            for row in range(rows):
                barrier = Block(WHITE, (BLOCK_SIZE))
                barrier.rect.x = 55 + (200 * spacer) + (row * 10)
                barrier.rect.y = 450 + (column * 10)
                self.barrier_group.add(barrier)
                self.all_sprite_list.add(barrier)

    def make_defenses(self):
        for spacing, spacing in enumerate(xrange(4)):
            self.make_barrier(3, 9, spacing)

    def kill_all(self):
        for items in [self.bullet_group, self.player_group,
        self.alien_group, self.missile_group, self.barrier_group]:
            for i in items:
                i.kill()

    def is_dead(self):
        if self.lives < 0:
            self.screen.blit(self.game_font.render(
            "The war is lost! You scored: " + str(
            self.score), 1, RED), (250, 15))
            self.rounds_won = 0
            self.refresh_screen()
            self.level_up = 50
            self.explode = False
            self.alien_explode = False
            pygame.time.delay(3000)
            return True

    def defenses_breached(self):
        for alien in self.alien_group:
            if alien.rect.y > 410:
                self.screen.blit(self.game_font.render(
                "The aliens have breached Earth defenses!",
                1, RED), (180, 15))
                self.refresh_screen()
                self.level_up = 50
                self.explode = False
                self.alien_explode = False
                pygame.time.delay(3000)
                return True

    def win_round(self):
        if len(self.alien_group) < 1:
            self.rounds_won += 1
            self.screen.blit(self.game_font.render(
            "You won round " + str(self.rounds_won) +
            "  but the battle rages on", 1, RED), (200, 15))
            self.refresh_screen()
            pygame.time.delay(3000)
            return True

    def next_round(self):
        self.explode = False
        self.alien_explode = False
        for actor in [self.missile_group,
        self.barrier_group, self.bullet_group]:
            for i in actor:
                i.kill()
        self.alien_wave(self.level_up)
        self.make_defenses()
        self.level_up += 50

    def calc_collisions(self):
        pygame.sprite.groupcollide(
        self.missile_group, self.barrier_group, True, True)
        pygame.sprite.groupcollide(
        self.bullet_group, self.barrier_group, True, True)

        for z in pygame.sprite.groupcollide(
        self.bullet_group, self.alien_group, True, True):
            self.alien_explode = True
            self.explodey_alien.append(z.rect.x)
            self.explodey_alien.append(z.rect.y)
            self.score += 10
            self.explosion_fx.play()

        if pygame.sprite.groupcollide(
        self.player_group, self.missile_group, False, True):
            self.lives -= 1
            self.explode = True
            self.explosion_fx.play()

    def main_loop(self):
        while not GameState.end_game:
            while not GameState.start_screen:
                GameState.game_time = pygame.time.get_ticks()
                GameState.alien_time = pygame.time.get_ticks()
                self.control()
                self.make_missile()
                self.calc_collisions()
                self.refresh_screen()
                if self.is_dead() or self.defenses_breached():
                    GameState.start_screen = True
                for actor in [self.player_group, self.bullet_group,
                self.alien_group, self.missile_group]:
                    for i in actor:
                        i.update()
                if GameState.shoot_bullet:
                    self.make_bullet()
                if self.win_round():
                    self.next_round()
            self.splash_screen()
        pygame.quit()

if __name__ == '__main__':
    pv = Game()
    pv.main_loop()
```



Create a Minecraft Minesweeper game

Use your Raspberry Pi and Python knowledge to code a simple mini-game in Minecraft

Resources

Jessie or Raspbian:
raspberrypi.org/downloads

Python:
www.python.org/

You may remember or have even played the classic Minesweeper PC game that originally dates back to the 60s. Over the years it has been bundled with most operating systems, appeared on mobile phones, and even featured as a mini-game variation on *Super Mario Bros*.

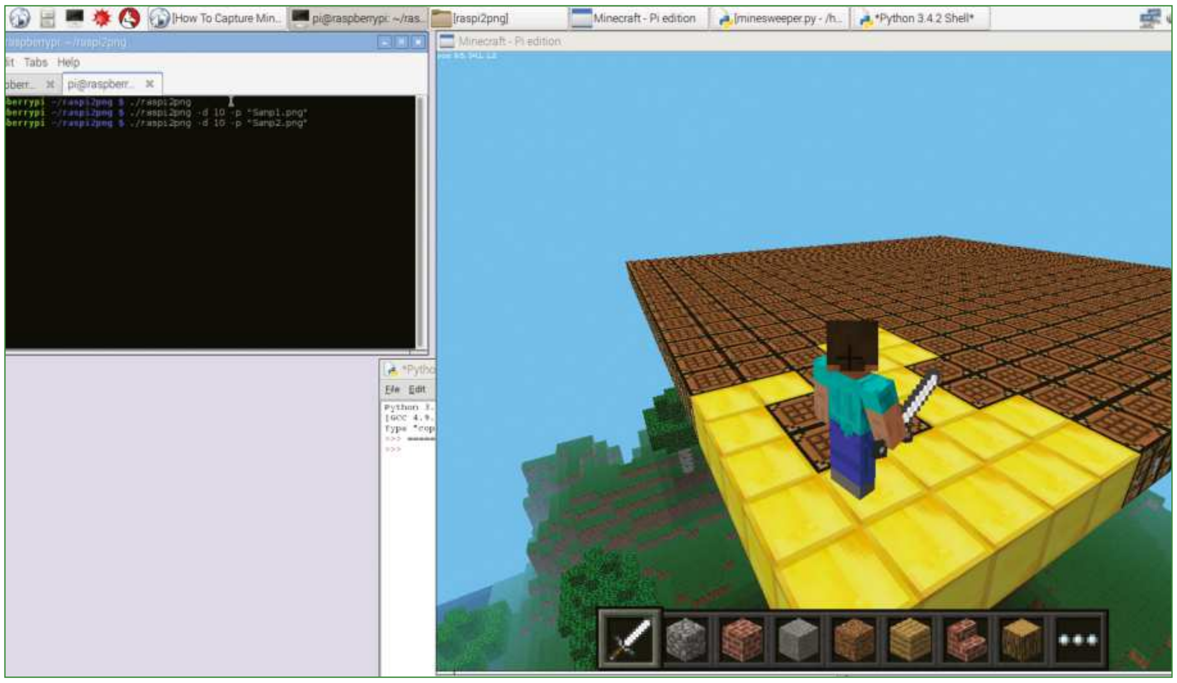
This project will walk you through how to create a simple version in *Minecraft*: it's *Minecraft* Minesweeper! You will code a program that sets out an arena of blocks and turns one of these blocks into a mine. To play the game, guide your player around the board. Each time you stand on a block you turn it to gold and collect points, but watch out for the mine as it will end the game and cover you in lava!

01 Update and install

To update your Raspberry Pi, open the terminal and type:

```
sudo apt-get upgrade
sudo apt-get update
```

The new Raspberry Pi OS image already has Minecraft and Python installed. The Minecraft API which enables you to interact with *Minecraft* using Python is also pre-installed. If you are using an old OS version, we would highly recommend you downloading and then updating your version to either the most recent Jessie or Raspbian image.



```
berrypi ~/raspi2png $ ./raspi2png
berrypi ~/raspi2png $ ./raspi2png -d 10 -p "Samp1.png"
berrypi ~/raspi2png $ ./raspi2png -d 10 -p "Samp2.png"
```

Right The safe blocks have been turned into gold – the rest are potential mines!

Switching to the shell

Switching between the Python Shell and Minecraft window can be frustrating, especially as MC overlays the Python window. The best solution is to half the windows across the screen. (Don't run MC full-screen as the mouse coordinates are off). Use the Tab key to release the keyboard and mouse from the MC window.

02 Importing the modules

Load up your preferred Python editor and start a new window. You need to import the following modules: import random to calculate and create the random location of the mine, and import time to add pauses and delays to the program. Next, add a further two lines of code: from mcpi import minecraft and mc = minecraft.Minecraft.create(). These create the program link between Minecraft and Python. The mc variable enables you to write "mc" instead of "minecraft.Minecraft.create()".

```
import random
import time
from mcpi import minecraft
mc = minecraft.Minecraft.create()
```

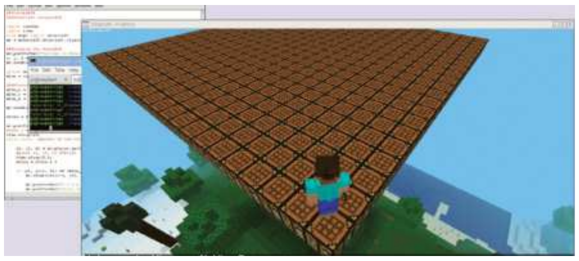
03 Grow some flowers

Using Python to manipulate *Minecraft* is easy; create the program below to test it is working. Each block has its own ID number, and flowers are 38. The x, y, z = mc.player.getPos() line gets the player's current position in the world and returns it as a set of coordinates: x, y, z. Now you know where you are standing in the world, blocks can be placed using mc.setBlock(x, y, z, flower). Save your program, open MC and create a new world.

```
flower = 38
while True:
 x, y, z = mc.player.getPos()
 mc.setBlock(x, y, z, flower)
 time.sleep(0.1)
```

04 Running the code

Reducing the size of the MC window will make it easier for you to see both the code and the program running; switching between both can be frustrating. The Tab key will release the keyboard and mouse from the MC window. Run the Python program and wait for it to load – as you walk around, you'll drop flowers! Change the ID number in line 1 to change the block type, so instead of flowers, try planting gold, water or even melons.



05 Posting a message to the Minecraft world

It is also possible to post messages to the *Minecraft* world. This is used later in the game to keep the player informed that the game has started and also of their current score. In your previous program add the following line of code under the flower = 38 line, making this line 2: mc.postToChat("I grew some flowers with code"). Now save and run the program by pressing F5 – you will see the message pop up. You can try changing your message, or move to the next step to start the game.

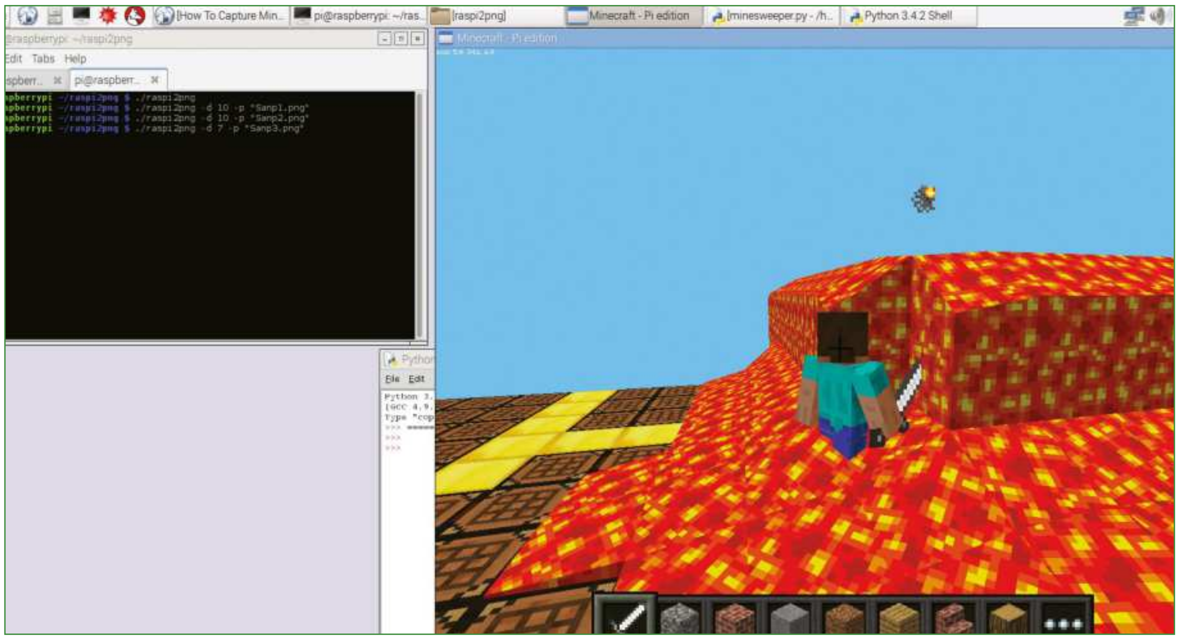
06 Create the board

The game takes place on a board created where the player is currently standing, so it is advisable to fly into the air or find a space with flat terrain before running your final program. To create the board you need to find the player's current location in the world using the code x, y, z = mc.player.getPos(). Then use the mc.setBlocks code in order to place the blocks which make up the board:

```
mc.setBlocks(x, y-1, z, x+20, y-1, z+20, 58).
```

The number 58 is the ID of the block that is a crafting table. You can increase or decrease the size of the board by changing the +20. In the code example above, the board size is 20 x 20 blocks, which gives you a 400-block arena to play within.

»



```
pberrypi ~/raspi2png $ ./raspi2png
pberrypi ~/raspi2png $ ./raspi2png -d 10 -p "Sanp1.png"
pberrypi ~/raspi2png $ ./raspi2png -d 10 -p "Sanp2.png"
pberrypi ~/raspi2png $ ./raspi2png -d 7 -p "Sanp3.png"
```

Right Nothing says "game over" quite like a huge eruption of lava

07 Creating the mine

In the previous step you found the player's location on the board. This x, y, z data can be reused to place the mine on the board. The code **mine = random.randrange(0, 11, 1)** generates a random number between 1 and 10. Combine this with the player's current x axis position and add the random number to the position – this creates a random mine block on the board.

```
mine_x = int(x+mine)
mine_y = int(y-1)
mine_z = int(z+mine)
```

Use setBlock to place the mine: **mc.setBlock(mine_x, mine_y, mine_z,58)**. Using **y-1** ensures that the block is placed on the same level as the board and is therefore hidden. The number 58 is the block ID, which you can change if you wish to see where the mine is; this is useful for testing that the rest of the code is working correctly. Remember to change it back before you play!

08 Create a score variable

Each second that you remain alive within the game, a point is added to your score. Create a variable to store the current score, setting it to a value of zero at the beginning of the game. Use the **postToChat** code to announce the score at the beginning of the game. Note that MC cannot print a value to chat, so the score is first converted into a string before it is displayed.

```
score = 0
mc.postToChat("Score is "+str(score))
time.sleep(10)
```

09 Check the player's position on the board

Next, you need to check the player's position on the board and see if they are standing on the mine. This uses a **while** loop to continually check that your player's position is safe, no mine, else game over. Since the player's coordinate position is used to build the original board and place the mine, you have to find the player's position again and store it as a new variable – x1, y1 and z1

```
while True:
  x1, y1, z1 = mc.player.getTilePos()
```

10 One point, please

Now that the player has moved one square they are awarded a point. This is a simple action of adding the value one to the existing score value. This is achieved using **score = score + 1**. Since it sits inside a loop, it will add one point each time the player moves.

```
time.sleep(0.1)
 score = score + 1
```

11 The tension increases…

Once you have been awarded the point, the next stage of the game is to check whether the block you are standing on is a safe block or if it is the mine. This uses a conditional to compare the coordinates of the block beneath you – x1, y1-1, z1 – with the mine_x, mine_y, mine_z position of the mine. If they are equal then you are standing on the mine. In the next step you will code the explosion:

```
if (x1, y1-1, z1) == (mine_x, mine_y, mine_z):
```

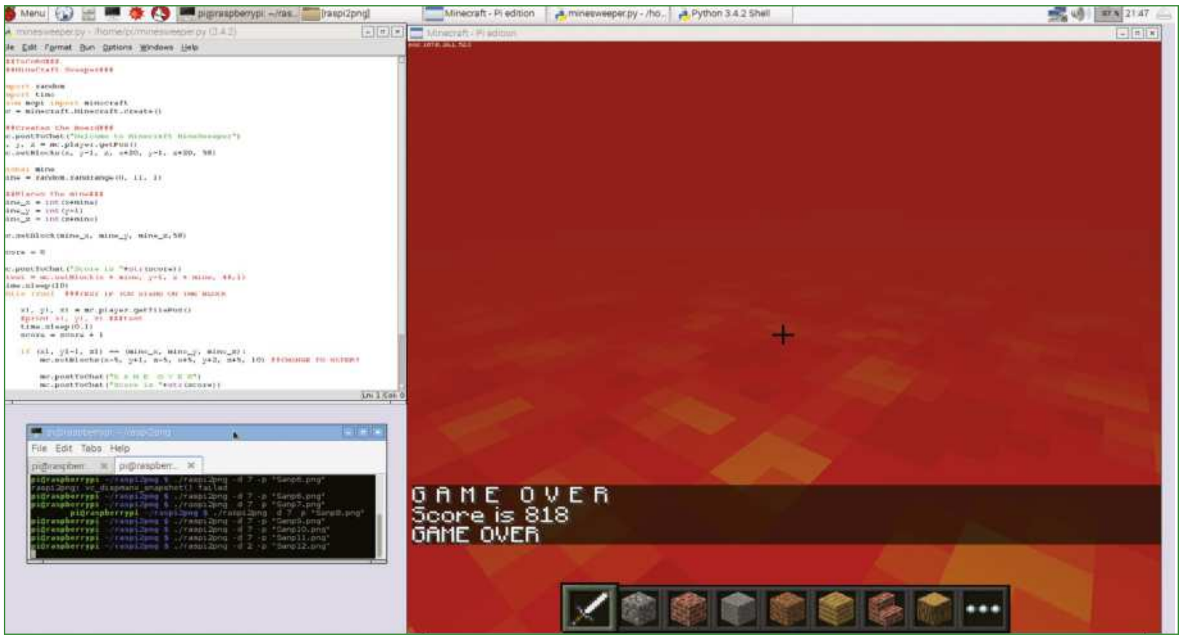
12 Setting the mine off

In the previous step a conditional checks whether you are standing on the mine or a safe block. If it is the mine then it will explode. To create this, use lava blocks, which will flow and engulf the player. You can use the **mc.setBlocks** code to set blocks between two points. Lava blocks are affected by gravity, so setting them higher than the player means that the lava flows down over the player.

```
mc.setBlocks(x-5, y+1, z-5, x+5, y+2, z+5, 10)
```

Other Minecraft hacks

If you enjoy programming and manipulating Minecraft then there are more great Raspberry Pi -based projects for you to check out. Our expert has a bunch of them at tecoed.co.uk/minecraft.html. The folks behind Adventures In Minecraft have some great guides over at stuffaboutcode.com/p/minecraft.html, as well.



```
G A M E  O V E R
Score is 818
GAME OVER
```

Left Once finished, our mini-game uses the chat console to report your score

13 Game over

If you do stand on the mine, the game is over. Use the post to chat code to display a “Game Over” message in the *Minecraft* World.

```
mc.postToChat(“G A M E  O V E R”)
```

14 Final score

The last part of the game is to give a score. This uses the score variable that you created in Step 8 and then uses the **mc.postToChat** code. Convert the score to a string first so that it can be printed on the screen. Since your turn has ended, add a break statement to end the loop and stop the code from running.

15 Safe block

But what if you missed the mine? The game continues and you'll need to know where you have previously been on the board. Use the code **mc.setBlock(x1, y1-1, z1, 41)** to change the block you are standing on into gold or another material of your choice. In the code, the Y positon is Y – 1, which selects the block beneath the player's feet.

16 Increment the score

As well as living to play another turn, you also gain a point. This is achieved by incrementing the score variable by one each time you turn the block gold and return to the beginning of the loop to check the status of the next block you step on. The **postToChat** is to tell you that you have survived another move!

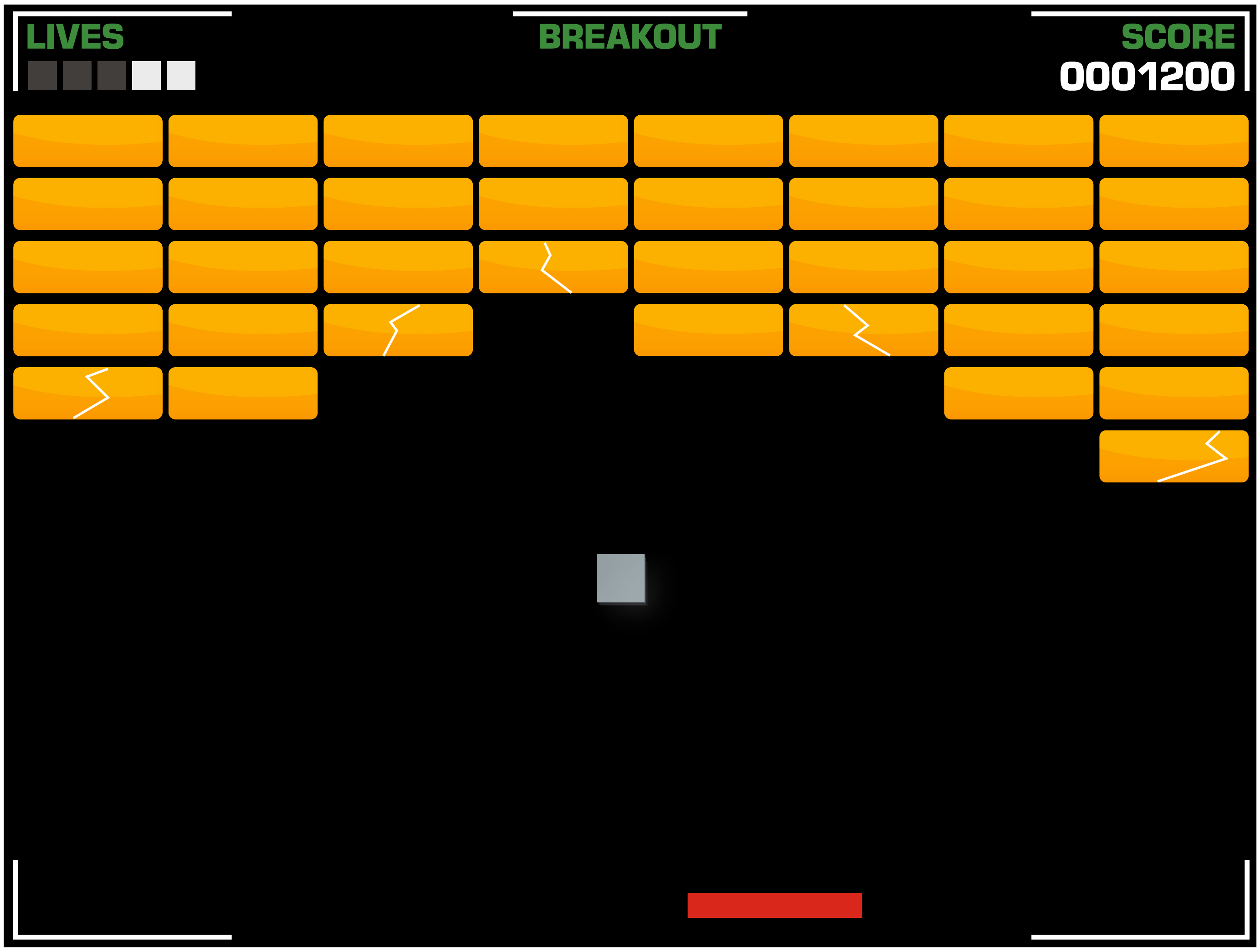
```
score = score + 1
mc.postToChat(“You are safe”)
```

17 Run the game

That completes the code for the program. Save it and then start a *Minecraft* game. Once the world has been created, run the Python program. Move back to the *Minecraft* window and you will see the board created in front of you.

Full code listing

```
import random
import time
from mcpi import minecraft
mc = minecraft.Minecraft.create()

###Creates the board###
mc.postToChat(“Welcome to Minecraft MineSweeper”)
x, y, z = mc.player.getPos()
mc.setBlocks(x, y-1, z, x+20, y-1, z+20, 58)

global mine
mine = random.randrange(0, 11, 1)

###Places the mine###
mine_x = int(x+mine)
mine_y = int(y-1)
mine_z = int(z+mine)
mc.setBlock(mine_x, mine_y, mine_z,58)
score = 0
mc.postToChat(“Score is “+str(score))

time.sleep(5)
while True: ###Test if you are standing on the mine

  x1, y1, z1 = mc.player.getTilePos()
  #print x1, y1, z1 ###test
  time.sleep(0.1)
  score = score + 1

  if (x1, y1-1, z1) == (mine_x, mine_y, mine_z):
    mc.setBlocks(x-5, y+1, z-5, x+5, y+2, z+5, 10)
    mc.postToChat(“G A M E O V E R”)
    mc.postToChat(“Score is ”+str(score))
    break
  else:
    mc.setBlock(x1, y1-1, z1, 41)
mc.postToChat(“GAME OVER”)
```



Pygame Zero

Pygame Zero cuts out the boilerplate to turn your ideas into games instantly, and we'll show you how

Resources

Pygame Zero:
pygame-zero.readthedocs.org

Pygame:
pygame.org/download.shtml

Pip
pip-installer.org

Python 3
www.python.org/

Code from FileSilo (optional)

Games are a great way of understanding a language: you have a goal to work towards, and each feature you add brings more fun. However, games need libraries and modules for graphics and other essential games features. While the Pygame library made it relatively easy to make games in Python, it still brings in boilerplate code that you need before you get started – barriers to you or your kids getting started in coding.

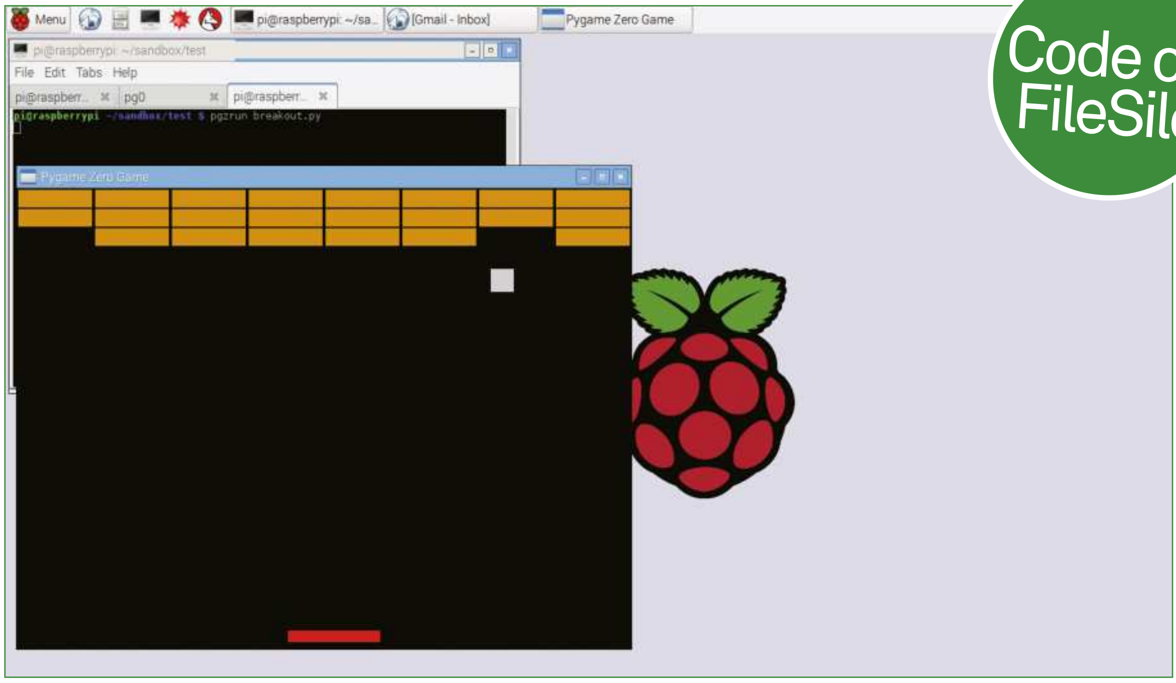
Pygame Zero deals with all of this boilerplate code for you, aiming to get you coding games instantly. Pg0 (as we'll abbreviate it) makes sensible assumptions about what you'll need for a game – from the size of the window to importing the game library – so that you can get straight down to coding your ideas.

Pg0's creator, Daniel Pope, told us that the library "grew out of talking to teachers at Pycon UK's education track, and trying to understand that they need to get immediate results and break lessons into bite-size fragments, in order to keep a whole class up to speed."

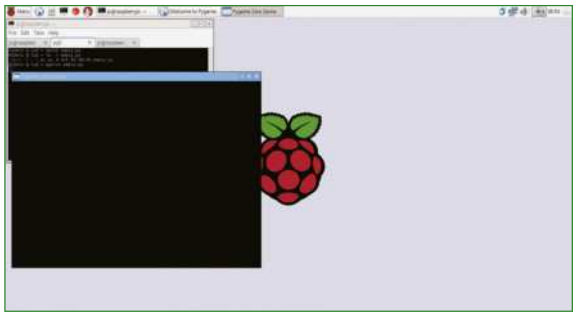
To give you an idea of what's involved here, we'll build up a simple game from a *Pong*-type bat and ball through to smashing blocks *Breakout*-style. The project will illustrate what can be done with very little effort. Pg0 is in early development but still offers a great start – and has been included on the Pi since the Raspbian Jessie image.

We'll look at installation on other platforms, but first let's see what magic it can perform.

Code on FileSilo



Right *Breakout* is a classic arcade game that can be reimagined in Pygame Zero



Young and old

In situations where Pygame is used boilerplate and all with young people, great results can also be achieved (see Bryson Payne's book), but Pygame and Pg0, despite their use as powerful educational tools, are also good for creating games for coders no matter what stage of learning they are at.

Great games are all about the gameplay, driven by powerful imaginations generating images, animations, sounds and journeys through game worlds. Good frameworks open up this creative activity to people who are not traditional learners of programming, which is an area where Python has long excelled.

01 Zero effort

Although game writing is not easy, getting started certainly is. If you've got Raspbian Jessie installed on your Pi, you're ready to go. Open a terminal and type:

```
touch example.py
pgzrun example.py
```

And you'll see an empty game window open (Ctrl+Q will close the window). Yes, it's that easy to get started!

02 Python 3

If you haven't got the latest Raspberry Pi OS chances are you'll have neither Pg0 nor Pygame installed. The Python's pip package installer will take care of grabbing Pg0 for you, but the preceding steps vary by distro. One thing you will need is Python 3.2 (or newer). If you've been sticking with Python 2.x in your coding (perhaps because it's used in a tutorial you're following), make Pg0 your chance for a gentle upgrade to Python 3.

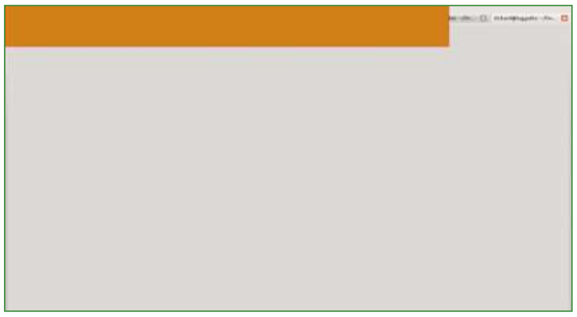
03 Older Raspbian

If you're still running Raspbian Wheezy, you'll need to run the following steps to install Pygame Zero:

```
sudo apt-get update
sudo apt-get install python3-setuptools python3-pip
sudo pip3 install pgzero
```

04 No Pi?

You don't even need a Raspberry Pi to install Pygame Zero – just install the Pygame library, then use pip to install Pygame Zero. Instructions vary by distro, but a good place to start is the documentation: **bit.ly/1GYznUB**.



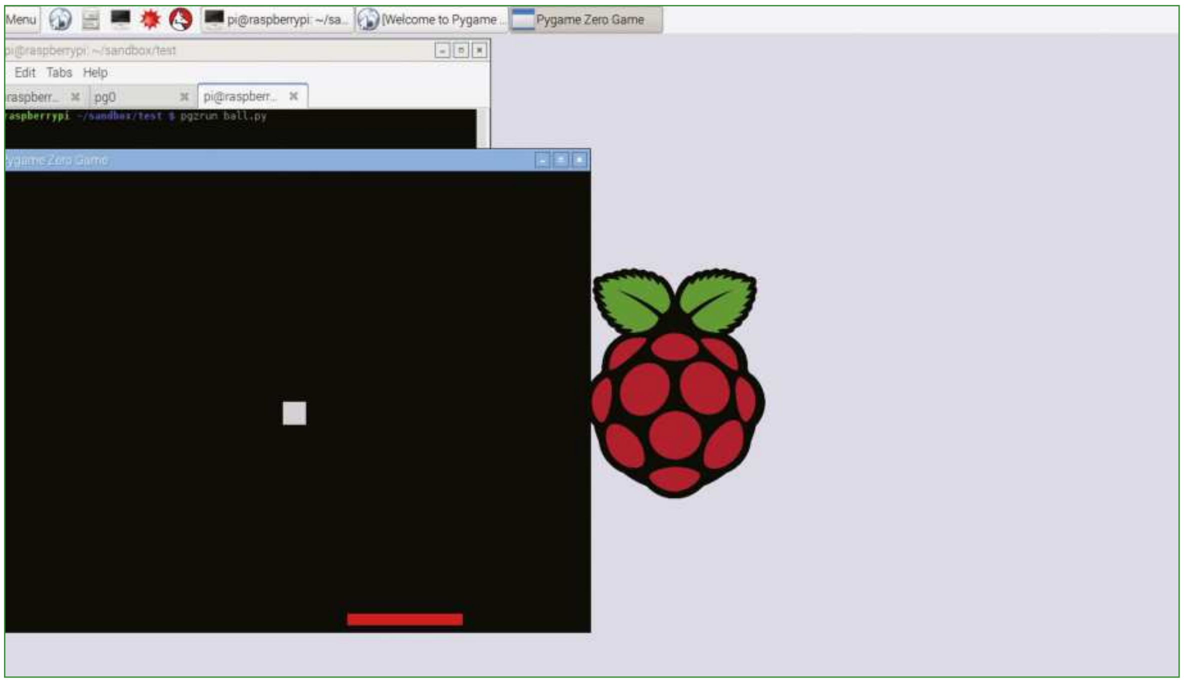
05 Intro.py

That default black square of 800 by 600 pixels we saw in Step 1 can now be overridden manually. For example, we can use the following code to replace it with an oversized gold brick, in a sly nod to *Breakout*:

```
WIDTH = 1000
HEIGHT = 100
def draw():
  screen.fill((205, 130, 0))
```

That colour tuple takes RGB values, so you can quickly get colours off a cheatsheet; **screen** is built into Pg0 for the window display, with methods available for all sorts of different sprites…

»



```
raspberrypi ~/sandbox/test $ pgzrun ball.py
```

Right The bat and ball come first – they're the cornerstones of *Pong* and *Breakout*

Program objects

David Ames, who uses Pg0 to teach younger children to code at events across the UK, told us: "One thing to avoid when it comes to teaching kids is Object Orientation." OOP (object-oriented programming) is partly abstracted away by Pg0, but it can't be ignored.

Perhaps the best approach is using Pg0 and some simple code to start, then dropping in a piece of OO when it's needed to solve a particular problem.

With the Code Club age group – about eight to eleven – feeding information to solve practical problems works well. It can work with adults, too – but there's always someone who's read ahead and has a few tricky questions.

```
89, in main
  File "/usr/local/lib/python3.4/dist-packages/pgzero/game.py", line 192, in run
    self.load_handlers()
  File "/usr/local/lib/python3.4/dist-packages/pgzero/game.py", line 87, in load_handlers
    spellcheck(vars(self.mod))
  File "/usr/local/lib/python3.4/dist-packages/pgzero/spellcheck.py", line 176, in spellcheck
    param, None
  File "/usr/local/lib/python3.4/dist-packages/pgzero/spellcheck.py", line 122, in error
    suggestion=suggestion
pgzero.spellcheck.InvalidParameter: on_key_down() hook accepts no parameter a
richard@luggable:~/Documents/code/python/pg0/lud/breakout$ pgzrun total2.py
richard@luggable:~/Documents/code/python/pg0/lud/breakout$ cp move.py bounce.py
richard@luggable:~/Documents/code/python/pg0/lud/breakout$ nano bounce.py
richard@luggable:~/Documents/code/python/pg0/lud/breakout$ pgzrun bounce.py
Loser!
Traceback (most recent call last):
```

06 Sprite

The intro example from the Pg0 docs expands on that with the **Actor** class, which will automatically load the named sprite (Pg0 will hunt around for a .jpg or .png in a subdirectory called images).

```
alien = Actor('alien')
alien.pos = 100, 56
WIDTH = 500
HEIGHT = alien.height + 20
def draw():
   screen.clear()
   alien.draw()
```

You can download the alien from the Pg0 documentation (**bit.ly/1Sm5lM7**) and try out the animation shown there, but we're taking a different approach in our game.

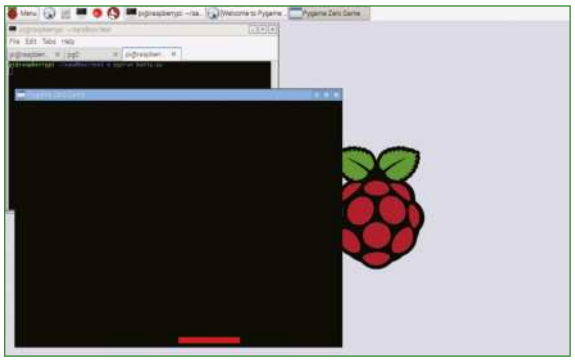
07 Breakout via Pong

While the Pi is something of a tribute to 1980s 8-bit computers, *Breakout* comes from the 1970s and is a direct descendant of the early arcade classic *Pong*. We'll follow the route from *Pong* to *Breakout* (which historically involved Apple founders Steve Wozniak and Steve Jobs) in the steps to creating our code, leaving you with the option of developing the *Pong* elements into a proper game, as well as refining the finished *Breakout* clone.

08 Batty

You can think of *Breakout* as essentially being a moving bat – that is, you're hitting a moving ball in order to knock out blocks. The bat is a rectangle, and Pygame's **Rect** objects store and manipulate rectangular areas – we use **Rect((left, top), (width, height))**, before which we define the bat colour and then call upon the **draw** function to put the bat on the screen, using the **screen** function.

```
W = 800
H = 600
RED = 200, 0, 0
bat = Rect((W/2, 0.96 * H), (150, 15))
def draw():
   screen.clear()
   screen.draw.filled_rect(bat, RED)
```



09 Mouse move

We want to move the bat, and the mouse is closer to an arcade paddle than the arrow keys. Add the following:

```
def on_mouse_move(pos):
   x, y = pos
   bat.center = (x, bat.center[1])
```

Use **pgzrun** to test that you have a screen, bat and movement.

“To get the ball to move we need to define move(ball) for each case where the ball meets a wall”

Full code listing

```
## Breakout type game to demonstrate Pygame Zero library
## Based originally upon Tim Viner’s London Python Dojo
## demonstration
## Licensed under MIT License - see file COPYING

from collections import namedtuple
import pygame
import sys
import time

W = 804
H = 600
RED = 200, 0, 0
WHITE = 200,200,200
GOLD = 205,145,0

ball = Rect((W/2, H/2), (30, 30))
Direction = namedtuple(‘Direction’, ‘x y’)
ball_dir = Direction(5, -5)

bat = Rect((W/2, 0.96 * H), (120, 15))

class Block(Rect):

    def __init__(self, colour, rect):
        Rect.__init__(self, rect)
        self.colour = colour

blocks = []
for n_block in range(24):
    block = Block(GOLD, ((((n_block % 8)* 100) + 2, ((n_block //
            8) * 25) + 2), (96, 23)))
    blocks.append(block)

def draw_blocks():
    for block in blocks:
        screen.draw.filled_rect(block, block.colour)

def draw():
    screen.clear()
    screen.draw.filled_rect(ball, WHITE)
    screen.draw.filled_rect(bat, RED)
    draw_blocks()

def on_mouse_move(pos):
    x, y = pos
    bat.center = (x, bat.center[1])

def on_mouse_down():
    global ball_dir
    ball_dir = Direction(ball_dir.x * 1.5, ball_dir.y * 1.5)
```

10 Square ball

In properly retro graphics-style, we define a square ball too – another rectangle, essentially, with the (30, 30) size making it that subset of rectangles that we call a square.

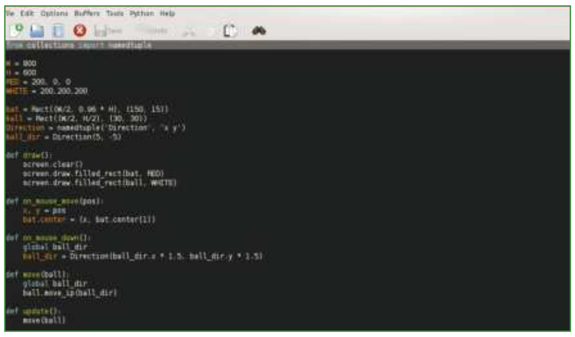
We’re doing this because **Rect** is another built-in in Pg0. If we wanted a circular ball, we’d have to define a class and then use Pygame’s **draw.filled_circle(pos, radius, (r, g, b))** - but **Rect** we can call directly. Simply add:

```
WHITE = 200,200,200
ball = Rect((W/2, H/2), (30, 30))
```

... to the initial variable assignments, and:

```
    screen.draw.filled_rect(ball, WHITE)
```

... to the **def draw()** block.



```
from collections import namedtuple

W = 800
H = 600
RED = 200, 0, 0
WHITE = 200,200,200

bat = Rect((W/2, 0.96 * H), (150, 15))
ball = Rect((W/2, H/2), (30, 30))
Direction = namedtuple('Direction', 'x y')
ball_dir = Direction(5, -5)

def draw():
    screen.clear()
    screen.draw.filled_rect(bat, RED)
    screen.draw.filled_rect(ball, WHITE)

def on_mouse_move(pos):
    x, y = pos
    bat.center = (x, bat.center[1])

def on_mouse_down():
    global ball_dir
    ball_dir = Direction(ball_dir.x * 1.5, ball_dir.y * 1.5)

def move(ball):
    global ball_dir
    ball.move_ip(ball_dir)

def update():
    move(ball)
```

11 Action!

Now let’s make the ball move. Download the tutorial resources in **FileSilo.co.uk** and then add the code inside the ‘move.py’ file to assign movement and velocity. Change the **5** in **ball_dir = Direction(5, -5)** if you want the ball slower or faster, as your processor (and dexterity) demands – but it’s hard to tell now because the ball goes straight off the screen! Pg0 will call the **update()** function you define once per frame, giving the illusion of smooth(ish) scrolling if you’re not running much else.

12 def move(ball)

To get the ball to move within the screen we need to define **move(ball)** for each case where the ball meets a wall. For this we use **if** statements to reverse the ball’s direction at each of the boundaries.

Note the hardcoded value of 781 for the width of screen, minus the width of ball – it’s okay to hardcode values in early versions of code, but it’s the kind of thing that will need changing if your project expands. For example, a resizable screen would need a value of **W - 30**.

13 Absolute values

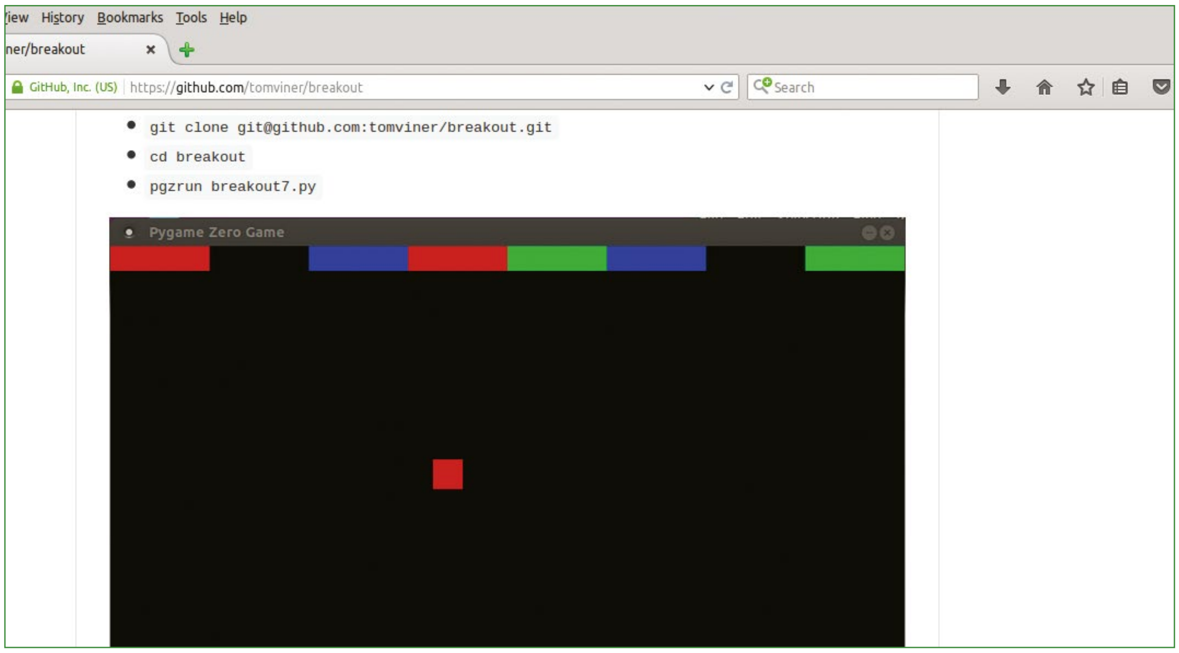
You might expect multiplying y by minus one to work for reversing the direction of the ball when it hits the bat:

```
ball_dir = Direction(ball_dir.x, -1 * ball_dir.y)
```

... but you actually need to use **abs**, which removes any minus signs, then minus:

```
ball_dir = Direction(ball_dir.x, - abs(ball_dir.y))
```

Try it without the finished code and see if you get some strange behaviour. Your homework is to work out why.


iew History Bookmarks Tools Help
ner/breakout
GitHub, Inc. (US) https://github.com/tomviner/breakout
Search
Pygame Zero Game

```
git clone git@github.com:tomviner/breakout.git
cd breakout
pgzrun breakout7.py
```

Right Tom Viner's array of blocks negates the need for bordered rectangles

Pg0 +1

There's a new version of Pg0 in development – it may even be out as you read this. Pg0 creator Daniel Pope tells us "a tone generation API is in the works," and that at the Pg0 PyConUK sprint, "we finished Actor rotation."

Contributions are welcome – not only to the Pg0 code, but more examples are needed not just to show what can be done, but to give teachers tools to enthuse children about the creative act of programming.

Pg0 has also inspired GPIO Zero, to make GPIO programming easier on the Raspberry Pi, with rapid development occurring on this new library as we go to press.

14 Sounds

Also upon bat collision, **sounds.blip.play()** looks in the sounds subdirectory for a sound file called blip. You can download the sounds (and finished code) from **FileSilo.co.uk**.

Actually, now we think about it, ignore the previous comment about homework – your real homework is to turn what we've written so far into a proper game of *Pong*! But first let's finish turning it into *Breakout*!

15 Blockhead!

If you're not very familiar with the ancient computer game *Breakout*, then:

```
apt-get install lbreakout2
```

... and have a play. Now, we haven't set our sights on building something quite so ambitious in just these six pages, but we do need blocks.

16 Building blocks

There are many ways of defining blocks and distributing them onto the screen. In Tom Viner's team's version, from the London Python Dojo – which was the code that originally inspired this author to give this a go – the blocks are sized in relation to number across the screen, thus:

```
N_BLOCKS = 8
BLOCK_W = W / N_BLOCKS
BLOCK_H = BLOCK_W / 4
BLOCK_COLOURS = RED, GREEN, BLUE
```

Using multicoloured blocks which are then built into an array means that blocks can join without needing a border. With its defining variables in terms of screen width, it's good sustainable code, which will be easy to amend for different screen sizes – see **github.com/tomviner/breakout**.

However, the array of colour bricks in a single row is not enough for a full game screen, so we're going to build our array from hard-coded values...

17 Going for gold

Create a Block class:

```
class Block(Rect):
  def __init__(self, colour, rect):
      Rect.__init__(self, rect)
      self.colour = colour
```

... and pick a nice colour for your blocks:

```
GOLD = 205,145,0
```

18 Line up the blocks

This builds an array of 24 blocks, three rows of eight:

```
blocks = []
for n_block in range(24):
   block = Block(GOLD, ((((n_block % 8)* 100) + 2,
      ((n_block // 8) * 25) + 2), (96, 23)))
   blocks.append(block)
```

19 Drawing blocks

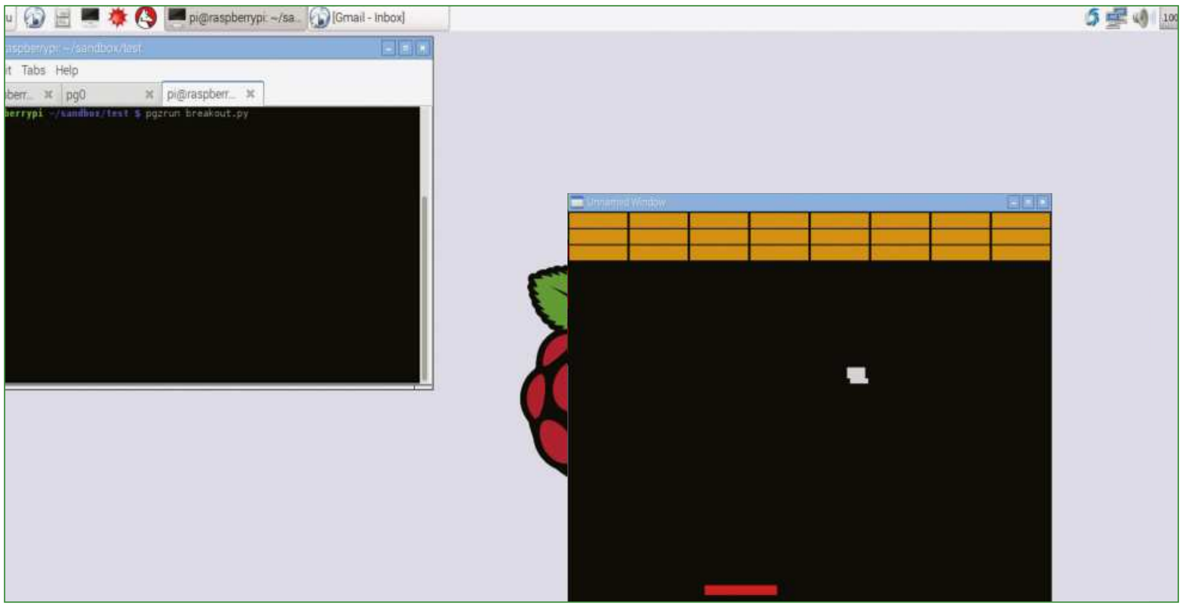
Draw_blocks() is added to **def draw()** after defining:

```
def draw_blocks():
   for block in blocks:
      screen.draw.filled_rect(block, block.colour)
```

20 Block bashing

All that remains with the blocks is to expand **def move(ball)** – to destroy a block when the ball hits it.

```
to_kill = ball.collidelist(blocks)
if to_kill >= 0:
   sounds.block.play()
   ball_dir = Direction(ball_dir.x, abs(ball_dir.y))
   blocks.pop(to_kill)
```



```
errypi ~/sandbox/test $ pgzrun breakout.py
```

Left Test your game once it's finished – then test other people's *Breakout* games to see how the code differs

Full code listing (cont.)

```
def move(ball):
    global ball_dir
    ball.move_ip(ball_dir)

    if ball.x > 781 or ball.x <= 0:
        ball_dir = Direction(-1 * ball_dir.x, ball_dir.y)
    if ball.y <= 0:
        ball_dir = Direction(ball_dir.x, abs(ball_dir.y))
    if ball.colliderect(bat):
        sounds.blip.play()
        ball_dir = Direction(ball_dir.x, - abs(ball_dir.y))

    to_kill = ball.collidelist(blocks)
    if to_kill >= 0:
        sounds.block.play()
        ball_dir = Direction(ball_dir.x, abs(ball_dir.y))
        blocks.pop(to_kill)

    if not blocks:
        sounds.win.play()
        sounds.win.play()
        print("Winner!")
        time.sleep(1)
        sys.exit()

    if ball.y > H:
        sounds.die.play()
        print("Loser!")
        time.sleep(1)
        sys.exit()

def update():
    move(ball)
```

21 Game over

Lastly, we need to allow for the possibility of successfully destroying all blocks.

```
if not blocks:
    sounds.win.play()
    sounds.win.play()
    print("Winner!")
    time.sleep(1)
    sys.exit()
```

22 Score draw

Taking advantage of some of Pygame Zero's quickstart features, we've a working game in around 60 lines of code. From here, there's more Pg0 to explore, but a look into Pygame unmediated by the Pg0 wrapper is your next step but one.

First refactor the code; there's plenty of room for improvement – see the example 'breakout-refactored.py' which is included in your tutorial resources. Try adding scoring, the most significant absence in the game. You could try using a global variable and writing the score to the terminal with **print()**, or instead use **screen.blit** to put it on the game screen. Future versions of Pg0 might do more for easy score keeping.

23 Class of nine lives

For adding lives, more layers, and an easier life-keeping score, you may be better defining the class **GameClass** and enclosing much of the changes you wish to persist within it, such as **self.score** and **self.level**. You'll find a lot of Pygame code online doing this, but you can also find Pg0 examples, such as the excellent pi_lander example by Tim Martin: **github.com/timboe/pi_lander**.

24 Don't stop here

This piece is aimed at beginners, so don't expect to understand everything! Change the code and see what works, borrow code from elsewhere to add in, and read even more code. Keep doing that, then try a project of your own – and let us know how you get on.

Web development

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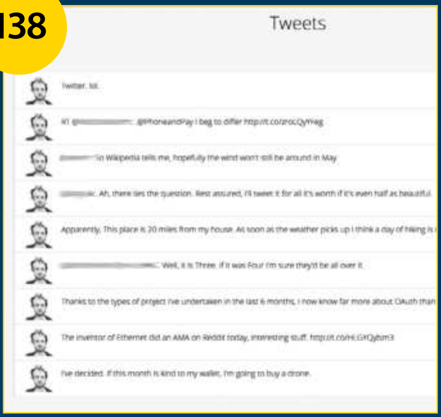

Tweets

Twitter, lol.

RT [redacted] @iPhoneandPay I beg to differ http://t.co/zrocQyYreg

[redacted] So Wikipedia tells me, hopefully the wind won't still be around in May

[redacted] Ah, there lies the question. Rest assured, I'll tweet it for all it's worth if it's even half as beautiful

Apparently, This place is 20 miles from my house. As soon as the weather picks up I think a day of hiking is

[redacted] Well, it is Three. If it was Four I'm sure they'd be all over it.

Thanks to the types of project I've undertaken in the last 6 months, I now know far more about OAuth than

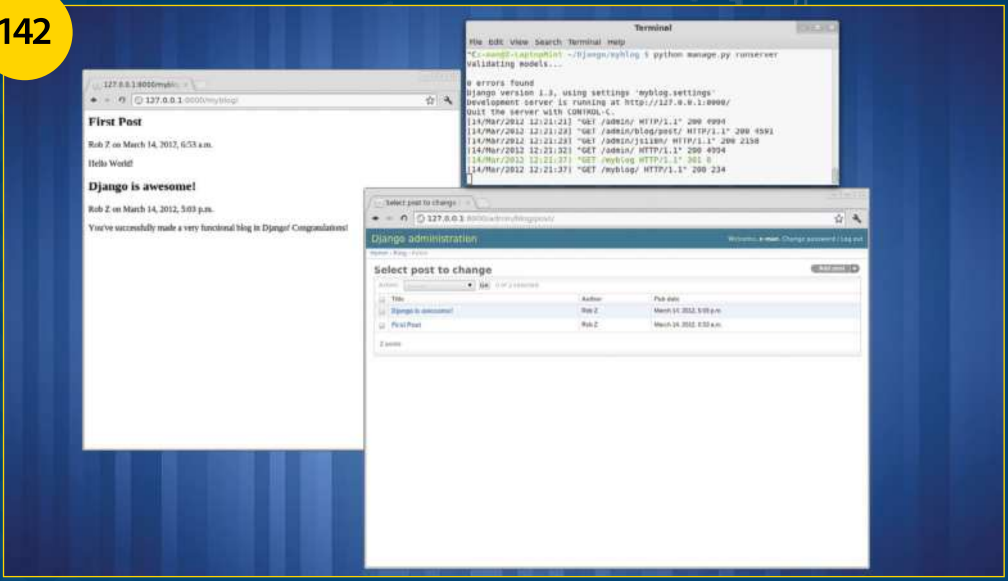
The inventor of Ethernet did an AMA on Reddit today, interesting stuff. http://t.co/HLGYQybm3

I've decided. If this month is kind to my wallet, I'm going to buy a drone.

132

“Python is a versatile language, perfect for making websites”

142


127.0.0.1:8000/myblog/

First Post

Rob Z on March 14, 2012, 6:53 a.m.

Hello World!

Django is awesome!

Rob Z on March 14, 2012, 5:03 p.m.

You've successfully made a very functional blog in Django! Congratulations!

Terminal

```
~C:-mang0-laptopMint ~/Django/myblog $ python manage.py runserver
Validating models...

0 errors found
Django version 1.3, using settings 'myblog.settings'
Development server is running at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
[14/Mar/2012 12:21:21] "GET /admin/ HTTP/1.1" 200 4994
[14/Mar/2012 12:21:23] "GET /admin/blog/post/ HTTP/1.1" 200 4591
[14/Mar/2012 12:21:23] "GET /admin/jsi18n/ HTTP/1.1" 200 2158
[14/Mar/2012 12:21:32] "GET /admin/ HTTP/1.1" 200 4934
[14/Mar/2012 12:21:37] "GET /myblog HTTP/1.1" 301 0
[14/Mar/2012 12:21:37] "GET /myblog/ HTTP/1.1" 200 234
```

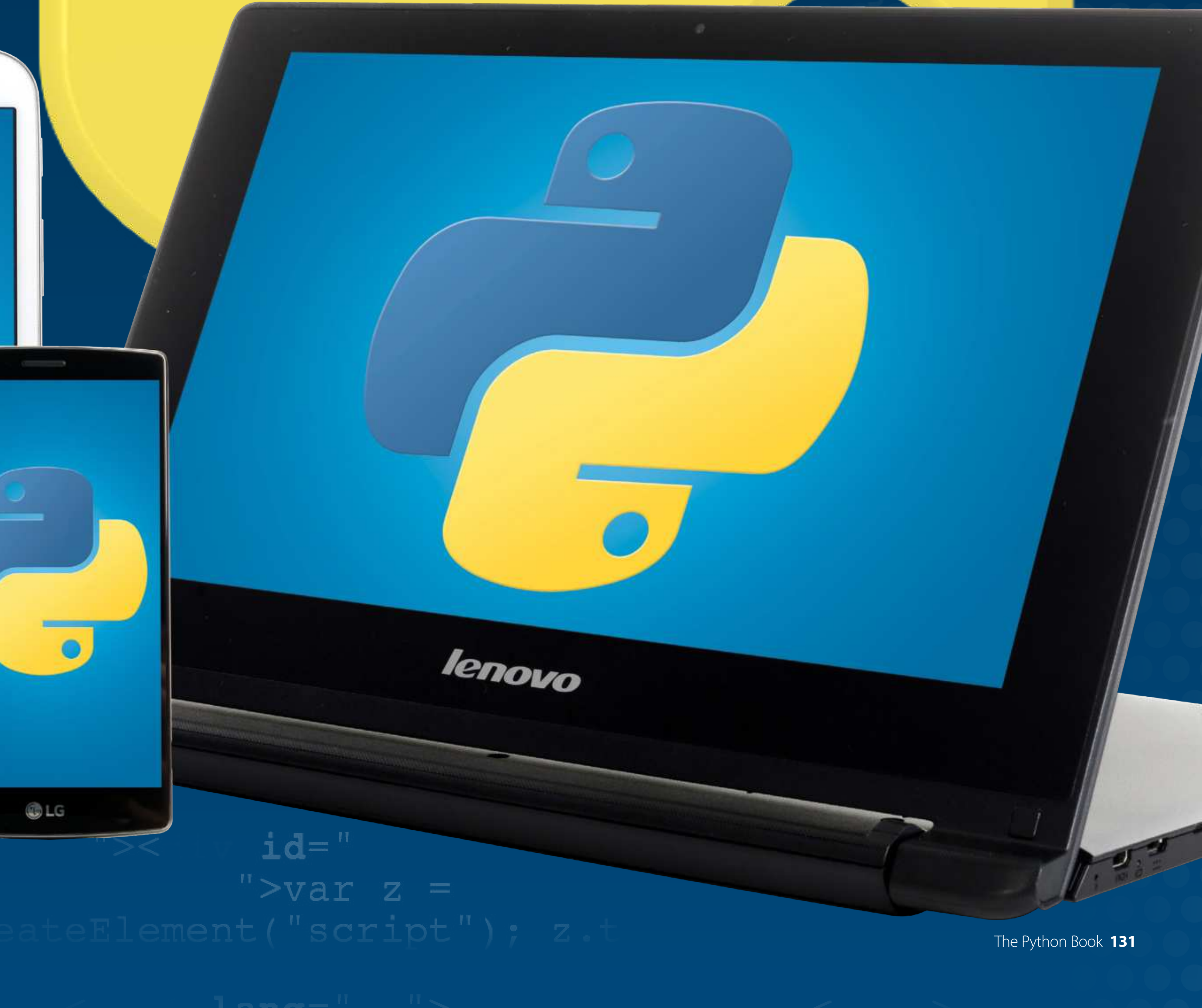
Select post to change — 127.0.0.1:8000/admin/blog/post/

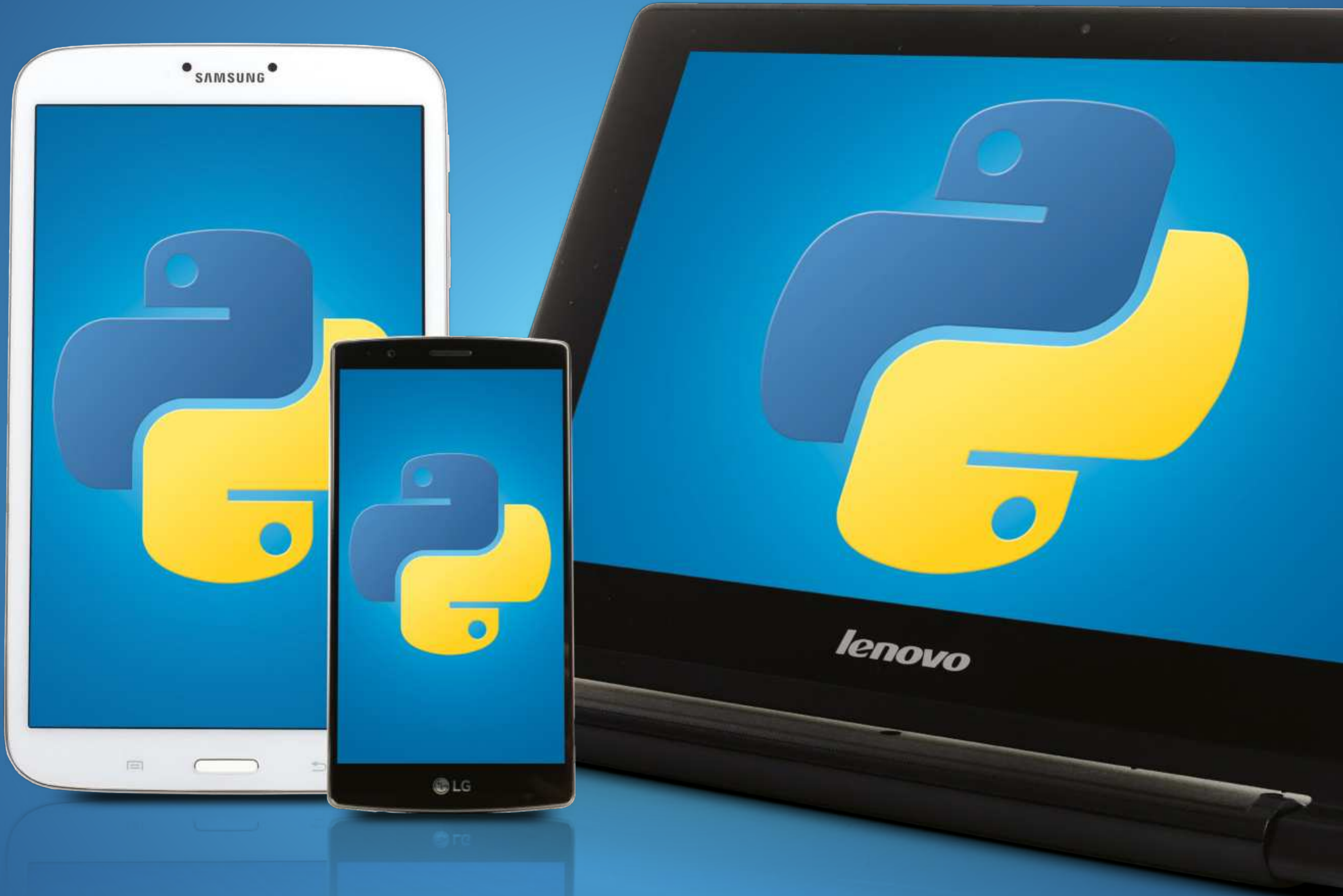
Django administration

Select post to change

Title	Author	Pub date
Django is awesome!	Rob Z	March 14, 2012, 5:03 p.m.
First Post	Rob Z	March 14, 2012, 6:53 a.m.

2 posts





DEVELOP WITH PYTHON

Don't be fooled into thinking Python is a restrictive language or incompatible with the modern web. Explore options for building Python web apps and experience rapid application development

Why?

First released in 1991, companies like Google and NASA have been using Python for years

Thanks to the introduction of the Web Server Gateway Interface (WSGI) in 2003, developing Python web apps for general web servers became a viable solution as opposed to restricting them to custom solutions.

Python executables and installers are widely available from the official Python site at **www.python.org**.

Mac OS X users can also benefit greatly from using Homebrew to install and manage their Python versions. Whilst OS X comes bundled with a version of Python, it has some potential drawbacks. Updating your OS may clear out any downloaded packages, and Apple's implementation of the library differs greatly from the official release. Installing using Homebrew helps you to keep up to date and also means you get the Python package manager pip included.

Once Python is installed the first package to download should be virtualenv using 'pip install virtualenv', which enables you to create project-specific shell environments. You can run projects on separate versions of Python with separate project-specific packages installed.

Check out the detailed Hitchhiker's Guide to Python for more information: **docs.python-guide.org/en/latest**.

Frameworks

Let's take a look at some of the frameworks available when developing Python web applications

Django djangoproject.com

GOOD FOR: Large database-driven web apps with multiuser support and sites that need to have heavily customisable admin interfaces

Django contains a lot of impressive features, all in the name of interfaces and modules. These include autowiring, admin interfaces and database migration management tools by default for all of your projects and applications. Django will help to enable rapid application development for enterprise-level projects, whilst also enabling a clear modular reuseable approach to code using subapplications.

Tornado tornadoweb.org

GOOD FOR: Web socket interaction and long polling due to its ability to scale to manage vast numbers of connections

Tornado is a networking library that works as a nonblocking web server and web application framework. It's known for its high performance and scalability and was initially developed for friendfeed, which was a real-time chat system that aggregated several social media sites. It closed down in April 2015 as its user numbers had declined steadily, but Tornado remains as active and useful as ever.

Flask flask.pocoo.org

GOOD FOR: Creating full-featured RESTful APIs. Its ability to manage multiple routes and methods is very impressive

Flask's aim is to provide a set of commonly used components such as URL routing and templates. Flask will also work on controlling the request and response objects, all-in-all this means it is lightweight but is still a powerful microframework.

PyramiD pylonsproject.org

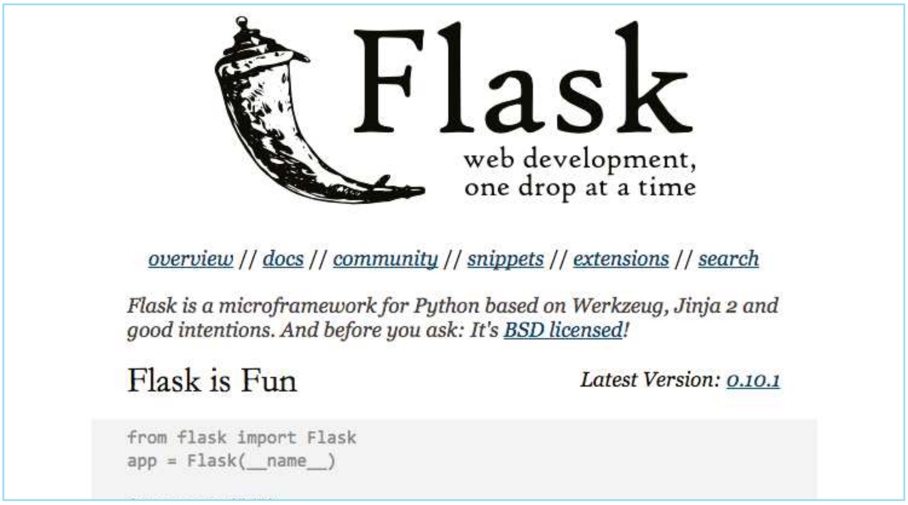
GOOD FOR: Highly extensible and adaptable to any project requirement. Not a lightweight system either

Heavily focused on documentation, Pyramid brings all the much needed basic support for most regular tasks. Pyramid is open source and also provides a great deal of extensibility – it comes with the powerful Werkzeug Debugger too.

Werkzeug werkzeug.pocoo.org

GOOD FOR: API creation, interacting with databases and following strict URL routes whilst managing HTTP utilitie

Werkzeug is the underlying framework for Flask and other Python frameworks. It provides a unique set of tools that will enable you to perform URL routing processes as well as request and response objects, and it also includes a powerful debugger.


Flask
web development,
one drop at a time
overview // docs // community // snippets // extensions // search

Flask is a microframework for Python based on Werkzeug, Jinja 2 and good intentions. And before you ask: It's BSD licensed!

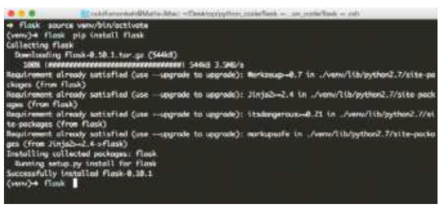
Flask is Fun

Latest Version: 0.10.1

```
from flask import Flask
app = Flask(__name__)
```

Create an API

Let us explore the Flask microframework and build a simple yet powerful RESTful API with minimal code



```
→ flask  source venv/bin/activate
(venv)→ flask  pip install flask
Collecting flask
  Downloading Flask-0.10.1.tar.gz (544kB)
    100% |████████████████████████████████| 544kB 3.5MB/s
Requirement already satisfied (use --upgrade to upgrade): Werkzeug>=0.7 in ./venv/lib/python2.7/site-pa
ckages (from flask)
Requirement already satisfied (use --upgrade to upgrade): Jinja2>=2.4 in ./venv/lib/python2.7/site-pack
ages (from flask)
Requirement already satisfied (use --upgrade to upgrade): itsdangerous>=0.21 in ./venv/lib/python2.7/si
te-packages (from flask)
Requirement already satisfied (use --upgrade to upgrade): markupsafe in ./venv/lib/python2.7/site-packa
ges (from Jinja2>=2.4->flask)
Installing collected packages: flask
  Running setup.py install for flask
Successfully installed flask-0.10.1
(venv)→ flask
```

01 Install Flask

Create a new directory inside of which your project will live. Open a Terminal window and navigate to be inside your new directory. Create a new virtual environment for this project, placed inside a new directory called 'venv', and activate it. Once inside the new virtual shell, proceed to installing Flask using the 'pip install Flask' command.

```
virtualenv venv
. venv/bin/activate
pip install Flask
```

02 Create Index

Create a new file in the root of the project location called 'index.py'. The sample API will use a SQLite database, so we need to import that module for use in the application. We'll also import some core components from the Flask module to handle request management and response formatting as well as some other functions. The minimum import for a Flask application is Flask itself.

```
import sqlite3
from flask import Flask, request, g,
redirect, url_for, render_template,
abort, jsonify
```

03 Declare Config

For a small application we can declare configuration options as upper-case name value pairs inside the main module, which we'll do now. Here we can define the path and name of the SQLite database and also set the Flask debug output to True for development work. Initialise the Flask application to a namespace and then import the config values set directly above it. We then run the application. All routes must be placed above these last two lines.

```
# Config
DATABASE = '/tmp/api.db'
DEBUG = True
app = Flask(__name__)
app.config.from_object(__name__)
# Add methods and routes here
if __name__ == '__main__':
app.run()
```

04 Connect to Database

With the database path defined, we need a way to create connection to the database for the application to obtain data. Create a new method called 'connet_db' to manage this for us. As a method we can call it when we set up a prerequest hook shortly. This will return a new open connection using the database details set in the configuration object.

```
def connect_db():
return sqlite3.connect(app.
config['DATABASE'])
```

05 Database Schema

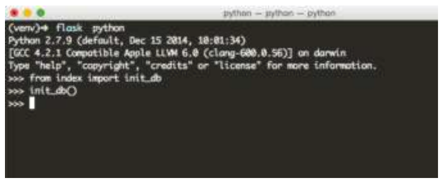
Our SQLite database will only contain one table. Create a new file called 'schema.sql' in the root of the project directory. This fill will contain the SQL commands required to create the table and populate it with some sample bootstrapped data.

```
drop table if exists posts;
create table posts (
    id integer primary key autoincrement,
    title text not null,
    text text not null
);
insert into posts (title, text) values
('First Entry', 'This is some text');
insert into posts (title, text) values
('Second Entry', 'This is some more text');

insert into posts (title, text) values
('Third Entry', 'This is some more text
(again)');
```

06 Instantiate the Database

To populate the database with the new table and any associated data, we will need to import and apply the schema to the database. Add a new module import at the top of the project file to obtain the 'contextlib.closing()' method. What we will do next is create a method that will initialise the database by reading the contents of schema.sql and executing it against the open database.

```
from contextlib import closing
def init_db():
  with closing(connect_db()) as db:
    with app.open_resource('schema.sql',
mode='r') as f:
      db.cursor().executescript(f.read())
    db.commit()
```



```
(venv)→ flask  python
Python 2.7.9 (default, Dec 15 2014, 10:01:34)
[GCC 4.2.1 Compatible Apple LLVM 6.0 (clang-600.0.56)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> from index import init_db
>>> init_db()
>>>
```

07 Populate the Database

To populate the database you can now run the init_db inside an active python shell. To do so enter a shell by typing 'python' inside your environment, and then running the command below. Alternatively, you can use the sqlite3 command and pipe the schema.sql file into the database.

```
# Importing the database using the
init_db method
python
>>> from index import init_db
>>> init_db()
# Piping the schema using SQLite3
sqlite3 /tmp/api.db < schema.sql
```

08 Request DB Connection

With the database created and populated we need to be able to ensure we have an open connection and close it accordingly when finished. Flask has some decorator methods to help us achieve this. The before_request() method will establish the connection and stores it in the g object for use throughout the request cycle. We can then close the connection after the cycle using the teardown_request() method.

```
@app.before_request
def before_request():
  g.db = connect_db();
```

“World-renowned image-sharing service Instagram and social pinboard Pinterest have implemented Python as part of their web stack, opting for Django”

```
@app.teardown_request
def teardown_request(exception):
  db = getattr(g, 'db', None)
  if db is not None:
    db.close()
```

09 Display Posts

Create your first route so that we can return and display all available posts. To query the database we execute a SQL statement against the stored db connection. The results are then mapped to values using Python's dict method and saved as the posts variable. To render a template we then call render_template() and pass in the file name and the variable to display as the second argument. Multiple variables can be passed through as a comma-separated list.

```
@app.route('/')
def get_posts():
  cur = g.db.execute('select title, text
from posts order by id desc')
  posts = [dict(title=row[0], text=row[1])
for row in cur.fetchall()]
  return render_template('show_posts.
html', posts=posts)
```

10 Template Output

Flask expects templates to be available within the templates directory in the root of the project, so make sure that you create that directory now. Next, add a new file called 'show_posts.html'. The dynamic values are managed using Jinja2 template syntax, the default templating engine for Flask applications. Save this file in the templates directory.

```
<ul class=posts>
  {% for post in posts %}
  <li><h2>{{ post.title }}</h2>{{ post.
text|safe }}
  {% else %}
  <li>Sorry, no post matches your
request.
  {% endfor %}
</ul>
```

11 Make an API Response

To create an API response we can define a new route with a specific API endpoint. Once again, we query the database for all posts. The data is then returned as JSON, using the JSONify method to do so. We can add specific values such as post count and a custom message if you wish, as well as the actual posts variable, formatted as JSON.

```
@app.route('/api/v1/posts/',
methods=['GET'])
def show_entries():
  cur = g.db.execute('select title, text
from posts order by id desc')
  posts = [dict(title=row[0],
text=row[1]) for row in ur.fetchall()]
  return jsonify({'count': len(posts),
'posts': posts})
```

12 Get a specific Post

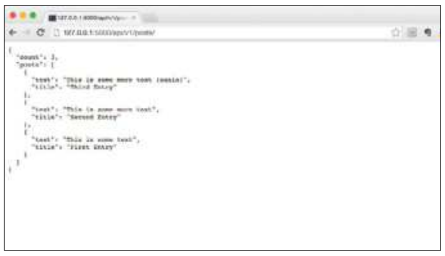
To obtain a specific post from the API we need to create a new route, which will accept a dynamic value as part of the URI. We can also choose to use this route for multiple request methods, which are in this case GET and DELETE. We can determine the method by checking the request.method value and run it against a conditional if/else statement.

```
@app.route('/api/v1/posts/<int:post_id>',
methods=['GET', 'DELETE'])
def single_post(post_id):
  method = request.method
  if method == 'GET':
    cur = g.db.execute('select title,
text from posts where id =?', [post_id])
  posts = [dict(title=row[0],
text=row[1]) for row in cur.fetchall()]
    return jsonify({'count': len(posts),
'posts': posts})
  elif method == 'DELETE':
    g.db.execute('delete from posts
where id = ?', [post_id])
    return jsonify({'status': 'Post
deleted'})
```

13 Run the application

To run your Flask application, navigate using the active Terminal window into the root of the project. Ensuring you are in an active virtual environment Python shell, enter the command to run the main index file. The built-in server will start and the site will be accessible in the browser on default port local address http://127.0.0.1:5000.

```
python index.py
```



```
{
  "count": 3,
  "posts": [
    {
      "text": "This is some more text (again)",
      "title": "Third Entry"
    },
    {
      "text": "This is some more text",
      "title": "Second Entry"
    },
    {
      "text": "This is some text",
      "title": "First Entry"
    }
  ]
}
```

14 API JSON Output

The root of the application will render the template we previously created. Multiple routes can be generated to create a rich web application. Visiting an API-specific URL in the browser will return the requested data as cleanly formatted JSON. The ability to define custom routes like a versioned RESTful endpoint is incredibly powerful.

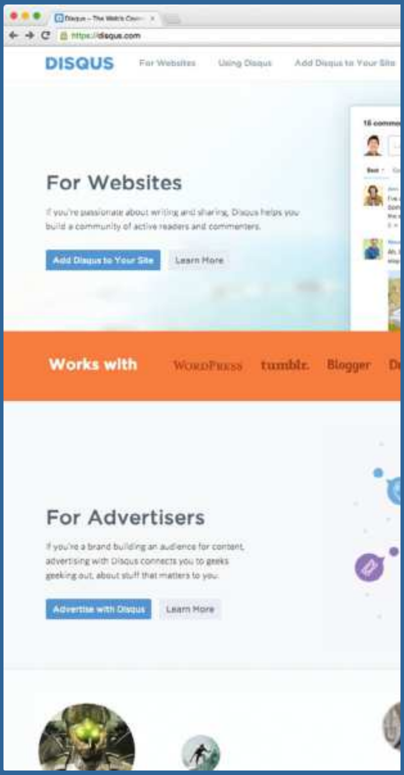
Python in the wild

Interested in Python development? You'd be in good company with big names currently using it

Disqus, the popular social interaction comment service provider, has been implementing their production applications in Python for a very long time. Python's benefit for the development team was its ability to scale effectively and cater for a large number of consumers whilst also providing an effective underlying API for internal and external use. The company are now starting to run some production apps in Go, but the majority of code still runs on Python.

World-renowned image sharing service Instagram and social pin board Pinterest have also implemented Python as part of their web stack, opting for Django to assist with the functionality and ability to cater for the many thousands of content views and requests made to their services.

Mozilla, Atlassian's Bitbucket repository service, and popular satire site The Onion have all been noted as using Django for their products.

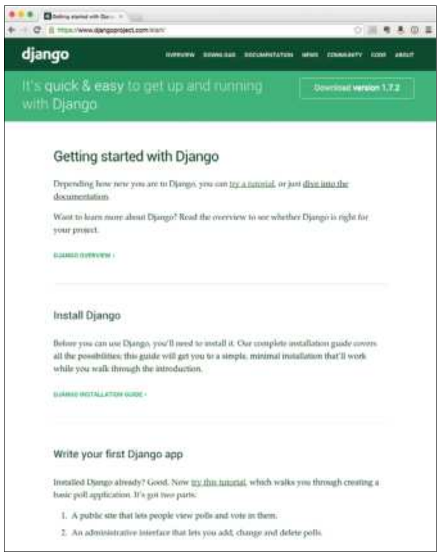


Django application development

Django is a full Python web-app framework with impressive command-line tools

Installing Django

The installation of Django is relatively easy once you have python installed. See for yourself as we build a simple app here



django

It's quick & easy to get up and running with Django

Download version 1.7.2

Getting started with Django

Depending how new you are to Django, you can try a tutorial, or just dive into the documentation.

Want to learn more about Django? Read the overview to see whether Django is right for your project.

DJANGO OVERVIEW ›

Install Django

Before you can use Django, you'll need to install it. Our complete installation guide covers all the possibilities; this guide will get you to a simple, minimal installation that'll work while you walk through the introduction.

DJANGO INSTALLATION GUIDE ›

Write your first Django app

Installed Django already? Good. Now try this tutorial, which walks you through creating a basic poll application. It's got two parts:

1. A public site that lets people view polls and vote in them.
2. An administrative interface that lets you add, change and delete polls.

01 Create Virtual Environment

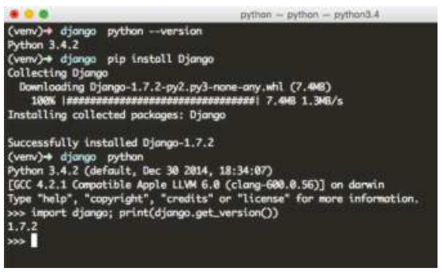
Create a new directory for your project and navigate inside it using a new Terminal window. Create a new virtual environment for this project, opting to use the latest Python 3. Your Python 3 location may vary, so be sure to set the correct path for the binary package.

```
virtualenv -p /usr/local/bin/python3 venv
```

02 Activate and Install

Using your Terminal window, activate the virtual environment to start the project-specific shell. VirtualEnv has a local version of the Python package manager pip installed, so it's fairly straight forward to run the command to install Django.

```
. venv/bin/activate
pip install Django
```

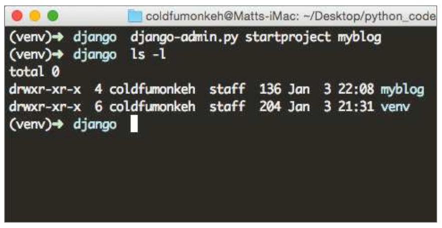


```
(venv)➜ django  python --version
Python 3.4.2
(venv)➜ django  pip install Django
Collecting Django
  Downloading Django-1.7.2-py2.py3-none-any.whl (7.4MB)
    100% |################################| 7.4MB 1.3MB/s
Installing collected packages: Django

Successfully installed Django-1.7.2
(venv)➜ django  python
Python 3.4.2 (default, Dec 30 2014, 18:34:07)
[GCC 4.2.1 Compatible Apple LLVM 6.0 (clang-600.0.56)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> import django; print(django.get_version())
1.7.2
>>> 
```

03 Create Core Project

The Django install contains some incredibly useful command-line tools, which will help you to run a number of repetitive and difficult tasks. Let's use one of them to create a fresh project structure for us. Run the django-admin.py script with the name of the project that you want created.

```
django-admin.py startproject myblog
```



```
(venv)➜ django  django-admin.py startproject myblog
(venv)➜ django  ls -l
total 0
drwxr-xr-x  4 coldfumonkeh  staff  136 Jan  3 22:08 myblog
drwxr-xr-x  6 coldfumonkeh  staff  204 Jan  3 21:31 venv
(venv)➜ django  
```

04 Initial Migration

Navigate into the project directory via the Terminal window. Some of the installed apps included in the project generation require database tables.

Using the helper, run a migration command in order to create all of these automatically. The Terminal window will keep you informed of all of your progress and what has been applied from the migration.

```
cd myblog
python manage.py migrate
```

05 Create App

Each Django project is made up of at least one application or module. Run the startapp command to create a new blog app module, which will generate the required code adjacent to the main project structure.

```
python manage.py startapp blog
```

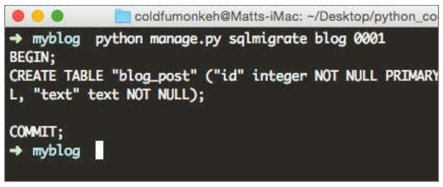
Database models & migration

Django's ability to manage the migration and maintenance of database schema and project models is very impressive

01 Generate the model

Open blog/models.py and create the first model class, providing the property names and types for each. You can dig deeper into field types via the docs here: bit.ly/1yln1kn. Once complete, open myblog/settings.py and add the blog app to the list of allowed installed applications so that the project will load it.

```
# blog/models.py
class Post(models.Model):
  title = models.CharField(max_
length=200)
  text = models.TextField()
# myblog/settings.py
INSTALLED_APPS = ('django.contrib.admin',
..., 'django.contrib.staticfiles', 'blog')
```



```
➜ myblog  python manage.py sqlmigrate blog 0001
BEGIN;
CREATE TABLE "blog_post" ("id" integer NOT NULL PRIMARY
L, "text" text NOT NULL);

COMMIT;
➜ myblog  
```

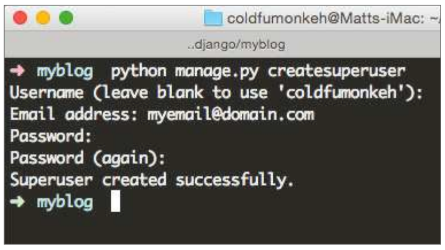
02 Data Migration

Any creation of models or changes to data need to be migrated. To do so we need to make migration files from the model data, which generate sequentially numbered files. Then we run a specific migration to generate the required SQL and the final migrate command performs the database execution.

```
python manage.py makemigrations blog
python manage.py sqlmigrate blog 0001
python manage.py migrate
```

Autowiring the admin interface

Admin sections can be problematic in their own right. Django provides an extensible admin interface for you



```
coldfumonkeh@Matts-iMac: ~
..django/myblog
➜ myblog  python manage.py createsuperuser
Username (leave blank to use 'coldfumonkeh'):
Email address: myemail@domain.com
Password:
Password (again):
Superuser created successfully.
➜ myblog
```

01 Create Admin User

Django makes content administration incredibly easy and has an admin section available in a default project as standard at http://127.0.0.1:8000/admin. To log in you need to create a superuser account. Run the associated command and specify user details as required to then proceed and log in.

```
python manage.py createsuperuser
```

02 Switch on blog management

Having logged in to the administration interface you will be greeted with features to manage users and group roles and privileges, which alone are very powerful and provided for you by Django. There is not yet, however, any access to manage our blog posts so let's turn that on.

Using the dev server

Django ships with a very helpful built-in development server, which will help you out by autocompiling and reloading after you have completed all of your file changes. All you have to do to start the server is to run the 'python manage.py runserver' command from your Terminal window within the project directory.

03 Enable Admin Management

To enable our module and associated models to be managed through the admin interface, we need to register them with the admin module. Open blog/admin.py and then go on to import and register the models in turn (we only have one of these currently though). Save the file and refresh the admin site to see the posts that are now available to manage.

```
from django.contrib import admin

# Register your models here.
```

04 Create a View

With the admin interface accepting new submissions for our post class we'll create a view page to display them. Open blog/views.py and import the Post class from the models. Create a method to obtain all posts from the database and output them as a string.

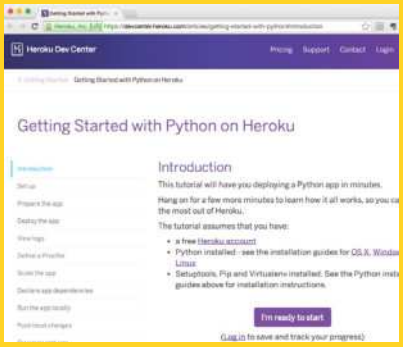
```
from django.http import HttpResponse
from blog.models import Post
def index(request):
  post_list = Post.objects.order_by('-id')
[:5]
  output = '<br />'.join([p.title for p
in post_list])

return HttpResponse(output)
```

05 Manage the URLs

Create 'blog/urls.py' and add the code to import the views that were just made in the module and the accompanying URL patterns. Open myblog/urls.py and add the URL function call to implement a new URL for the app to display the view. Visit http://127.0.0.1:5000/blog in your browser to render the new view.

```
# blog/urls.py

from django.conf.urls import patterns,url
from blog import views
urlpatterns = patterns('',
  url(r'^$', views.index, name='index'),
)

# myblog/urls.py
urlpatterns = patterns('',
  url(r'^blog/', include('blog.urls')),
  url(r'^admin/', include(admin.site.urls)),
)
```

Hosting Python apps



Heroku Dev Center

Getting Started with Python on Heroku

Introduction

This tutorial will have you deploying a Python app in minutes.

Hang on for a few more minutes to learn how it all works, so you ca the most out of Heroku.

The tutorial assumes that you have:

- a free Heroku account
- Python installed - see the installation guides for OS X, Windo Linux
- Setuptools, Pip and Virtualenv installed. See the Python insta guides above for installation instructions.

Heroku heroku.com

This app is perhaps one of the most well-known cloud hosting providers. Their stack server environments support a number of core web app languages including Python as standard. Their unique Toolbelt command-line features and integration with Git repositories, as well as being incredibly quick and easy to scale and improve performance, makes them an obvious choice. A free account will let you run a Python web app on one dyno instance without any cost.

Host, run, and code Python in the cloud!

Get started for free. Our basic plan gives you access to machines with a full Python environment already installed. You can develop and host your website or any other code directly from your browser without having to install software or manage your own server.

Need more power? Upgraded plans start at $5/month.

Python Anywhere www.pythonanywhere.com

Another hosted option, and one created specifically for Python applications in general is Python Anywhere. The free basic option plan has enough weight and power behind it to get you up and running with a Python web app without having to scale, but as soon as your project gains traction, you can switch plans and boost your plans performance.

It offers an incredibly impressive range of modules as standard, available to import into your application immediately to get you started, including Django and Flask should you need them.

Creating dynamic templates with Flask, Jinja2 and Twitter

Create a dynamic webpage with Twitter and Flask's rendering engine, Jinja2

Resources

Python 3

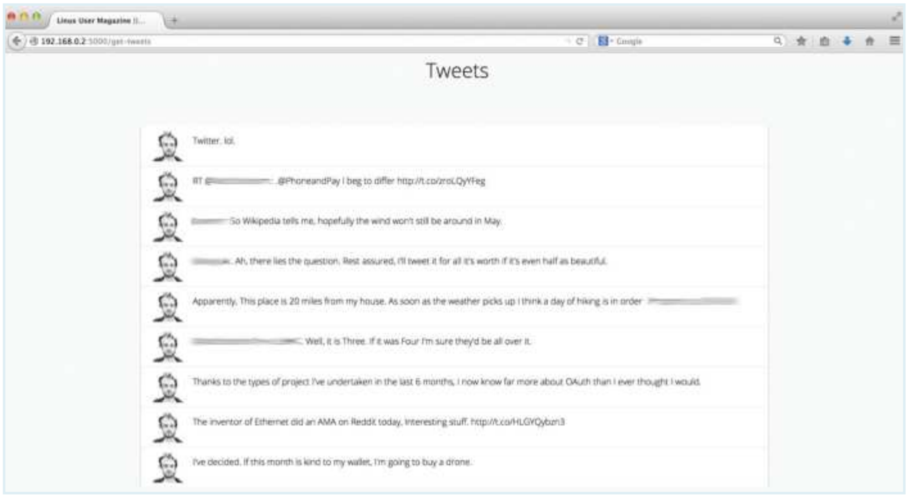
Flask: flask.pocoo.org

Flask GitHub: github.com/mitsuhiko/flask

A Twitter account

Your favourite text editor

Code downloaded from FileSilo


Linux User Magazine
192.168.0.2:5000/get-tweets

Tweets

Twitter. lol.

RT [redacted] @PhoneandPay I beg to differ http://t.co/zroLQyYFeg

[redacted] So Wikipedia tells me, hopefully the wind won't still be around in May.

[redacted] Ah, there lies the question. Rest assured, I'll tweet it for all it's worth if it's even half as beautiful.

Apparently, This place is 20 miles from my house. As soon as the weather picks up I think a day of hiking is in order [redacted]

[redacted] Well, it is Three. If it was Four I'm sure they'd be all over it.

Thanks to the types of project I've undertaken in the last 6 months, I now know far more about OAuth than I ever thought I would.

The inventor of Ethernet did an AMA on Reddit today. Interesting stuff. http://t.co/HLGYQybzn3

I've decided. If this month is kind to my wallet, I'm going to buy a drone.

The template uses a loop to generate a list of Twitter tweets

Python and Flask are a great combination when you're looking to handle the Twitter OAuth process and build requests to obtain tokens. We've used Twitter here because of the large amount of easily digestible data available on it. However, since Twitter adheres to the standards set out by OAuth 1.0, the code we've used to sign and build requests can be modified to work with any third-party API using the same standard without a great deal of work. For years PHP has been a mainstay of template generation, but now with well-documented frameworks such as Flask, Sinatra and Handlebars, the ability to use powerful scripting languages greatly improves our ability to make great web services. Here, we're going to use Python, Flask and its templating engine to display tweets. Flask comes with the super-nifty Jinja2 templating engine, If you're familiar with Node.js or front-end JavaScript, the syntax will look very similar to the Handlebars rendering engine. But, before we dive into that, we need to organise some of the example code that we're using for this.

01 Rearranging our code

Server code can get messy and unmaintainable quickly, so the first thing we're going to do is move our helper functions to another file and import them into our project, much like you would a module. This way, it will be clear which functions are our server logic and endpoints and which are generic Python functions. Open the **TwitterAuthentication** file downloaded from FileSilo (stored under **Twitter OAuth files**) and locate the getParameters, sign_request and create_oauth_headers functions. Cut and paste them into a new file called **helpers.py** in the root of your project folder. At the top of this file we want to import some libraries.

```
import urllib, collections, hmac, ↵
binascii, time, random, string
```

```
from hashlib import sha1
```

Now we can head back over to server.py and import the helper functions back into our project. We do this by simply calling `import helpers`. Because Python is smart, It will look in the current directory for a helpers.py file before it looks for a system module. Now every function included in helpers.py is accessible to our project. All we need to do to call them is prepend our the methods we called before with helper.function_name and it will execute. For sign_request, we'll need to pass our oauth_secret and consumer_secret for each request rather than accessing it from the session. Adjust the function declaration like so:

```
def sign_request(parameters, method,
↵baseURL, consumer_secret, oauth_
secret):
```

02 server.py modules

With a lot of the modules needed in this project having been moved to **helpers.py**, we can now remove most of them from **server.py**. If we amend our first import statement to be…

```
import urllib2, time, random, json
```

…our project will continue to function as it did before. Note the addition of the json module: we'll be using that later as we start handling Twitter data. Having Flask use a rendering engine is super-simple. Flask comes packaged with the Jinja2 template rendering engine, so we've nothing to install – we just need to import the package into the project. We can do this by adding render_template to the end of our `from flask import` […] statement.

03 Our first template

Now that we have a rendering engine, we need to create some templates for it to use. In the root of our project's folder, create a new folder called **templates**. Whenever we try to render a template, Flask will look in this folder for the template specified. To get to grips with templating, we'll rewrite some of our authentication logic to use a template, rather than manually requesting endpoints. In **templates**, create an **index.html** file. You can treat this HTML file like any other – included in the resources for this tutorial is an index.html that includes all of the necessary head tags and <!DOCTYPE> declarations for this file.

04 Rendering our template

In **server.py**, let's create a route for '/' to handle the authorisation process.

```
@app.route('/')
def home():

  if not 'oauth_token' in session:
      session.clear()
      session['oauth_secret'] = ''
      session['oauth_token'] = ''
  return render_template('index.html')
```

It's a simple function: all we want to do is check whether or not we have an oauth_token already and create those properties in the Flask session so we don't throw an error if we try to access it erroneously. In order to send our generated template in response to the request, we **`return render_template('index.html')`**.

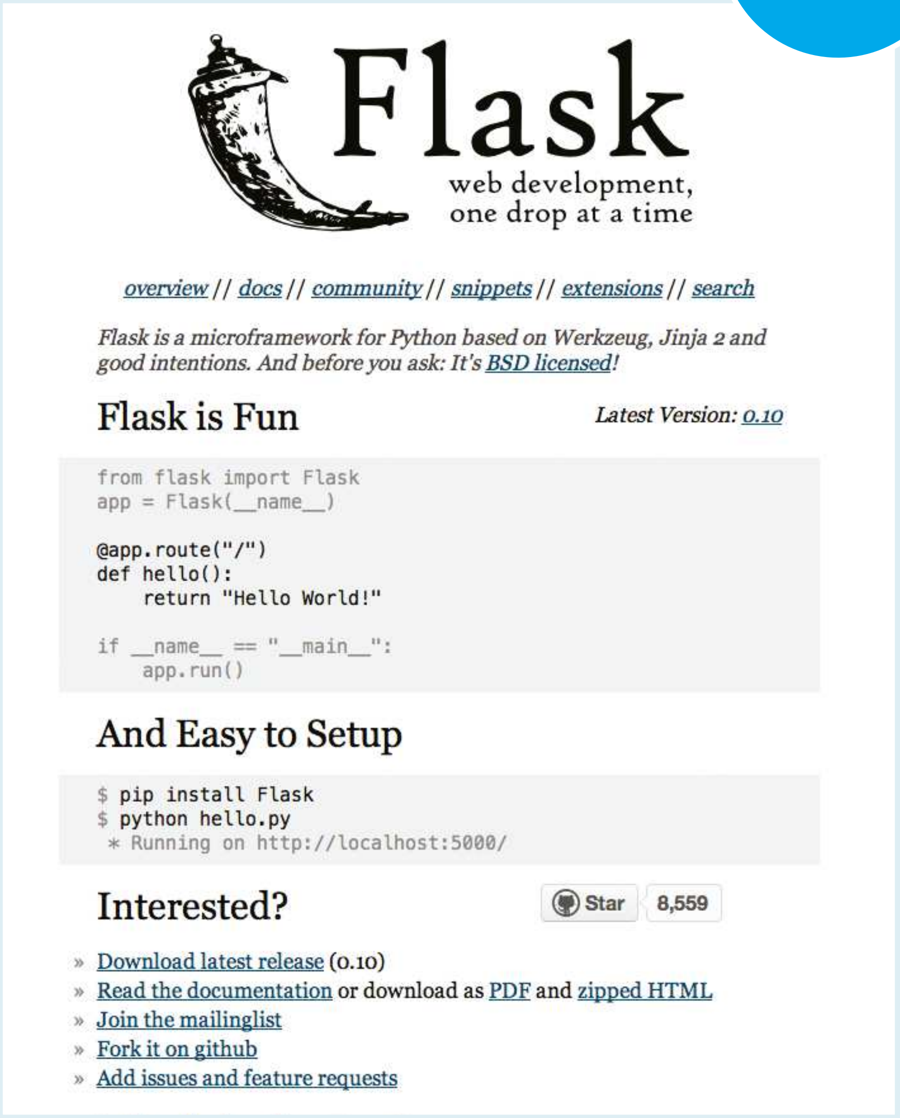
05 Template variables

We can choose to send variables to our template with `render_template('index.htm', variableOne=value, variableTwo=Value)` but in this instance we don't need to as each template has access to the request and session variables.

Fig 01

```
{% if session['oauth_token'] != "" %}
    <h1>Already Authorised</h1>
    <div class="dialog">
<p>Hello, You've authenticated!<br>Let's <a href="/get-tweets">get some tweets</a></p>
    </div>
{% else %}
    <h1>Authorisation required</h1>
    <div class="dialog">
        <p>We need to <a href="/authenticate">authenticate</a></p>
    </div>

{% endif %}
```

Code on FileSilo


The BSD-licensed Flask is easy to set up and use – check out the website for more info

Flask
web development, one drop at a time
overview // docs // community // snippets // extensions // search

Flask is a microframework for Python based on Werkzeug, Jinja 2 and good intentions. And before you ask: It's BSD licensed!

Flask is Fun

Latest Version: 0.10

```
from flask import Flask
app = Flask(__name__)

@app.route("/")
def hello():
    return "Hello World!"

if __name__ == "__main__":
    app.run()
```

And Easy to Setup

```
$ pip install Flask
$ python hello.py
 * Running on http://localhost:5000/
```

Interested?

» Download latest release (0.10)
» Read the documentation or download as PDF and zipped HTML
» Join the mailinglist
» Fork it on github
» Add issues and feature requests

Open **index.html**. All code executed in a Flask template is contained within {% %}. As this is our homepage, we want to direct users accordingly, So let's check if we've got an access token **(Fig 01)**. Between the **ifs** and **else** of the template is standard HTML. If we want to include some data – for example, the access token – we can just add **{{ session['oauth_token'] }}** in the HTML and it will be rendered in the page. Previously, in our **/authorised** endpoint, we would display the OAuth token that we received from Twitter; however, now that we have a template, we can redirect our users back our root URL and have a page rendered for us that explains the progress we've made.

06 Getting lost (and then found again)

With every server, some things get misplaced or people get lost. So how do we handle this? Rather than defining a route, we can define a handler that deals with getting lost.

```
@app.errorhandler(404)
def fourOhFour(error):
return render_template('fourohfour.html')
```

If a page or endpoint is requested and triggers a 404, then the **fourOhFour** function will be fired. In this case, we'll generate a template that tells the user, but we could also redirect to another page or dump the error message.

07 Static files

Pretty much every webpage uses JavaScript, CSS and images, but where do we keep them? With Flask we can define a folder for use with static content. For Flask, we create a **static** folder in the root of our project and access files by calling **/static/css/styles.css** or **/static/js/core.js**. The tutorial resources include a CSS file for styling this project.

08 Let's get some tweets

So now we know how to build templates, let's grab some tweets to display. In **server.py** define a new route, **get-tweets**,like so:

```
@app.route('/get-tweets')
@app.route('/get-tweets/<count>')
def getTweets(count=0):
```

You'll notice that unlike our other authentication endpoints, we've made two declarations. The first is a standard route definition: it will

"Now we know how to build templates, let's grab some tweets to display"

intercept and handle the path **get-tweets**. The second lets us define a parameter that we can use as a value in our **getTweets** function. By including **count=0** in our function declaration, we ensure that there will always be a default value when the function is executed; this way we don't have to check the value is present before we access it. If a value is included in the URL, it will override the value in the function. The string inside the **<variable name>** determines the name of the variable. If you want the variable passed to the function to have a specific type, you can include a converter with the variable name. For example, if we wanted to make sure that **<count>** was always an integer instead of a float or string, we'd define our route like so:

```
@app.route('/get-tweets/<int:count>')
```

09 Checking our session and building our request

Before we start grabbing tweets, we want to run a quick check to make sure we have the necessary credentials and if not, redirect the user back the authorisation flow. We can do this by having Flask respond to the request with a redirection header, like so:

```
if session['oauth_token'] == "" or ↵
session['oauth_secret'] == "":
        return redirect(rootURL)
```

Assuming we have all we need, we can start to build the parameters for our request **(Fig 02)**. You'll notice that the nonce value is different from that in our previous requests. Where the nonce value in our authenticate and authorise requests can be any random arrangement of characters that uniquely identify the request, for all subsequent requests the nonce needs to be a 32-character hexadecimal string using only the characters a-f. If we add the following function to our **helpers.py** file, we can quickly build one for each request.

```
def nonce(size=32, chars="abcdef" +
↵string.digits):
  return ''.join(random.choice ↵
(chars) for x in range(size))
```

10 Signing and sending our request

We've built our parameters, So let's sign our request and then add the signature to the parameters **(Fig 03)**.

Before we create the authorisation headers, we need to remove the **count** and **user_id** values from the **tweetRequestParams** dictionary, otherwise the signature we just created won't be valid for the request. We can achieve this with the **del** keyword. Unlike our token requests, this request is a GET request, so instead of including the parameters in the request body, we define them as query parameters.

```
?count=tweetRequestParams['count'] ↵
&user_id=tweetRequestParams['user_id']
```

11 Handling Twitter's response

Now we're ready to fire off the request and we should get a JSON response back from Twitter. This is where we'll use the json module we imported earlier. By using the **json.loads** function, we can parse the JSON into a dictionary that we can access and we'll pass through to our **tweets.html** template.

```
tweetResponse = json. ↵
loads(httpResponse.read())
return render_template('tweets.html',
↵data=tweetResponse)
```

Whereas before, we accessed the session to get data into our template, this time we're explicitly passing a value through to our template.

12 Displaying our tweets

Let's create that template now, exactly the same as **index.html** but this time, instead of using a conditional, we're going to create a loop to generate a list of tweets we've received.

First, we check that we actually received some data from our request to Twitter. If we've got something to render, we're ready to work through it, otherwise we'll just print that we didn't get anything.

Once again, any template logic that we want to use to generate our page is included between {% %}. This time we're creating a loop; inside the loop we'll be able to access any property we have of that object and print it out. In this template we're going to create an <li> element for each tweet we received and display the user's profile picture and text of the tweet (Fig 04). In our template we can access properties using either dot notation (.) or with square brackets ([]). They behave largely the same; the [] notation will check for an attribute on the dictionary or object defined whereas the . notation will look for an item with the same name. If either cannot find the parameter specified, it will return undefined. If this occurs, the template will not throw an error, it will simply print an empty string. Keep this in mind if your template does not render the expected data: you've probably just mis-defined the property you're trying to access. Unlike traditional Python, we need to tell the template where the **for** loop and **if**/**else** statements end, so we do that with {% endfor %} and {% endif %}.

13 Flask filters

Sometimes, when parsing from JSON, Python can generate erroneous characters that don't render particularly well in HTML. You may notice that after **tweet['text']** there is **|forceescape**, This is an example of a Flask filter; it allows us to effect the input before we render – in this case it's escaping our values for us. There are many, many different built-in filters that come included with Flask. Your advisor recommends a full reading of all the potential options.

14 Wrapping up

That's pretty much it for templating with Flask. As we've seen, it's insanely quick and easy to build and deploy dynamic sites. Flask is great tool for any Python developer looking to run a web service. Although we've used Twitter to demonstrate Flask's power, all of the techniques described can be used with any third-party service or database resource. Flask can work with other rendering engines, such as Handlebars (which is superb), but Jinja2 still needs to be present to run Flask and conflicts can occur between the two engines. With such great integration between Flask and Jinja2, it makes little sense to use another engine outside of very specific circumstances.

Fig 02

```
tweetRequestParams = {
    "oauth_consumer_key" : consumer_key,
    "oauth_nonce" : helpers.nonce(32),
    "oauth_signature_method" : "HMAC-SHA1",
    "oauth_timestamp" : int(time.time()),
    "oauth_version" : "1.0",
    "oauth_token" : session[‚Äòoauth_token'],
    "user_id" : session['user_id'],
    "count" : str(count)
}
```

Fig 03

```
tweetRequest = helpers.sign_request(tweetRequestParams, "GET", ↵
"https://api.twitter.com/1.1/statuses/user_timeline.json", consumer_secret, ↵
session['oauth_secret'])

tweetRequestParams["oauth_signature"] = tweetRequest

makeRequest=urllib2.Request("https://api.twitter.com/1.1/statuses/ ↵
user_timeline.json?count=" + tweetRequestParams['count'] + "&user_id=" ↵
+ tweetRequestParams['user_id'])

del tweetRequestParams['user_id'], tweetRequestParams['count']

makeRequest.add_header("Authorization", helpers.create_oauth_ ↵
headers(tweetRequestParams))

try:
    httpResponse = urllib2.urlopen(makeRequest)
except urllib2.HTTPError, e:
    return e.read()
```

Fig 04

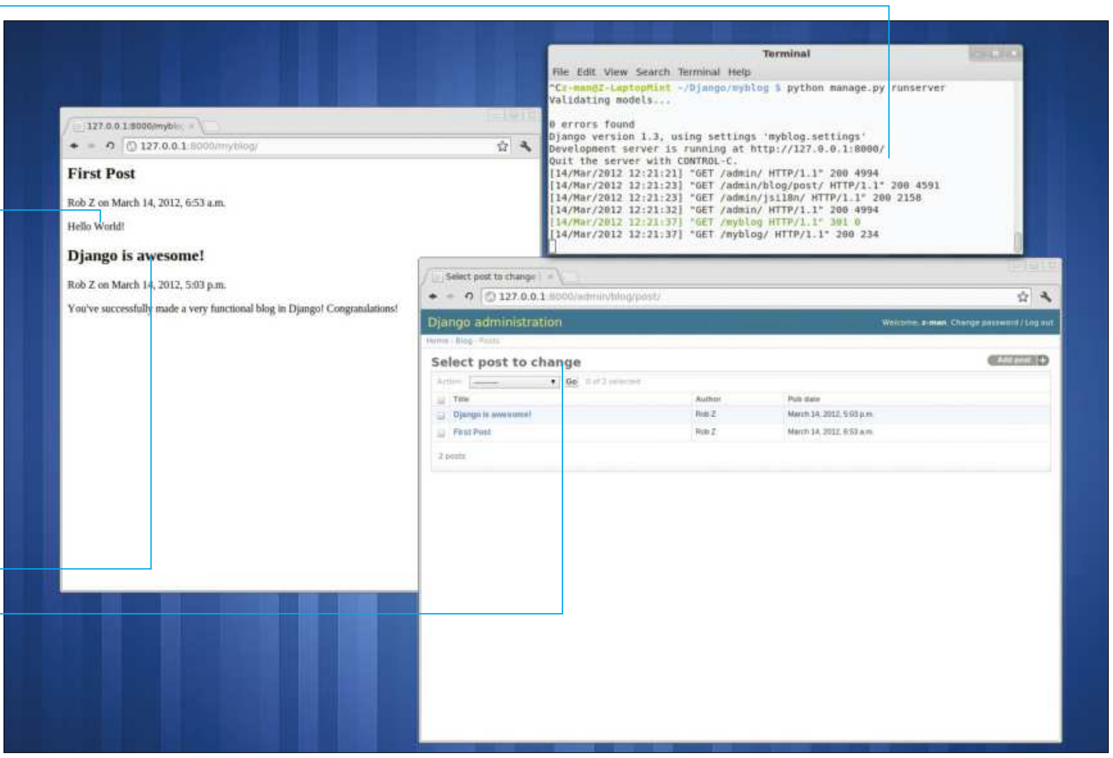
```
{% if data %}

    <ul id="tweets">
        {% for tweet in data %}
            <li>
                <div class="image">
                    <img src="{{ tweet['user']['profile_image_url_https'] ↵
}}" alt="User Profile Picture">
                </div>
                <div class="text">
                    <a>{{ tweet['text']|forceescape }}</a>
                </div>
            </li>
        {% endfor %}
    </ul>

{% else %}
  <p>We didn't get any tweets :(</p>
{% endif %}
```

Django comes with a lightweight development server so you can test all your work locally

Django is of course able to read and write to SQL databases, but it needs very little prior knowledge to succeed in doing so

Using HTML and CSS in conjunction with Django is clear and straightforward; it's much easier to bug-fix than PHP

Django comes with a generic back-end site that is set up in seconds, and easily customisable after that



```
^Cz-man@Z-LaptopMint ~/Django/myblog $ python manage.py runserver
Validating models...

0 errors found
Django version 1.3, using settings 'myblog.settings'
Development server is running at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
[14/Mar/2012 12:21:21] "GET /admin/ HTTP/1.1" 200 4994
[14/Mar/2012 12:21:23] "GET /admin/blog/post/ HTTP/1.1" 200 4591
[14/Mar/2012 12:21:23] "GET /admin/jsi18n/ HTTP/1.1" 200 2158
[14/Mar/2012 12:21:32] "GET /admin/ HTTP/1.1" 200 4994
[14/Mar/2012 12:21:37] "GET /myblog HTTP/1.1" 301 0
[14/Mar/2012 12:21:37] "GET /myblog/ HTTP/1.1" 200 234
```

First Post

Rob Z on March 14, 2012, 6:53 a.m.

Hello World!

Django is awesome!

Rob Z on March 14, 2012, 5:03 p.m.

You've successfully made a very functional blog in Django! Congratulations!

Select post to change

Title	Author	Pub date
Django is awesome!	Rob Z	March 14, 2012, 5:03 p.m.
First Post	Rob Z	March 14, 2012, 6:53 a.m.

2 posts

Resources

Python 3
www.python.org

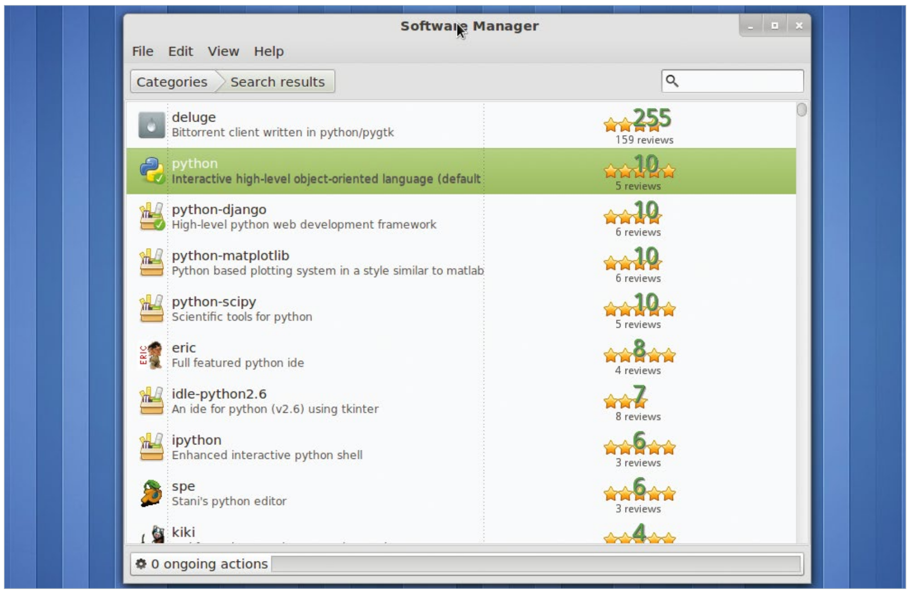
Django Source Code
www.djangoproject.com

Build your own blog with Django

Learn how to use this extremely powerful Python-based web framework to create a complete blog from scratch in record time

Creating your own blog always feels like a great accomplishment. Sure, you could use the fantastic WordPress if you need a complete blog with every feature you'd ever need right now. And Tumblr exists for people who just want to write something, or post pictures of corgis in space. You don't have full control from start to finish with a prefabricated blog, though, and neither of these is written in the fantastic Django. Django is of course based on Python, the object-orientated programming language designed to have clearly readable syntax. Due to its Python base, it's an incredibly powerful and simple-to-use language for web development with a vast array of applications.

So let's use it to make a blog. In this first section of the process we will explore how to set up Django, writing and reading to a database, creating a front- and back-end, and some interactions with HTML.



```
Software Manager
File  Edit  View  Help
Categories  Search results

deluge                                                      255
Bittorrent client written in python/pygtk                   159 reviews
python                                                      10
Interactive high-level object-oriented language (default    5 reviews
python-django                                               10
High-level python web development framework                 6 reviews
python-matplotlib                                           10
Python based plotting system in a style similar to matlab   6 reviews
python-scipy                                                10
Scientific tools for python                                 5 reviews
eric                                                        8
Full featured python ide                                    4 reviews
idle-python2.6                                              7
An ide for python (v2.6) using tkinter                      8 reviews
ipython                                                     6
Enhanced interactive python shell                           3 reviews
spe                                                         6
Stani's python editor                                       3 reviews
kiki                                                        4

0 ongoing actions
```

01 Install Python

Django is based on Python, and requires it to be installed to develop on. Python 3 is the recommended version, and this is installed with the python package. If you want to check your version, start the Python shell by typing 'python' into the terminal.

02 Install Django

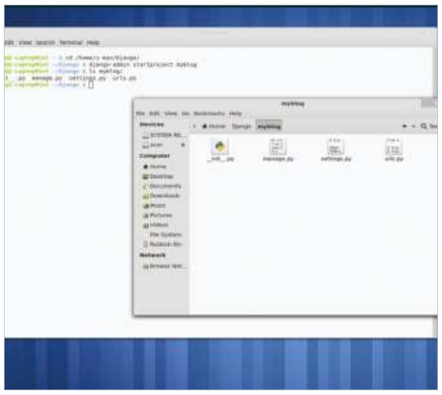
Most operating systems will have a Django package available in the repository, like python-django in Debian. The Django website has a list if you have trouble finding it, or you could build it from source. Make sure you install the latest version.

03 Verify your Django

To make sure Django installed properly, and that you have the right version, enter the Python shell by typing 'python' and **enter the following:**

```
import django
print(django.get_version())
```

It will return a version number if it has installed correctly, which should be 1.3.

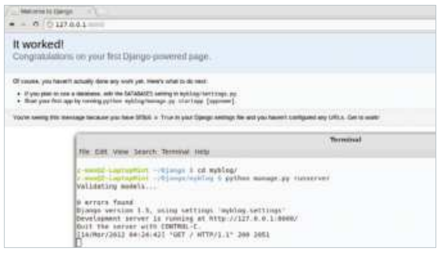


04 Start a new project

In the terminal, cd to the folder you want to develop the blog in, and then **run the next command:**

```
django-admin startproject myblog
```

Here, 'myblog' can be replaced by whatever you wish to name the project, but we'll use it for the upcoming examples.



It worked!
Congratulations on your first Django-powered page.

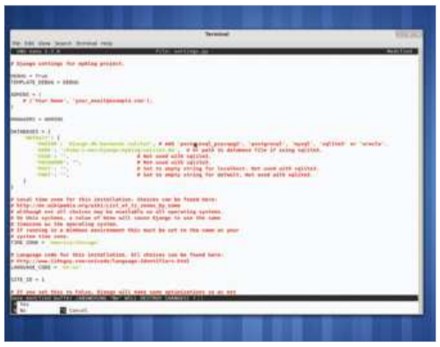
```
$ cd myblog/
$ python manage.py runserver
Validating models...

0 errors found
Django version 1.3, using settings 'myblog.settings'
Development server is running at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
[14/Mar/2012 04:24:42] "GET / HTTP/1.1" 200 2051
```

05 Start the development server

Django comes with a lightweight development server to test out work locally. We can also use it to check our work, so cd to the myblog folder and **then use:**

```
python manage.py runserver
```

If all goes well, it should return zero errors. Use Ctrl+C to exit the server.



06 Configure the database

The database settings are kept in the settings.py file. Open it up with your favourite editor and go to the Databases section. **Change ENGINE to:**

```
'ENGINE': 'django.db.backends.
sqlite3',
```

And in NAME, put the absolute path – for example:

```
'NAME': '/home/user/projects/myblog/
sqlite.db',
```

Save and exit.

07 Create the database

The database file will be generated by **using the command:**

```
python manage.py syncdb
```

During the creation, it will ask you to set up a superuser, which you can do now.

The SQLite database file will be created in your myblog folder.

08 Create your blog

Now it's time to create a blog app in your project. **Type:**

```
python manage.py startapp blog
```

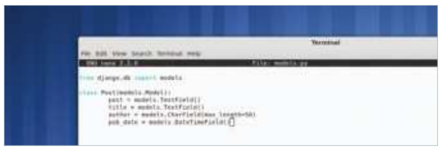
This creates the models file which is where all your data lives. You can change 'blog' to another name, but we'll use it in our examples.

09 Start your blog model

We can now take the first steps in creating our blog model. Open models.py and change it so it **says the following:**

```
from django.db import models
class Post(models.Model):
    post = models.TextField()
```

This creates the Post class, which has a subclass that contains your blog text.



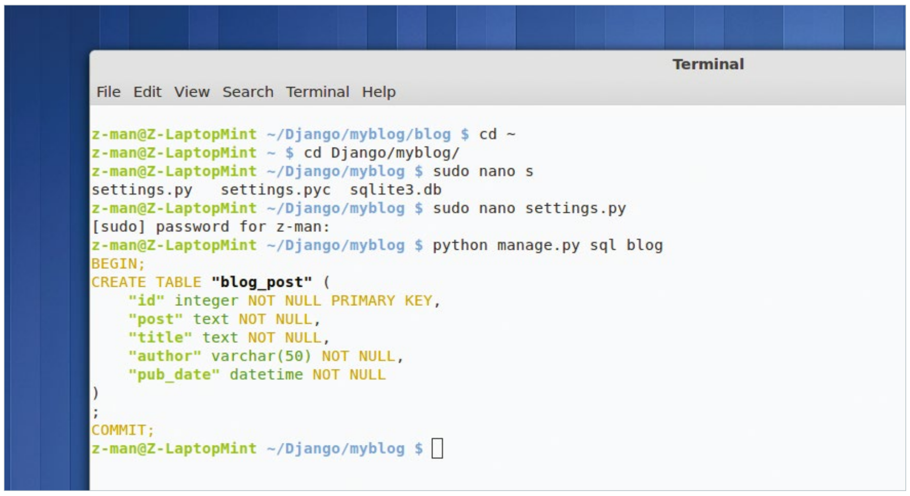
10 Customise your blog

Let's now expand the blog model a bit so it resembles a more classic blog:

```
class Post(models.Model):
    post = models.TextField()
    title = models.TextField()
    author = models.CharField(max_
length=50)
    pub_date = models.DateTimeField()
```

A CharField needs to have a character limit defined, and DateTimeField holds the time values.

You don't have full control from start to finish with a prefabricated blog – but you will with Django



```
z-man@Z-LaptopMint ~/Django/myblog/blog $ cd ~
z-man@Z-LaptopMint ~ $ cd Django/myblog/
z-man@Z-LaptopMint ~/Django/myblog $ sudo nano s
settings.py   settings.pyc  sqlite3.db
z-man@Z-LaptopMint ~/Django/myblog $ sudo nano settings.py
[sudo] password for z-man:
z-man@Z-LaptopMint ~/Django/myblog $ python manage.py sql blog
BEGIN;
CREATE TABLE "blog_post" (
    "id" integer NOT NULL PRIMARY KEY,
    "post" text NOT NULL,
    "title" text NOT NULL,
    "author" varchar(50) NOT NULL,
    "pub_date" datetime NOT NULL
)
;
COMMIT;
z-man@Z-LaptopMint ~/Django/myblog $ 
```

11 Install your app

Your app needs to be installed to your project, which is very simple. Open the settings.py file again, go to the INSTALLED_APPS section **and add:**

```
'blog',
```

Then run the following to create the database tables:

```
python manage.py sql blog
```

And finally:

```
python manage.py syncdb
```

12 Set up to post

Now we can create a post and test out our code. First though, **enter the Python shell:**

```
python manage.py shell
```

Then execute these commands to add all the necessary fields and data:

```
from blog.models import Post
import datetime
```

13 Let's blog

Create the post. **For this example, we will call it test_post:**

```
test_post = Post()
```

Now let's add the blog content:

```
test_post.post = 'Hello World!'
test_post.title = 'First Post'
test_post.author = 'Me'
test_post.pub_date = datetime.
datetime.now()
```

And then save it with:

```
test_post.save()
```

14 Start the site back-end

To create the admin site, edit urls.py from the myblog directory, and uncomment or **add the following lines:**

```
from django.contrib import admin
admin.autodiscover()
url(r'^admin/', include(admin.site.
urls)),
```

Save and exit, then edit settings.py and uncomment this line from INSTALLED_APPS:

```
'django.contrib.admin',
```

The admin site is now at 127.0.0.1:8000/admin/.

15 Setup the admin page

The admin page has a generic, usable template, but you need to configure it to view, edit, create and delete posts. First, create a new file admin.py in the blog directory **and enter:**

```
from blog.models import Post
from django.contrib import admin

admin.site.register(Post)
```

To have the posts display nicely on the site, edit models.py **and add:**

```
class Post (models.Model):
    …
    def __unicode__(self):
        return self.title
```

Save, and run:

```
python manage.py syncdb
```

The admin page is now usable! You should be able to see the other posts, and it's now a lot easier to add more.

16 Activate the front-end

Open up urls.py from the myblog directory in your editor and **add the following to the urlpatterns section:**

```
url(r'^myblog/', 'blog.urls.index')),
```

One of the examples in the file can be uncommented and edited to this as well. It points to a model we will now create.

17 Create another urls file

You need to create another urls file in the app directory, in our case blog/urls.py. Create it and **add the following:**

```
from django.template import Context, 
loader
from blog.models import Post
from django.http import HttpResponse
def index(request):
    post_list = Post.objects.all()
    t = loader.get_template('blog/
index.html')
    c = Context({
        'post_list': poll_list,
    })
    return HttpResponse(t.render(c))
```

"Django is an incredibly powerful and simple-to-use language"

18 Start the template

The code we've just written looks for a template that currently doesn't exist. We first need to tell Django where templates are to be looked for in settings.py:

```
TEMPLATE_DIRS = (
    '/home/user/projects/templates',
)
```

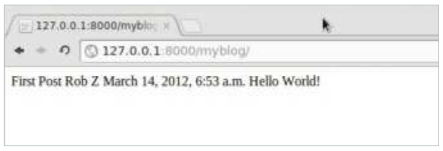
You can put the template directory wherever you want, as long as it's referenced here.

19 Write a template

Now to write the site template. In our example, we're using index.html:

```
{% for post in post_list %}
    {{ post.title }}
    {{ post.author }}
    {{ post.pub_date }}
    {{ post.post }}
{% endfor %}
```

This needs to be located in a folder with the same name as your app within the template directory.



127.0.0.1:8000/myblo

127.0.0.1:8000/myblog/

First Post Rob Z March 14, 2012, 6:53 a.m. Hello World!

20 View your handiwork

Let's make sure this worked. Start the developer **server with:**

```
python manage.py runserver
```

And navigate to 127.0.0.1:8000/myblog/.

It's not pretty, but you should have successfully called upon your stored data. We'll spend the next steps tidying it up a bit.

21 Format the front page

Go back into the template file, index.html, and **add the following html tags:**

```
{% for post in post_list %}
    <h2>{{ post.title }}</h2>
    {{ post.author }} on {{ post.pub_
date }}
    <p>{{ post.post }}</p>
{% endfor %}
```

This is just an example – the post can be in any order with any tags.

22 Spruce up the admin list

We'll do this in the admin.py file in our blog directory; open it in your editor and make the **following changes:**

```
from blog.models import Post
from django.contrib import admin
class Admin(admin.ModelAdmin):
    list_display = ['title', 'author', 
'pub_date']
admin.site.register(Post, Admin)
```

In this case 'list_display' is a fixed variable name.

23 A logical post page

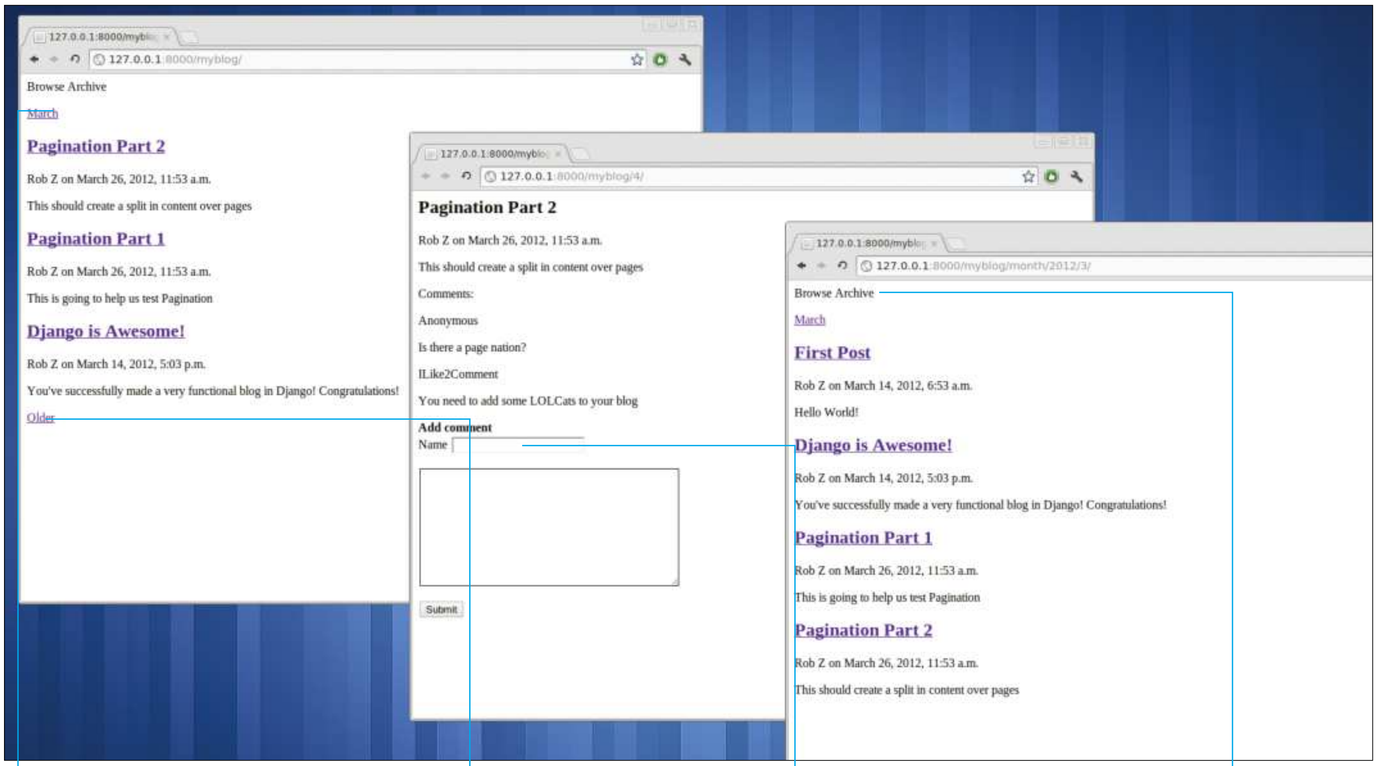
The new post page on the site might not be in an order you're comfortable with. We'll change that now in admin.py with the **following additions:**

```
class Admin(admin.ModelAdmin):
    list_display = ['title', 'author', 
'pub_date']
    fields = ['title', 'pub_date', 
'author', 'post']
admin.site.register(Post, Admin)
```

Remember to save!

24 A functional blog

So there you have it! Navigating to 127.0.0.1:8000/admin/ or 127.0.0.1:8000/myblog/ will show off the fine work you've created. Django is dead easy to use once you know how, and there are plenty of tweaks you should be able to make after this tutorial.



127.0.0.1:8000/myblog/

Browse Archive

March

Pagination Part 2

Rob Z on March 26, 2012, 11:53 a.m.

This should create a split in content over pages

Pagination Part 1

Rob Z on March 26, 2012, 11:53 a.m.

This is going to help us test Pagination

Django is Awesome!

Rob Z on March 14, 2012, 5:03 p.m.

You've successfully made a very functional blog in Django! Congratulations!

Older

127.0.0.1:8000/myblog/4/

Pagination Part 2

Rob Z on March 26, 2012, 11:53 a.m.

This should create a split in content over pages

Comments:

Anonymous

Is there a page nation?

ILike2Comment

You need to add some LOLCats to your blog

Add comment

Name

Submit

127.0.0.1:8000/myblog/month/2012/3/

Browse Archive

March

First Post

Rob Z on March 14, 2012, 6:53 a.m.

Hello World!

Django is Awesome!

Rob Z on March 14, 2012, 5:03 p.m.

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Pagination Part 1

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Pagination Part 2

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This should create a split in content over pages

With Django we can make simple sidebars that list archives by month

Django has built-in code to deal with pagination very cleanly and effectively

Allow your readers to give you feedback, and moderate them in the admin panel

With minimal extra code, our template can display the month archive from the sidebar

Deliver content to your blog

We continue building an awesome blog using the powerful Django framework, and this tutorial is all about the front-end content delivery

Resources

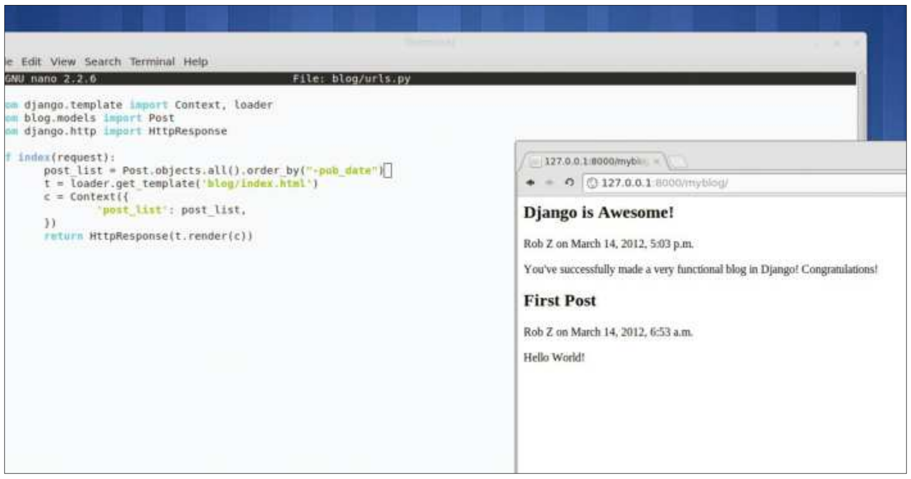
Python 3
http://www.python.org

Django
https://www.djangoproject.com

In the last tutorial we began to build the most basic of blogs, and learned how to use a bit of Django in the process. We can now set up a new project, create a database and write basic code to read and write to the database. All simple stuff, but of course it's core to building websites where Django might be called upon.

Here we will give the front end of the site an overhaul, making it more of the standard you would expect from a modern blog. This will include a sidebar, pages, post pages and the ability to add and moderate comments. In the process we will learn some more of the benefits that come with using Django to develop websites.

You should keep using Django 4 for this tutorial, as we did before.



```
GNU nano 2.2.6                    File: blog/urls.py

om django.template import Context, loader
om blog.models import Post
om django.http import HttpResponse

f index(request):
        post_list = Post.objects.all().order_by("-pub_date")
        t = loader.get_template('blog/index.html')
        c = Context({
                'post_list': post_list,
        })
        return HttpResponse(t.render(c))
```

Django is Awesome!

Rob Z on March 14, 2012, 5:03 p.m.

You've successfully made a very functional blog in Django! Congratulations!

First Post

Rob Z on March 14, 2012, 6:53 a.m.

Hello World!

01 New blog order

We left off last time with the blog displaying posts in chronological order, which isn't very helpful to readers. To correct this, open up urls.py in the blog folder and edit the **following line:**

```
post_list = Post.objects.all().order_
by("-pub-date")
```

This makes sure that posts are displayed in reverse order (newest first).

02 A view to a page

You'll want to be able to link specific pages, of course, and to do that we first have to define what goes into these pages in the urls.py file in the **blog folder:**

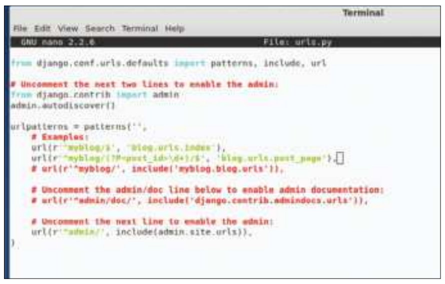
```
def post_page(request, post_id):
    post_page = Post.objects.
get(pk=post_id)
    return render_to_response('blog/
post.html', {'post_page': post_page})
```

03 Clean up your code

You may notice that we used a different return command to the index definition – this is a shortcut that makes writing the code a bit easier. To get it working, **add:**

```
from django.shortcuts import render_to_
response
```

We recommend that you edit the index code to match post_page.



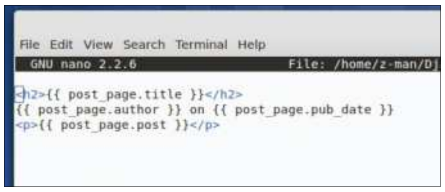
```
GNU nano 2.2.6                    File: urls.py

from django.conf.urls.defaults import patterns, include, url

# Uncomment the next two lines to enable the admin:
from django.contrib import admin
admin.autodiscover()

urlpatterns = patterns('',
    # Examples:
    url(r'^myblog/$', 'blog.urls.index'),
    url(r'^myblog/(?P<post_id>\d+)/$', 'blog.urls.post_page'),
    # url(r'^myblog/', include('myblog.blog.urls')),

    # Uncomment the admin/doc line below to enable admin documentation:
    # url(r'^admin/doc/', include('django.contrib.admindocs.urls')),

    # Uncomment the next line to enable the admin:
    url(r'^admin/', include(admin.site.urls)),
)
```

04 Edit URLs

In urls.py in myblog we need to make some additions and modifications for the website to direct to the **post correctly:**

```
url(r'^myblog/$', 'blog.urls.index'),
url(r'^myblog/(?P<post_id>\d+)/$',
'blog.urls.post_page'),
```

The post_id is the number of the post, which is auto-generated. The '$' is important to make the redirection work.

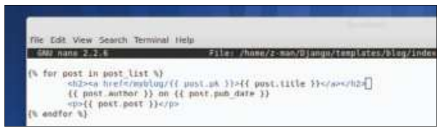


```
GNU nano 2.2.6                    File: /home/z-man/Dj

<h2>{{ post_page.title }}</h2>
{{ post_page.author }} on {{ post_page.pub_date }}
<p>{{ post_page.post }}</p>
```

05 A post template

We told the post_page to point towards a template we now need to create. In the same location as index.html, create post.html with the following formatting to resemble the **front page:**

```
<h2>{{ post_page.title }}</h2>
{{ post_page.author }} on {{ post_page.
pub_date }}
<p>{{ post_page.post }}</p>
```



```
GNU nano 2.2.6                    File: /home/z-man/Django/templates/blog/index

{% for post in post_list %}
        <h2><a href=/myblog/{{ post.pk }}>{{ post.title }}</a></h2>
        {{ post.author }} on {{ post.pub_date }}
        <p>{{ post.post }}</p>
{% endfor %}
```

06 Link to the page

Let's get these links working from the main page. Open up the index.html file and make the **following change:**

```
<h2><a href=/myblog/{{ post.pk }}>{{
post.title }}</a></h2>
```

This is a very simple addition using an absolute link, and requires no fiddling with the views or model.

07 Pagination

To get blog posts split up over pages, we need to make some additions to urls.py in the **blog folder:**

```
post_list = Post.objects.all().order_
by("-pub_date")
paginator = Paginator(post_list, 3)
try: list_page = request.GET.
get("list_page", '1')
except ValueError: list_page = 1
post_list = paginator.page(list_page)
return render_to_response('blog/index.
html', {'post_list': post_list})
```

08 Please turn over

Now we need to add the navigation links to the blog, so open the index template **for editing:**

```
{% if post_list.has_previous %}
    <a href="?list_page={{ post_list.
previous_page_number }}">Newer </a>
{% endif %}
{% if post_list.has_next %}
    <a href="?list_page={{ post_list.
next_page_number }}"> Older</a>
{% endif %}
```

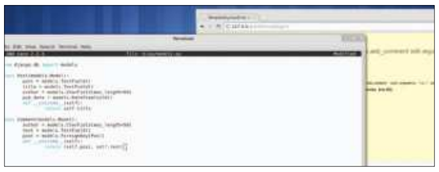
»

09 Wrong page

Let's add a quick bit of code to return somebody to the previous page if they get the URL wrong:

```
from django.core.paginator import
Paginator, EmptyPage, InvalidPage

try:
    post_list = paginator.page(list_
page)
except (EmptyPage, InvalidPage):
    post_list = paginator.
page(paginator.num_pages)
```

The last part replaces 'post_list = paginator.page(list_page)'.



10 Have your say

Everyone has their opinion on the internet. You can give your readers the ability to comment, and we'll start **by editing models.py:**

```
class Comment(models.Model):
    author = models.CharField(max_
length=50)
    text = models.TextField()
    post = models.ForeignKey(Post)
    def __unicode__(self):
        return (self.post, self.text)
```

We've made it so they can put their name with a comment.

11 Back to the comment

We now need to add a small line to the urls.py file in myblog so the comment can be posted then sent **back to the original page:**

```
url(r'^myblog/add_comment/(\d+)/$',
'blog.urls.add_comment'),
```

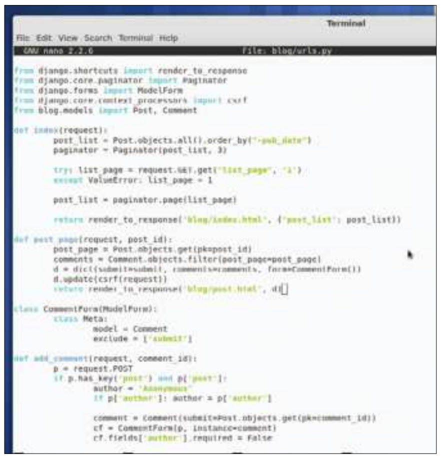
This URL pattern calls the ID of the page that you're on.

"We need to be able to process the data and metadata in the forms"

12 Form a comment

We need to be able to process the data and metadata in the forms, so let's add a class to urls.py in the blog folder with the **following additions:**

```
from django.forms import ModelForm
from blog.models import Post, Comment
class CommentForm(ModelForm):
    class Meta:
        model = Comment
        exclude = ['post']
```



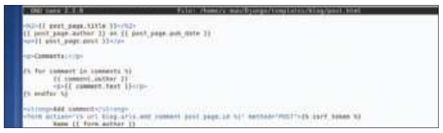
```
File  Edit  View  Search  Terminal  Help
 GNU nano 2.2.6                     File: blog/urls.py

from django.shortcuts import render_to_response
from django.core.paginator import Paginator
from django.forms import ModelForm
from django.core.context_processors import csrf
from blog.models import Post, Comment

def index(request):
        post_list = Post.objects.all().order_by('-pub_date')
        paginator = Paginator(post_list, 3)

        try: list_page = request.GET.get('list_page', '1')
        except ValueError: list_page = 1

        post_list = paginator.page(list_page)

        return render_to_response('blog/index.html', {'post_list': post_list})

def post_page(request, post_id):
        post_page = Post.objects.get(pk=post_id)
        comments = Comment.objects.filter(post_page=post_page)
        d = dict(submit=submit, comments=comments, form=CommentForm())
        d.update(csrf(request))
        return render_to_response('blog/post.html', d)

class CommentForm(ModelForm):
        class Meta:
                model = Comment
                exclude = ['submit']

def add_comment(request, comment_id):
        p = request.POST
        if p.has_key('post') and p['post']:
                author = 'Anonymous'
                if p['author']: author = p['author']

                comment = Comment(submit=Post.objects.get(pk=comment_id))
                cf = CommentForm(p, instance=comment)
                cf.fields['author'].required = False
```

13 In the post

We need to attribute the comments to the post they're being made on, so update the **post_page definition:**

```
from django.core.context_processors
import csrf
def post_page(request, post_id):
    post_page = Post.objects.
get(pk=post_id)
    comments = Comment.objects.
filter(post=post_page)
    d = dict(post_page=post_page,
comments=comments, form=CommentForm())
    d.update(csrf(request))
    return render_to_response('blog/
post.html', d)
```

The CSRF tag is to prevent cross-site request forgery.



```
 GNU nano 2.2.6              File: /home/[illegible]/templates/blog/post.html

<h2>{{ post_page.title }}</h2>
{{ post_page.author }} on {{ post_page.pub_date }}
<p>{{ post_page.post }}</p>

<p>Comments:</p>

{% for comment in comments %}
        {{ comment.author }}
        <p>{{ comment.text }}</p>
{% endfor %}

<strong>Add comment</strong>
<form action="{% url blog.urls.add_comment post_page.id %}" method="POST">{% csrf_token %}
        Name {{ form.author }}
```

14 Comment template

Let's get the post page ready for comments by **adding this to post.html:**

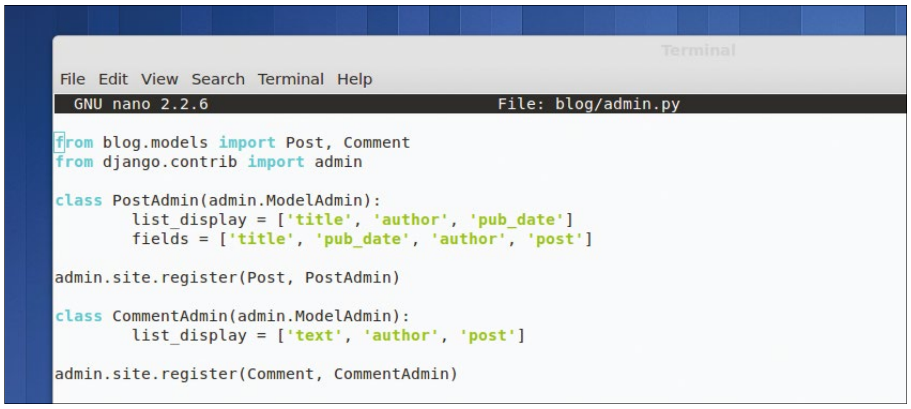
```
<p>Comments:</p>
{% for comment in comments %}
    {{ comment.author }}
    <p>{{ comment.text }}</p>
{% endfor %}
<strong>Add comment</strong>
<form action="{% url blog.urls.
add_comment post_page.id %}"
method="POST">{% csrf_token %}
    Name {{ form.author }}
    <p>{{ form.text }}</p>
    <input type="submit"
value="Submit">
</form>
```

15 Define your comments

The final step is defining the comments in blog/urls.py, **and it's a big one:**

```
def add_comment(request, comment_id):
    p = request.POST
    if p.has_key('text') and p['text']:
        author = 'Anonymous'
        if p['author']: author =
p['author']
        comment = Comment(post=Post.
objects.get(pk=comment_id))
        cf = CommentForm(p,
instance=comment)
        cf.fields['author'].required =
False
        comment =
cf.save(commit=False)
        comment.author = author
        comment.save()
    return HttpResponseRedirect(reverse
('blog.urls.post_page', args=[comment_
id]))
```

This ensures text has been entered, and if not specified author is 'Anonymous'. Before testing, run syncdb so comment tables can be created.

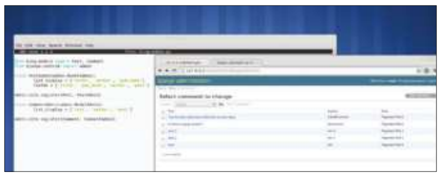


```
File  Edit  View  Search  Terminal  Help
 GNU nano 2.2.6                              File: blog/admin.py

from blog.models import Post, Comment
from django.contrib import admin

class PostAdmin(admin.ModelAdmin):
        list_display = ['title', 'author', 'pub_date']
        fields = ['title', 'pub_date', 'author', 'post']

admin.site.register(Post, PostAdmin)

class CommentAdmin(admin.ModelAdmin):
        list_display = ['text', 'author', 'post']

admin.site.register(Comment, CommentAdmin)
```

16 Administrate

Like the posts, we can get the Admin page to see comments. Start editing blogs/admin.py to get this **feature added:**

```
from blog.models import Post, Comment
from django.contrib import admin
class PostAdmin(admin.ModelAdmin):
    list_display = ['title', 'author',
'pub_date']
    fields = ['title', 'pub_date',
'author', 'post']
admin.site.register(Post, PostAdmin)
```



17 Comment-specific admin features

Now we can add the comment-specific admin features without causing any clashes:

```
class CommentAdmin(admin.ModelAdmin):
    list_display = ['text', 'author',
'post']
admin.site.register(Comment,
CommentAdmin)
```

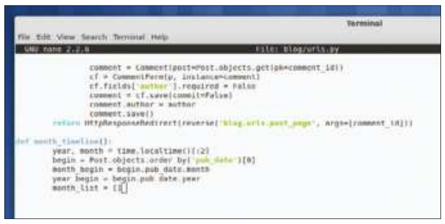
This will show the comments on the admin site, and you can see the comment, the author and the post it's connected to.

18 Sidebar beginnings

Django makes it pretty easy to order posts by years and months, but first we need to import some new models into blog/urls.py:

```
import time
from calendar import month_name
```

We are going to define two new functions, month_timeline and month, in order to make the sidebar.



```
 GNU nano 2.2.6                              File: blog/urls.py

            comment = Comment(post=Post.objects.get(pk=comment_id))
            cf = CommentForm(p, instance=comment)
            cf.fields['author'].required = False
            comment = cf.save(commit=False)
            comment.author = author
            comment.save()
        return HttpResponseRedirect(reverse('blog.urls.post_page', args=(comment_id,)))

def month_timeline():
        year, month = time.localtime()[:2]
        begin = Post.objects.order_by('pub_date')[0]
        month_begin = begin.pub_date.month
        year_begin = begin.pub_date.year
        month_list = []
```

19 Start to define month_timeline

First we need to get all the information from the posts:

```
def month_timeline():
    year, month = time.localtime()[:2]
    begin = Post.objects.order_by('pub_
date')[0]
    month_begin = begin.pub_date.month
    year_begin = begin.pub_date.year
    month_list = []
```

The '[:2]' makes sure we only get the time information we need.

20 Finish your definition

Now we will order the posts by month and year starting from our first month.

```
for y in range(year, year_begin-1, -1):
    start, end = 12, 0
    if y == year: start = month
    if y == year_begin: end = month_
begin-1
    for m in range(start, end, -1):
        month_list.append((y, m,
month_name[m]))
    return month_list
```

21 Return to reader

With the list organised, we can now define month so we can display it on the blog:

```
def month(request, year, month):
    post_list = Post.objects.
filter(pub_date__year=year, pub_date__
month=month)
    return render_to_response('blog/
index.html', dict(sidebar_list=post_
list, month_list=month_timeline()))
```

Now we need to link it up to the index template.

22 Finalise your sidebar definition

Edit the return command on the index function to include the sidebar information:

```
return render_to_response('blog/index.
html', dict(post_list=post_list,
sidebar_list=post_list.object_list,
month_list=month_timeline()))
```

Then add this line to urls.py in myblog so a month page can be rendered:

```
url(r'^myblog/month/(\d+)/(\d+)/$',
'blog.urls.month'),
```

All we need to do now is display the information on the site.

23 Sidebar on the web

Go to the index template. First of all, change the first line of the post forloop to:

```
{% for post in sidebar_list %}
```

Simple enough. Now we need to add the sidebar information:

```
{% for month in month_list %}
    <p><a href="{% url blog.urls.month
month.0 month.1 %}">{{ month.2 }}</
a></p>
{% endfor %}
```

24 Sidebar finale

Obviously it's not at the side right now – that's a job for the HTML and CSS. The info is there, though, and you can manipulate it any way you want. However, your blog is now a lot more friendly to your readers.

Resources

Python:
http://www.python.org
Django:
https://www.djangoproject.com

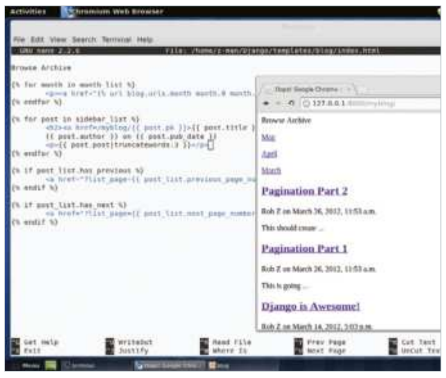
Enhance your blog with extra features

To add to the previous tutorials, we'll cover some of the more advanced features you can utilise with the power of Django

We've been building our Django blog to create and display posts, allow people to make comments, and filter posts by month like a classic blog sidebar. We still have a bit of a way to go until it looks and behaves more like a classic blog, though.

In this tutorial, we're going to add in summaries, excerpts, categories and finally an RSS feed. This allows us to look at a few things – firstly we'll get a better understanding of cross-model referencing and how that works in the admin site. We will also go through how to make changes to the database, and how Django helps when creating an SQL query.

Finally, the RSS feed is part of a standard feed library in Django itself. We will learn how to import and use it to create a simple list of the latest entries that click through to the posts. By the end of the tutorial your Django blog will finally be finished!



```
Browse Archive

{% for month in month_list %}
        <p><a href="{% url blog.urls.month month.0 month...
{% endfor %}

{% for post in sidebar_list %}
        <h2><a href=/myblog/{{ post.pk }}>{{ post.title }...
        {{ post.author }} on {{ post.pub_date }}
        <p>{{ post.post|truncatewords:3 }}</p>
{% endfor %}

{% if post_list.has_previous %}
        <a href="?list_page={{ post_list.previous_page_nu...
{% endif %}

{% if post_list.has_next %}
        <a href="?list_page={{ post_list.next_page_number...
{% endif %}
```

Browse Archive
May
April
March
Pagination Part 2
Rob Z on March 26, 2012, 11:53 a.m.
This should create ...
Pagination Part 1
Rob Z on March 26, 2012, 11:53 a.m.
This is going ...
Django is Awesome!
Rob Z on March 14, 2012, 5:03 a.m.

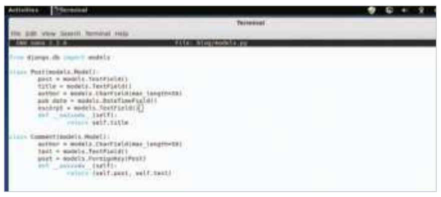
01 Summarise

On a normal blog we're going to have much longer articles. We can generate a summary of each of these on the index page template like so:

```
<p>{{ post.post|truncatewords:3 }}</p>
```

This automatically takes the first three words of the post – of course, you can use any number.

> **"We're going to add summaries, excerpts and an RSS feed"**



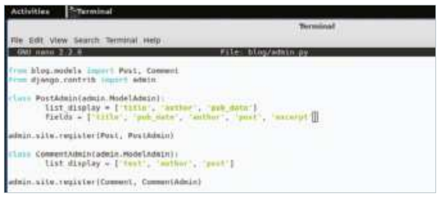
```
from django.db import models

class Post(models.Model):
        post = models.TextField()
        title = models.TextField()
        author = models.CharField(max_length=50)
        pub_date = models.DateTimeField()
        excerpt = models.TextField()
        def __unicode__(self):
                return self.title

class Comment(models.Model):
        author = models.CharField(max_length=50)
        text = models.TextField()
        post = models.ForeignKey(Post)
        def __unicode__(self):
                return (self.post, self.text)
```

02 Manual excerpt

If you don't want an automatic summary, we can add an excerpt field to our post model so you can craft one manually:

```
excerpt = models.TextField()
```

To limit the characters in your excerpt, use a CharField like for our author section.



```
from blog.models import Post, Comment
from django.contrib import admin

class PostAdmin(admin.ModelAdmin):
        list_display = ['title', 'author', 'pub_date']
        fields = ['title', 'pub_date', 'author', 'post', 'excerpt']

admin.site.register(Post, PostAdmin)

class CommentAdmin(admin.ModelAdmin):
        list_display = ['text', 'author', 'post']

admin.site.register(Comment, CommentAdmin)
```

03 Write an excerpt

To write the excerpt, or append it to the previous posts, we'll have to add it to the admin page. Open up admin.py and edit the fields section of the AdminPost class to add excerpt:

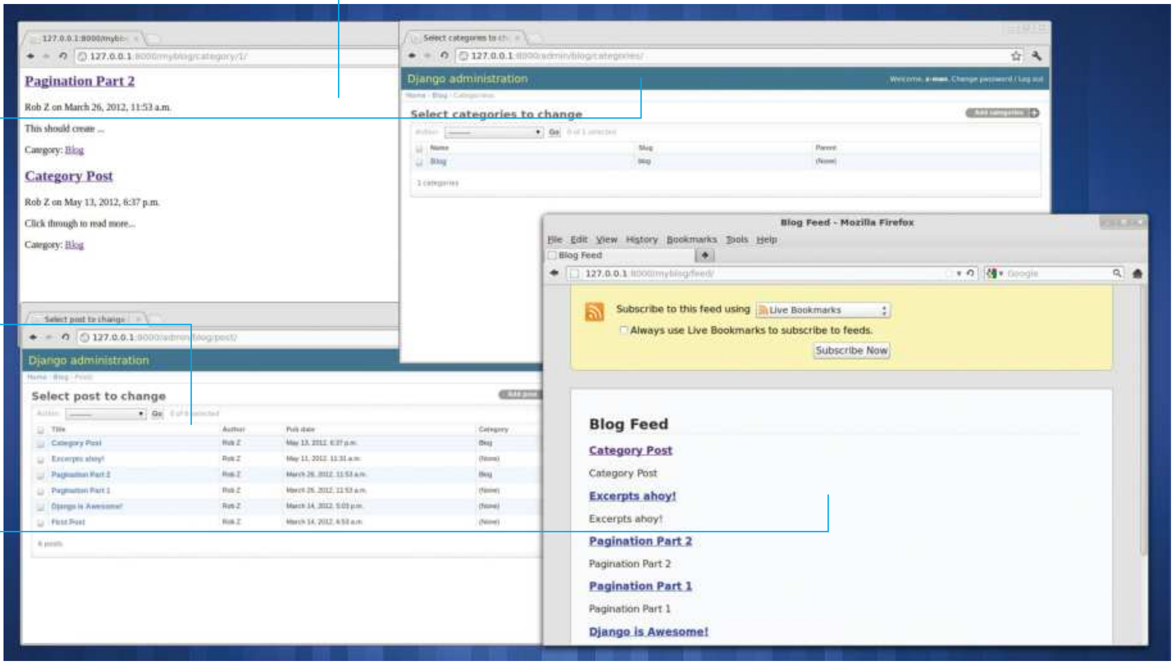
```
fields = ['title', 'pub_date',
'author', 'post', 'excerpt']
```

Have automatic summaries or manually crafted excerpts for your blog posts

Create and manage parent and child categories as a separate function of the blog

Learn how to alter the database to create posts with categories, and add them to other posts

Create custom RSS feeds using built-in Django functions



04 Excerpt or summary

You can replace the post content in the index template with the excerpt, but we can keep it as a backup for if the excerpt is empty:

```
{% if post.excerpt %} <p>{{ post.
excerpt }}</p> {% else %} <p>{{ post.
post|truncatewords:3 }}</p> {% endif %}
```

05 Database error

If you've decided to test the changes, you'll have noticed our web server has stopped working. This is because there is no excerpt column in our database. Therefore we need to add the excerpt column. To find out how, run:

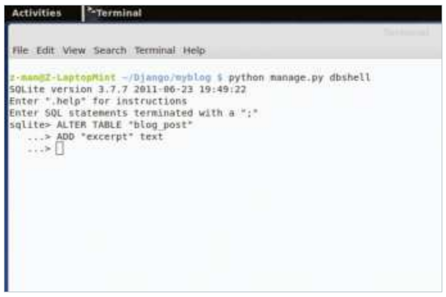
```
$ python manage.py sqlall blog
```

06 Database query

The output will show you what the SQL code is to add the models to the database. We want to add the excerpt field specifically, which should look something like this:

```
"excerpt" text NOT NULL
```

Make a note of it.



```
z-man@Z-LaptopMint ~/Django/myblog $ python manage.py dbshell
SQLite version 3.7.7 2011-06-23 19:49:22
Enter ".help" for instructions
Enter SQL statements terminated with a ";"
sqlite> ALTER TABLE "blog_post"
   ...> ADD "excerpt" text
   ...> 
```

07 Alter table

To get into the database shell and add the field, run: `$ python manage.py dbshell` Then we need to use an ALTER TABLE query:

```
ALTER TABLE "blog_post".
```

And then enter the code we noted down like so:

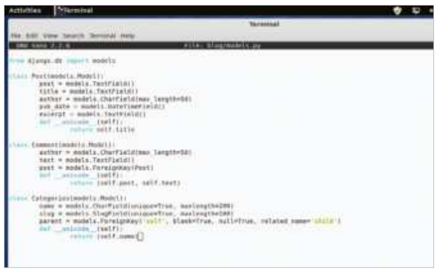
```
ADD "excerpt" text;
```

08 Save the changes

We've removed NOT NULL as we already have entries that won't have an excerpt, and want to make it so an auto summary can be made. Save the changes with: `COMMIT;` and then exit the shell with: `.quit`

09 Test it out

Now we can test out the excerpt code – create a new post or edit an existing one to have an excerpt. If you've followed our steps correctly it should work; if not, you may need to do a bit of bug fixing.

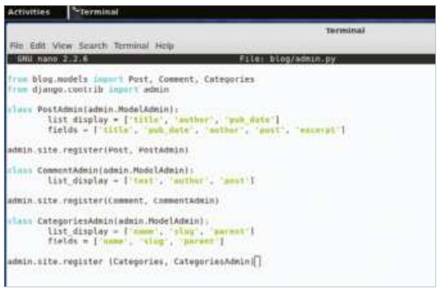


```
from django.db import models

class Post(models.Model):
        post = models.TextField()
        title = models.TextField()
        author = models.CharField(max_length=50)
        pub_date = models.DateTimeField()
        excerpt = models.TextField()
        def __unicode__(self):
                return self.title

class Comment(models.Model):
        author = models.CharField(max_length=50)
        text = models.TextField()
        post = models.ForeignKey(Post)
        def __unicode__(self):
                return (self.post, self.text)

class Categories(models.Model):
        name = models.CharField(unique=True, max_length=200)
        slug = models.SlugField(unique=True, max_length=100)
        parent = models.ForeignKey('self', blank=True, null=True, related_name='child')
        def __unicode__(self):
                return (self.name)
```

10 Category model

We can add a model for blog categories: `class Categories(models.Model): name = models.CharField(unique=True, max_length=200) slug = models.SlugField(unique=True, max_length=100) parent = models.ForeignKey('self', blank=True, null=True, related_name='child') def __unicode__(self): return (self.name)`

This allows for parent and child categories.



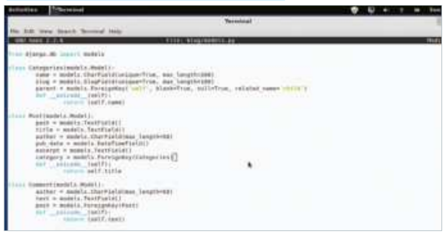
```
from blog.models import Post, Comment, Categories
from django.contrib import admin

class PostAdmin(admin.ModelAdmin):
        list_display = ['title', 'author', 'pub_date']
        fields = ['title', 'pub_date', 'author', 'post', 'excerpt']

admin.site.register(Post, PostAdmin)

class CommentAdmin(admin.ModelAdmin):
        list_display = ['text', 'author', 'post']

admin.site.register(Comment, CommentAdmin)

class CategoriesAdmin(admin.ModelAdmin):
        list_display = ['name', 'slug', 'parent']
        fields = ['name', 'slug', 'parent']

admin.site.register (Categories, CategoriesAdmin)
```

11 Administrate categories

We can add it to the admin site by creating a Categories section in admin.py: `class CategoriesAdmin(admin.ModelAdmin): list_display = ['name', 'slug', 'parent'] fields = ['name', 'slug', 'parent'] admin.site.register(Categories, CategoriesAdmin)`

Before we can make categories, though, we need to create the database table:

`$ python manage.py syncdb`



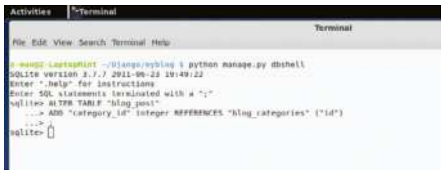
12 Categorise the posts

Similarly to what we did with the comments, we want to add a ForeignKey to the Post model so we can attribute a post to a category. Add this line: `category = models.ForeignKey(Categories)`

And move Categories to the top of models.py.

13 Database category

Like before, we'll find out the SQL needed to alter the table: `$ python manage.py sqlall blog` Which for our example returns a somewhat different code than before: `"category_id" integer NOT NULL REFERENCES "blog_categories" ("id")` It's an ID we're getting, not text, from the categories table.



```
-LaptopMint ~/Django/myblog $ python manage.py dbshell
SQLite version 3.7.7 2011-06-23 19:49:22
Enter ".help" for instructions
Enter SQL statements terminated with a ";"
sqlite> ALTER TABLE "blog_post"
   ...> ADD "category_id" integer REFERENCES "blog_categories" ("id")
   ...> ;
sqlite> 
```

14 Alter table – part 2

Again let's enter the database shell: `python manage.py dbshell` We'll continue much like before, but with the new code: `ALTER TABLE "blog_post" ADD "category_id" integer REFERENCES "blog_categories" ("id");` And finally, to save: `COMMIT;`

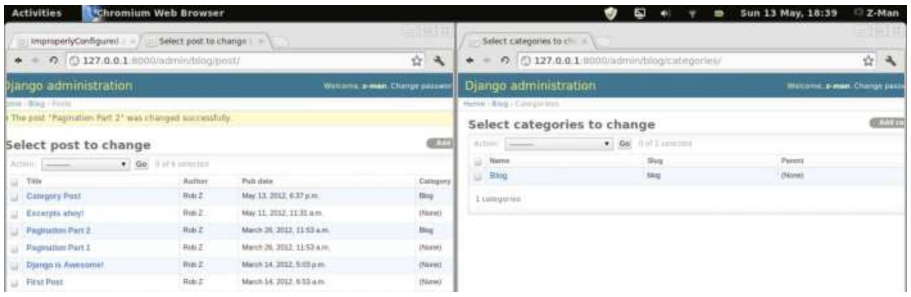
"We can now create categories separately"

16 Category display

As our urls.py in the blog directory gets all the post fields, to the index template we just add: `<p>Category: {{ post.category }}</p>` And to the post template: `<p>Category: {{ post_list.category }}</p>`

17 Category page

First we need to define our category in blog/urls.py. Import Categories and then add: `def blog_categories(request, category_id): categories = Categories.objects.get(pk=category_id)` We need the category_id to call the corresponding posts.



Select post to change

Title	Author	Pub date	Category
Category Post	Rob Z	May 13, 2012, 6:37 p.m.	Blog
Excerpts ahoy!	Rob Z	May 11, 2012, 11:31 a.m.	(None)
Pagination Part 2	Rob Z	March 26, 2012, 11:53 a.m.	Blog
Pagination Part 1	Rob Z	March 26, 2012, 11:53 a.m.	(None)
Django is Awesome!	Rob Z	March 14, 2012, 5:03 p.m.	(None)
First Post	Rob Z	March 14, 2012, 6:53 a.m.	(None)

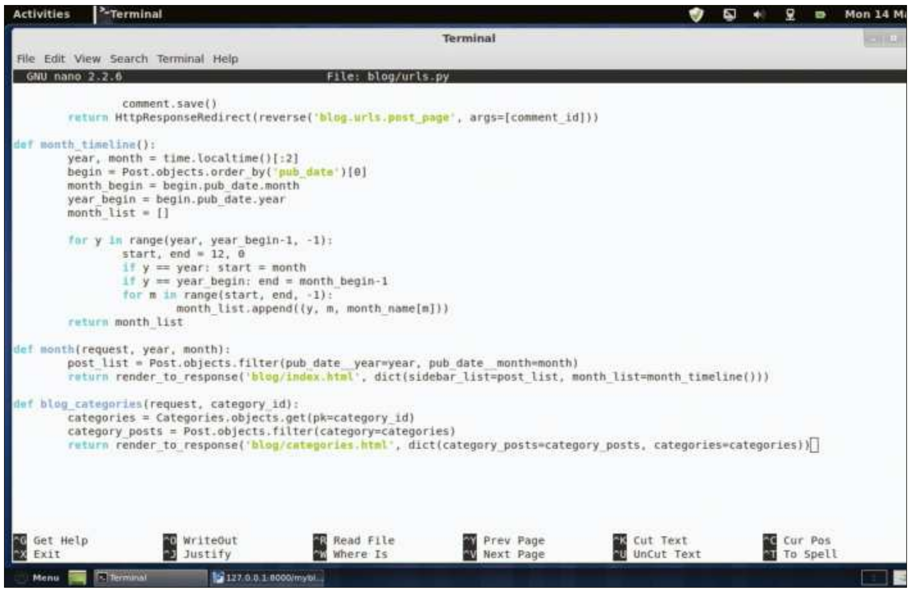
Select categories to change

Name	Slug	Parent
Blog	blog	(None)

1 categories

15 Administrate categories – part 2

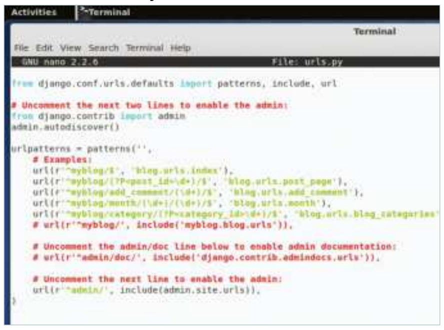
Now we can go back to admin.py and add the new category fields to the PostAdmin model: `list_display = ['title', 'author', 'pub_date', 'category'] fields = ['title', 'pub_date', 'author', 'post', 'excerpt', 'category']` Our previous blog posts with no category have disappeared! To fix this, go back to models.py and make this change to the Post model: `category = models.ForeignKey(Categories, blank=True, null=True)` So we can now create categories separately, assign them to posts, and view posts without a category.



```
GNU nano 2.2.6                    File: blog/urls.py

                comment.save()
        return HttpResponseRedirect(reverse('blog.urls.post_page', args=[comment_id]))

def month_timeline():
        year, month = time.localtime()[:2]
        begin = Post.objects.order_by('pub_date')[0]
        month_begin = begin.pub_date.month
        year_begin = begin.pub_date.year
        month_list = []

        for y in range(year, year_begin-1, -1):
                start, end = 12, 0
                if y == year: start = month
                if y == year_begin: end = month_begin-1
                for m in range(start, end, -1):
                        month_list.append((y, m, month_name[m]))
        return month_list

def month(request, year, month):
        post_list = Post.objects.filter(pub_date__year=year, pub_date__month=month)
        return render_to_response('blog/index.html', dict(sidebar_list=post_list, month_list=month_timeline()))

def blog_categories(request, category_id):
        categories = Categories.objects.get(pk=category_id)
        category_posts = Post.objects.filter(category=categories)
        return render_to_response('blog/categories.html', dict(category_posts=category_posts, categories=categories))
```

18 Category definition

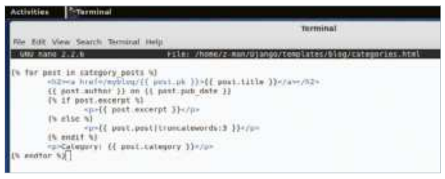
Finish the definition by using the parent_id to filter the correct Posts, then render the response: `category_posts = Post.objects.filter(category=categories) return render_to_response('blog/categories.html', dict(category_posts=category_posts, categories=categories))`
Again we're calling a new template that we'll construct shortly.



```
GNU nano 2.2.6                    File: urls.py

from django.conf.urls.defaults import patterns, include, url

# Uncomment the next two lines to enable the admin:
from django.contrib import admin
admin.autodiscover()

urlpatterns = patterns('',
    # Examples:
    url(r'^myblog/$', 'blog.urls.index'),
    url(r'^myblog/(?P<post_id>\d+)/$', 'blog.urls.post_page'),
    url(r'^myblog/add_comment/(\d+)/$', 'blog.urls.add_comment'),
    url(r'^myblog/month/(\d+)/(\d+)/$', 'blog.urls.month'),
    url(r'^myblog/category/(?P<category_id>\d+)/$', 'blog.urls.blog_categories'
    # url(r'^myblog/', include('myblog.blog.urls')),

    # Uncomment the admin/doc line below to enable admin documentation:
    # url(r'^admin/doc/', include('django.contrib.admindocs.urls')),

    # Uncomment the next line to enable the admin:
    url(r'^admin/', include(admin.site.urls)),
)
```

19 Category URLs

We'll create the URL in urls.py as for the post page, only it'll give the slug of the category instead of an ID in the link: `url(r'^myblog/category/(?P<category_id>\d+/$', 'blog.urls.blog_categories'),`



```
GNU nano 2.2.6        File: /home/z-man/Django/templates/blog/categories.html

{% for post in category_posts %}
        <h2><a href=/myblog/{{ post.pk }}>{{ post.title }}</a></h2>
        {{ post.author }} on {{ post.pub_date }}
        {% if post.excerpt %}
                <p>{{ post.excerpt }}</p>
        {% else %}
                <p>{{ post.post|truncatewords:3 }}</p>
        {% endif %}
        <p>Category: {{ post.category }}</p>
{% endfor %}
```

20 Category template

We'll use something similar to the Index and Post template to create a category page template: `{% for post in category_posts %} <h2><a href=/myblog/{{ post.pk }}>{{ post.title }}</a></h2> {{ post.author }} on {{ post.pub_date }} % if post.excerpt %} <p>{{ post.excerpt }}</p> {% else %} <p>{{ post.post|truncatewords:3 }}</p> {% endif %} <p>Category: {{ post.category }}</p> {% endfor %}`

21 Category clickthrough

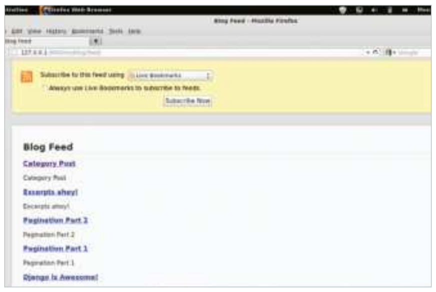
Finally, let's make the categories click through to the relevant page by changing the category display to be: `<p>Category: <a href=/myblog/category/{{ categories.pk }}>{{ post.category }}</a></p>` This can go on the categories, post and index template.

22 RSS

Django has a built-in RSS framework. In blog/urls.py add: `from django.contrib.syndication.views import Feed class BlogFeed(Feed): title = "Blog Feed" link = "/" def items(self): return Post.objects.order_by("-pub_date") def item_title(self, post): return post.title`

23 RSS links

We need to define item_link for the feed so that the feed items can link to the right place. We have to give the complete URL and the post ID for it work: `def item_link(self, post): link = "http://127.0.0.1:8000/myblog/"+str(post.pk) return link`

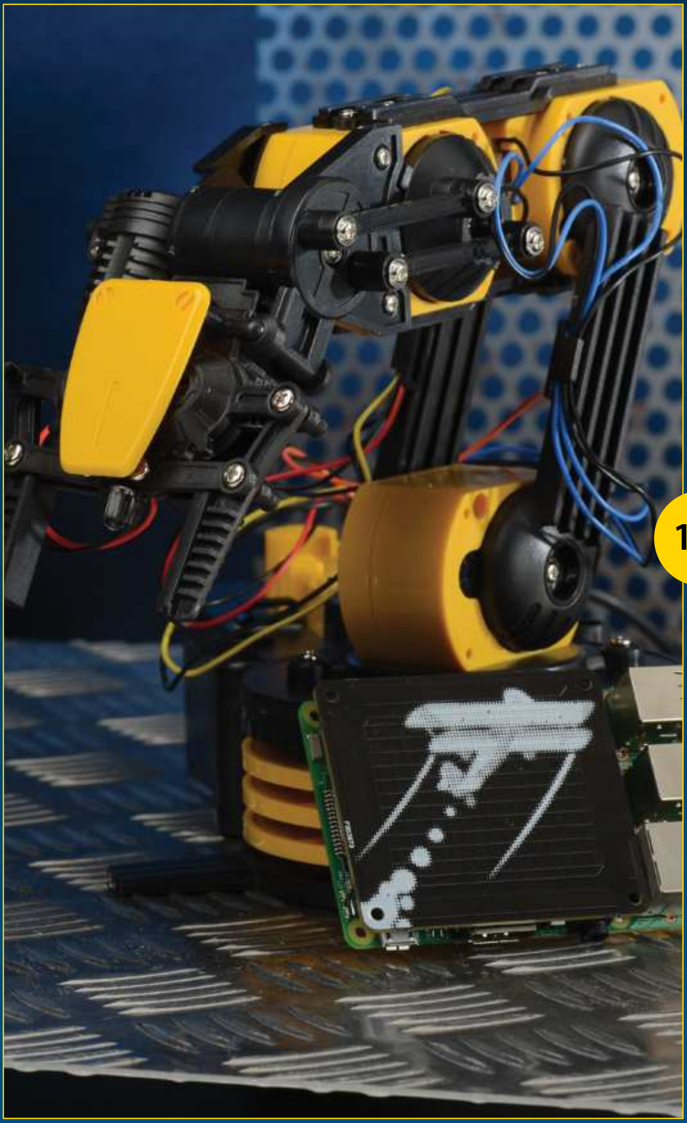


24 RSS URLs

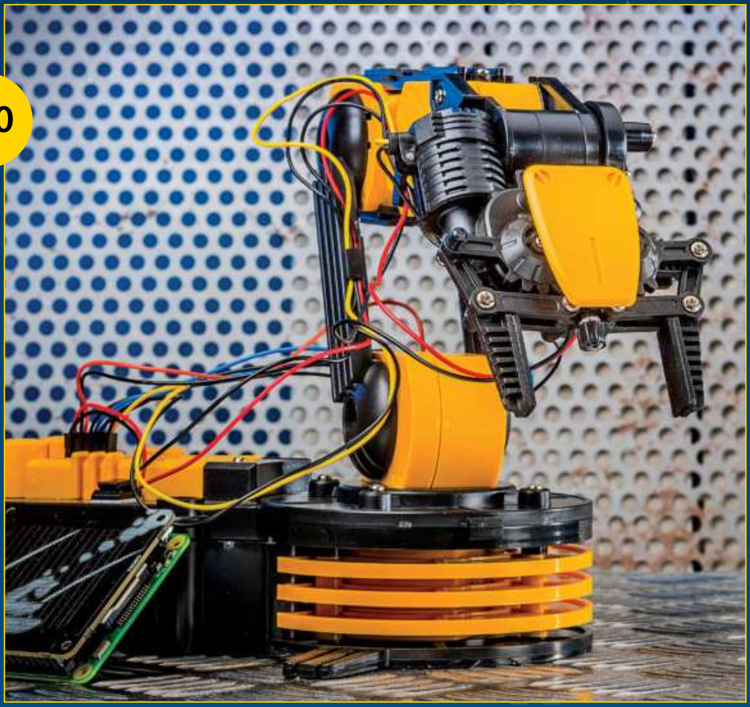
The final step is adding the feed URL to urls.py: `url(r'^myblog/feed/$', BlogFeed()),` And now your blog is now fully functional. With a bit more tweaking and theming, you can get it online and blog away!

"Finally, let's make the categories click through to the relevant page"

Use Python with Pi



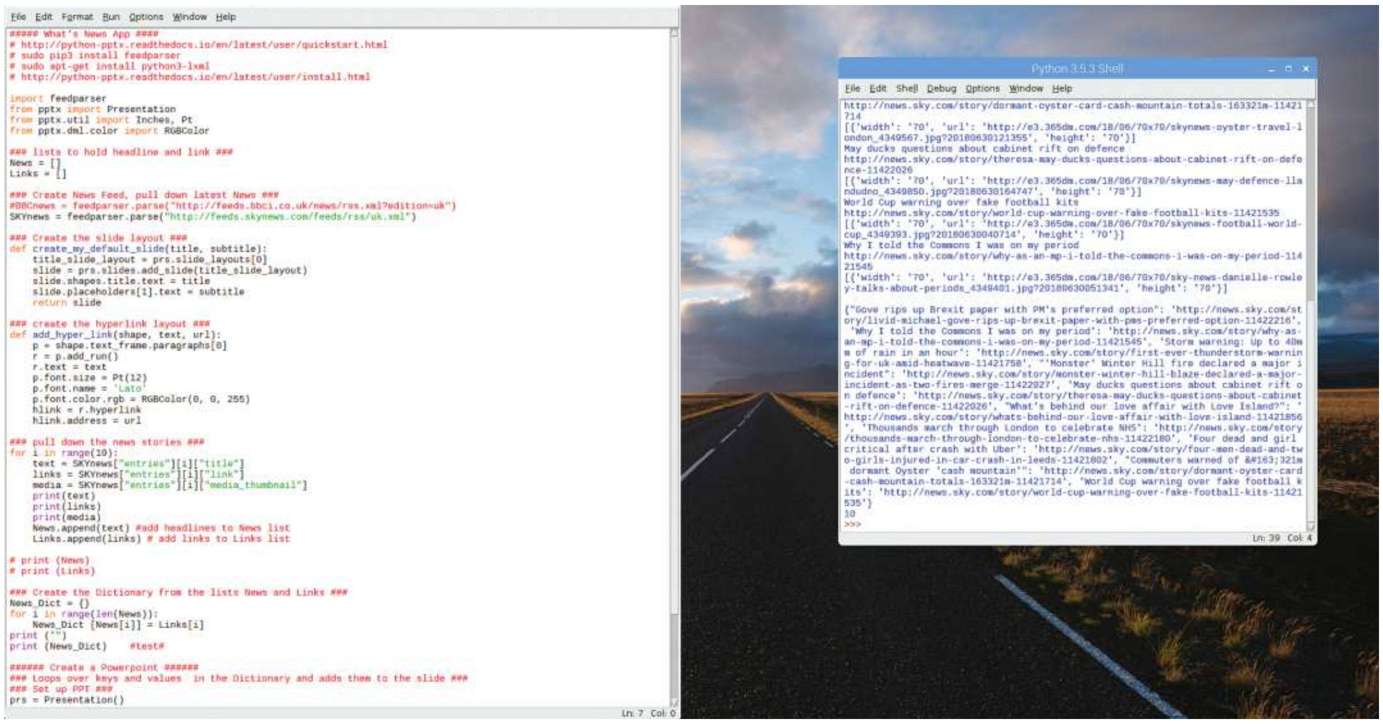
160



168

Raspberry Pi: Build an automated news machine

Use Python code to pull down the latest news into a simple presentation, with hyperlinks to each story



```
##### What's News App ####
# http://python-pptx.readthedocs.io/en/latest/user/quickstart.html
# sudo pip3 install feedparser
# sudo apt-get install python3-lxml
# http://python-pptx.readthedocs.io/en/latest/user/install.html

import feedparser
from pptx import Presentation
from pptx.util import Inches, Pt
from pptx.dml.color import RGBColor

### lists to hold headline and link ###
News = []
Links = []

### Create News Feed, pull down latest News ###
#BBCnews = feedparser.parse("http://feeds.bbci.co.uk/news/rss.xml?edition=uk")
SKYnews = feedparser.parse("http://feeds.skynews.com/feeds/rss/uk.xml")

### Create the slide layout ###
def create_my_default_slide(title, subtitle):
    title_slide_layout = prs.slide_layouts[0]
    slide = prs.slides.add_slide(title_slide_layout)
    slide.shapes.title.text = title
    slide.placeholders[1].text = subtitle
    return slide

### create the hyperlink layout ###
def add_hyper_link(shape, text, url):
    p = shape.text_frame.paragraphs[0]
    r = p.add_run()
    r.text = text
    p.font.size = Pt(12)
    p.font.name = 'Lato'
    p.font.color.rgb = RGBColor(0, 0, 255)
    hlink = r.hyperlink
    hlink.address = url

### pull down the news stories ###
for i in range(10):
    text = SKYnews["entries"][i]["title"]
    links = SKYnews["entries"][i]["link"]
    media = SKYnews["entries"][i]["media_thumbnail"]
    print(text)
    print(links)
    print(media)
    News.append(text) #add headlines to News list
    Links.append(links) # add links to Links list

# print (News)
# print (Links)

### Create the Dictionary from the lists News and Links ###
News_Dict = {}
for i in range(len(News)):
    News_Dict [News[i]] = Links[i]
print ("")
print (News_Dict)    #test#

###### Create a Powerpoint ######
### Loops over keys and values  in the Dictionary and adds them to the slide ###
### Set up PPT ###
prs = Presentation()
```

```
http://news.sky.com/story/dormant-oyster-card-cash-mountain-totals-163321m-11421
714
[{'width': '70', 'url': 'http://e3.365dm.com/18/06/70x70/skynews-oyster-travel-l
ondon_4349567.jpg?20180630121355', 'height': '70'}]
May ducks questions about cabinet rift on defence
http://news.sky.com/story/theresa-may-ducks-questions-about-cabinet-rift-on-defe
nce-11422026
[{'width': '70', 'url': 'http://e3.365dm.com/18/06/70x70/skynews-may-defence-lla
ndudno_4349850.jpg?20180630164747', 'height': '70'}]
World Cup warning over fake football kits
http://news.sky.com/story/world-cup-warning-over-fake-football-kits-11421535
[{'width': '70', 'url': 'http://e3.365dm.com/18/06/70x70/skynews-football-world-
cup_4349393.jpg?20180630040714', 'height': '70'}]
Why I told the Commons I was on my period
http://news.sky.com/story/why-as-an-mp-i-told-the-commons-i-was-on-my-period-114
21545
[{'width': '70', 'url': 'http://e3.365dm.com/18/06/70x70/sky-news-danielle-rowle
y-talks-about-periods_4349401.jpg?20180630051341', 'height': '70'}]

{"Gove rips up Brexit paper with PM's preferred option": 'http://news.sky.com/st
ory/livid-michael-gove-rips-up-brexit-paper-with-pms-preferred-option-11422216',
 'Why I told the Commons I was on my period': 'http://news.sky.com/story/why-as-
an-mp-i-told-the-commons-i-was-on-my-period-11421545', 'Storm warning: Up to 40m
m of rain in an hour': 'http://news.sky.com/story/first-ever-thunderstorm-warnin
g-for-uk-amid-heatwave-11421758', "'Monster' Winter Hill fire declared a major i
ncident": 'http://news.sky.com/story/monster-winter-hill-blaze-declared-a-major-
incident-as-two-fires-merge-11422027', 'May ducks questions about cabinet rift o
n defence': 'http://news.sky.com/story/theresa-may-ducks-questions-about-cabinet
-rift-on-defence-11422026', "What's behind our love affair with Love Island?": '
http://news.sky.com/story/whats-behind-our-love-affair-with-love-island-11421856
', 'Thousands march through London to celebrate NHS': 'http://news.sky.com/story
/thousands-march-through-london-to-celebrate-nhs-11422180', 'Four dead and girl
critical after crash with Uber': 'http://news.sky.com/story/four-men-dead-and-tw
o-girls-injured-in-car-crash-in-leeds-11421802', "Commuters warned of &#163;321m
 dormant Oyster 'cash mountain'": 'http://news.sky.com/story/dormant-oyster-card
-cash-mountain-totals-163321m-11421714', 'World Cup warning over fake football k
its': 'http://news.sky.com/story/world-cup-warning-over-fake-football-kits-11421
535'}
10
>>>
```

News is everywhere. We are constantly bombarded with news stories via mobile devices, tablets, laptops, TVs and radios. You probably also overhear people discussing news stories. Traditionally the type of newspaper that you read was used to indicate what type of person you were – a kind of litmus test of your income, political views, social status and where your ethics and morals are aligned. For example, an article by IBT in 2013 found that 40 per cent of readers of the *New Yorker* were making more than $75,000 (approximately £59,000) a year.

Nowadays, the news caters for every taste with variations such as gossip, detailed, statistical analysis, photographic and so many more. Then there is 'fake news', which is by no means a modern concept – its roots go back to the Second World War.

Whatever your news preference, this tutorial will walk you through customising and building your own bespoke, automated 'News Machine'. Select your favourite news source and use feedparser to pull down five, ten, 15 or more news stories. Then use python-pptx to write your news data into a presentation and save it to your folder. Open the file, and you have your own customised newspaper that includes up to the minute news headlines and a hyperlink to each of the stories. Don't like what you're reading? Simply change your source and run the program again.

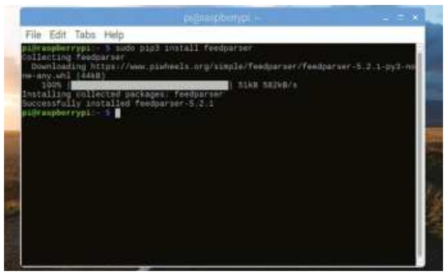
UK wetter and hotter than at any time in a century

Above Harvest stories from news sites to create your own feed

Resources

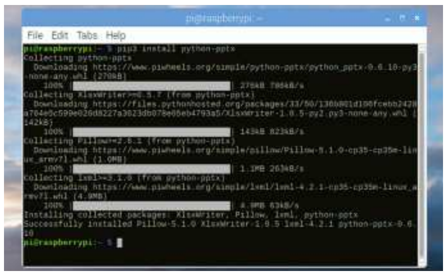
feedparser:
github.com/kurtmckee/feedparser

Python-pptx
github.com/scanny/python-pptx



```
pi@raspberrypi:~ $ sudo pip3 install feedparser
Collecting feedparser
  Downloading https://www.piwheels.org/simple/feedparser/feedparser-5.2.1-py3-no
ne-any.whl (44kB)
    100% |████████████████████████████████| 51kB 582kB/s
Installing collected packages: feedparser
Successfully installed feedparser-5.2.1
pi@raspberrypi:~ $ 
```

01 Install feedparser
The program uses a Python library called feedparser. The process of parsing basically means taking input from a string and then returning some data. feedparser applies this process to web feeds such as RSS, Atom and RDF. In our program, feedparser is used to collect input from news websites, which is then downloaded and used to pull out data, such as the headline and a hyperlink to the website where the news story is stored. Open the LXTerminal window and type `sudo pip3 install feedparser`. This will download the required Python library.

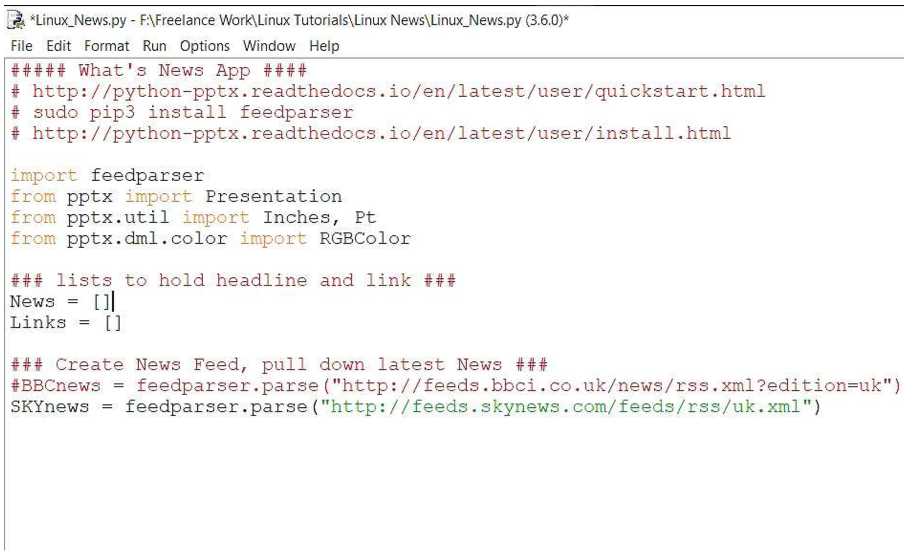


```
pi@raspberrypi:~ $ pip3 install python-pptx
Collecting python-pptx
  Downloading https://www.piwheels.org/simple/python-pptx/python_pptx-0.6.10-py3
-none-any.whl (270kB)
    100% |████████████████████████████████| 276kB 786kB/s
Collecting XlsxWriter>=0.5.7 (from python-pptx)
  Downloading https://files.pythonhosted.org/packages/33/50/136b801d190fcebb242b
a784e5c599e026d8227a3823db078e86eb4793a5/XlsxWriter-1.0.5-py2.py3-none-any.whl (
142kB)
    100% |████████████████████████████████| 143kB 823kB/s
Collecting Pillow>=2.6.1 (from python-pptx)
  Downloading https://www.piwheels.org/simple/pillow/Pillow-5.1.0-cp35-cp35m-lin
ux_armv7l.whl (1.0MB)
    100% |████████████████████████████████| 1.1MB 263kB/s
Collecting lxml>=3.1.0 (from python-pptx)
  Downloading https://www.piwheels.org/simple/lxml/lxml-4.2.1-cp35-cp35m-linux_a
rmv7l.whl (4.9MB)
    100% |████████████████████████████████| 4.9MB 63kB/s
Installing collected packages: XlsxWriter, Pillow, lxml, python-pptx
Successfully installed Pillow-5.1.0 XlsxWriter-1.0.5 lxml-4.2.1 python-pptx-0.6.
10
pi@raspberrypi:~ $ 
```

02 Install Python-pptx
Python-pptx is a program for creating customised presentations via Python code. Data from webpages, Twitter, databases and so on can be automatically captured and written to slides. The Python-pptx libaray can be used to customise the slide layout, colour, font and style. Return to the LXTerminal window and enter the command `sudo pip3 install python-pptx` to download the required library.

03 Import the required modules
Open your Python3 editor and start a new file. Begin by importing `feedparser`, line one, which is used to download the data from the news website. The next three lines enable the program to create the presentation. Import `presentation` from the Python-pptx library, line two, and then the pptx utilities, line three, which enable you to customise the point size of the font. This is useful for setting your own sizes for the news headline and the hyperlink. Last, import the colour modules, line four, so that you can change the colour of your fonts.

```
import feedparser
from pptx import Presentation
from pptx.util import Inches, Pt
from pptx.dml.color import
RGBColor
```



Linux_News.py - F:\Freelance Work\Linux Tutorials\Linux News\Linux_News.py (3.6.0)
File Edit Format Run Options Window Help

```
##### What's News App ####
# http://python-pptx.readthedocs.io/en/latest/user/quickstart.html
# sudo pip3 install feedparser
# http://python-pptx.readthedocs.io/en/latest/user/install.html

import feedparser
from pptx import Presentation
from pptx.util import Inches, Pt
from pptx.dml.color import RGBColor

### lists to hold headline and link ###
News = []
Links = []

### Create News Feed, pull down latest News ###
#BBCnews = feedparser.parse("http://feeds.bbci.co.uk/news/rss.xml?edition=uk")
SKYnews = feedparser.parse("http://feeds.skynews.com/feeds/rss/uk.xml")
```

04 Create the lists
Now create two lists to hold the data which feedparser collects from the news websites. Lists are a useful feature of programming languages and work much like shopping lists. You can add items to them, delete, edit and even merge lists. Next, create a variable and use feedparser to collect the news headlines. The code below includes two different news websites, and you can try either of them. These are used in **Step 10** to access the news data.

```
News = []
Links = []

#BBCnews = feedparser.
parse("http://feeds.bbci.co.uk/news/
rss.xml?edition=uk")
SKYnews = feedparser.parse("http://
feeds.skynews.com/feeds/rss/uk.xml)
```

05 Create the slide layout, part 1
In order to make the presentation we need to create a function which customises and builds the slides. Begin by defining the name of the function and then adding the parameters `title` and `subtitle`. When the program runs, these will be replaced with the news headline and a hyperlink to the webpage. On line two set the slide layout to `0` – this is the standard default presentation slide layout, with a title and subtitle textbox. Next create a variable which holds the slide information comprising its layout, the title and the subtitle.

```
def create_my_default_slide(title,
subtitle):
title_slide_layout = prs.slide_
layouts[0]
slide = prs.slides.add_slide(title_
slide_layout)
```

06 Create the slide layout, part 2
To complete this function we state where the parsed information needs to be placed. On line one, add the pptx code to assign the news headline from the `title` variable to an individual slide. The command `shapes` enables you to select the empty title textbox on the slide and write the news headline into it. Line two does the same except that it assigns the weblink to the second placeholder on the slide, the `subtitle` textbox.

```
slide.shapes.title.text = title
slide.placeholders[1].text =
subtitle
return slide
```

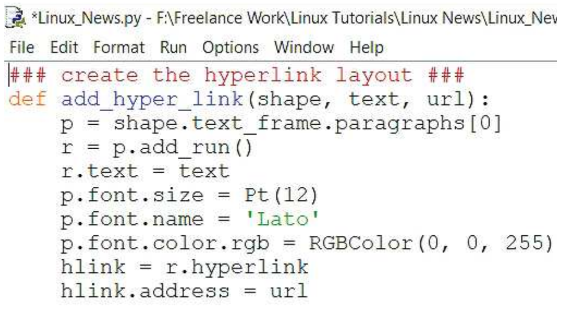
07 Create the hyperlink, part 1
Next we need to write a function to create and edit the hyperlinks. Each hyperlink needs to display a link to the web page and, when clicked on, should take the user to the specific news story on the website.

Begin the process by naming the function, line one, and add the following arguments. `shape` is used to select which box on the slide the hyperlink is written to, and `text` adds the string to the textbox. The last argument is `url`, which adds and enables a hyperlink address.

On line two, assign `shape.text_frame` to a variable named `p`. These properties enable you to manipulate the text within the frame.

Click to add title

Click to add subtitle


*Linux_News.py - F:\Freelance Work\Linux Tutorials\Linux News\Linux_Nev

File Edit Format Run Options Window Help

```
### create the hyperlink layout ###
def add_hyper_link(shape, text, url):
    p = shape.text_frame.paragraphs[0]
    r = p.add_run()
    r.text = text
    p.font.size = Pt(12)
    p.font.name = 'Lato'
    p.font.color.rgb = RGBColor(0, 0, 255)
    hlink = r.hyperlink
    hlink.address = url
```

Adding an image to each slide

On some sites it may be possible to download images and add them to your slide. Simply add the file location of the image to a variable and then use `slide.shapes.add_pictures(img_path, left, top)` to add the image and define the position of the image on the slide. Further details can be found at **http://bit.ly/lud_pptx.**

The final line of code writes the text to the textboxes.

```
def add_hyper_link(shape, text,
url):
p = shape.text_frame.paragraphs[0]
r = p.add_run()
```

08 Create the hyperlink, part 2

The middle section of the function defines font attributes. Line one adds the text which is collected in **Step 10** from the news website to the text frame. On line two, we use `p.font.size` to set the size of the font. This uses standard point sizes, which are abbreviated to `Pt` followed by the actual size – we're using 12pt here, but of course you can change it.On line three, we assign the font typeface we want to use. In the code below it's set to `Lato`. If you like, replace this with the name of your preferred font choice. Note the use of the `r.` and `p.` from the previous step to add and manipulate the text within the text frame.

```
r.text = text
p.font.size = Pt(12)
p.font.name = 'Lato'
```

09 Create the hyperlink, part 3

The final part of the function enables you to customise the colour of the hyperlink that appears on the slide. This uses the standard RGB colour values. Add line one, which sets the text font to pure blue – or you can change the values to add your own customised colour. On line two use the code `r.hyperlink` to turn text into a working hyperlink; this is then assigned to a variable called `hlink`. Then use this variable to convert the URL from the downloaded data into a hyperlink, line three.

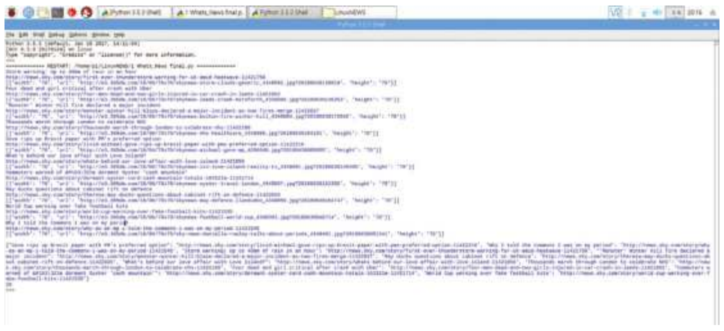
```
p.font.color.rgb = RGBColor(0, 0,
255)
    hlink = r.hyperlink
    hlink.address = url
```

10 Pull down news stories

The main part of the program uses a `for` loop on line one to pull down the news data. The value 10 refers to how many stories the program will pull down; again, you can always change this later on if you want more or fewer. On line two, we create a variable to hold the headlines from the Sky News website; this accesses and uses the feedparser that we created in **Step 4**.

On the next line we do the same for the hyperlinks. This returns the website hyperlinks for the first 10 news stories. At the end of this step you can save and run your program to see if it's working correctly. It won't create the presentation yet, but you will be presented with 10 news stories and 10 links.

```
for i in range(10):
    text = SKYnews["entries"][i]
```


[illegible]

```
["title"]
        links = SKYnews["entries"][i]
["link"]
        print(text)
        print(links
```

11 Append the data to the lists

In **Step 4** we created two lists named News and Links. In this step we add the news headlines that are stored in the variable from the previous step, named `text`, to the News list, line one. This uses the append function which adds each headline to the end of the list. Next, do the same for the hyperlinks, appending them to the Links list that we created in **Step 4**.

```
News.append(text) #add headlines to
News list
Links.append(links) #add links to
Links list
```

12 Create a dictionary of news and links

Now that we have a list of headlines and a list of hyperlinks, we can combine them into a dictionary. This works in the same way as any dictionary: you look up the word and it gives you a definition. In this program, however, the keyword is the headline and the definition is the hyperlink. Create a new dictionary named `News_Dict`, line one. Then for each entry in the News list, add it to the dictionary, assigning the hyperlink to the News headline, line three. The last line of code can be omitted, but it's useful for testing the code.

```
News_Dict = {}
for i in range(len(News)):
    News_Dict [News[i]] = Links[i]
print (News_Dict)
```

13 Create the presentation, part 1

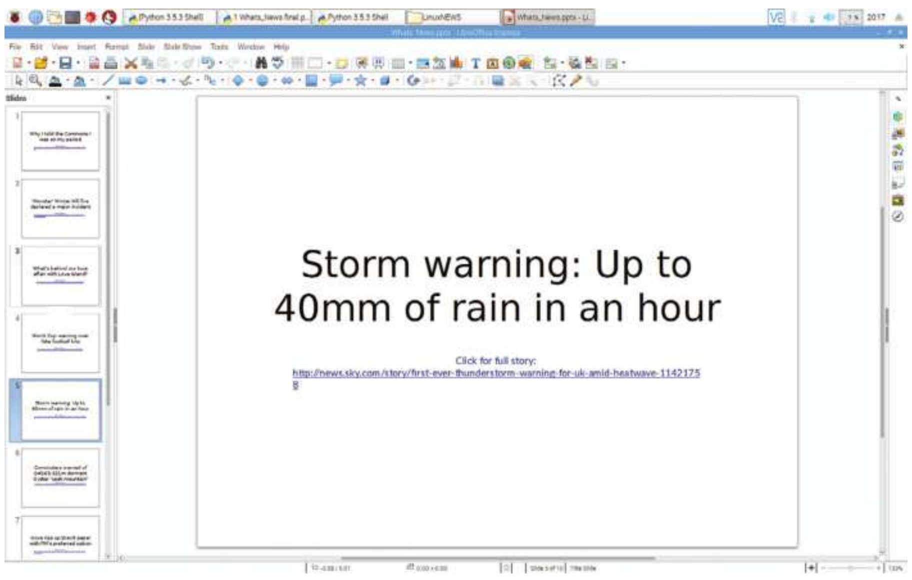
The last section of the program creates the presentation. First assign the `Presentation()` class to the variable `prs`. Next create a `for` loop, which for each of the entries in the dictionary creates a new slide using the function from **Step 5**. This places the headline into the title placeholder on the slide, and then places the hyperlink into the subtitle placeholder. As hyperlink addresses are not always user friendly and could be any length, we should assign the hyperlink address the text label `Click for full story`, which we do in line three.

```
prs = Presentation()
for key, value in News_Dict.
items():
        this_slide = create_my_
default_slide("%s" % key, "Click for
full story: ")
```

14 Create the presentation, part 2

For the next step, we need to write the hyperlinks to each slide. In **Step 8** and **9**, the function converts the text string into an operational hyperlink. Line one uses the `add` method to write each unique hyperlink to the text label on each slide. The label is selected using the code `this_slide.shapes[1]`, where `[1]` refers to the second textbox on the slide. The final line of code is actually optional, and prints out the total number of slides in the presentation. This is useful for checking that the program is working accurately –ten news stories should always create ten slides.

```
add_hyper_link(this_slide.shapes[1],
value, value)
print(len(prs.slides))
```


Storm warning: Up to 40mm of rain in an hour

Click for full story:
http://news.sky.com/story/first-ever-thunderstorm-warning-for-uk-amid-heatwave-11421758

15 Create the presentation, part 3

The final line of the program, `prs.save()`, builds and saves the presentation. The presentation file is saved to the same folder where the Python program is stored and executed from. You can alter the file location and the name of the file if you need to do so.

```
prs.save('Whats_News.pptx')
```

16 Run the program

Save your code and then run it by pressing F5. The program will connect to the news website and download stories. You can adjust the number that you require by editing the value in step 10.

The program then bundles the slides together and exports them as a file with the .pptx extension (Microsoft PowerPoint's default format). You can view the presentation directly on the Raspberry Pi using Libre Office, or transfer the file to another device and use most standard presentation software to open it.

Feel free, of course, to improve the program further – perhaps by adding some error-checking code in case the downloading of data fails for some reason.

Make the What's News? app

Why not create an automated news machine, and add email functionality and a button to trigger up-to-the-minute news feeds? Simply press the big red button and the program runs, pulls down the news, creates the presentation and then emails it to a preselected account. It's great for educational environments; see **http://www.tecoed.co.uk/whats-news-app.html**.

Tutorial files available:
filesilo.co.uk

Control a Robotic Arm with just your fingertips

Build, hack and move a robotic arm with flicks, finger movements and gestures

Resources

Maplin Robotic Arm
Pimoroni Skywriter
Raspberry Pi 2, 3 or 4

This tutorial combines the Maplin Robotic Arm and Pimoroni's Skywriter HAT to enable you to take control of the robot with just the touch of your fingertips. The arm can move through three points of articulation and ends in a clamp to give you maximum flexibility with movement. The arm also moves through 120 degrees in the wrist, 300 degrees at the elbow, 180 degrees at the base in the vertical and 270 degrees in the horizontal. It is easy to assemble and is a great beginners' robot. In this tutorial you will first install the Python modules to enable your Raspberry Pi to interact with the USB port, and then learn how to use Python code to send commands to and receive them from the arm. Next we'll write a simple program to control the arm; this is actually great fun and you can start to practice picking up objects and then trying to move them to another location. The Skywriter is an electrical near-field 3D-sensing board that recognises a number of gestures including taps and flicks. These gestures can be made at a specific location on the board (north, south, east, west or in the centre) then programmed to respond in a particular way.

The second half of the tutorial shows you how to install and set up the Skywriter and code some of the gestures. Finally, both the arm and the Skywriter code are combined to create a program where you assign a particular arm movement to a particular gesture, creating the controls at your fingertips. For example, a tap on the north of the board could move the arm up, a tap at the bottom (the south position) could move it downwards. Watch this video to see the project in action: https://www.youtube.com/watch?v=SVDXbcSi08I

01 Build your Robot Arm

The Robotic Arm comes in kit form with a detailed set of instructions covering how to build the parts and combine them into the final arm. This will take you around three or so hours which is perfect for a rainy day. The arm kit includes all the required parts except for the batteries. The trickiest part is to ensure that the wiring is the correct way round. This will not damage the arm but it will result in the arm moving in the opposite direction to the programmed direction.

02 Update your Pi

After building the arm, plug in your Raspberry Pi and boot it up. At this point do not plug in the arm. First update the software and OS. Ensure that your Pi is connected to the Internet, open the LX terminal window and type,

```
$ sudo apt-get update
$ sudo apt-get upgrade
```

Wait for the software to download and install, then reboot, typing `sudo reboot`.

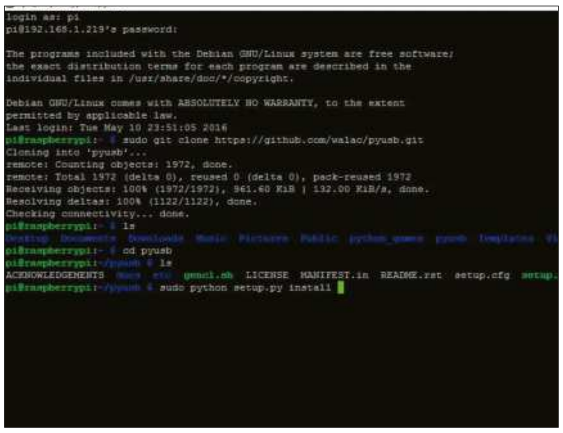
03 Install the PyUSB software

To use the Python programming language to interact with your robot arm, first install the PyUSB module. It provides a connection with Python and easy access to your Raspberry Pi's Universal Serial Bus (USB) where the arm is plugged in.

In the terminal window, type:

```
sudo git clone https://github.com/walac/pyusb.git
```

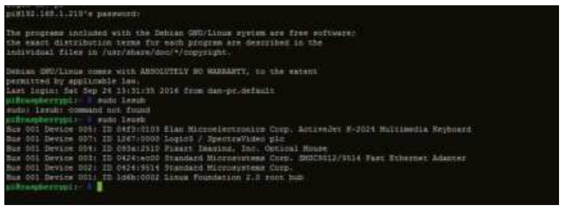
Once installed move to the pyusb folder, type `cd pyusb`, then type the code `sudo python setup.py install`. This will install the required module. Finally, reboot your Raspberry Pi with `sudo reboot`.



```
login as: pi
pi@192.168.1.219's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Tue May 10 23:51:05 2016
pi@raspberrypi:~ $ sudo git clone https://github.com/walac/pyusb.git
Cloning into 'pyusb'...
remote: Counting objects: 1972, done.
remote: Total 1972 (delta 0), reused 0 (delta 0), pack-reused 1972
Receiving objects: 100% (1972/1972), 961.60 KiB | 132.00 KiB/s, done.
Resolving deltas: 100% (1122/1122), done.
Checking connectivity... done.
pi@raspberrypi:~ $ ls
Desktop  Documents  Downloads  Music  Pictures  Public  python_games  pyusb  Templates  Vi
pi@raspberrypi:~ $ cd pyusb
pi@raspberrypi:~/pyusb $ ls
ACKNOWLEDGEMENTS  docs  etc  gendl.sh  LICENSE  MANIFEST.in  README.rst  setup.cfg  setup.
pi@raspberrypi:~/pyusb $ sudo python setup.py install
```

04 Attach the robotic arm to the Pi

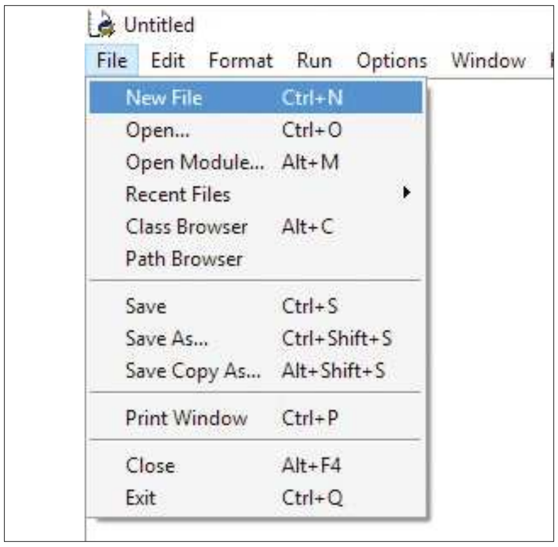
Now that you have installed the required software to program the arm, plug it in. To do this simply take the USB lead from the arm and slot it into one of the available USB sockets on your Raspberry Pi. Turn the arm on using the power switch located on the base of the arm. You can test that the connection is live and the arm is recognised by opening the LX Terminal and typing `sudo lssub`. This will return a list of the hardware connected to the USB ports.



```
pi@192.168.1.219's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Sep 24 13:31:35 2016 from dan-pc.default
pi@raspberrypi:~ $ sudo lssub
sudo: lssub: command not found
pi@raspberrypi:~ $ sudo lsusb
Bus 001 Device 005: ID 04f3:0103 Elan Microelectronics Corp. ActiveJet K-2024 Multimedia Keyboard
Bus 001 Device 007: ID 1267:0000 Logic3 / SpectraVideo plc
Bus 001 Device 004: ID 093a:2510 Pixart Imaging, Inc. Optical Mouse
Bus 001 Device 003: ID 0424:ec00 Standard Microsystems Corp. SMSC9512/9514 Fast Ethernet Adapter
Bus 001 Device 002: ID 0424:9514 Standard Microsystems Corp.
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
pi@raspberrypi:~ $
```

05 Take control of the arm

The arm is controlled by sending a line of code via the USB to the arm. This code includes the duration time of each movement as well as the coordinates to identify which motors to turn and on or off and in which directions to turn them. The actual codes to move the arm are fairly verbose, however Python simplifies them into manageable single lines of code.



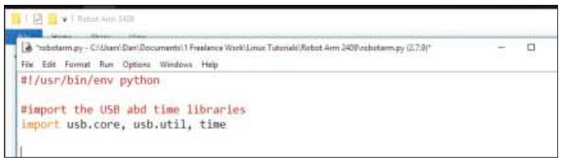
06 Open Python

From the menu of the taskbar select and open the LX Terminal, double click the logo. Administrative privileges are required to access the arm via Python, so open Python as a sudo user. In the LX Terminal type `sudo idle` and press Return. When IDLE has loaded, open a new window, click File and then select New Window.

07 Import the required libraries

At the top of the window, create your program. Import the time, core usb and usb utility libraries, line 1. These enable you to send commands to the USB port and control the arm. USB is a complex protocol, but PyUSB has good defaults for most common configurations, minimising the need for verbose amounts of code. The time library permits you to add short delays between each movement of the Arm. Add the line of code as below.

```
import usb.core, usb.util, time
```


robotarm.py - C:\Users\Dan\Documents\1 Freelance Work\Linux Tutorials\Robot Arm 2409\robotarm.py (2.7.9)
File Edit Format Run Options Windows Help

```
#!/usr/bin/env python

#import the USB abd time libraries
import usb.core, usb.util, time
```

Experiment with the gestures to find ones that suit you

The Skywriter boasts a number of gestures that you can experiment with and use in your own program. For example, the board can be used to detect you making a circular gesture, referred to as an air wheel. The Skywriter is also perfect for controlling additional projects, like changing the volume on your music player, or using the gestures to create music or play samples. Check out the full code for these examples and more at https://github.com/pimoroni/skywriter-hat/tree/master/examples

»

Robot arm movements

Use the list below to reference the various movements of the robot. The text after each # is a comment and used to identify the command.

```
MoveArm(1,[0,1,0]) #rotate base anti-clockwise
MoveArm(1,[0,2,0]) #rotate base clockwise
MoveArm(1,[64,0,0]) #shoulder up
MoveArm(1,[128,0,0]) #shoulder down
MoveArm(1,[16,0,0]) #elbow up
MoveArm(1,[32,0,0]) #elbow down
MoveArm(1,[4,0,0]) #wrist up
MoveArm(1,[8,0,0]) #wrist down
MoveArm(1,[2,0,0]) #grip open
MoveArm(1,[1,0,0]) #grip closed
MoveArm(1,[0,0,1]) #light on
MoveArm(1,[0,0,0]) #light off
```

08 Name the USB device

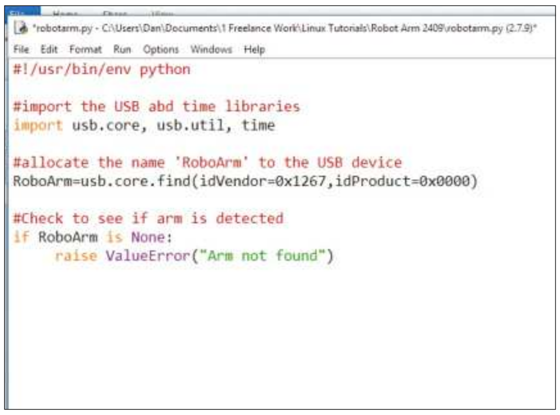
Now use Python to find the USB arm. On the next line down, create a variable called RoboArm to store the information about the location of the robotic arm – this is basically which USB port it is plugged into. Now name the device that is plugged into the Raspberry Pi USB port. To do this, enter the ID Vendor number and the product ID details to search for the arm. If you are using a different arm or model number, you will need to locate these two details and replace them in the line of code.

```
RoboArm=usb.core.find(idVendor=0x1267,idProduct=
0x0000)
```

09 Find the robotic arm

The next step is to search for the robotic arm to ensure that it is plugged into the USB port and also turned on. This uses a simple conditional, an **if** statement, to make this check. If the arm is not found, then an error message is returned to the Python window to let you know to plug it in, turn it on, or both! Note the second line of the code is indented.

```
if RoboArm is None:
    raise ValueError("Arm not found")
```



```
*robotarm.py - C:\Users\Dan\Documents\1 Freelance Work\Linux Tutorials\Robot Arm 2409\robotarm.py (2.7.9)*
File Edit Format Run Options Windows Help
#!/usr/bin/env python

#import the USB abd time libraries
import usb.core, usb.util, time

#allocate the name 'RoboArm' to the USB device
RoboArm=usb.core.find(idVendor=0x1267,idProduct=0x0000)

#Check to see if arm is detected
if RoboArm is None:
    raise ValueError("Arm not found")
```

10 Create a function, part 1

You need a small delay between each movement of the arm. Create a new variable called Duration and assign a value of 1, line 1. On the next line down, create a function that includes the duration value you just created, and also a code to stop the arm moving. On line 3, add the code to transfer the movement commands to the USB port and relay them to the robotic arm. Note again that this line is indented.

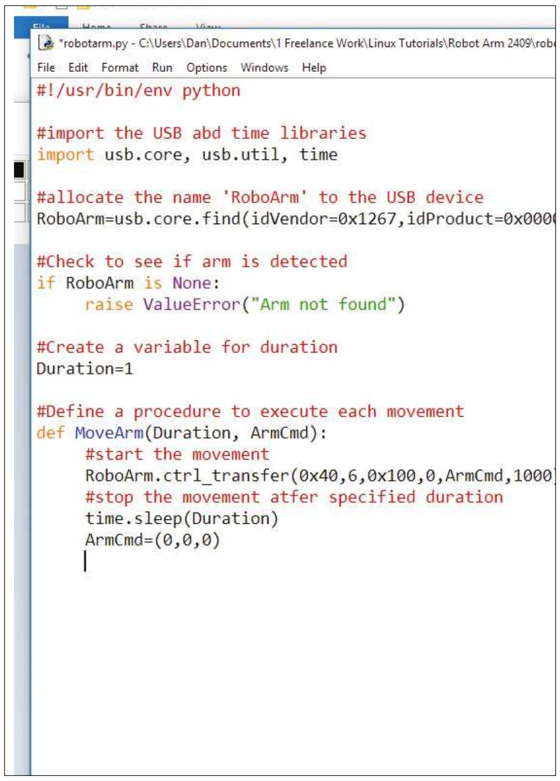
```
Duration = 1
```

```
def MoveArm(Duration, ArmCmd):
    #start the movement
    RoboArm.ctrl_transfer(0x40,6,0x100,0,ArmCmd,1000)
```

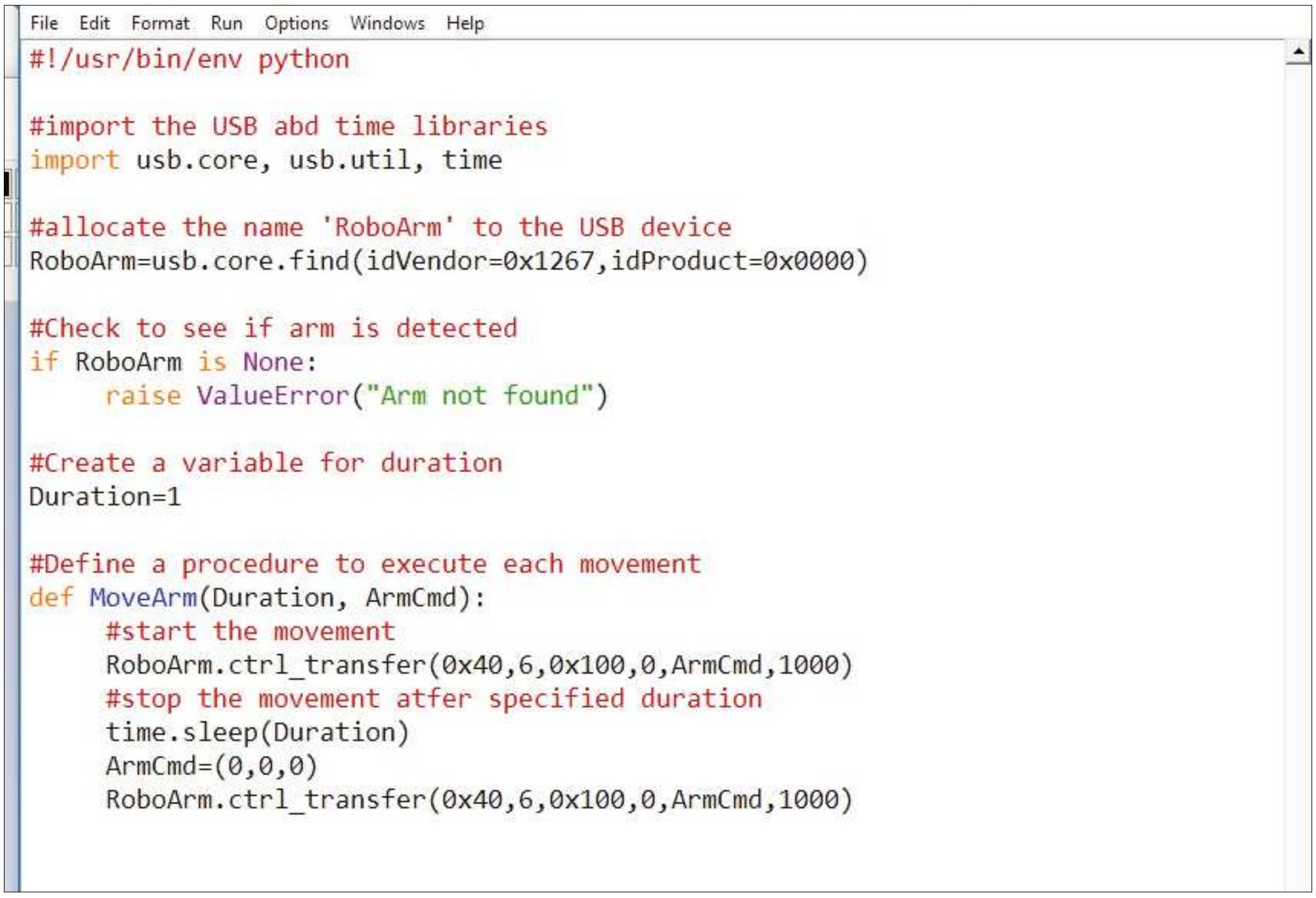
11 Create a function, part 2

On the next line down, add a small duration time to set a limit for the duration of the action. In this example the duration is set to 1, meaning that each movement or action will happen once. You can experiment with the duration time by changing the value you set in Step 10. After each of the movements occur they need to stop. Use the code ArmCmd=(0,0,0) line two, to prepare a code to stop the motors turning and end the movement.

```
#stop the movement after specified duration
    time.sleep(Duration)
    ArmCmd=(0,0,0)
```



```
*robotarm.py - C:\Users\Dan\Documents\1 Freelance Work\Linux Tutorials\Robot Arm 2409\rob
File Edit Format Run Options Windows Help
#!/usr/bin/env python

#import the USB abd time libraries
import usb.core, usb.util, time

#allocate the name 'RoboArm' to the USB device
RoboArm=usb.core.find(idVendor=0x1267,idProduct=0x000

#Check to see if arm is detected
if RoboArm is None:
    raise ValueError("Arm not found")

#Create a variable for duration
Duration=1

#Define a procedure to execute each movement
def MoveArm(Duration, ArmCmd):
    #start the movement
    RoboArm.ctrl_transfer(0x40,6,0x100,0,ArmCmd,1000
    #stop the movement atfer specified duration
    time.sleep(Duration)
    ArmCmd=(0,0,0)
```



```
#!/usr/bin/env python

#import the USB abd time libraries
import usb.core, usb.util, time

#allocate the name 'RoboArm' to the USB device
RoboArm=usb.core.find(idVendor=0x1267,idProduct=0x0000)

#Check to see if arm is detected
if RoboArm is None:
    raise ValueError("Arm not found")

#Create a variable for duration
Duration=1

#Define a procedure to execute each movement
def MoveArm(Duration, ArmCmd):
    #start the movement
    RoboArm.ctrl_transfer(0x40,6,0x100,0,ArmCmd,1000)
    #stop the movement atfer specified duration
    time.sleep(Duration)
    ArmCmd=(0,0,0)
    RoboArm.ctrl_transfer(0x40,6,0x100,0,ArmCmd,1000)
```

12 Create a function, part 3

The last part of the function is to send the stop command to the arm, line 1. This connects to the arm and then transfers to the ArmCmd=(0,0,0) code that you set up in the previous step. Note that it is stored in a variable called ArmCmd which means that you can change the command that is transferred to the arm. This line is also indented.

```
RoboArm.ctrl_transfer(0x40,6,0x100,0,ArmCmd,1000)
```

13 Movement and action code

Once you have completed the function, you can now use it to control the arm. Each movement or action has a unique set of digits that identify how long the movement last for, which motors need to be turned on or off and in which direction they need to turn. Each command begins MoveArm, then the first number is the duration the movement lasts for. For example, '1' is basically, do this instruction or movement for one second. This is then followed by the required motor information to turn it: `MoveArm(1,[0,1,0]) #rotate base anti-clockwise`.

14 Turn a light on

On the next line down, underneath the function, add the code to turn the light on. Type the command `MoveArm(1,[0,0,1]) #light on`. The #light on is a comment and is not required to control the arm. It is used to identify to the user what the code does: it turns the light on. This is useful when you have several commands in the program.

15 Run the program

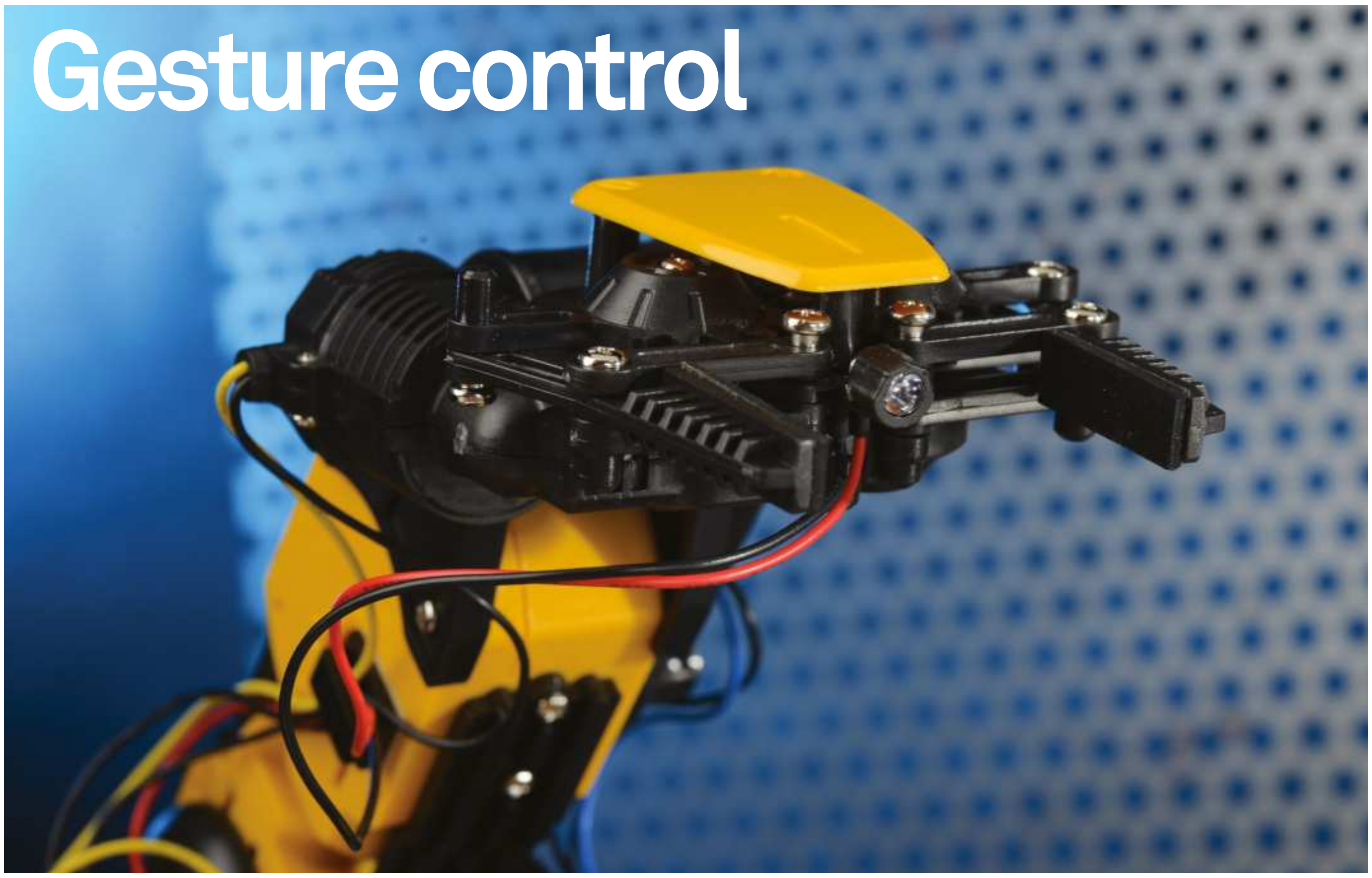
Now you have a complete program that will connect to the USB port, search for the robotic arm, prepare a function and then transfer an instruction that controls the arm, turning the light on. Save the program into your home folder. An easy way to do this is to press F5 on the keyboard, name and save the file, press Enter and then it will run. Look at the light on the arm, it will be on!

16 Turn the light off

The light will now stay on unless you code it to turn off. If you add this line straight after the 'turn on' command, then the light will switch on and off so fast that you will not see it. On the next line down, add a short delay of two seconds, line one, and then turn the light off, line 2. Save and run your program using the F5 button. Check out the full code listing to see the code for all the available movements. You can use these code lines to build up movements and experiment with the arm's functions.

"Use these code lines to build up movements and experiment with the arm's functions"

Gesture control



17 Skywriter movements

The Pimoroni Skywriter HAT is an electrical near-field 3D gesture-sensing board that uses a 4-layer PCB for the best sensing performance, up to 5cm away! It has the capability to collect full 3D position data and gesture information (swipes, taps, double taps, flicks and swirls) and then respond to them with an action that you set. It also comes fully assembled.

18 Install the software

Pimoroni has made it extremely easy to install the software for your Skywriter HAT. Load the LX Terminal and type:

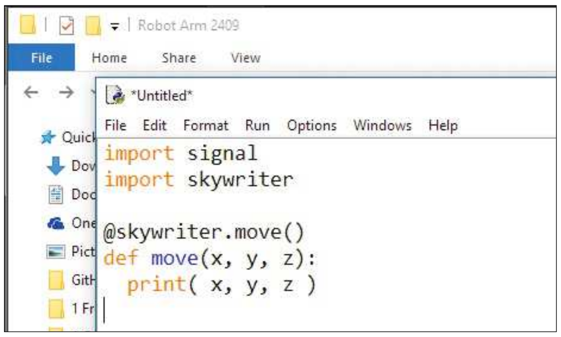
```
sudo curl -sS get.pimoroni.com/skywriter | bash
```

Follow the instructions that are displayed on the screen; these involve giving permission to install the software and agreeing to the changes that the library requires. This will now download the required libraries and a selection of Skywriter examples and programs for you to try out. When installation has completed, reboot your Raspberry Pi, and then you can get started with the next part of the process.

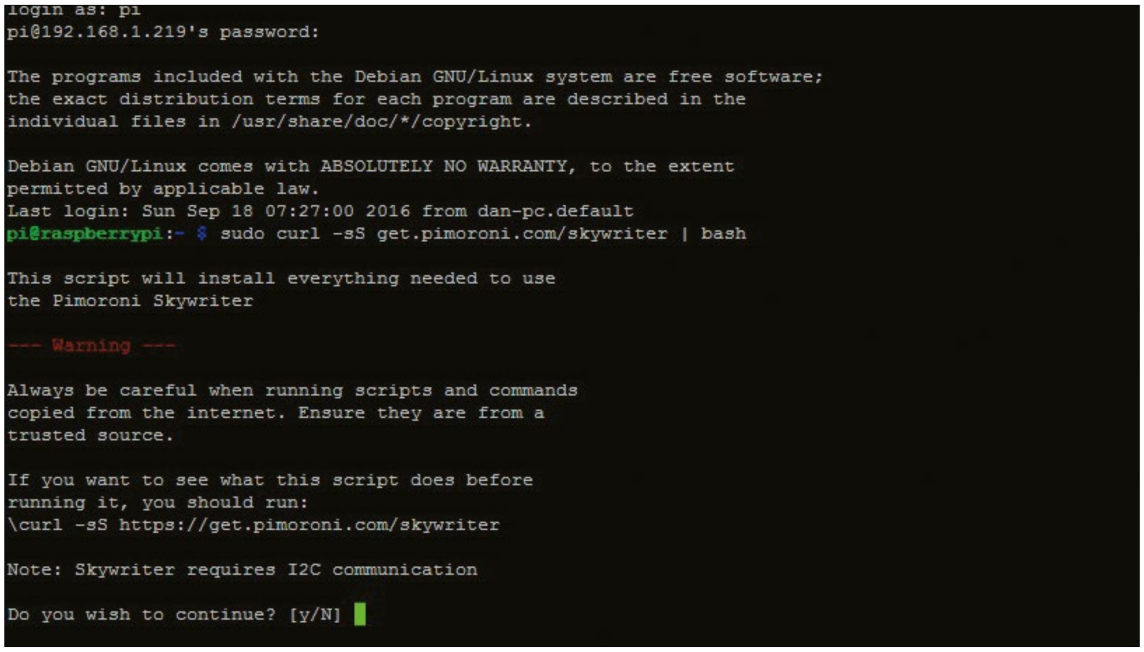
19 Your first Skywriter program

Open a new Python file, (remember to use the LX terminal method as used in Step 6, as administrative privileges are required) and add the code below. First import the libraries to talk to the Skywriter, lines 1 and 2. Next create a function called move that will sense the position of your finger on the Skywriter, line 3. Next read the x, y and z co-ordinates, line 4, and finally print these to the Python window. Save the program and run it. Move your finger over the Skywriter. Note that because it has touch-capacitive capabilities you do not need to actually touch the board, just hover above it.

```
import signal
import skywriter

@skywriter.move()
def move(x, y, z):
  print( x, y, z )
```



```
import signal
import skywriter

@skywriter.move()
def move(x, y, z):
  print( x, y, z )
```



```
login as: pi
pi@192.168.1.219's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sun Sep 18 07:27:00 2016 from dan-pc.default
pi@raspberrypi:~ $ sudo curl -sS get.pimoroni.com/skywriter | bash

This script will install everything needed to use
the Pimoroni Skywriter

--- Warning ---

Always be careful when running scripts and commands
copied from the internet. Ensure they are from a
trusted source.

If you want to see what this script does before
running it, you should run:
\curl -sS https://get.pimoroni.com/skywriter

Note: Skywriter requires I2C communication

Do you wish to continue? [y/N]
```

20 Double tap

In this program you can double tap a part of the Skywriter board and it will tell you the location of the tap. This makes use of a variable called position, line 3, which stores your tap location as either north, east, south, west or centre, depending on where you tap it. Line 4 prints out the position that you double tapped at. For example, if you double tap at the top of the board it will print, `Double tap! North`. All signals are cleared after the tap to ensure that each tap is clearly identified, line 5. Save and run the program; tap, tap.

```
import signal
import skywriter
def doubletap(position):
  print('Double tap!', position)
signal.pause()
```

21 A single tap

When making any of the gestures such as tap, double-tap, touch, flick and so on, you can identify the location of the gesture on the Skywriter board and respond with a particular action. For example, you can touch the board at the top; this is the North position. The right is East, South is the bottom and West is on the left. A conditional can be used to check the physical position where you touched the Skywriter and then return one of five responses.

22 Sensing a position

Create a new function that senses when the user taps the board, line 3, then wait for the tap and record the location on the board where the user touched it. This is stored in a variable called position1, line 4. Add an `if` statement, line 6, to check and compare the position. If it is tapped at the top of the board, the north position, then print 'north'. Use an `elif` statement, line 8, to check for a tap at the bottom of the board, the south position. Save the program and run it.

```
import signal
import skywriter

@skywriter.tap()
def tap(position1):
  print('Tap!', position1)
  if position1 == 'north':
    print ("North")
  elif position1 == 'south':
    print ("South")
```

23 Slow down the responsiveness

The double tap is when you press the Skywriter twice in quick succession, a tap is a single press, but, if you press it once and then again, it will be interpreted as a double tap. You may wonder how a tap is distinguished from a double tap. To resolve this issue, add a repeat rate to the tap code. This means that the action, the tap, is only repeated once. Increase the repeat rate value if you still find the two gestures are not distinct enough.

```
@skywriter.tap(repeat_rate=1)
```

24 Sense a flick

Another useful gesture that you can be detected is a flick. Simply set up the Skywriter to wait for flicks, line 1. Then create a function that recognises the flick and records the direction of the flick, for example, south to north or east to west, line 2. Then print out confirmation that a flick was registered including the start and finish positions of the flick direction, line 3.

```
@skywriter.flick()
def flick(start,finish):
  print('Got a flick!', start, finish)
```

»

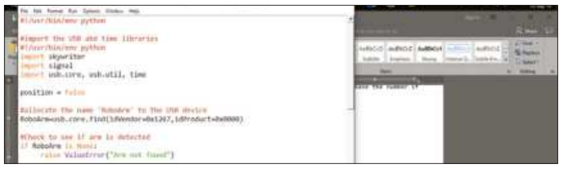
New Skywriter board

Pimoroni has developed a larger Skywriter gesture board which works in three dimensions. It can sense your gestures from up to 15cm away, which means that you can embed it underneath non-conductive materials. This makes it suitable for wearables and projects where you want to conceal the board. All the common gestures are recognised such as taps, flicks and double taps, but these can be made from further away. You can even use it as a mouse or keyboard. Find out more details here: http://bit.ly/2dJF0sw

25 Edit your robot code

Now that you have tried some of the Skywriter commands you can use and adapt these to control the robotic arm. Open the previous robot arm file from Step 16 and import the additional required libraries at the top of the program window.

```
import skywriter
import signal
```

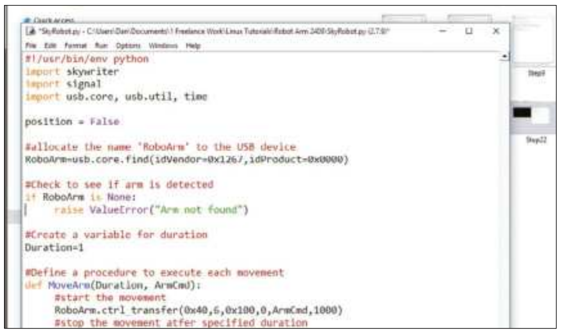


```
#!/usr/bin/env python

#import the USB and time libraries
#!/usr/bin/env python
import skywriter
import signal
import usb.core, usb.util, time

position = False

#allocate the name 'RoboArm' to the USB device
RoboArm=usb.core.find(idVendor=0x1267,idProduct=0x0000)

#Check to see if arm is detected
if RoboArm is None:
    raise ValueError("Arm not found")
```

26 Add Skywriter movements to raise the elbow

Next add the code that controls the robot based on the Skywriter gesture that it senses. Under the function, set up the `touch` command to register a touch, line 1, and create a variable to hold the position where you pressed the board, north, south, east etc, line 2. Now check the position and use an if statement to check if you touched the north positon, line 3. If it is touched then use the robot arm code to move the arm, line 4. Finally print a quick message to inform the user that the elbow has now been raised.

```
@skywriter.touch(repeat_rate=1) ###Raise / lower the
wrist
def touch(position2):
  if position2 == 'north':
    MoveArm(1,[16,0,0]) #elbow up
    print "Elbow Up"
```



```
#!/usr/bin/env python
import skywriter
import signal
import usb.core, usb.util, time

position = False

#allocate the name 'RoboArm' to the USB device
RoboArm=usb.core.find(idVendor=0x1267,idProduct=0x0000)

#Check to see if arm is detected
if RoboArm is None:
    raise ValueError("Arm not found")

#Create a variable for duration
Duration=1

#Define a procedure to execute each movement
def MoveArm(Duration, ArmCmd):
    #start the movement
    RoboArm.ctrl_transfer(0x40,6,0x100,0,ArmCmd,1000)
    #stop the movement atfer specified duration
```

27 Add more touch movements

Now add some more movements to the program. On the next line down and indented inline with the **if** statement position, add an **elif** statement to check for the south position being touched, line 1. If you touch the board at the bottom, in the south position, then it will register the response and move the elbow down, line 2. Save your program by pressing F5, then run and test it.

```
elif position2 == 'south':
    MoveArm(1,[32,0,0]) #elbow down
```

28 Add control for the grip

Continue to build up and assign the arm movements to the various gestures you make. Below the previous line of code add another **elif** statement to check for the west positon, line 1, then use the arm command code to open the grip, line 2. Close the grip by touching east on the Skywriter, line three, and then add the code to close the grip, line 4.

```
elif position2 == 'west':
    MoveArm(1,[1,0,0]) #grip close
elif position2 == 'east':
    MoveArm(1,[2,0,0]) ##grip open
```

29 Using Taps

Any of the Skywriter gestures can be used to control the arm. On a new line, create a new function to identify taps, line 1. Note that the repeat rate is set to a value of 1 to remove the possibility of a double tap. Next create a new variable called position1, line 2, this is to stop the gesture overwriting the previous variable (For example, if the light is turned on, you might wish to move the arm but keep the light turned on). On line 4, check the position of the tap, then print the movement that the arm will make, line 5 (This is optional). As with the previous steps, assign the movement code for the arm; for example move the shoulder up, line 6.

```
@skywriter.tap(repeat_rate=1)
def tap(position1):
  print('Tap!', position1)
  if position1 == 'north':
    print "Shoulder Up!"
    MoveArm(1,[64,0,0]) #shoulder up
```

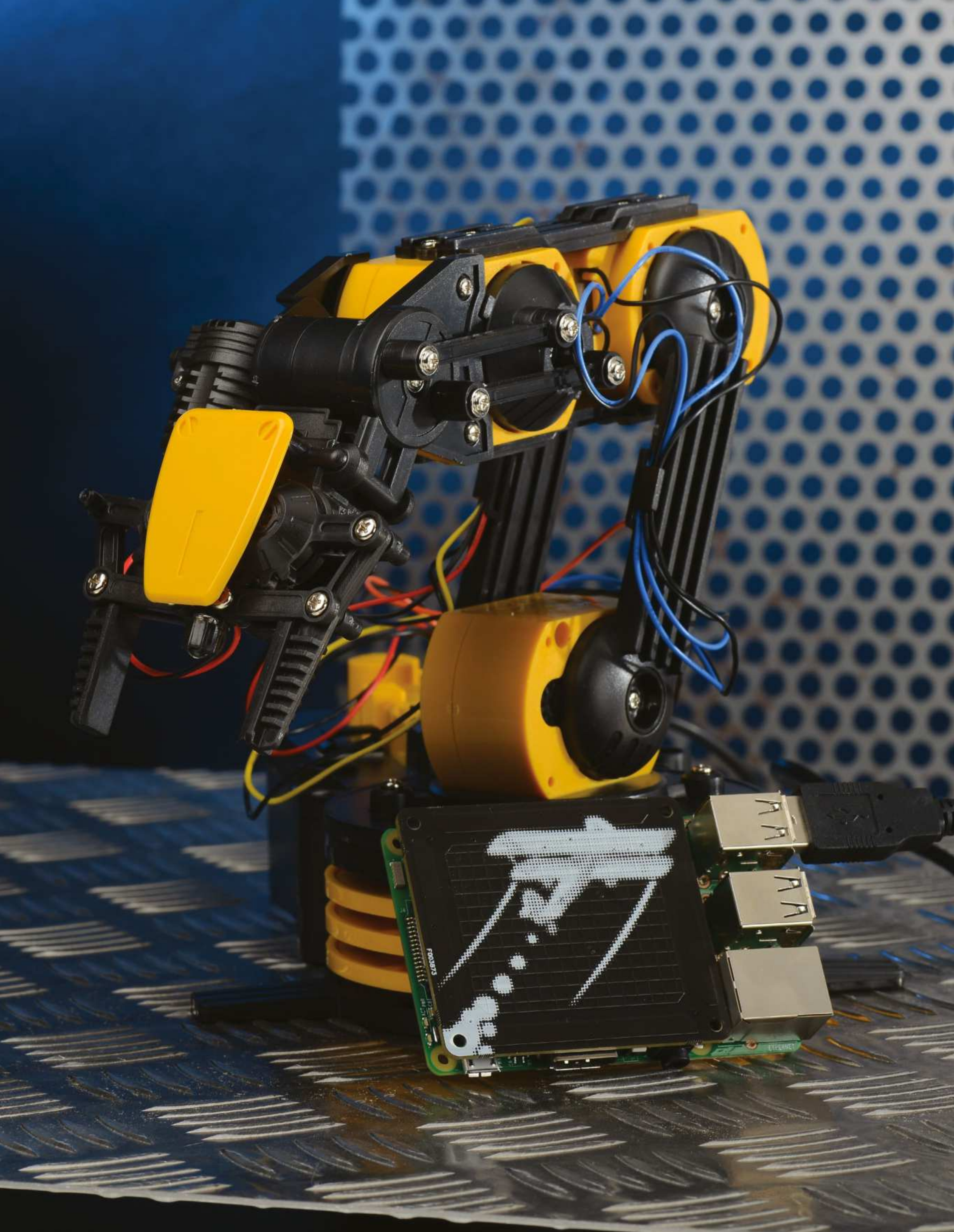
30 Shoulder down

To move the shoulder down, use a similar format to that in Step 27. On the next line down, in line with the indentation level of the **if** statement, add an **elif** statement to check for a tap on the south position, line 1. Add an optional print statement to display that a tap has been registered, line 2, and then add the command to move the shoulder downwards, line 3. Save and run your program.

```
elif position1 == 'south':
    print "Shoulder Down!"
    MoveArm(1,[128,0,0]) #shoulder down
```

31 Put it all together

Continue to create your program in a similar fashion as demonstrated in Steps 26 to 30. First choose the type of gesture/input that you want to use, then set up a function to identify the gesture and the position on the Skywriter where the gesture took place, for example, north, south, west etc. Next use conditionals, **if** and **elif** statements, to check the position and then respond with a robot arm movement using the codes found in the full listing. Use the example program in the tutorial resources as a basic set up for your ideas and then expand and customise to add your own gestures and movements.



Hack a toy with the Raspberry Pi: Part 1

Learn how to master four simple hacks and embed them into a toy

Resources

An old/new toy
Resistors
Small disc motor
LED
A radio
Small webcam
Female-to-female jumper jerky wire

Combining an old toy and a Raspberry Pi, you can embed a selection of components to create your own augmented toy that responds to user input. For example, take a £3 R2-D2 sweet dispenser, light it up, play music and stream a live web feed to your mobile device. Part one of this two-part tutorial covers setting up four basic features: an LED for the eye, a haptic motor to simulate an electric shock, a webcam stream from a hidden camera and the Star Wars theme tune broadcast to a radio. You may choose to combine these with your own hacks or use them as standalone features in other projects.

Don't feel limited to just using a Star Wars toy either – we used the R2D2 figure because it was cheap, available and popular, but there's no limit to the toys that you can experiment with. Action figures (provided that they can be disassembled and/or have a stand or cavity that can be used to hold the electronics) and plushy or cuddly toys both lend themselves well to this kind of maker project, especially if they accompany a movie or TV show that has recognisable music or sound effects that you can make them broadcast. Part two covers how to set up the toy and set up triggers to start features.

R2D2 is © LucasFilm

01 Set up an LED

LEDs are really easy to set up and control. They make a nice addition to your toy and can be used as eyes, flashing buttons or, in this example, R2-D2's radar eye. Take your LED and hold the longest leg; this is the positive arm and connects to the input. Wrap the resistor around the leg and attach to a female jumper jerky wire. Now take the negative arm and attach this to another jumper wire.

02 Attach the LED

Take the positive wire, the one with the resistor, to GPIO 17, which is physical pin number 11 (look at the far-left top pin and count down six pins). This pin will provide the current that powers the LED. Connect the other wire to any of the ground pins, (GND) 6, 9, 14, 20, 39; you may need to move this around later as you add more wires for the other components.

03 Light up the LED

To turn the LED on and off, use the gpiozero library, which was developed to simplify the interaction between code and a physical computer. Open the LX Terminal and type

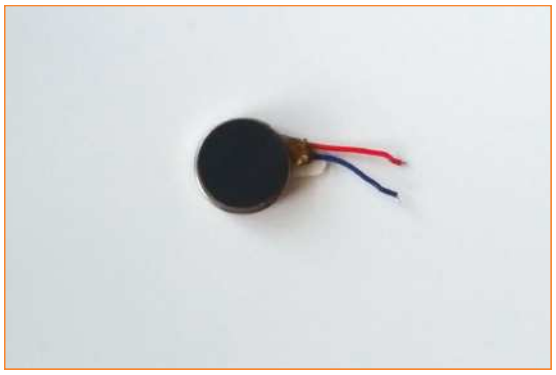
```
sudo apt-get install python3-gpiozero
```

to install the library (Remove the '3' if you want to use it with Python 2). Once installation is completed, open a new Python window and import the LED module (line 2 of the following code). Assign the pin number of the LED (line 3) and finally turn it on and off (lines 6 and 8). Save your code and run it to make the LED flash. Change the timings to suit your own project.

```
import time
from gpiozero import LED
led = LED(17)
led.off()

while True:
  led.on()
  time.sleep(0.5)
  led.off()
  time.sleep(0.5)
```

04 Add a vibration

You may want the toy to vibrate or shake when it is touched. R2-D2 is known for giving out electric shocks and a safe way to emulate this is to add haptic feedback, similar to that when you press a key on the screen of your mobile. Pimoroni stocks a suitable disc motor (bit.ly/29hIEla), which will deliver a short vibration. Take each of the wires and connect them each to a female-to-female jumper wire.



05 Wire up the disc motor

Take the positive wire from the motor (usually coloured red) and attach it to GPIO pin 9; this is physical pin number 21. The black wire connects to a ground pin – the nearest is physical pin 25; from pin 21, drop down two pins on the left and this is number 25. Start a new program or add the code to your existing program. Import the RPi.GPIO library (line 1) and set the board to the BCM setting. This ensures that the GPIO numbering system is used.

```
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BCM)
import time
```

06 Turn the motor on

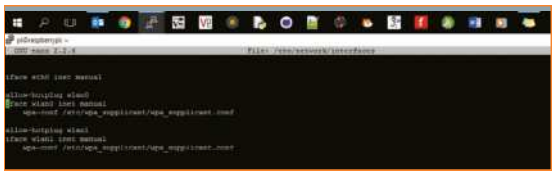
To enable the motor, first set the output pin, number 9. This tells the program that GPIO pin 9 is an output. Next, set the GPIO pin to 'HIGH' (line 2), this is the same as turning it on. Current flows through and your motor will turn on. Add a short pause (line 3) before setting the output to LOW, which turns the motor off. Play around with the timings to find the perfect pause for your needs

```
sudo apt-get install python3-gpiozero
GPIO.output(9, GPIO.HIGH)
time.sleep(5)
GPIO.output(9, GPIO.LOW)
```

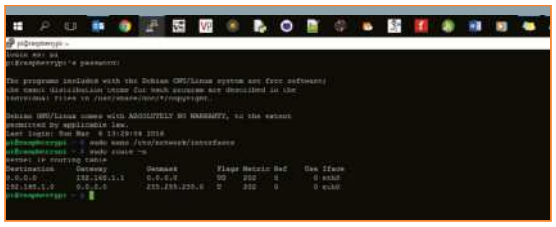
07 Hack a web camera

A small web camera can be hidden within the toy as an eye or more discreetly within the body of the toy. This can be used to take photos or stream a live feed to a laptop or mobile device. Take your webcam and carefully strip away the plastic shell so you are left with the board and lens. Depending on the size of your toy, adjust the casing so that it fits and can be hidden.

```
[illegible]
```



```
  GNU nano 2.2.6                File: /etc/network/interfaces

iface eth0 inet manual

allow-hotplug wlan0
iface wlan0 inet manual
    wpa-conf /etc/wpa_supplicant/wpa_supplicant.conf

allow-hotplug wlan1
iface wlan1 inet manual
    wpa-conf /etc/wpa_supplicant/wpa_supplicant.conf
```



```
login as: pi
pi@raspberrypi's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sun Mar  6 13:29:58 2016
pi@raspberrypi ~ $ sudo nano /etc/network/interfaces
pi@raspberrypi ~ $ sudo route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.1.1     0.0.0.0         UG    202    0        0 eth0
192.168.1.0     0.0.0.0         255.255.255.0   U     202    0        0 eth0
pi@raspberrypi ~ $
```

R2-D2 in action

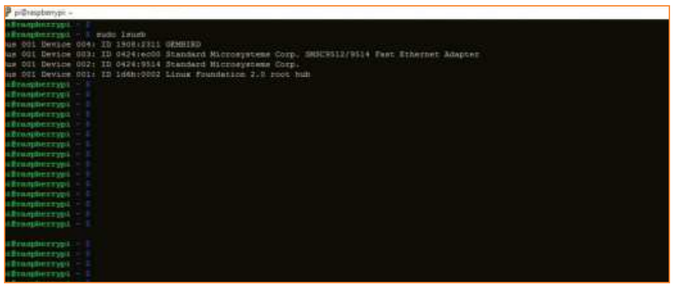
Check out the video of the completed R2-D2 toy hack and see the features in action. This may give you some ideas for your own toy hack. youtu.be/VnOsUaS5jSY

08 Set up a static IP address

Each time you connect to the internet, your Pi will be given a new IP address; this is called a dynamic IP address. This can cause issues, as when it changes, other devices will no longer be able to locate your Pi. To create one that stays the same (a static IP address), load the LX Terminal, type ifconfig and make a note of the inet addr, the Broadcast and the Mask numbers. Then type route -n and note down the Gateway address. Now type sudo nano /etc/network/interfaces, find the line iface wlan0 inet dhcp and change it to:

```
iface wlan0 inet static
address 192.168.1.5
netmask 255.255.255.0
gateway 192.168.1.1
network 192.168.1.0
broadcast 192.168.1.255
```

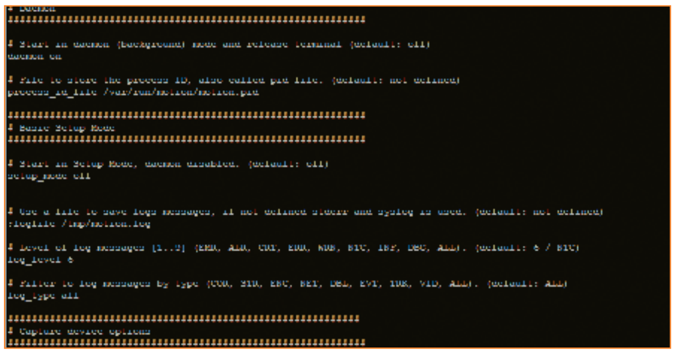
Replace the numbers with yours (which you noted down). Press **CTRL+X** together to save and exit the nano text editor. When you reboot your Pi, it will now have a static IP address which will not change when you reboot or reconnect.



```
pi@raspberrypi ~ $
pi@raspberrypi ~ $ sudo lsusb
Bus 001 Device 004: ID 1908:2311 GEMBIRD
Bus 001 Device 003: ID 0424:ec00 Standard Microsystems Corp. SMSC9512/9514 Fast Ethernet Adapter
Bus 001 Device 002: ID 0424:9514 Standard Microsystems Corp.
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $

pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
pi@raspberrypi ~ $
```

09 Install the web server

To set up the web server, open the LX Terminal and update your Raspberry Pi by typing sudo apt-get update, sudo apt-get upgrade. Next, install the Motion software that will control the webcam: type sudo apt-get install motion. Once it is finished, attach your USB webcam and type lususb and you will see that your webcam is recognised.



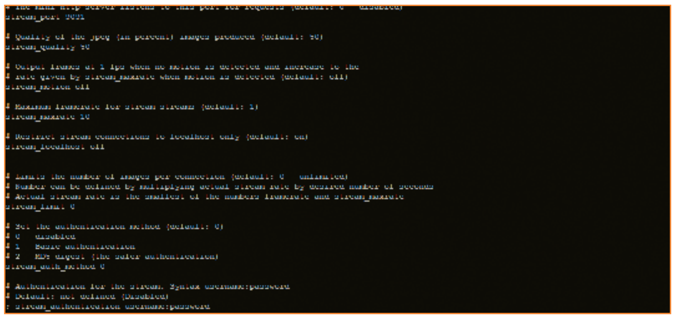
```
# Daemon
############################################################

# Start in daemon (background) mode and release terminal (default: off)
daemon on

# File to store the process ID, also called pid file. (default: not defined)
process_id_file /var/run/motion/motion.pid

############################################################
# Basic Setup Mode
############################################################

# Start in Setup-Mode, daemon disabled. (default: off)
setup_mode off


# Use a file to save logs messages, if not defined stderr and syslog is used. (default: not defined)
;logfile /tmp/motion.log

# Level of log messages [1..9] (EMR, ALR, CRT, ERR, WRN, NTC, INF, DBG, ALL). (default: 6 / NTC)
log_level 6

# Filter to log messages by type (COR, STR, ENC, NET, DBL, EVT, TRK, VID, ALL). (default: ALL)
log_type all

############################################################
# Capture device options
############################################################
```

10 Configure the software – part 1

There are now seven configurations to change in order to get the most suitable output from the camera. You can experiment with these to see which produces the best results. In the LX Terminal, type:

```
sudo nano /etc/motion/motion.conf
```

...to load the configuration file. Locate the daemon line (you can find the lines by pressing CTRL+W, which loads a keyword search) and ensure that it is set to ON; this will start Motion as a service when you boot your Pi. Next, find the webcam_localhost and set this to OFF so that you can access motion from other computers and devices.



```
# The mini-http server listens to this port for requests (default: 0 = disabled)
stream_port 8081

# Quality of the jpeg (in percent) images produced (default: 50)
stream_quality 50

# Output frames at 1 fps when no motion is detected and increase to the
# rate given by stream_maxrate when motion is detected (default: off)
stream_motion off

# Maximum framerate for stream streams (default: 1)
stream_maxrate 10

# Restrict stream connections to localhost only (default: on)
stream_localhost off


# Limits the number of images per connection (default: 0 = unlimited)
# Number can be defined by multiplying actual stream rate by desired number of seconds
# Actual stream rate is the smallest of the numbers framerate and stream_maxrate
stream_limit 0

# Set the authentication method (default: 0)
# 0 = disabled
# 1 = Basic authentication
# 2 = MD5 digest (the safer authentication)
stream_auth_method 0

# Authentication for the stream. Syntax username:password
# Default: not defined (Disabled)
; stream_authentication username:password
```

11 Configure the software – part 2

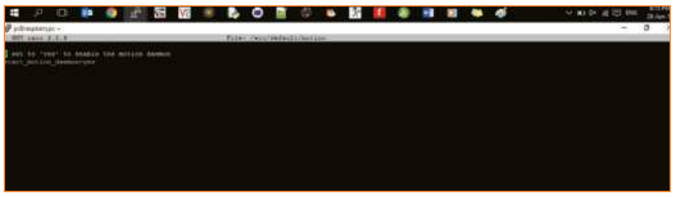
Next, find the stream_port, which is set to 8080. This is the port for the video and you can change it if you are having issues viewing the feed; 8081 provides a stable feed. Then, find the control_localhost line and set it to OFF. The port that you will access the web config interface is on the control_port line and the default is 8080; again, you can change it if you have any streaming issues. The frame rate is the number of frames per second that are captured by the webcam. The higher the frame rate, the better the quality, but setting it higher than 6fps will slow the Pi's performance and produce lag. Finally, set the post_capture and specify the number of frames to be captured after motion has been detected.

12 Running Motion as a daemon

A daemon is a program that runs in the background providing a service; in this project you want to run Motion. You do not want to manually have to start it every time you load the Pi; it's better that it automatically starts at bootup. In the LX Terminal, type sudo nano /etc/default/motion to edit the file. To set Motion to run as a service from bootup, you need to change the start_motion_daemon to Yes:

```
start_motion_daemon=yes
```

Save and exit the file using **CTRL+X** and restart your Pi.



```
  GNU nano 2.2.6                File: /etc/default/motion

# set to 'yes' to enable the motion daemon
start_motion_daemon=yes
```

13 Starting the web feed

Before viewing the feed, make a note of your IP address. In the LX Terminal, type sudo ifconfig, although you will have set this in step 8. Then start Motion by typing sudo service motion start. Wait for few seconds for it to initiate, then open a browser window on your device. Enter the IP address of your Pi, including the port number that you set in step 11. If you are using VLC player, go to File>Open Network and enter the IP address of your Pi followed by the
stream_port – for example, 192.168.1.50:8080. The port number in this example is 8080, but you set this in step 11 to 8081 or another value of your choice.

14 Install the Pi radio software

PiFM is a neat little library which enables your Raspberry Pi to broadcast to a radio. Note that this is only for experimentation and should you want to make a public broadcast you must obtain a suitable licence. Getting set up is simple: load the LX Terminal and make a new directory to extract the files into:

```
 start_motion_daemon=yes
mkdir PiFM
cd PiFM
```

Then download the required Python files:

```
sudo apt-get update,
sudo apt-get upgrade,
wget http://www.omattos.com/pifm.tar.gz
```

Finally, extract the files using the code:

```
sudo tar xvzf pifm.tar.gz
```

15 Add a simple aerial and then broadcast

Setting up the hardware is really easy. In fact, there is no need to attach anything as the Pi can transmit directly from physical pin 7 without the need to alter anything. However, you will probably want to extend the range of the broadcast by adding a wire to GPIO 4 (pin number 7). Unbelievably, this can extend the range of the broadcast to up to 100 metres! Ensure that you are in the PiFM folder and then broadcast the WAV file with the code line:

```
sudo ./pifm name_of_wav_file.wav 100.0
```

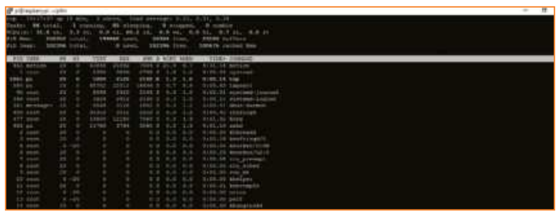
In this example, the *Star Wars* theme will play, but you can create and add your own sound files. The '100.0' refers to the FM frequency of the broadcast; this can be changed between a range of 88 and 108MHz. Turn on your radio and adjust to the appropriate frequency and you will hear your message being played.

16 Stop the broadcast

If you wish to end the broadcast before the song or voice has finished, then you will need to kill the transmission. In a new terminal window, type top. This will list all the running programs. Look for PiFM somewhere near the beginning of the list and note the ID number. Return to the LX Terminal and type sudo kill 2345, replacing the 2345 with the appropriate process ID number. This will ensure that each broadcast is new and the Pi is only trying to transmit one WAV file at a time.

17 Next time…

You now have four mini hacks which you have prepared and can adapt and combine. You may want to try embedding some of your own hacks that you have created. Over the page we will cover how to wire up and deploy them!



BCM number

GPIO pins are a physical interface between the Pi and the outside world. At the simplest level, you can think of them as switches that you can turn on or off. You can also program your Raspberry Pi to turn them on or off (output). The GPIO.BCM option means that you are referring to the pins by the 'Broadcom SoC channel' number. The GPIO.BOARD option specifies that you are referring to the pins by their physical location on the header.

R2D2 is © LucasFilm

Hack a toy with the Raspberry Pi: Part 2

Embed your hacks into your toy and create the code to bring it to life

Resources

An old/new toy
Resistors
Small disc motor
LED
A radio
Small webcam
Female-to-female jumper jerky wire
Tactile button

In part one of this 'hack a toy' tutorial you created four hacks that were originally used to augment a £3 R2D2 sweet dispenser making it light up, vibrate, play music and stream a live web feed to a mobile device. You may have been working on your own features to use and customise your toy. Part two of this tutorial begins by showing two different ways to set up and use a button to trigger your hacks. One method is to add and code your own button, the second method is to utilise the toy's own built-in button. The next part walks you through how to wire up, code and test each of the individual features before combining them into a single program which will bring your toy to life.

01 Prepare a button

A button is a simple and effective way of triggering the hacks that you created in part one of this tutorial. Take a 4 x 6mm tactile button or similar and solder / attach a wire to each of its sides. Take each wire and connect it to one end of a female-to-female jumper wire. You can solder these into place or remove the plastic coating and wrap them around each metal contact.

02 Set up the button

Next set up and test the button to ensure that it is working correctly. Take one of the wires and slot it onto GPIO pin 17, this is physical pin number 11 on the board. The second wire connects to a ground pin, indicated by a minus sign or the letters GND. The pin directly above GPIO pin 17 is a ground pin, physical pin number nine. This will complete the circuit and make the button functional.

03 Test the button

Open your Python editor and start a new file. Use the test program below to check that the button is functioning correctly. To ensure the buttons are responsive, use a pull up resistor code GPIO.PUD_UP, line 4. This removes multiple touches and means that only one 'press' is registered each time the button is pressed. Save and run the program. If it is working correctly it will return the message "Button works".

```
import RPi.GPIO as GPIO
 GPIO.setmode(GPIO.BCM)
 GPIO.cleanup()
 GPIO.setup(17, GPIO.IN, GPIO.PUD_UP)

 while True:
   if GPIO.input(17) == 0:
     print "Button works"
```

04 Use the button on the toy

Instead of adding your own button you can utilise an existing button on the toy to trigger the events. On the R2D2 example this is the button at the front which releases the sweets and plays the classic R2D2 beep sound. Using a screwdriver or suitable tool, open the casing of your toy and then locate the electrics of the button. Locate the negative wire and cut this in two. Now attach a jumper wire to each of the ends. You can test that the connection is still working by joining the two jumper wires together and pressing the button.

05 Wire up your button

If your toy has a button to trigger a sound or movement then it will use batteries. These will still be used to power the toy but the extra circuit you added in Step 4 creates a secondary circuit. When you press the button you join the two contacts and in turn complete the circuit, this sends a small current around the circuit which can be detected by the GPIO pin on the Raspberry Pi. Take one of the wires and attach it to GPIO pin 1, the 3.3 volts which will provide the current.

Attach the other wire to GPIO pin 15, physical pin number 10. Pin 15 checks for a change in current.

When the button is in its normal state, i.e. it has not been pressed, no current flows from the 3.3v pin as the circuit is broken. When you press the button it joins the contacts, the circuit completes and the current flows. Pin 15 registers a change in state which is used to trigger an event.

06 Test the button

Open a new Python file and enter the test code below. On line four a Pull Down is used to check for the change in state. The toy's button completes the circuit and GPIO pin 15 receives a little current. Its state becomes True or 1, line six, and then it triggers the display of a confirmation message. The final line prints out a confirmation message each time the button is pressed.

```
import time
 import RPi.GPIO as GPIO
 GPIO.setmode(GPIO.BCM)
  GPIO.setup(15, GPIO.IN, GPIO.PUD_DOWN) #checks for
a change on pin 7
 while True:
    if GPIO.input(15) == 1:
       print (“You touched R2D2!”)
```

07 Wire up the LED

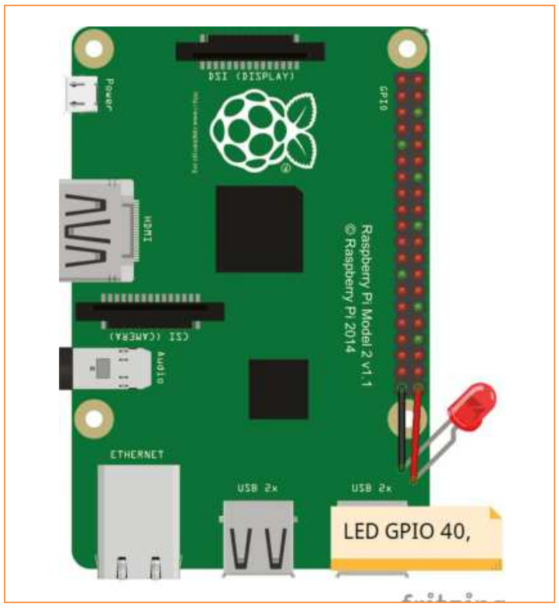
Now to connect the individual hacks to your toy. These examples are based on Part One of the tutorial but can be replaced with your own. Shut your Pi down and unplug the power. Assuming that the LED is connected to the jumper jerky wires, take the positive wire of the LED, the one with the resistor, and attach it to GPIO pin 21. This is physical pin number 40, the one at the very bottom-right of the pins. The black wire connects to a ground pin. The nearest one is physical pin 39 just to the left of pin 40; attach it here.

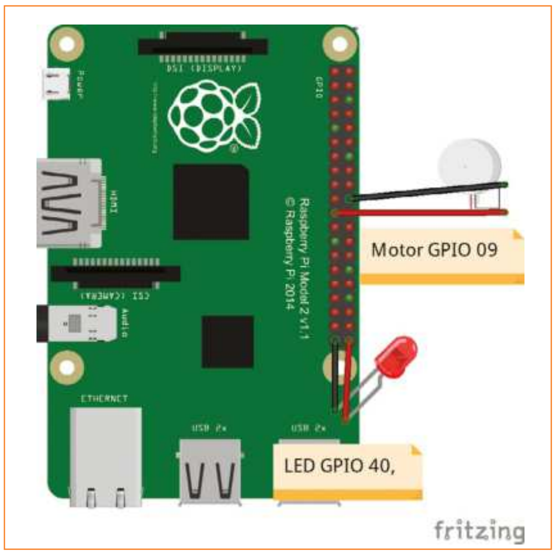
08 Wire up the motor

Next take the positive wire from the motor, usually coloured red, and attach it to GPIO 09, which is physical pin number 21. You will then need to connect the other wire to any of the ground pins, (GND) 6, 9, 14, 20, 39. You may find that you need to relocate this wire later on as you add more wires for the other components.

09 Add the PiFM aerial

The Raspberry Pi can broadcast to your radio directly from physical pin 7 without the need to alter anything. However, you will probably want to extend the range of the broadcast by adding a wire to GPIO 04, physical pin number 7. Unbelievably this can extend the range of the broadcast up to 100 metres. You must use physical pin number 7 to broadcast





so move around any other wires that may be attached from your own hacks.

10 Add the web camera

The web camera is the simplest component to connect as it uses one of the USB ports. Once you have plugged it in use

»

gpiozero

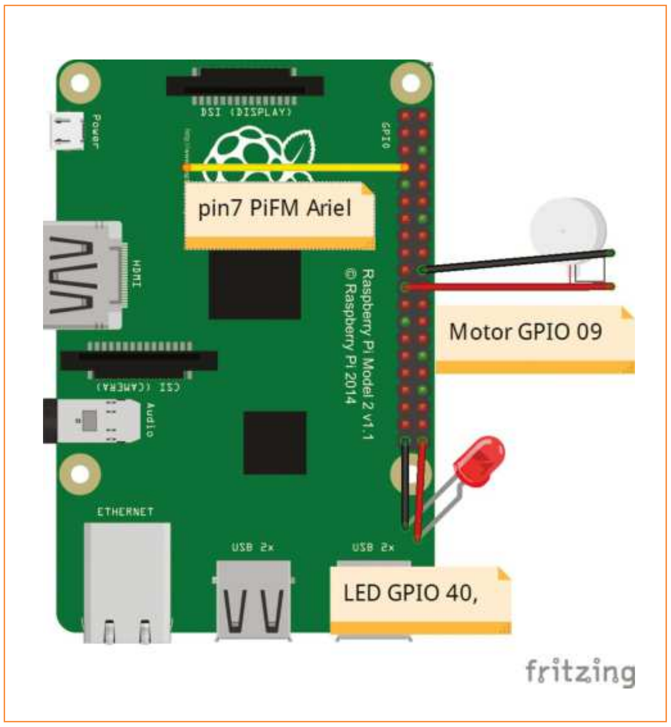
This is a smart Python library that makes interaction with the GPIO pins really simple, for example you can control an LED with the code led.on(). It covers a massive range of components, hardware and add on boards. You can find out more here https://gpiozero.readthedocs.io/en/v1.2.0/#

the command `sudo lsusb` to list the connections to the port. If it displays the name of your web camera, then it has been successfully recognised and is ready to go. Consider stripping away the plastic shell so you are left with just the board and lens. Adjust the casing so that it fits neatly and can be hidden within your toy.

11 Setting up the program

Assuming that you have installed all the required software modules and libraries for your hacks, you are now ready to create the program to control your toy's extra features.

Open a file in your Python editor and import os, this will control the PiFM and web camera, line 1. Next import the PiFM library; the webcam runs automatically when you boot up your Pi, see Part One in issue 168, Step 12. Set the GPIO pins to BCM on line 6 and then define the PUD for the button setup you are using. The first option, line 7, is for a button that is already connected to your toy, the second is to be used if you have added your own button.



```
import os
import sys
import time
import RPi.GPIO as GPIO
import PiFm
GPIO.setmode(GPIO.BCM)

GPIO.setup(15, GPIO.IN, GPIO.PUD_DOWN) #checks for a change on
pin 7
GPIO.setup(17, GPIO.IN, GPIO.PUD_UP)
```

12 Set up the other outputs

Next prepare the two other GPIO outputs, in this example the LED and the motor. Set these as outputs using the code GPIO.setup(9, GPIO.OUT), line 1 and then turn the LED off using the code GPIO.output(21, GPIO.LOW). This ensures that when you start your program running the LED and the motor do not run until the trigger button is pressed.

```
GPIO.setup(9, GPIO.OUT)
GPIO.output(9, GPIO.HIGH)

GPIO.setup(21, GPIO.OUT)
GPIO.output(21, GPIO.LOW)
```

13 Set up the LED

Create a function to store the code that will control the LED, making it turn on for five seconds and then turn off again, lines 2, 3 and 4. Then set up a simple message to display at the start of the program to let you know that the toy is ready and the pins are prepared. This is useful for debugging your program.

```
def LED_Eye():
  GPIO.output(21, GPIO.HIGH)
  time.sleep(5)
  GPIO.output(21, GPIO.LOW)

print ("Welcome to R2D2")
```

14 Trigger the events

Set up a while loop to continually check if the button has been pressed, line 1. Use an IF statement to check when the button has been pressed and that the input is HIGH. This uses the line GPIO.input(15) == 1: In this case the 1 refers to an equivalent value of True or On; this relates to the circuit being completed and a current flowing through as discussed in Step 6. Then trigger the motor to turn on using GPIO.output(9, GPIO.LOW) line 5, and call the function LED_Eye() to execute, lighting up the LED, line 6.

```
while True:
  if GPIO.input(15) == 1:
    print ("You touched R2D2!")
    '''Enable LED and Motor'''
    GPIO.output(9, GPIO.LOW)
    LED_Eye()
```

15 Trigger the webcam and radio broadcast

Finally, start the web camera streaming using the line os.system('service motion start') and check out the feed on your viewing device. While the webcam is running, start the radio broadcast with PiFm.play_sound("sound.wav"), line 4.

The default FM station is set to 100FM, tune in your radio to hear your sound being played. Then stop the web feed after the sound has finished using the line os.system('service motion stop'). Note that this code is indented on the same level as the previous lines.

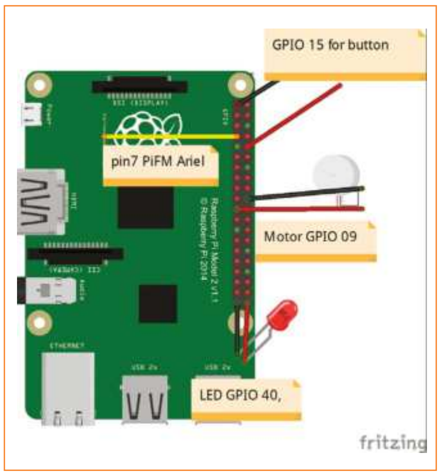
```
'''start webcam'''
os.system('service motion start')
'''Play the Star Wars Theme'''
 PiFm.play_sound("sound.wav")
 '''Stop the Webcam'''
 os.system('service motion stop')
```

16 Embed the hack into the toy

Once you have all your hacks triggering within the code, embed the wires and your Pi within your toy. You may choose to display the hardware and create a more 'augmented' style toy or discreetly hide it all away, surprising potential users when they interact with it.

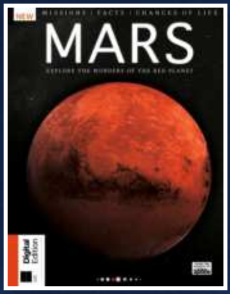
R2D2 is © LucasFilm

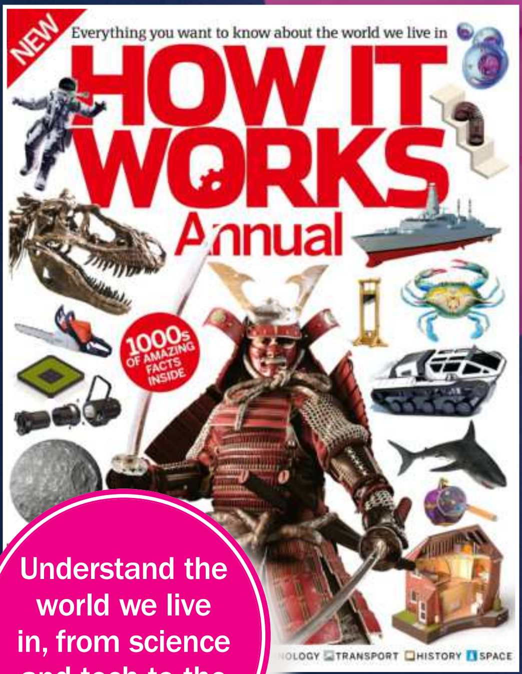
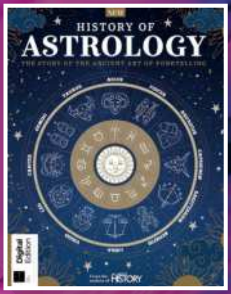
“ Action figures and plushy or cuddly toys both lend themselves well to this kind of maker project, especially if they accompany a film or TV show ”

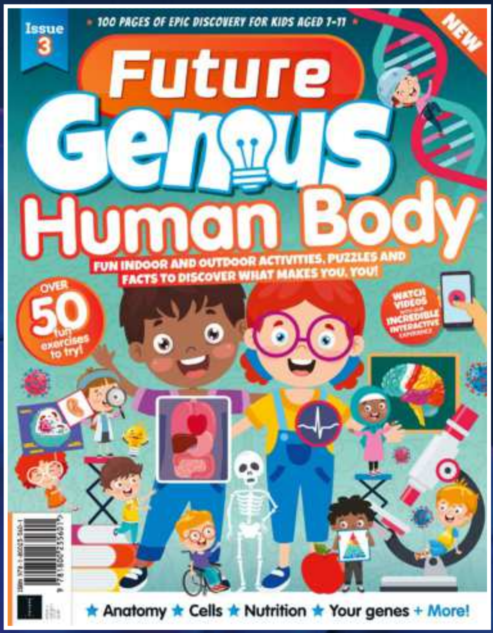


Full code listing

```
import os
import sys
import time
import RPi.GPIO as GPIO
import PiFm
GPIO.setmode(GPIO.BCM)
import time

GPIO.setup(15, GPIO.IN, GPIO.PUD_DOWN) #checks for a
change on pin 7

###Reset Motor
GPIO.setup(9, GPIO.OUT)
GPIO.output(9, GPIO.HIGH)

###Reset LED
GPIO.setup(21, GPIO.OUT)
GPIO.output(21, GPIO.LOW)

###Controls the LED eye
def LED_Eye():
    GPIO.output(21, GPIO.HIGH)
    time.sleep(5)
    GPIO.output(21, GPIO.LOW)

print (“Welcome to R2D2”)

while True:
    if GPIO.input(15) == 1:
        print (“You touched R2D2!”)

        ‘’’Enable LED’’’
        GPIO.output(9, GPIO.LOW)

        LED_Eye()

        ‘’’Enable the Haptic Motor’’’
        GPIO.output(9, GPIO.HIGH)

        ‘’’start webcam’’’
        os.system(‘service motion start’)
        ‘’’Play the Star Wars Theme’’’
        PiFm.play_sound(“sound.wav”)

        ‘’’Stop the Webcam’’’
        os.system(‘service motion stop’)
```



HOW IT WORKS
The Collection

Future Genius
Human Body

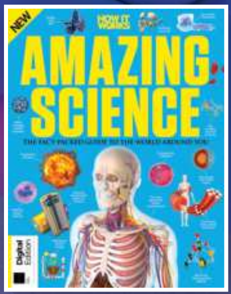
HOW YOUR BODY WORKS

INCREDIBLE HISTORY

The SPACE RACE

ROBOTS

SPACE

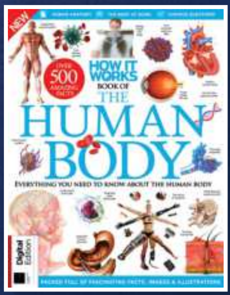

AMAZING SCIENCE

Life's Little Mysteries

BLACK HOLES

THE Science COLLECTION

Future Genius
Ancient Egypt

UNDERSTANDING HABITS

THE HUMAN BODY

HOW TO USE FileSilo

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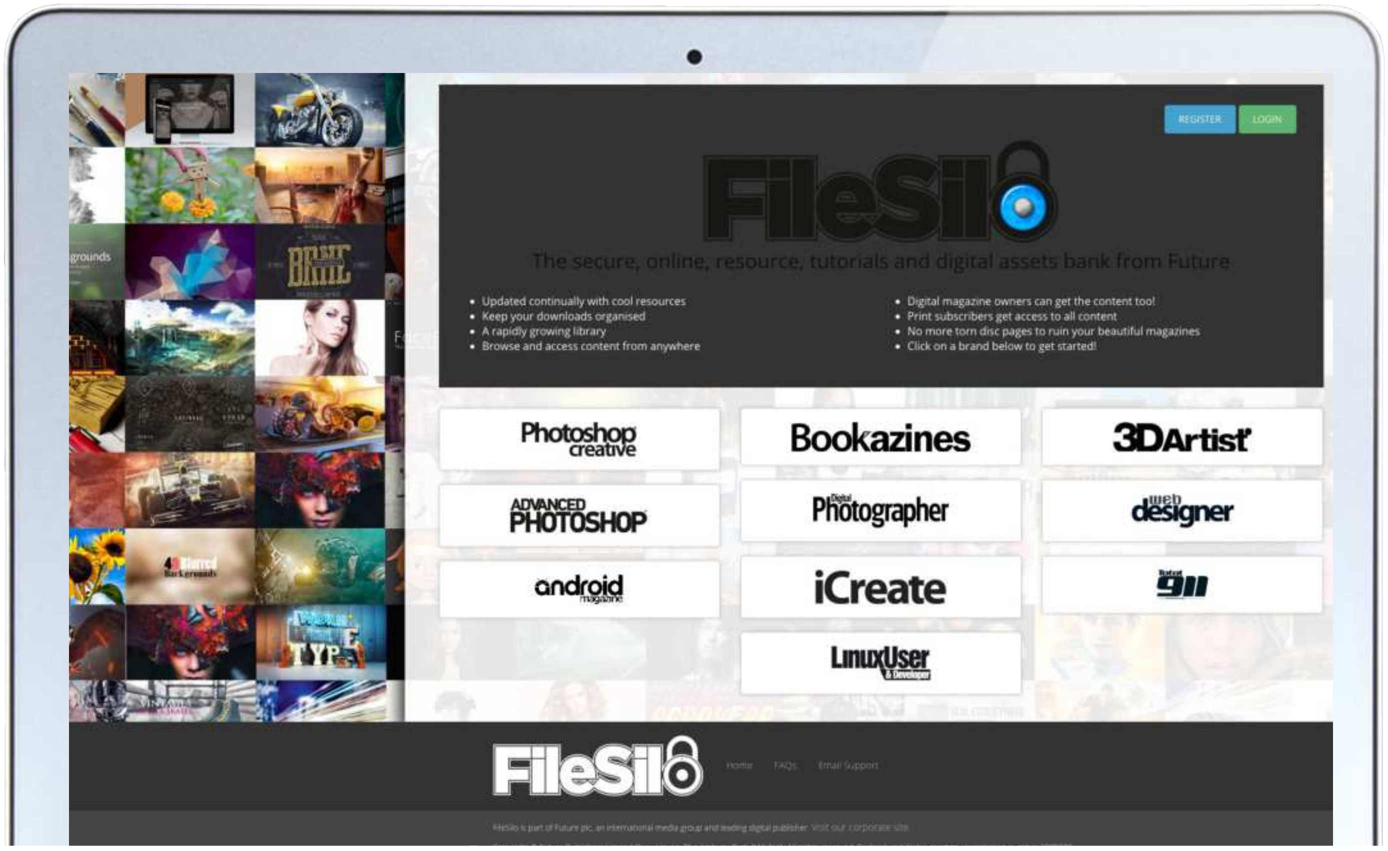

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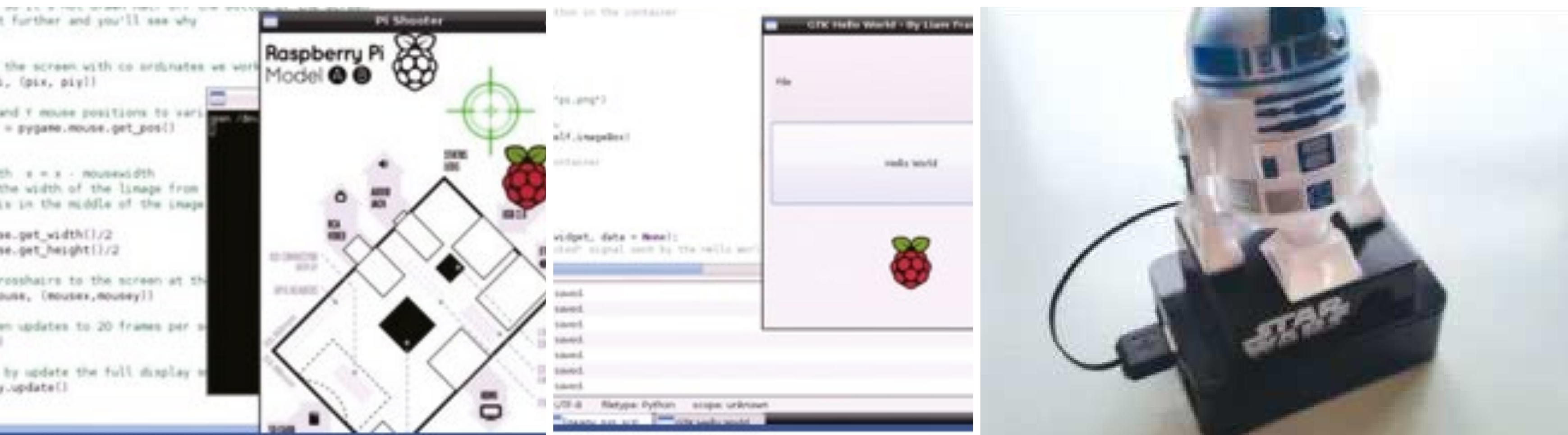

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