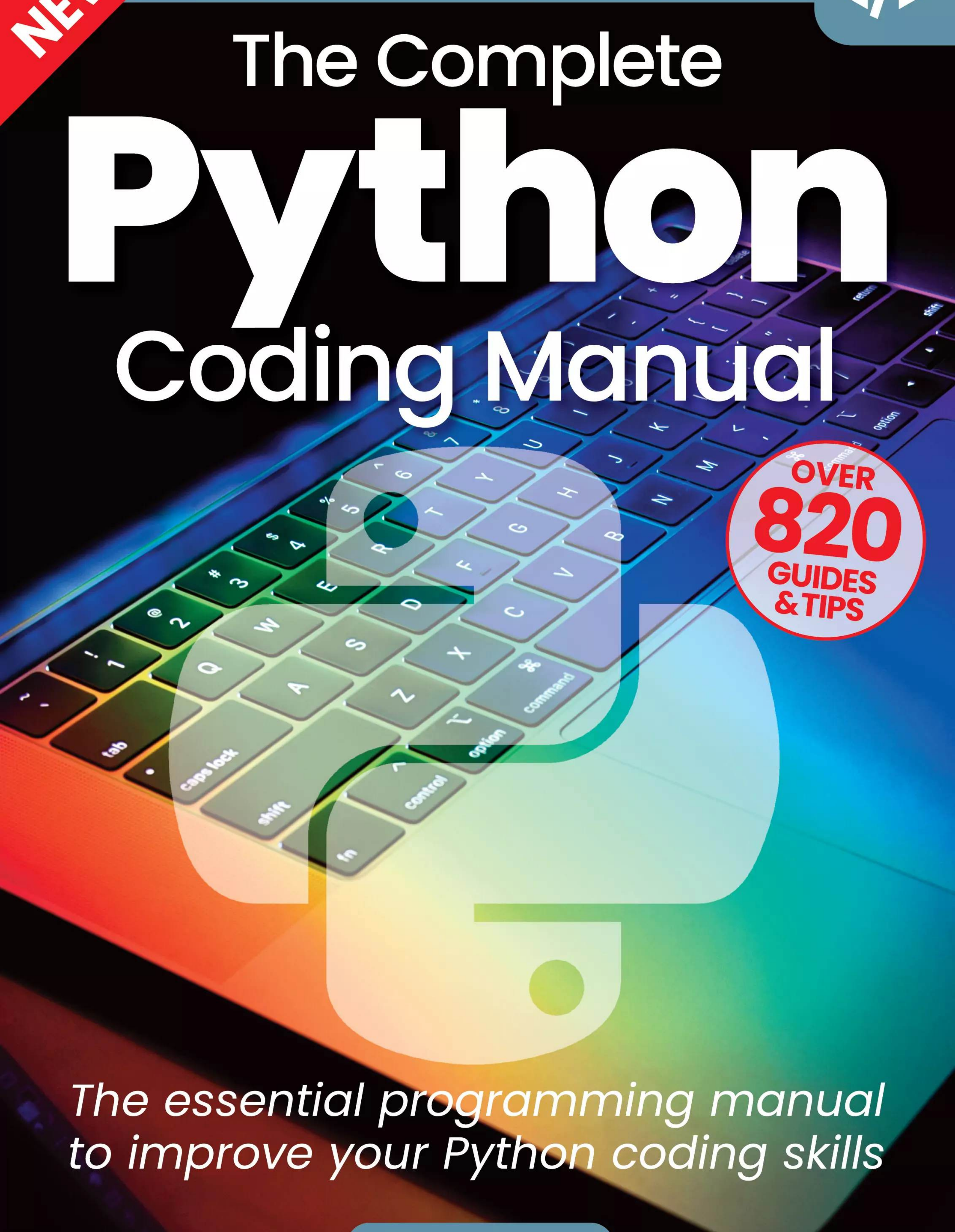
NEW

MASTER PYTHON PROGRAMMING

</>

The Complete Python Coding Manual



OVER 820 GUIDES & TIPS

The essential programming manual to improve your Python coding skills

www.pclpublications.com

Papercut

100% INDEPENDENT

The Complete Python Coding Manual

Unlock your imagination with Python...

There are few coding languages that have enjoyed the success of Python. Thanks to Python's unique development, everyone can learn the code that is: helping to drive such technological projects as the Large Hadron Collider, collating the petabytes of data that made up the first image of a Black Hole and creating the next generation of Artificial Intelligence. It doesn't take long to get to grips with Python, but you need to start small.

This guide will help you form the foundation of your Python coding future, from installing the language on to your computer, through to forming user interaction and complex variables. There's so much you can do with Python and within these pages you'll find everything you need to know to become a Python programmer, ready for the next level of advanced coding.

Whether you're looking to learn Python for future career prospects, or just have some fun and discover something new, our step-by-step tutorials and guides will give you that much-needed foothold to help you on your way.

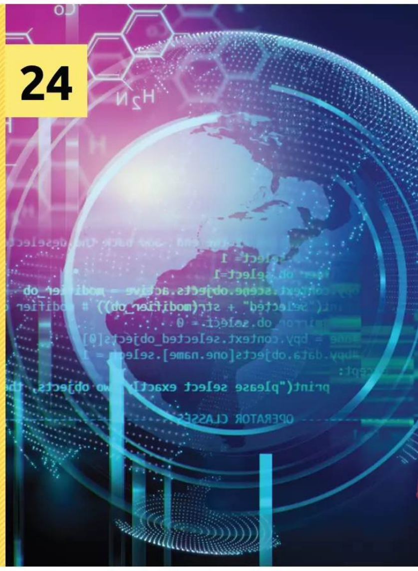
So let's dive in and start coding with Python.

Papercut
www.pclpublications.com

Contents

6 Getting Started

Hello World 24



62 Working with Data

Using Modules

88

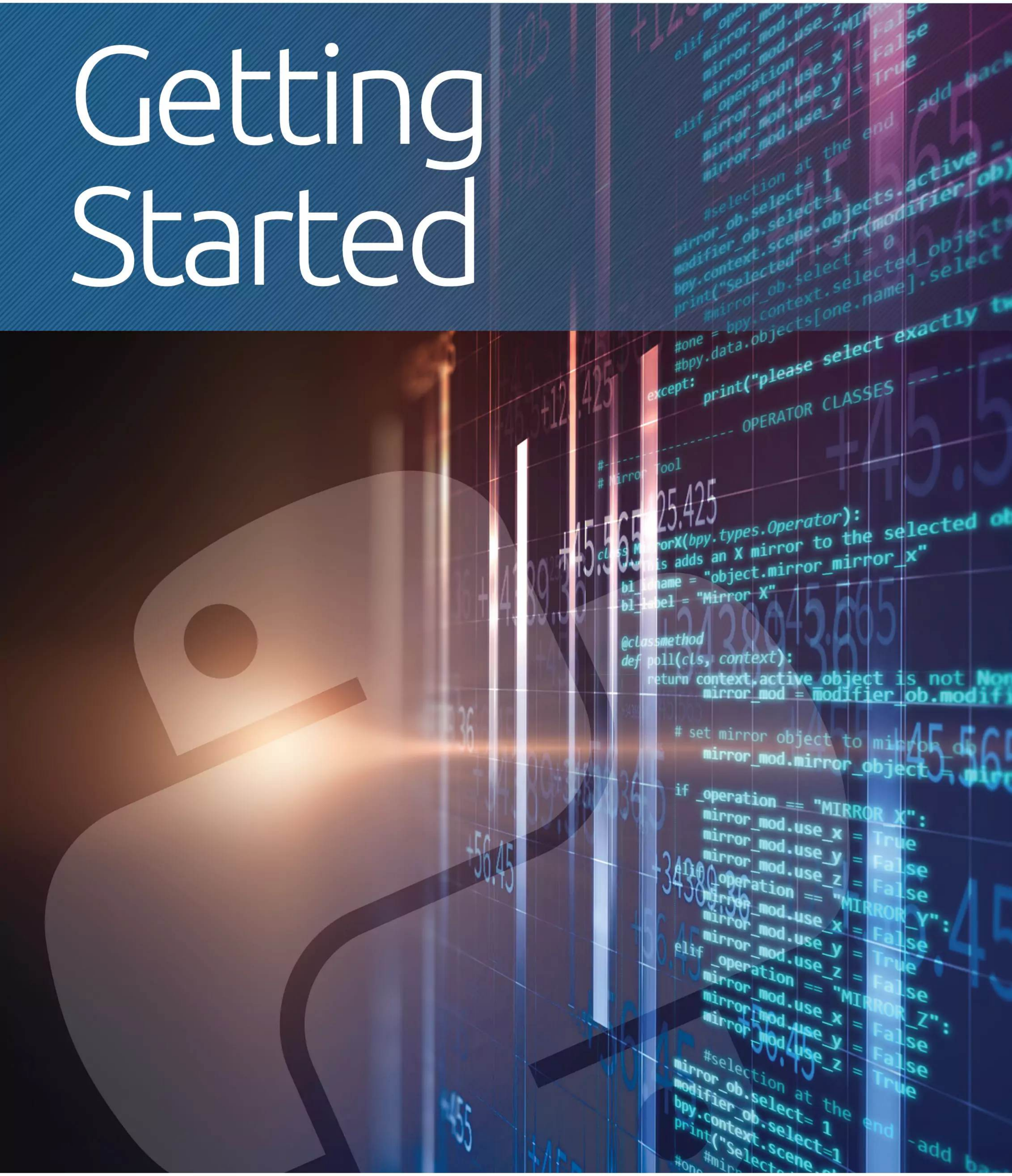
110

Code Repository

Understanding Linux

136

Getting Started



Python is a high-level, general-purpose programming language that was developed by Guido van Rossum in the late eighties and is based upon a number of other languages, while being the successor to the popular ABC language.

It has been devised to work on a human level, so it's readable and understandable without needing to delve into obscure volumes of machine code, hexadecimal characters, or even ones and zeros. It's clear, logical, comprehensive, powerful and functional, yet also easy to follow and learn.

You will find Python at the heart of some of the most interesting and cutting-edge technologies in the world. It's the code that binds supercomputer algorithms together; it's used in the space industry, and in science and engineering. AI, and the likes of Alexa and Siri, Cortana and the Google Assistant all utilise Python for their powerful voice recognition technology. It's simply an amazing, versatile and incredible language to learn.

So let's get started and explore what you need to become a Python programmer.

Being a Programmer

Programmer, developer, coder, they're all titles for the same occupation, someone who creates code. What they're creating the code for can be anything from a video game to a critical element on-board the International Space Station. How do you become a programmer though?

Times have changed since programming in the '80s, but the core values still remain.

"It's up to you how far to take your coding adventure!"

```
#include<stdio.h>
#include<dos.h>
#include<stdlib.h>
#include<conio.h>
void getup()
{
    textcolor(BLACK);
    textbackground(15);
    clrscr();
    window(10,2,70,3);
    cprintf("Press X to Exit, Press Space to Jump");
    window(62,2,80,3);
    cprintf("SCORE : ");
    window(1,25,80,25);
    for(int x=0;x<79;x++)
    cprintf("п");
    textcolor(0);
}

int t,speed=40;
void ds(int jump=0)
{
    static int a=1;

    if(jump==0)
        t=0;
    else if(jump==2)
        t--;
    else t++;
    window(2,15-t,18,25);
    cprintf("                  ");
    cprintf("         млпллллм");
    cprintf("         лллллллл");
    cprintf("         ллллnnnn");
    cprintf(" л      млллnnn ");
    cprintf(" ллм  млллллммм ");
    cprintf(" пллллллллллл  п ");
    cprintf("   пллллллллп     ");
    if(jump==1 || jump==2){
    cprintf("    ллп пл        ");
    cprintf("    лм   лм       ");
    }else if(a==1)
    {
    cprintf("    пллп  ппп     ");
    cprintf("      лм          ");
    a=2;
    }
    else if(a==2)
    {
    cprintf("     плм пл       ");
    cprintf("         лм       ");
    a=1;
    }
    cprintf("                 ");
    delay(speed);
}
void obj()
{
```

Being able to follow a logical pattern and see an end result is one of the most valued skills of a programmer.

MORE THAN CODE

For those of you old enough to remember the '80s, the golden era of home computing, the world of computing was a very different scene to how it is today. 8-bit computers that you could purchase as a whole, as opposed to being in kit form and you having to solder the parts together, were the stuff of dreams; and getting your hands on one was sheer bliss contained within a large plastic box. However, it wasn't so much the new technology that computers then offered, moreover it was the fact that for the first time ever, you could control what was being viewed on the 'television'.

Instead of simply playing one of the thousands of games available at the time, many users decided they wanted to create their own content, their own games; or simply something that could help them with their homework or home finances. The simplicity of the 8-bit home computer meant that creating something from a few lines of BASIC code was achievable and so the first generation of home-bred programmer was born.

From that point on, programming expanded exponentially. It wasn't long before the bedroom coder was a thing of the past and huge teams of designers, coders, artists and musicians were involved in making a single game. This of course led to the programmer becoming more than simply someone who could fashion a sprite on the screen and make it move at the press of a key.

Naturally, time has moved on and with it the technology that we use. However, the fundamentals of programming remain the same; but what exactly does it take to be a programmer?

The single most common trait of any programmer, regardless of what they're doing, is the ability to see a logical pattern. By this we mean someone who can logically follow something from start to finish and envisage the intended outcome. While you may not feel you're such a person, it is possible to train your brain into this way of thinking. Yes, it takes time but once you start to think in this particular way you will be able to construct and follow code.

Second to logic is an understanding of mathematics. You don't have to be at a genius level but you do need to understand the rudiments of maths. Maths is all about being able to solve a problem and code mostly falls under the umbrella of mathematics.

Being able to see the big picture is certainly beneficial for the modern programmer. Undoubtedly, as a programmer, you will be part of a team of other programmers, and more than likely part of an even bigger team of designers, all of whom are creating a final product. While you may only be expected to create a small element of that final product, being able to understand what everyone else is doing will help you create something that's ultimately better than simply being locked in your own coding cubicle.

Finally, there's also a level of creativity needed to be a good programmer. Again though, you don't need to be a creative genius, just have the imagination to be able to see the end product and how the user will interact with it.

There is of course a lot more involved in being a programmer, including learning the actual code itself. However, with time, patience and the determination to learn, anyone can become a programmer. Whether you want to be part of a triple-A video game team or simply create an automated routine to make your computing life easier, it's up to you how far to take your coding adventure!

A Brief History of Coding

It's easy to think that programming a machine to automate a process, or calculate a value, is a modern concept that's only really happened in the last fifty years or so. However, that assumption is quite wrong, coding has actually been around for quite some time.

01000011 01101111 01100100 01101001 01101110 01100111

Essentially all forms of coding are made up of ones and zeros - on or off states. This works for both a modern computer and even the oldest known computational device.

~87 BC

It's difficult to pinpoint an exact start of when humans began to 'program' a device. However, it's widely accepted that the Antikythera Mechanism is possibly the first 'coded' artefact. It's dated to about 87 BC and is an ancient Greek analogue computer and orrery used to predict astronomical positions.

~850 AD

The Banū Mūsā brothers, three Persian scholars who worked in the House of Wisdom in Baghdad, published the Book of Ingenious Devices in around 850 AD. Among the inventions listed was a mechanical musical instrument: a hydro-powered organ that played interchangeable cylinders automatically.

1800

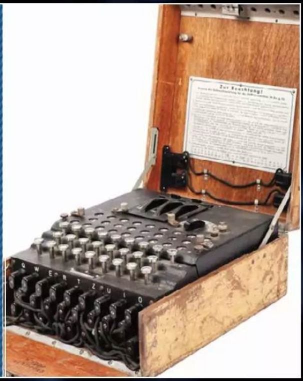
Joseph Marie Jacquard invents a programmable loom, which used cards with punched holes to create the textile design. However, it is thought that he based his design on a previous automated weaving process from 1725, by Basile Bouchon.

1842-1843

Ada Lovelace translated the memoirs of the Italian mathematician, Francis Maneclang, regarding Charles Babbage's Analytical Engine. She made copious notes within her writing, detailing a method of calculating Bernoulli Numbers using the engine. This is recognised as the first computer program. Not bad, considering there were no computers available at the time.

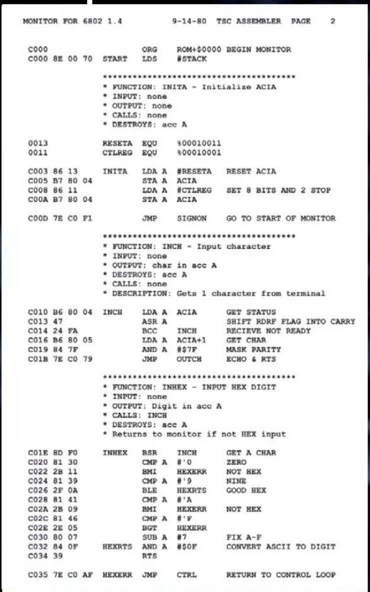
1930-1950

During the Second World War, significant advances were made in programmable machines. Most notably, the cryptographic machines used to decipher military codes used by the Nazis. The Enigma was invented by the German engineer Arthur Scherbius, but was made famous by Alan Turing at Bletchley Park's codebreaking centre.



From the 1970s, the development of the likes of C, SQL, C with Classes (C++), MATLAB, Common Lisp and more, came to the fore. The '80s was undoubtedly the golden age of the home computer, a time when silicon processors were cheap enough for ordinary folk to buy. This led to a boom in home/bedroom coders with the rise of 8-bit machines.

1951-1958



```
MONITOR FOR 6802 1.4          9-14-80  TSC ASSEMBLER  PAGE    2

 C000                 ORG    ROM+$0000 BEGIN MONITOR
 C000 8E 00 70  START  LDS    #STACK

                ****************************************
                * FUNCTION: INITA - Initialize ACIA
                * INPUT: none
                * OUTPUT: none
                * CALLS: none
                * DESTROYS: acc A

 0013           RESETA EQU    %00010011
 0011           CTLREG EQU    %00010001

 C003 86 13     INITA  LDA A  #RESETA   RESET ACIA
 C005 B7 80 04         STA A  ACIA
 C008 86 11            LDA A  #CTLREG   SET 8 BITS AND 2 STOP
 C00A B7 80 04         STA A  ACIA

 C00D 7E C0 F1         JMP    SIGNON    GO TO START OF MONITOR

                ****************************************
                * FUNCTION: INCH - Input character
                * INPUT: none
                * OUTPUT: char in acc A
                * DESTROYS: acc A
                * CALLS: none
                * DESCRIPTION: Gets 1 character from terminal

 C010 B6 80 04  INCH   LDA A  ACIA      GET STATUS
 C013 47               ASR A            SHIFT RDRF FLAG INTO CARRY
 C014 24 FA            BCC    INCH      RECIEVE NOT READY
 C016 B6 80 05         LDA A  ACIA+1    GET CHAR
 C019 84 7F            AND A  #$7F      MASK PARITY
 C01B 7E C0 79         JMP    OUTCH     ECHO & RTS

                ****************************************
                * FUNCTION: INHEX - INPUT HEX DIGIT
                * INPUT: none
                * OUTPUT: Digit in acc A
                * CALLS: INCH
                * DESTROYS: acc A
                * Returns to monitor if not HEX input

 C01E 8D F0     INHEX  BSR    INCH      GET A CHAR
 C020 81 30            CMP A  #'0       ZERO
 C022 2B 11            BMI    HEXERR    NOT HEX
 C024 81 39            CMP A  #'9       NINE
 C026 2F 0A            BLE    HEXRTS    GOOD HEX
 C028 81 41            CMP A  #'A
 C02A 2B 09            BMI    HEXERR    NOT HEX
 C02C 81 46            CMP A  #'F
 C02E 2E 05            BGT    HEXERR
 C030 80 07            SUB A  #7        FIX A-F
 C032 84 0F     HEXRTS AND A  #$0F      CONVERT ASCII TO DIGIT
 C034 39               RTS

 C035 7E C0 AF  HEXERR JMP    CTRL      RETURN TO CONTROL LOOP
```

The first true computer code was Assembly Language (ASM) or Regional Assembly Language. ASM was specific to the architecture of the machine on which it was being used. In 1951, programming languages fell under the generic term Autocode. Soon languages such as IPL, FORTRAN and ALGOL 58 were developed.

1959

Admiral Grace Hopper was part of the team that developed the UNIVAC I computer and she eventually developed a compiler for it. In time, the compiler she developed became COBOL (Common Business-oriented Language), a computer language that's still in use today.

1960-1970

Computer programming was mainly utilised by universities, the military and big corporations during the '60s and the '70s. A notable step toward a more user-friendly, or home user, language was the development of BASIC (Beginners All-purpose Symbolic Instruction Code) in the mid-sixties.

```
10 INPUT "What is your name: "; U$
20 PRINT "Hello "; U$
25 REM
30 INPUT "How many stars do you want: "; N
35 S$ = ""
40 FOR I = 1 TO N
50 S$ = S$ + "*"
55 NEXT I
60 PRINT S$
65 REM
70 INPUT "Do you want more stars? "; A$
80 IF LEN(A$) = 0 THEN GOTO 70
90 A$ = LEFT$(A$, 1)
100 IF (A$ = "Y") OR (A$ = "y") THEN GOTO 30
110 PRINT "Goodbye ";
120 FOR I = 1 TO 200
130 PRINT U$; " ";
140 NEXT I
150 PRINT
```

1970-1985

1990s-Present Day

The Internet age brought a wealth of new programming languages and allowed people access to the tools and knowledge needed to learn coding in a better way. Not only could a user learn how to code, they could also freely share their code and source other code to improve their own.

What can You Do with Python?

Python is an open-source, object-oriented programming language that's simple to understand and write, yet also powerful and extremely malleable. It's these characteristics that help make it such an important language to learn.

Python's ability to create highly readable code within a small set of instructions has a considerable impact on our modern digital world. From the ideal, first programmers' choice to its ability to create interactive stories and games; from scientific applications to artificial Intelligence and web-based applications, the only limit to Python is the imagination of the person coding in it.

It's Python's malleable design that makes it an ideal language for many different situations and roles. Even certain aspects of the coding world, that require more efficient code, still use Python. For example, NASA utilises Python both as a stand-alone language and as a bridge between other programming languages. This way, NASA scientists and engineers are able to get to the data they need without having to cross multiple language barriers; Python fills the gaps and provides the means to get the job done. You'll find lots of examples of this, where Python is acting behind the scenes. This is why it's such an important language to learn.

```
Beautiful is better than ugly.
Explicit is better than implicit.
Simple is better than complex.
Complex is better than complicated.
Flat is better than nested.
Sparse is better than dense.
Readability counts.
Special cases aren't special enough to break the rules.
Although practicality beats purity.
Errors should never pass silently.
Unless explicitly silenced.
In the face of ambiguity, refuse the temptation to guess.
There should be one-- and preferably only one --obvious way to do it.
Although that way may not be obvious at first unless you're Dutch.
Now is better than never.
Although never is often better than *right* now.
If the implementation is hard to explain, it's a bad idea.
If the implementation is easy to explain, it may be a good idea.
Namespaces are one honking great idea -- let's do more of those!
```

BIG DATA

Big data is a buzzword you're likely to have come across in the last couple of years. Basically, it means extremely large data sets that are available for analysis to reveal patterns, trends and interactions between humans, society and technology. Of course, it's not just limited to those areas, big data is currently being used in a variety of industries, from social media to health and welfare, engineering to space exploration and beyond.

Python plays a substantial role in the world of big data. It's extensively used to analyse huge chunks of the available big data and extract specific information based on what the user/company requires from the wealth of numbers present. Thanks to an impressive set of data processing libraries, Python makes the act of getting to the data, in amongst the numbers, that counts and presenting it in a fashion that's readable and useable for humans.

There are countless libraries and freely available modules that enable fast, secure and more importantly, accurate processing of data from the likes of supercomputing clusters. For example, CERN uses a custom Python module to help analyse the 600 million collisions per second that the Large Hadron Collider (LHC) produces. A different language handles the raw data, but Python is present to help sift through the data so scientists can get to the content they want without the need to learn a far more complex programming language.

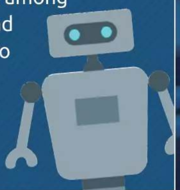
ARTIFICIAL INTELLIGENCE

Artificial Intelligence and Machine Learning are two of the most groundbreaking aspects of modern computing. AI is the umbrella term used for any computing process wherein the machine is doing something intelligent, working and reacting in similar ways to humans. Machine Learning is a subset of AI and provides the overall AI system with the ability to learn from its experiences.

However, AI isn't simply the creation of autonomous robots intent on wiping out human civilisation. Indeed, AI can be found in a variety of day-to-day computing applications where the 'machine', or more accurately the code, needs to learn from the actions of some form of input and anticipate what the input is likely to require, or do, next.

This model can be applied to Facebook, Google, Twitter, Instagram and so on. Have you ever looked up a celebrity on Instagram and then discovered that your searches within other social media platforms are now specifically targeted toward similar celebrities? This is a prime example of using AI in targeted advertising and behind the code and algorithms that predict what you're looking for, is Python.

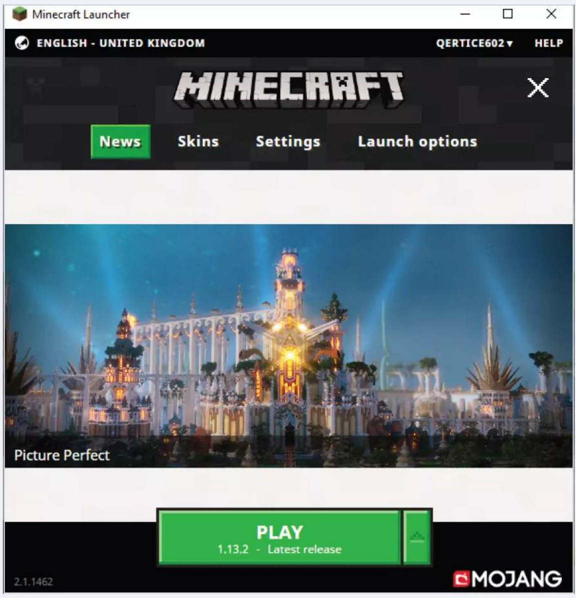
Spotify, for example, uses Python based code, among other things, to analyse your musical habits and offer playlists based on what you've listened to in the past. It's all clever stuff and, moving forward, Python is at the forefront of the way the Internet will work in the future.



WEB DEVELOPMENT

Web development has moved on considerably since the early days of HTML scripting in a limited text editor. The many frameworks and web management services available now means that building a page has become increasingly complex.

With Python, the web developer has the ability to create dynamic and highly secure web apps, enabling interaction with other web services and apps such as Instagram and Pinterest. Python also allows the collection of data from other websites and even apps built within other websites.



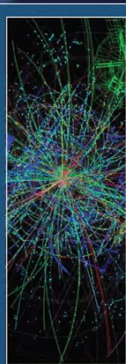
GAMING

Although you won't find too many triple-A rated games coded using Python, you may be surprised to learn that Python is used as an extra on many of the high-ranking modern games.

The main use of Python in gaming comes in the form of scripting, where a Python script can add customisations to the core game engine. Many map editors are Python compatible and you will also come across it if you build any mods for games, such as The Sims.

A lot of the online, MMORPG (Massively Multiplayer Online Role-Playing Game) games available utilise Python as a companion language for the server-side elements. These include: code to search for potential cheating, load balancing across the game's servers, player skill matchmaking and to check whether the player's client-side game matches the server's versions. There's also a Python module that can be included in a Minecraft server, enabling the server admin to add blocks, send messages and automate a lot of the background complexities of the game.

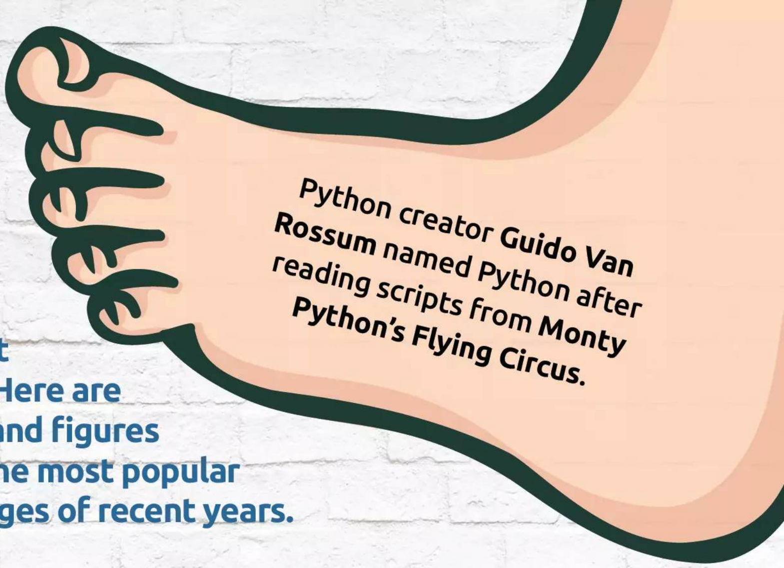
PYTHON EVERYWHERE



As you can see, Python is quite a versatile programming language. By learning Python, you are creating a well-rounded skillset that's able to take you into the next generation of computing, either professionally or simply as a hobbyist.

Whatever route you decide to take on your coding journey, you will do well to have Python in your corner.

PYTHON in NUMBERS



Python creator **Guido Van Rossum** named Python after reading scripts from **Monty Python's Flying Circus.**

There's a lot to like about Python, but don't just take our word for it. Here are some amazing facts and figures surrounding one of the most popular programming languages of recent years.

Alexa, Amazon's Virtual Personal Assistant, uses Python to help with speech recognition.

Data analysis and Machine Learning are the two most used Python examples.

As of the end of 2022, Python was the most discussed language on the Internet.

PYTHON AND LINUX SKILLS ARE THE THIRD MOST POPULAR I.T. SKILLS IN THE UK.

Disney Pixar uses Python in its Renderman software to operate between other graphics packages.

75%

OVER 75% OF RECOMMENDED CONTENT FROM NETFLIX IS GENERATED FROM MACHINE LEARNING – CODED BY PYTHON.

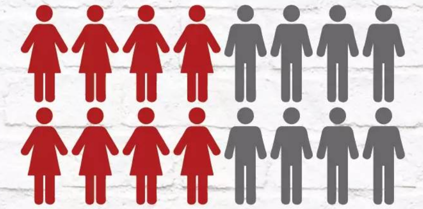
90%

90% OF ALL FACEBOOK POSTS ARE FILTERED THROUGH PYTHON-CODED MACHINE LEARNING.

75%

IT'S ESTIMATED THAT OVER 75% OF NASA'S WORKFLOW AUTOMATION SYSTEMS ON-BOARD THE I.S.S. USE PYTHON.

16,000



There are over 16,000 Python jobs posted every six months in the UK.

PYTHON SKILL-BASED POSITIONS ARE THE

16th

MOST SOUGHT-AFTER JOBS IN THE UK.

Python Data Science is thought to become the most sought-after job in the coming years.

Google is the top company for hiring Python developers, closely followed by Microsoft.

Data Science, Blockchain and Machine Learning are the fastest growing Python coding skills.

New York and San Francisco are the top Python developer cities in the world.

Python developers enjoy an average salary of

£60,000

95% OF ALL BEGINNER CODERS START WITH AND STILL USE, PYTHON AS THEIR PRIMARY OR SECONDARY LANGUAGE.

75% OF ALL PYTHON DEVELOPERS USE PYTHON 3, WHEREAS 25% STILL USE THE OUTDATED PYTHON 2 VERSION.

79% OF ALL PROGRAMMERS USE PYTHON ON A DAY-TO-DAY BASIS, 21% USE IT AS A SECONDARY LANGUAGE.

49% OF WINDOWS 10 DEVELOPERS USE PYTHON 3 AS THEIR MAIN PROGRAMMING LANGUAGE.

Why Python?

There are many different programming languages available for the modern computer, and some still available for older 8 and 16-bit computers too. Some of these languages are designed for scientific work, others for mobile platforms and such. So why choose Python out of all the rest?

PYTHON POWER

Ever since the earliest home computers were available, enthusiasts, users and professionals have toiled away until the wee hours, slaving over an overheating heap of circuitry to create something akin to magic.

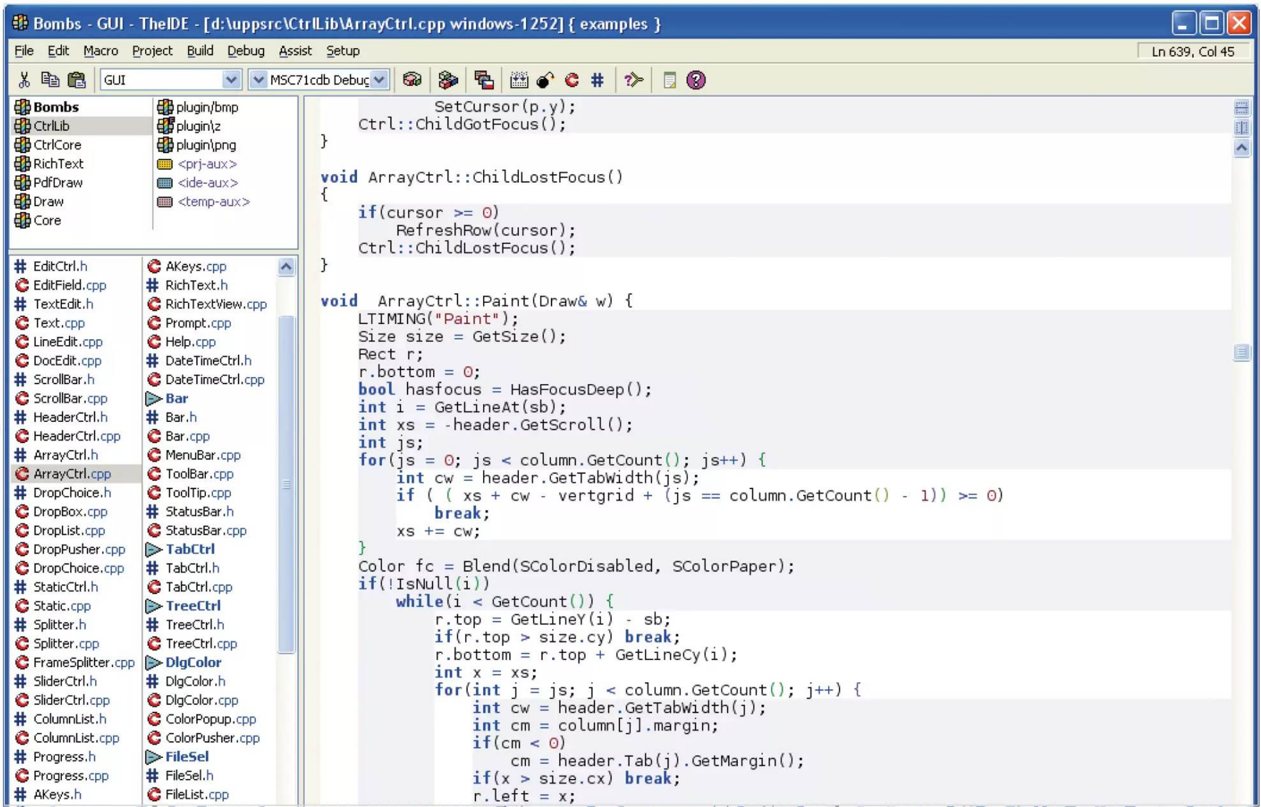
These pioneers of programming carved their way into a new frontier, forging small routines that enabled the letter 'A' to scroll across the screen. It may not sound terribly exciting to a generation that's used to ultra high-definition graphics and open world, multi-player online gaming. However, forty-something years ago it was blindingly brilliant.

Naturally these bedroom coders helped form the foundations for every piece of digital technology we use today. Some went on to become chief developers for top software companies, whereas others pushed the available hardware to its limits and founded the billion pound gaming empire that continually amazes us.

Regardless of whether you use an Android device, iOS device, PC, Mac, Linux, Smart TV, games console, MP3 player, GPS device built-in to a car, set-top box or a thousand other connected and 'smart' appliances, behind them all is programming.

All those aforementioned digital devices need instructions to tell them what to do, and allow them to be interacted with. These instructions form the programming core of the device and that core can be built using a variety of programming languages.

The languages in use today differ depending on the situation, the platform, the device's use and how the device will interact with its



environment or users. Operating systems, such as Windows, macOS and such are usually a combination of C++, C#, assembly and some form of visual-based language. Games generally use C++ whilst web pages can use a plethora of available languages such as HTML, Java, Python and so on.

More general-purpose programming is used to create programs, apps, software or whatever else you want to call them. They're widely used across all hardware platforms and suit virtually every conceivable application. Some operate faster than others and some are easier to learn and use than others. Python is one such general-purpose language.

Python is what's known as a High-Level Language, in that it 'talks' to the hardware and operating system using a variety of arrays, variables, objects, arithmetic, subroutines, loops and countless more interactions. Whilst it's not as streamlined as a Low-Level Language, which can deal directly with memory addresses, call stacks and registers, its benefit is that it's universally accessible and easy to learn.

```java
//file: Invoke.java
import java.lang.reflect.*;

class Invoke {
  public static void main( String [] args ) {
    try {
      Class c = Class.forName( args[0] );
      Method m = c.getMethod( args[1], new Class
      [] { } );
      Object ret =  m.invoke( null, null );
      System.out.println(
          "Invoked static method: " + args[1]
          + " of class: " + args[0]
          + " with no args\nResults: " + ret );
    } catch ( ClassNotFoundException e ) {
      // Class.forName(  ) can't find the class
    } catch ( NoSuchMethodException e2 ) {
      // that method doesn't exist
    } catch ( IllegalAccessException e3 ) {
      // we don't have permission to invoke that
      method
    } catch ( InvocationTargetException e4 ) {
      // an exception ocurred while invoking that
      method
      System.out.println(
          "Method threw an: " + e4.
          getTargetException(  ) );
    }
  }
}
```

Java is a powerful language that's used in web pages, set-top boxes, TVs and even cars.

Python was created over twenty six years ago and has evolved to become an ideal beginner's language for learning how to program a computer. It's perfect for the hobbyist, enthusiast, student, teacher and those who simply need to create their own unique interaction between either themselves or a piece of external hardware and the computer itself.

Python is free to download, install and use and is available for Linux, Windows, macOS, MS-DOS, OS/2, BeOS, IBM i-series machines, and even RISC OS. It has been voted one of the top five programming languages in the world and is continually evolving ahead of the hardware and Internet development curve.

So to answer the question: why Python? Simply put, it's free, easy to learn, exceptionally powerful, universally accepted, effective and a superb learning and educational tool.

```
  40 LET py=15
  70 FOR w=1 TO 10
  71 CLS
  75 LET by=INT (RND*28)
  80 LET bx=0
  90 FOR d=1 TO 20
 100 PRINT AT px,py;" U "
 110 PRINT AT bx,by;"o"
 120 IF INKEY$="p" THEN LET py=p
y+1
 130 IF INKEY$="o" THEN LET py=p
y-1        U
 135 FOR n=1 TO 100: NEXT n
 140 IF py<2 THEN LET py=2
 150 IF py>27 THEN LET py=27
 180 LET bx=bx+1
 185 PRINT AT bx-1,by;" "
 190 NEXT d
 200 IF (by-1)=py THEN LET s=s+1
 210 PRINT AT 10,10;"score=";s
 220 FOR v=1 TO 1000: NEXT v
 300 NEXT w

0 OK, 0:1
```

BASIC was once the starter language that early 8-bit home computer users learned.

```python
print(HANGMAN[0])
attempts = len(HANGMAN) - 1


while (attempts != 0 and "-" in word_guessed):
    print(("\nYou have {} attempts remaining").format(attempts))
    joined_word = "".join(word_guessed)
    print(joined_word)

    try:
        player_guess = str(input("\nPlease select a letter between A-Z" + "\n> ")).
    except: # check valid input
        print("That is not valid input. Please try again.")
        continue
    else:
        if not player_guess.isalpha(): # check the input is a letter. Also checks a
            print("That is not a letter. Please try again.")
            continue
        elif len(player_guess) > 1: # check the input is only one letter
            print("That is more than one letter. Please try again.")
            continue
        elif player_guess in guessed_letters: # check it letter hasn't been guessed
            print("You have already guessed that letter. Please try again.")
            continue
        else:
            pass

    guessed_letters.append(player_guess)

    for letter in range(len(chosen_word)):
        if player_guess == chosen_word[letter]:
            word_guessed[letter] = player_guess # replace all letters in the chosen

    if player_guess not in chosen_word:
```

Python is a more modern take on BASIC, it's easy to learn and makes for an ideal beginner's programming language.

Python on the Pi

If you're considering on which platform to install and use Python, then give some thought to one of the best coding bases available: the Raspberry Pi. The Pi has many advantages for the coder: it's cheap, easy to use, and extraordinarily flexible.

THE POWER OF PI

While having a far more powerful coding platform on which to write and test your code is ideal, it's not often feasible. Most of us are unable to jump into a several hundred-pound investment when we're starting off and this is where the Raspberry Pi can help out.

While having a far more powerful coding platform on which to write and test your code is ideal, it's not often feasible. Most of us are unable to jump into a several hundred-pound investment when we're starting off and this is where the Raspberry Pi can help out.

The Raspberry Pi is a fantastic piece of modern hardware that has created, or rather re-created, the fascination we once all had about computers, how they work, how to code and foundation level electronics. Thanks to its unique mix of hardware and custom software, it has proved itself to be an amazing platform on which to learn how to code; specifically, using Python.

While you're able, with ease, to use the Raspberry Pi to learn to code with other programming languages, it's Python that has been firmly pushed to the forefront. The Raspberry Pi uses Raspbian as its recommended, default operating system. Raspbian is a Linux OS, or to be more accurate, it's a Debian-based distribution of Linux. This means that there's already a built-in element of Python programming, as opposed to a fresh installation of Windows 10, which has no Python-specific base. However, the Raspberry Pi Foundation has gone the extra mile to include a vast range of Python modules, extensions and even examples, out of the box. So, essentially, all you need to do is buy a Raspberry Pi, follow the instructions on how to set one up (by using one of our excellent Raspberry Pi guides found at **www.bdmpublications.com**) and you can start coding with Python as soon as the desktop has loaded.

Significantly, there's a lot more to the Raspberry Pi, which makes it an excellent choice for someone who is starting to learn how to code in Python. The Pi is remarkably easy to set up as a headless node. This means that, with a few tweaks here and there, you're able to remotely connect to the Raspberry Pi from any other computer, or device, on your home network. For example, once you've set up the remote connectivity options, you can simply plug the Pi into the power socket anywhere in your house within range of your wireless router. As long as the Pi is connected, you will be able to remotely access the desktop from Windows or macOS as easily as if you were sitting in front of the Pi with a keyboard and mouse.

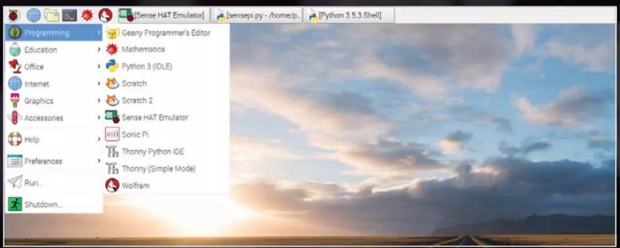
Using this method saves a lot of money, as you don't need another keyboard, mouse and monitor, plus, you won't need to allocate sufficient space to accommodate those extras either. If you're pushed for space and money, then for around £60, buying one of the many kits available will provide the Pi with a pre-loaded SD card (with the latest Raspbian OS), a case, power socket and cables, this is a good idea as you could, with very little effort, leave the Pi plugged into the wall under a desk, while still being able to connect to it and code.

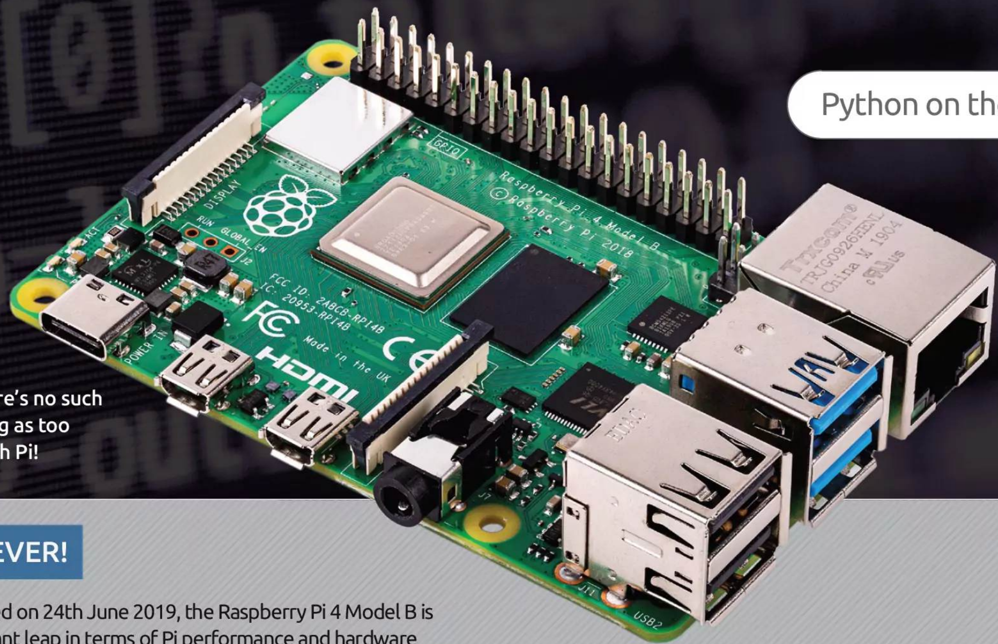
The main advantage is, of course, the extra content that the Raspberry Pi Foundation has included out of the box. The reason for this is that the Raspberry Pi's goal is to help educate the user, whether that's coding, electronics, or some other aspect of computing. To achieve that goal the Pi Foundation includes different IDEs for the user to compile Python code on; as well as both Python 2 and Python 3, there's even a Python library that allows you to communicate with Minecraft.

There are other advantages, such as being able to combine Python code with Scratch (an Object-Oriented programming language developed by MIT, for children to understand how coding works) and being able to code the GPIO connection on the Pi to further control any attached robotics or electronics projects. Raspbian also includes a Sense HAT Emulator (a HAT is a hardware attached piece of circuitry that offers different electronics, robotics and motorisation projects to the Pi), which can be accessed via Python code.

Consequently, the Raspberry Pi is an excellent coding base, as well as a superb project foundation. It is for these, and many other, reasons we've used the Raspberry Pi as our main Python codebase throughout this title. While the code is written and performed on a Pi, you're also able to use it in Windows, other versions of Linux and macOS. If the code requires a specific operating system, then, don't worry; we will let you know in the text.

Everything you need to learn to code with Python is included with the OS!





There's no such thing as too much Pi!

PI 4-EVER!

Introduced on 24th June 2019, the Raspberry Pi 4 Model B is a significant leap in terms of Pi performance and hardware specifications. It was also one of the quickest models, aside from the original Pi, to sell out.

With a new 1.5GHz, 64-bit, quad-core ARM Cortex-A72 processor, and a choice of 1GB, 2GB, or 4GB memory versions, the Pi 4 is one-step closer to becoming a true desktop computer. In addition, the Pi 4 was launched with the startling decision to include dual-monitor support, in the form of a pair of two micro-HDMI ports. You'll also find a pair of USB 3.0 ports, Bluetooth 5.0, and a GPU that's capable of handing 4K resolutions and OpenGL ES 3.0 graphics.

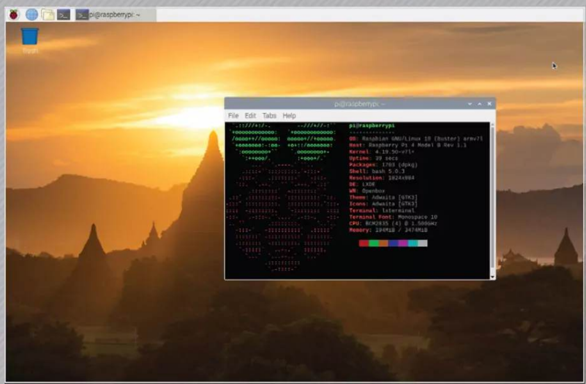
In short, the Pi 4 is the most powerful of the current Raspberry Pi models. However, the different memory versions have an increased cost. The 1GB version costs £34, 2GB is £44, and the 4GB version will set you back £54. Remember to also factor in one or two micro-HDMI cables with your order.

RASPBIAN BUSTER

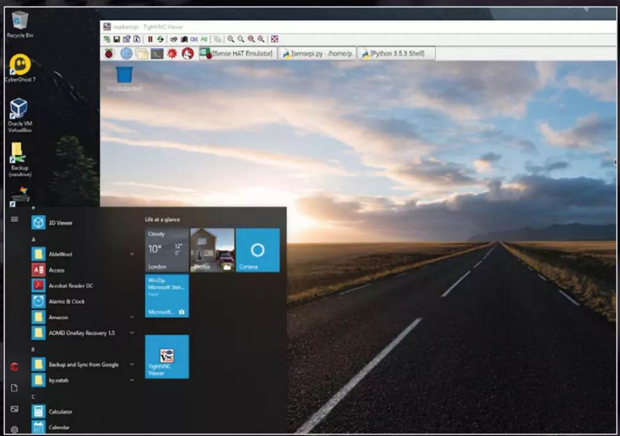
In addition to releasing the Pi 4, the Raspberry Pi team also compiled a new version of the Raspbian operating system, codenamed Buster.

In conjunction with the new hardware the Pi 4 boasts, Buster does offer a few updates. Although on the whole it's very similar in appearance and operation to the previous version of Raspbian. The updates are mainly in-line with the 4K's display and playback, giving the Pi 4 a new set of graphical drivers and performance enhancements.

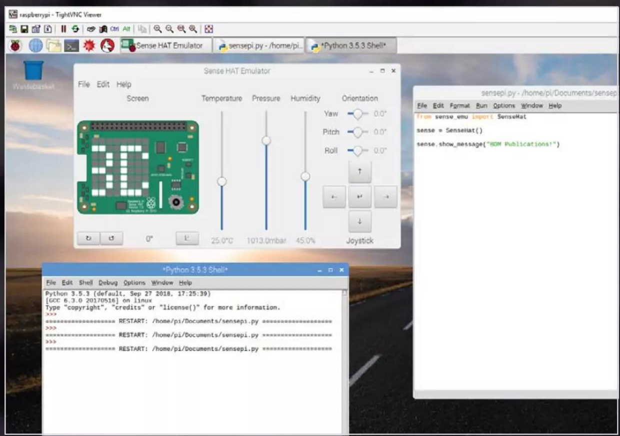
In short, what you see in this book will work with the Raspberry Pi 4 and Raspbian Buster!



Once set up, you can remotely connect to the Pi's desktop from any device/PC.



You can even test connected hardware with Python remotely, via Windows.



Using Virtual Machines

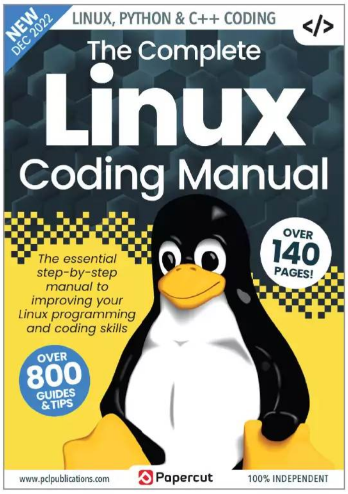
A Virtual Machine allows you to run an entire operating system from within an app on your desktop. This way, you're able to host multiple systems in a secure, safe and isolated environment. In short, it's an ideal way to code.

Sounds good, but what exactly is a Virtual Machine (VM) and how does it work?

The official definition of a virtual machine is 'an efficient, isolated duplicate of a real computer machine'. This basically means that a virtual machine is an emulated computer system that can operate in exactly the same way as a physical machine, but within the confines of a dedicated virtual machine operator, or Hypervisor.

The Hypervisor itself, is an app that will allow you to install a separate operating system, creating a virtual computer system within itself, complete with access to the Internet, your home network and so on.

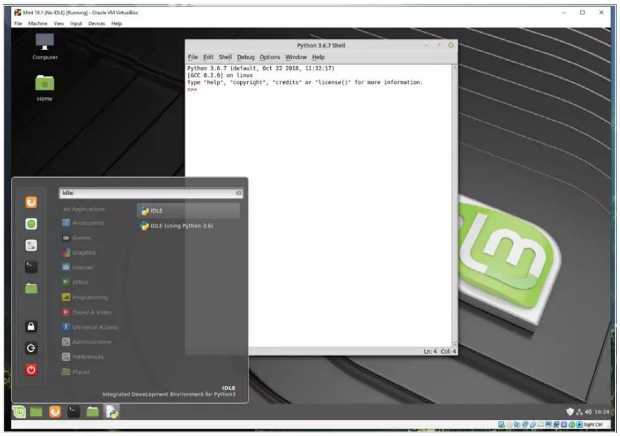
The Hypervisor will take resources from the host system - your physical computer, to create the virtual computer. This means that part of your physical computer's: memory, CPU, hard drive space and other shared resources, will be set aside for use in the virtual machine and therefore won't be available to the physical computer until the hypervisor has been closed down.



Our Linux titles contain steps on how to install a hypervisor and OS.

This resource overhead can be crippling for the physical machine if you don't already have enough memory, or hard drive space available, or your computer has a particularly slow processor. While it's entirely possible to run virtual machines on as little as 2GB of memory, it's not advisable. Ideally, you will need a minimum of 8GB of memory (you can get away with 4GB, but again, your physical computer will begin to suffer with the loss of memory to the virtual machine), at least 25 to 50GB of free space on your hard drive and a quad-core processor (again, you can have a dual-core CPU, but that can cause a bottleneck on your physical computer).

The limit to how many different virtual machines you host on your physical computer is restricted, therefore, by the amount of physical system resources you can allocate to each, while still leaving enough for your physical computer to operate on.



You're able to install Linux, and code inside a virtual machine on a Windows 10 host.

VIRTUAL OS

From within a hypervisor you're able to run a number of different operating systems. The type of OS depends greatly on the hypervisor you're running, as some are better at emulating a particular system over others. For example, VirtualBox, a free and easy to use hypervisor from Oracle, is great at running Windows and Linux virtual machines, but isn't so good at Android or macOS. QEMU is good for emulating ARM processors, therefore ideal for Android and such, but it can be difficult to master.

There are plenty of hypervisors available to try for free, with an equal amount commercially available that are significantly more powerful and offer better features. However, for most users, both beginner and professional, VirtualBox does a good enough job.

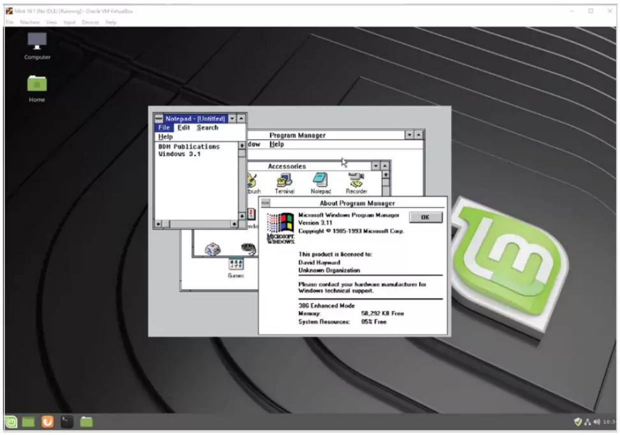
Within a hypervisor, you're able to set up and install any of the newer distributions of Linux, or if you feel the need, you're also able to install some of the more antiquated versions. You can install early versions of Windows, even as far back as Windows 3 complete with DOS 6.22 – although you may find some functionality of the VM lost due to the older drivers (such as access to the network).

With this in mind then, you're able to have an installation of Linux Mint, or the latest version of Ubuntu, running in an app on your Windows 10 PC. This is the beauty of using a virtual machine. Conversely, if your physical computer has Linux as its installed operating system, then with a hypervisor you're able to create a Windows 10 virtual machine – although you will need to have a licence code available to register and activate Windows 10.

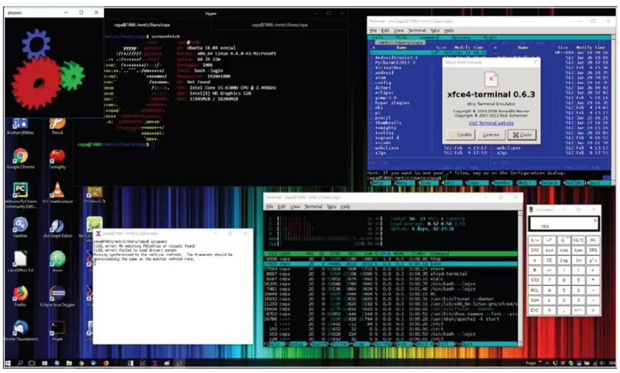
Using virtual machines removes the need to dual-boot. Dual-booting is having two, or more, physical operating systems installed on the same, or multiple, hard drives on a single computer. As the computer powers up, you're given the option to choose which OS you want to boot into. While this sounds like a more ideal scenario it isn't always as straight forward as it sounds, as all the operating systems that are booted into will have full access to the computer's entire system resources.

The problems with dual-booting come when one of the operating systems is updated. Most updates cover security patching, or bug fixing, however, some updates can alter the core - the kernel, of the OS. When these changes are applied, the update may alter the way in which the OS starts up, meaning the initial boot choice you made could be overwritten, leaving you without the ability to access the other operating systems installed on the computer. To rectify this, you'll need to access the Master Boot Record and alter the configuration to re-allow booting into the other systems. There's also the danger of possibly overwriting the first installed OS, or overwriting data and more often than not, most operating systems don't play well when running side-by-side. Indeed, while good, dual-booting has more than its fair share of problems. In contrast, using a virtual machine environment, while still problematic at times, takes out some of the more nasty and disastrous aspects of using multiple operating systems on a single computer.

Even old operating systems can be run inside a virtual machine.



Virtual machines can be as simple, or as complex as your needs require.

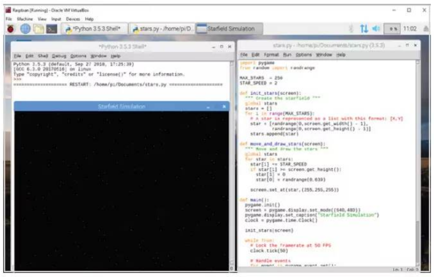


ADVANTAGES FOR CODERS

For the coder, having a virtual machine setup offers many advantages, the most popular being cross-platform code. Meaning if you write code within Windows 10, then with an installation of a Linux distro in a hypervisor, you're able to quickly and effortlessly power up the virtual machine and test your code in a completely different operating system. From this, you're able to iron out any bugs, tweak the code so it works better on a different platform and expand the reach of your code to non-Windows users.

The advantage of being able to configure a development environment, in specific ways for specific projects, is quite invaluable. Using a virtual machine setup greatly reduces the uncertainties that are inherent to having multiple versions of programming languages, libraries, IDEs and modules installed, to support the many different projects you may become involved in as a coder. Elements of code that 'talk' directly to specifics of an operating system can easily be overcome, without the need to clutter up your main, host system with cross-platform libraries, which in turn may have an effect on other libraries within the IDE.

Another element to consider is stability. If you're writing code that could potentially cause some instability to the core OS during its development phase, then executing and testing that code on a virtual machine makes more sense than testing it on your main computer; where having to repeatedly reboot, or reset something due to the code's instabilities, can become inefficient and just plain annoying.



Coding in Python on the Raspberry Pi Desktop OS inside a VM on Windows 10!

The virtual machine environment can be viewed as a sandbox, where you're able to test unsecure, or unstable code without it causing harm, or doing damage, to your main, working computer. Viruses and malware can be isolated within the VM without infecting the main computer, you're able to set up anonymity Internet use within the VM and you're able to install third-party software without it slowing down your main computer.

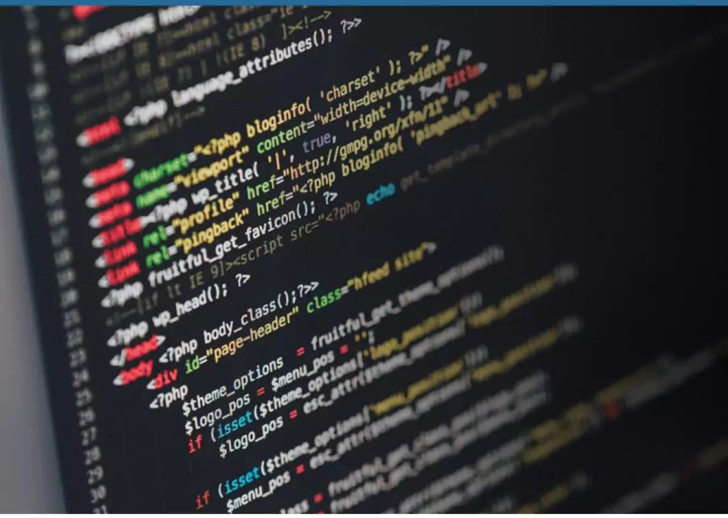
GOING VIRTUAL

While you're at the early stages of coding, using a virtual machine may seem a little excessive. However, it's worth looking into because coding in Linux can often be easier than coding in Windows, as some versions of Linux have IDEs pre-installed. Either way, virtualisation of an operating system is how many of the professional and successful coders and developers work, so getting used to it early on in your skill set is advantageous.

To start, look at installing VirtualBox. Then consider taking a look at our Linux titles, **https://bdmpublications.com/?s=linux&post_type=product**, to learn how to install Linux in a virtual environment and how best to utilise the operating system.

Creating a Coding Platform

The term 'Coding Platform' can denote a type of hardware, on which you can code, or a particular operating system, or even a custom environment that's pre-built and designed to allow the easy creation of games. In truth it's quite a loose term, as a Coding Platform can be a mixture of all these ingredients, it's simply down to what programming language you intend to code in and what your end goals are.



Coding can be one of those experiences that sounds fantastic, but to get going with it, is often confusing. After all, there's a plethora of languages to choose from, numerous apps that will enable you to code in a specific, or range, of languages and an equally huge amount of third-party software to consider. Then you access the Internet and discover that there are countless coding tutorials available, for the language in which you've decided you want to program, alongside even more examples of code. It's all a little too much at times.

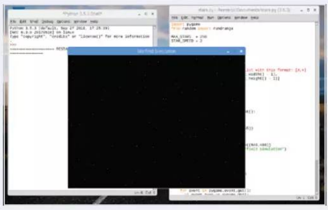
The trick is to slow down and, to begin with, not look too deeply into coding. Like all good projects, you need a solid foundation on which to build your skill and to have all the necessary tools available to hand to enable you to complete the basic steps. This is where creating a coding platform comes in, as it will be your learning foundation while you begin to take your first tentative steps into the wider world of coding.

HARDWARE

Thankfully, coding at the foundation level doesn't require specialist equipment, or a top of the range, liquid hydrogen-cooled PC. If you own a computer, no matter how basic, you can begin to learn how to code. Naturally, if your computer in question is a Commodore 64 then you may have some difficulty following a modern language tutorial, but some of the best programmers around today started on an 8-bit machine, so there's hope yet.

Access to the Internet is necessary to download, install and update the coding development environment, alongside a computer with either: Windows 10, macOS, or Linux installed. You can use other operating systems, but these are the 'big three' and you will find that most code resources are written with one, or all of these, in mind.

SOFTWARE



In terms of software, most of the development environments - the tools that allow you to code, compile the code and execute it - are freely available to download and install. There are some specialist tools available that will cost, but at this level they're not necessary; so don't be fooled into thinking you need to purchase any extra software in order to start learning how to code.

Over time, you may find yourself changing from the mainstream development environment and using a collection of your own, discovered, tools to write your code in. It's all personal preference in the end and as you become more experienced, you will start to use different tools to get the job done.

OPERATING SYSTEMS

Windows 10 is the most used operating system in the world, so it's natural that the vast majority of coding tools are written for Microsoft's leading operating system. However, don't discount macOS and especially Linux.

macOS users enjoy an equal number of coding tools to their Windows counterparts. In fact, you will probably find that a lot of professional coders use a Mac over a PC, simply because of the fact that the Mac operating system is built on top of Unix (the command-line OS that powers much of the world's filesystems and servers). This Unix layer lets you test programs in almost any language without using a specialised IDE.

Linux, however, is by far one of the most popular and important, coding operating systems available. Not only does it have a Unix-like backbone, but also it's also free to download, install and use and comes with most of the tools necessary to start learning how to code. Linux powers most of the servers that make up the Internet. It's used on nearly all of the top supercomputers, as well as specifically in organisations such as NASA, CERN and the military and it forms the base of Android-powered devices, smart TVs and in-car systems. Linux, as a coding platform, is an excellent idea and it can be installed inside a virtual machine without ever affecting the installation of Windows or macOS.

THE RASPBERRY PI

If you haven't already heard of the Raspberry Pi, then we suggest you head over to **www.raspberrypi.org**, and check it out. In short, the Raspberry Pi is a small, fully functional computer that comes with its own customised Linux-based operating system, pre-installed with everything you need to start learning how to code in Python, C++, Scratch and more.

It's incredibly cheap, costing around £35 and allows you to utilise different hardware, in the form of robotics and electronics projects, as well as offering a complete desktop experience. Although not the most powerful computing device in the world, the Raspberry Pi has a lot going for it, especially in terms of being one of the best coding platforms available.

YOUR OWN CODING PLATFORM

Whichever method you choose, remember that your coding platform will probably change, as you gain experience and favour one language over another. Don't be afraid to experiment along the way, as you will eventually create your own unique platform that can handle all the code you enter into it.

VIRTUAL MACHINES

A virtual machine is a piece of software that allows you to install a fully working, operating system within the confines of the software itself. The installed OS will allocate user-defined resources from the host computer, providing memory, hard drive space etc., as well as sharing the host computer's Internet connection.

The advantage of a virtual machine is that you can work with Linux, for example, without it affecting your currently installed host OS. This means that you can have Windows 10 running, launch your virtual machine client, boot into Linux and use all the functionality of Linux while still being able to use Windows.

This, of course, makes it a fantastic coding platform, as you can have different installations of operating systems running from the host computer while using different coding languages. You can test your code without fear of breaking your host OS and it's easy to return to a previous configuration without the need to reinstall everything again.

Virtualisation is the key to most big companies now. You will probably find, for example, rather than having a single server with an installation of Windows Server, the IT team have instead opted for a virtualised environment whereby each Windows Server instance is a virtual machine running from several powerful machines. This cuts down on the number of physical machines, allows the team to better manage resources and enables them to deploy an entire server dedicated to a particular task in a fraction of the time.

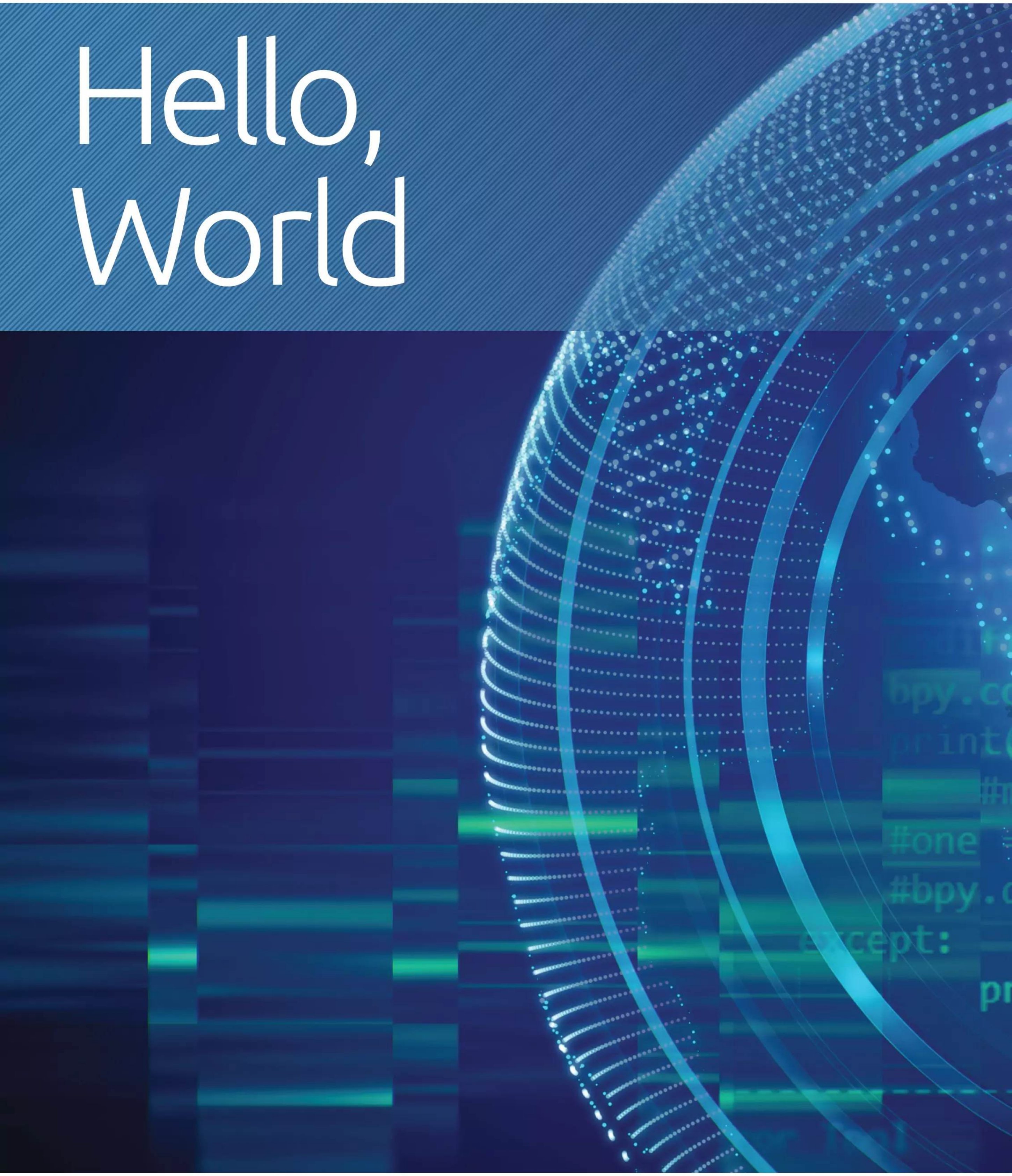
MINIX NEO N42C-4

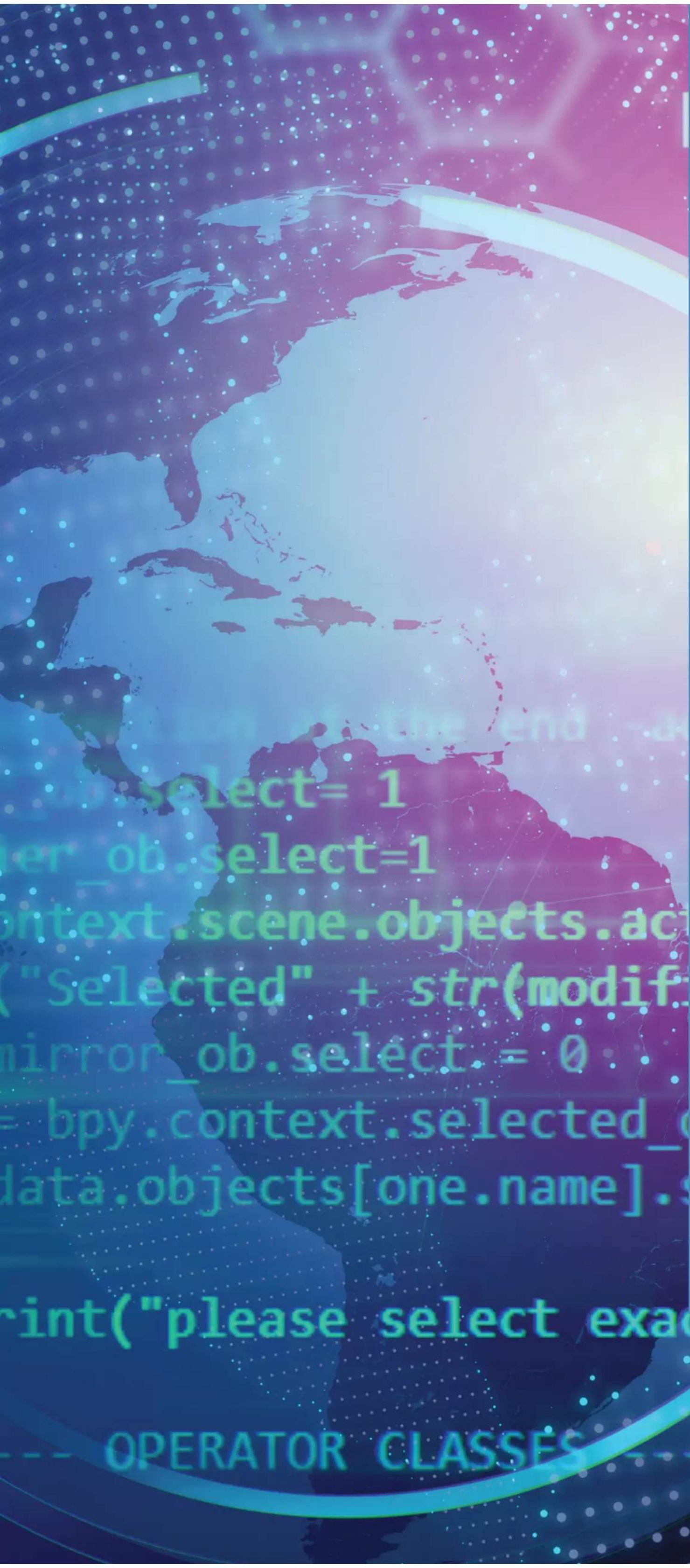
The NEO N42C-4 is an extraordinarily small computer from mini-PC developer, MINIX. Measuring just 139 x 139 x 30mm, this Intel N4200 CPU powered, Windows 10 Pro pre-installed computer is one of the best coding platforms we've come across.

The beauty, of course, lies in the fact that with increased storage and memory available, you're able to create a computer that can easily host multiple virtual machines. The virtual machines can cover Linux, Android and other operating systems, allowing you to write and test cross-platform code without fear of damaging, or causing problems, with other production or home computers.

The MINIX NEO N42C-4 starts at around £250, with the base 32GB eMMC and 4GB of memory. You'll need to add another hundred and fifty, or so, to increase the specifications, but consider that a license for Windows 10 Pro alone costs £219 from the Microsoft Store and you can begin to see the benefits of opting for a more impressive hardware foundation over the likes of the Raspberry Pi.

Hello, World





Getting started with Python may seem a little daunting at first, but, thankfully, the language has been designed with simplicity in mind. Like most things, you need to start slow, master the basics, learn how to get a result, and how to get what you want from the code.

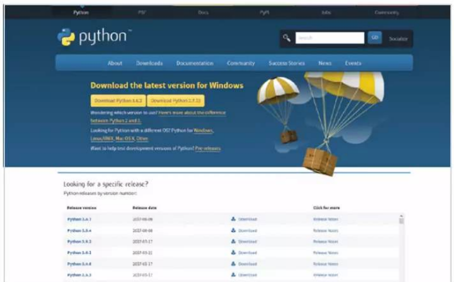
This section covers numbers and expressions, user input, conditions and loops and the types of errors you will undoubtedly come across in your time with Python: the core foundations of good coding and Python code.

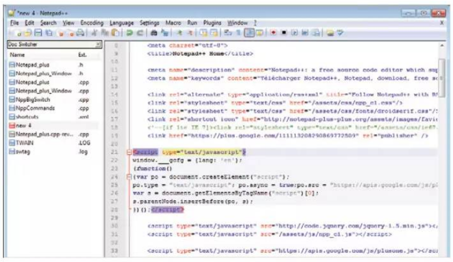
Equipment You Will Need

You can learn Python with very little hardware or initial financial investment. You don't need an incredibly powerful computer and any software that's required is freely available.

WHAT WE'RE USING

Thankfully, Python is a multi-platform programming language available for Windows, macOS, Linux, Raspberry Pi and more. If you have one of those systems, then you can easily start using Python.





COMPUTER

Obviously you're going to need a computer in order to learn how to program in Python and to test your code. You can use Windows (from XP onward) on either a 32 or 64-bit processor, an Apple Mac or Linux installed PC.

AN IDE

An IDE (Integrated Developer Environment) is used to enter and execute Python code. It enables you to inspect your program code and the values within the code, as well as offering advanced features. There are many different IDEs available, so find the one that works for you and gives the best results.

PYTHON SOFTWARE

macOS and Linux already come with Python preinstalled as part of the operating system, as does the Raspberry Pi. However, you need to ensure that you're running the latest version of Python. Windows users need to download and install Python, which we'll cover shortly.

TEXT EDITOR

Whilst a text editor is an ideal environment to enter code into, it's not an absolute necessity. You can enter and execute code directly from the IDLE but a text editor, such as Sublime Text or Notepad++, offers more advanced features and colour coding when entering code.

INTERNET ACCESS

Python is an ever evolving environment and as such new versions often introduce new concepts or change existing commands and code structure to make it a more efficient language. Having access to the Internet will keep you up-to-date, help you out when you get stuck and give access to Python's immense number of modules.

TIME AND PATIENCE

Despite what other books may lead you to believe, you won't become a programmer in 24-hours. Learning to code in Python takes time, and patience. You may become stuck at times and other times the code will flow like water. Understand you're learning something entirely new, and you will get there.