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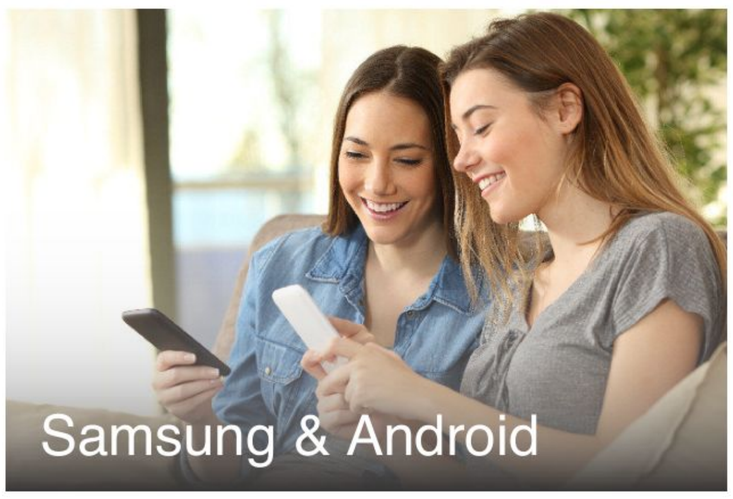

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BDM's i-Tech Special

Coding for Beginners

Turn your imagination into code…

You may not realise that coding is everywhere you look. Code controls nearly every aspect of our modern lives, from traffic lights, to switching the power on for a kettle. Each of these things, and a million others like them, have been coded to operate in a particular way, and they've been created by developers who have learned how to manipulate lines of code into something we take for granted.

Coding is an amazing skill, and with a little knowledge, you can begin to understand how our digital world is put together. Coding for Beginners is your first step into the wider world of code. Inside these pages, you will find the necessary tools to help you form a solid foundation, from learning how to get code into your computer, through to creating interesting and useful programs to help with real world problems.

This book will introduce you to the core concepts of C++, Python, Windows batch files and Linux Scripting. You'll get to code user interaction, store and manipulate variables, create strings and functions, and even make a game or two. Whatever your coding plans are for the future, Coding for Beginners is the start of your journey.

Sounds good? Then let's get coding.

"Good code is short, simple and symmetrical – the challenge is figuring out how to get there."

– Sean Parent (Developer and Author)

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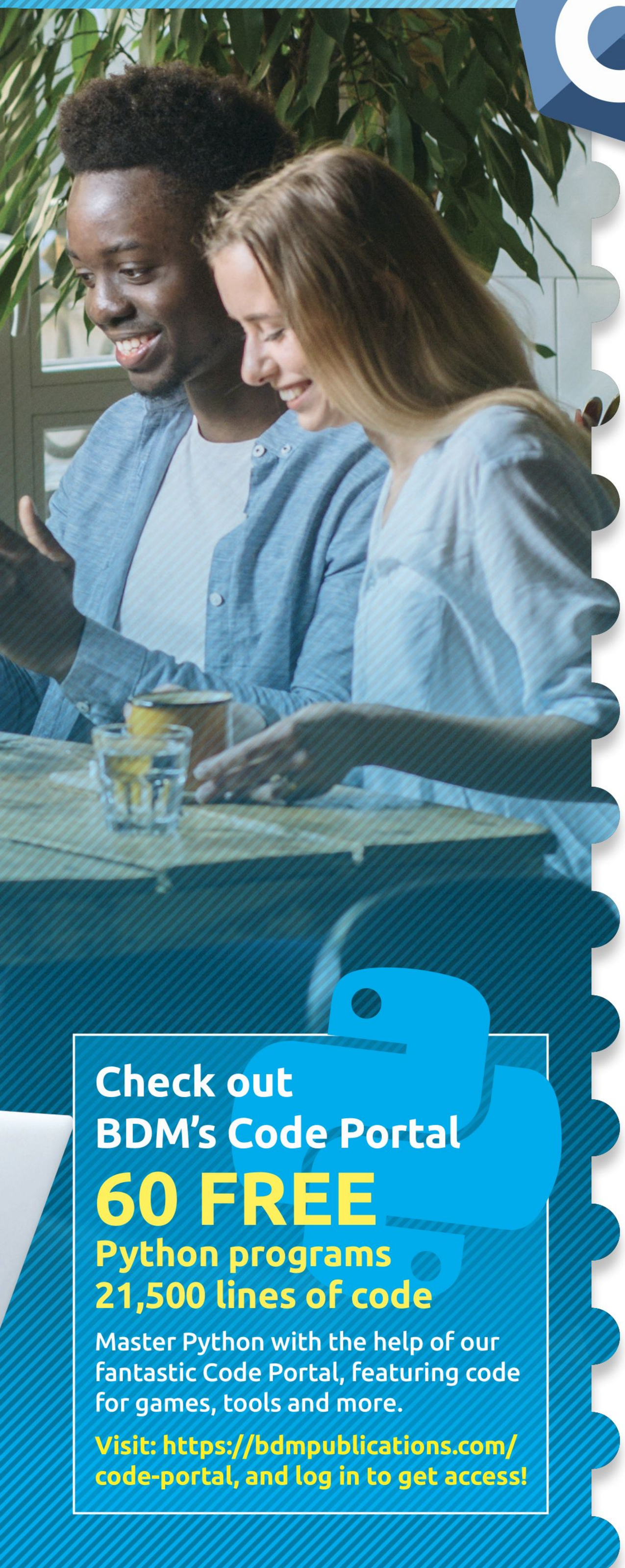

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There's something special about coding; creating the steps that allow a computer to produce content that you've made, even if it's simply asking a user to enter their name and replying with a hello. It means you're the one who has made this happen, and it's a satisfying feeling of accomplishment.

Coding for Beginners aims to get you coding quickly, and effectively. However, before you can create the next triple-A rated game, you need to learn the basics and build a solid foundation. This section looks at what being a programmer is all about, and starts you off in the amazing, interesting and fantastic world of code.

8 Being a Programmer

10 A Brief History of Coding

12 Choosing a Programming Language

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"How did you know so much about computers?"

"I didn't, it was the first one"

– Admiral Grace Hopper (Pioneer Programmer) when interviewed by David Letterman

Print("Coding for Beginners")

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("n");
    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("          лллллллм");
    cprintf("          ллллллллл");
    cprintf("          ллллллппп");
    cprintf(" л       мллллппп ");
    cprintf(" ллм  мллллллммм ");
    cprintf(" пллллллллллл  п ");
    cprintf("   пллллллллп     ");
    if(jump==1 || jump==2){
    cprintf("    ллп пл        ");
    cprintf("    лм   лм       ");
    }else if(a==1)
    {
    cprintf("    плпп  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 01100101

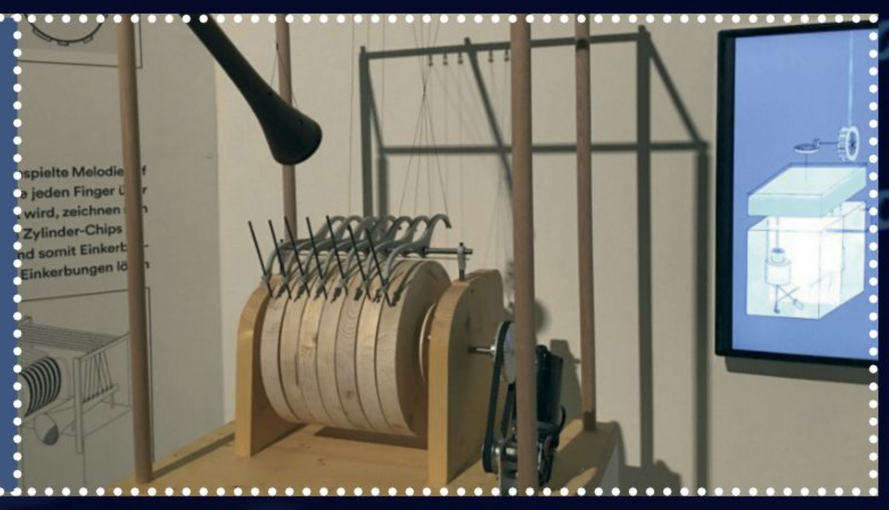
Essentially all forms of coding are made up of ones and zeros, on or off states. This works for a modern computer and even the oldest known computational device.

~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.

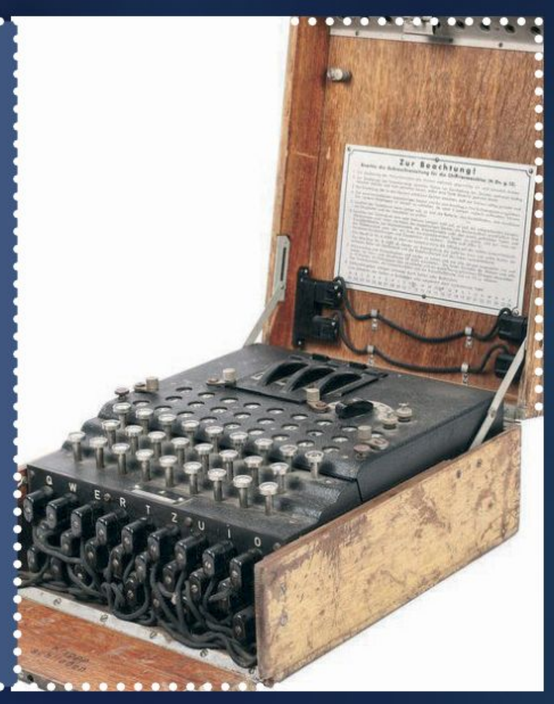
1842-1843

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

1951-1958

During the Second World War, there 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.



1959

```
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 it was being used on. In 1951 programming languages fell under the generic term Autocode. Soon languages such as IPL, FORTRAN and ALGOL 58 were developed.

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
```

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.

1970-1985

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.

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 but they could freely share their code and source other code to improve their own.

Choosing a Programming Language

It would be impossible to properly explain every programming language in a single book of this size. New languages and ways in which to 'talk' to a computer or device and set it instructions are being invented almost daily; and with the onset of quantum computing, even more complex methods are being born. Here is a list of the more common languages along with their key features.

SQL

SQL stands for Structured Query Language. SQL is a standard language for accessing and manipulating databases. Although SQL is an ANSI (American National Standards Institute) standard, there are different versions of the SQL language. However, to be compliant, they all support at least the major commands such as Select, Update and Delete in a similar manner.

JAVASCRIPT

JavaScript (often shortened to JS) is a lightweight, interpreted, object-oriented language with first class functions. JavaScript runs on the client side of the web, that can be used to design or program how the web pages behave on the occurrence of an event. JavaScript is an easy to learn and also powerful scripting language, widely used for controlling web page behaviour.

JAVA

Java is the foundation for virtually every type of networked application and is the global standard for developing enterprise software, web-based content, games and mobile apps. The two main components of the Java platform are the Java Application Programming Interface (API) and the Java Virtual Machine (JVM) that translates Java code into machine language.

C#

C# is an elegant object-oriented language that enables developers to build a variety of secure and robust applications that run on the .NET Framework. You can use C# to create Windows client applications, XML Web services, client server applications, database applications and much more. The curly-brace syntax of C# will be instantly recognisable to anyone familiar with C, C++ or Java.

PYTHON

Python is a widely used high level programming language used for general purpose programming, created by Guido van Rossum and first released in 1991. An interpreted language, Python has a design philosophy that emphasises code readability and a syntax that allows programmers to express concepts in fewer lines of code. This can make it easier for new programmers to learn.

C++

C++ (pronounced cee plus plus) is a general purpose programming language. It has imperative, object-oriented and generic programming features. It was designed with a bias toward system programming and embedded, resource-constrained and large systems, with performance, efficiency and flexibility of use as its design highlights.

RUBY

Ruby is a language of careful balance. Its creator, Yukihiro “Matz” Matsumoto, blended parts of his favourite languages (Perl, Smalltalk, Eiffel, Ada and Lisp) to form a new language. From its release in 1995, Ruby has drawn devoted coders worldwide. Ruby is seen as a flexible language; essential parts of Ruby can be removed or redefined, at will. Existing parts can be added to.

PERL

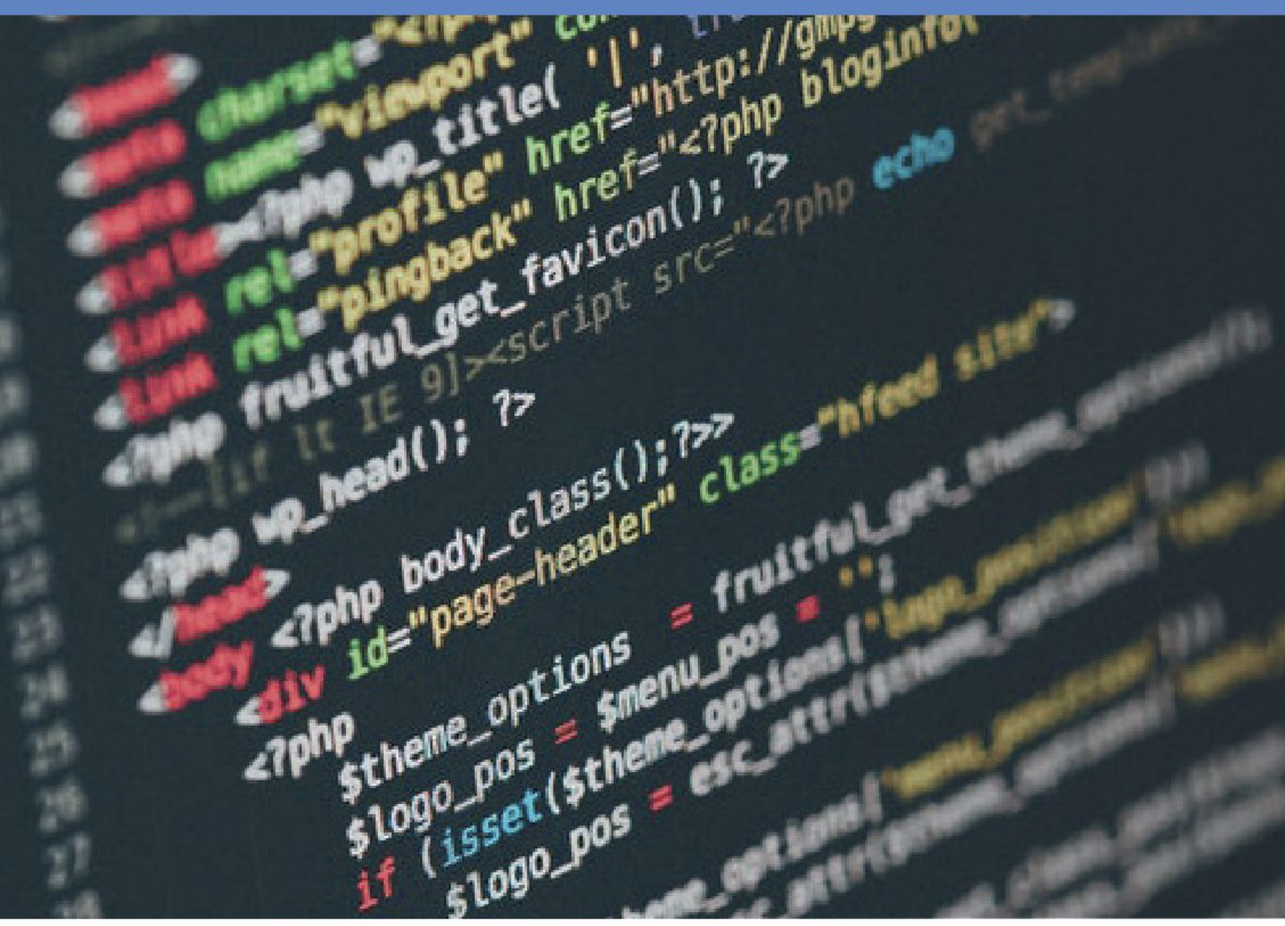
Perl is a general purpose programming language, used for a wide range of tasks including system administration, web development, network programming, GUI development and more. Its major features are that it’s easy to use, supports both procedural and object-oriented (OO) programming, has powerful built-in support for text processing and has one of the most impressive collections of third-party modules.

SWIFT

Swift is a powerful and intuitive programming language for macOS, iOS, watchOS and tvOS. Writing Swift code is interactive and fun; the syntax is concise yet expressive and Swift includes modern features that developers love. Swift code is safe by design, yet also produces software that runs lightning fast. A coding tutorial app, Swift Playgrounds, is available for the iPad.

Creating a Coding Platform

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



Coding can be one of those experiences that sounds fantastic, but is often confusing to tackle. After all, there's a plethora of languages to choose from, countless 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. In addition, by accessing the Internet, you will 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 first.

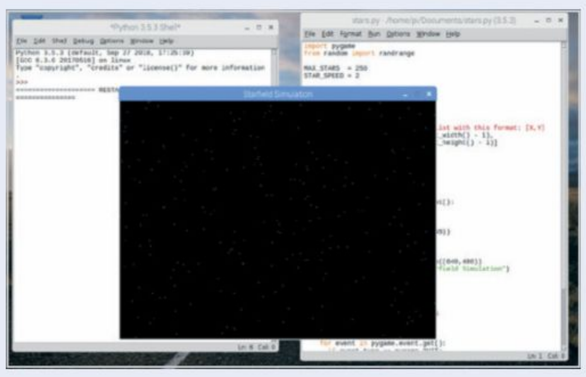
The trick is to slow down and, to begin with, not look too deeply into coding. Like all good projects, you need a solid foundation on which to build your skillset and to have all the necessary tools available to enable you to complete the basic steps. This is where creating a coding platform comes in, 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 the 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.

You will need access to the Internet to download, install and update the coding development environment, alongside a computer with 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



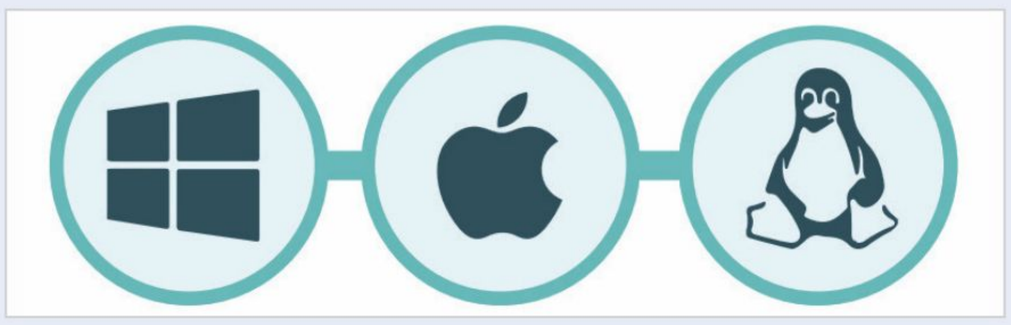
In terms of software, most of the development environments have the tools that allow you to code, compile the code and execute it, freely
available to download and install. There are some specialist tools available that will cost, but at this level they're not necessary, so don't be fooled into thinking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

Over time, you may find yourself progressing from the mainstream development environment and using a collection of your own, discovered, tools to write your code. 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 widely 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.



However, Linux is, by far and away, one of the most popular and important coding operating systems available. Not only does it have a Unix-like backbone, 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, it also 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. It comes with its own customised, Linux-based operating system that's pre-installed with everything you need to start learning how to code in Python, C++, Scratch and more.

Costing around £35, it's incredibly cheap 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.

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.

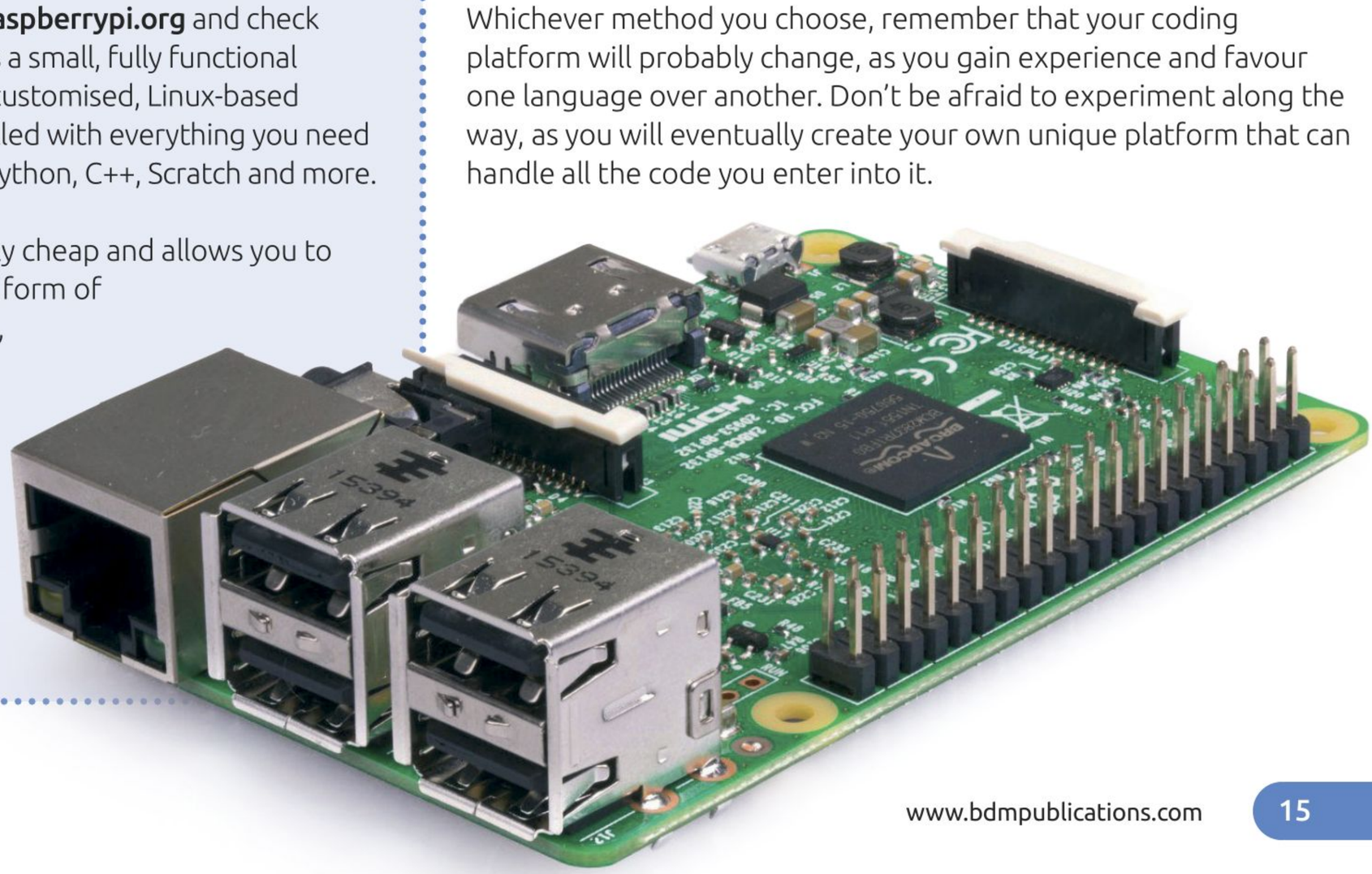
The advantage of a virtual machine is that you can work with Linux, for example, without it affecting your currently installed host OS. This means that you can have Windows 10 running and launch your virtual machine client, boot into Linux and use all the functionality of Linux, while still being able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

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.



Introducing C++

C++ is an amazing programming language. Most of what you see in front of you when you power up your computer, regardless of whether you're using Windows, macOS, or Linux is created using C++. Being able to code in C++ will open up a whole new world for you, in terms of desirable professional skills and the ability to code amazing apps and games.

C++ is an efficient and powerful language that's used to develop operating systems, applications, games and much more. It's the driving force behind the latest games, VR, and complex supercomputing algorithms.

We will help you take your first steps into the world of C++, and build a solid foundation on which you can code amazing content.

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Introducing C++

"The most important single aspect of software development is to be clear about what you are trying to build."

– Bjarne Stroustrup (Developer and creator of C++)

Why C++?

C++ is one of the most popular programming languages available today. Originally called C with Classes, the language was renamed to C++ in 1983. It's an extension of the original C language, and is a general purpose object-oriented (OOP) environment.

C EVERYTHING

Due to both the complexity of the language and its power and performance, C++ is often used to develop games, programs, device drivers, and even entire operating systems.

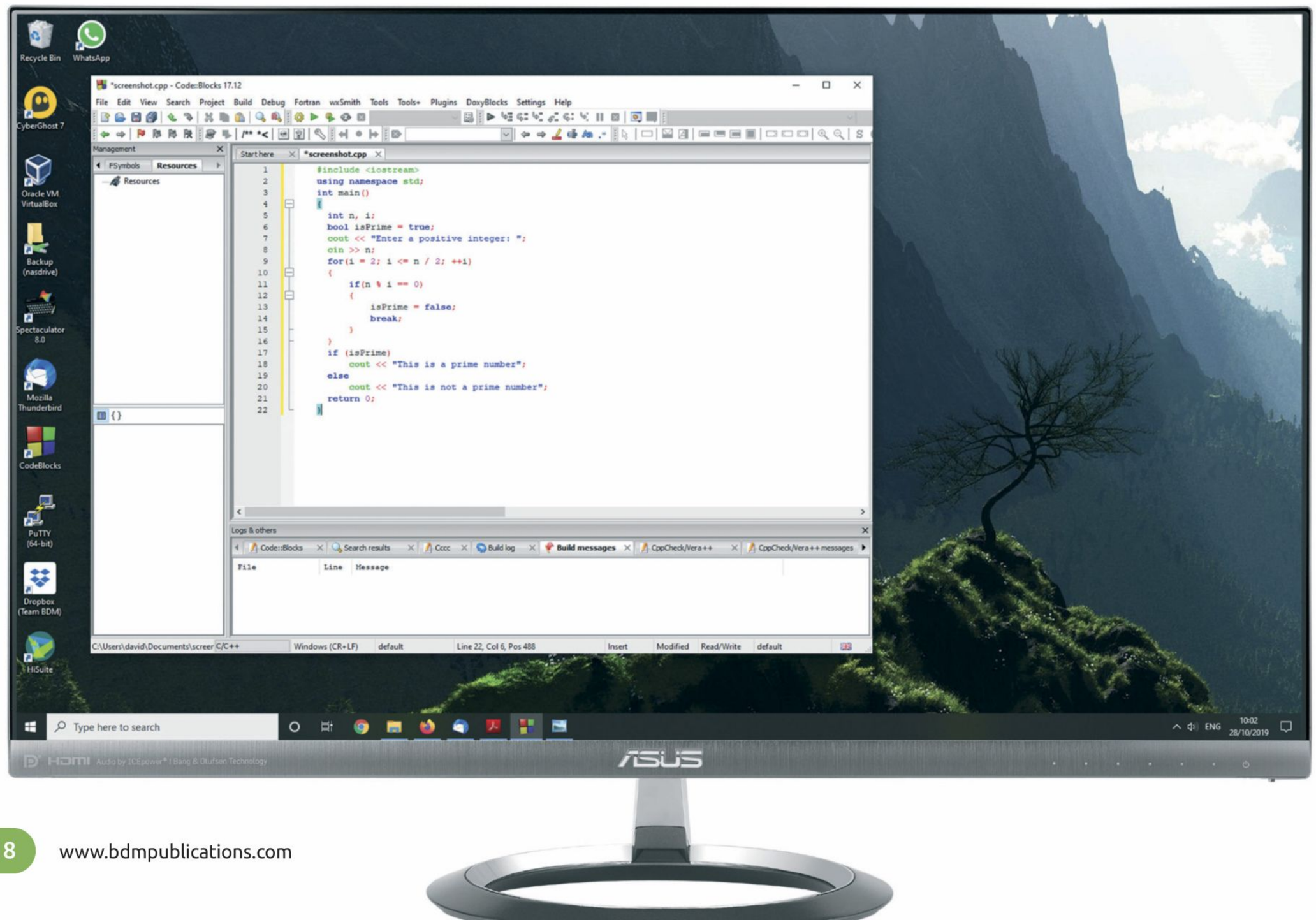
Dating back to 1979, the start of the golden era of home computing, C++, or rather C with Classes, was the brainchild of Danish computer scientist Bjarne Stroustrup, while working on his Ph.D thesis. Stroustrup's plan was to further the original C language, which had been widely used since the early seventies.

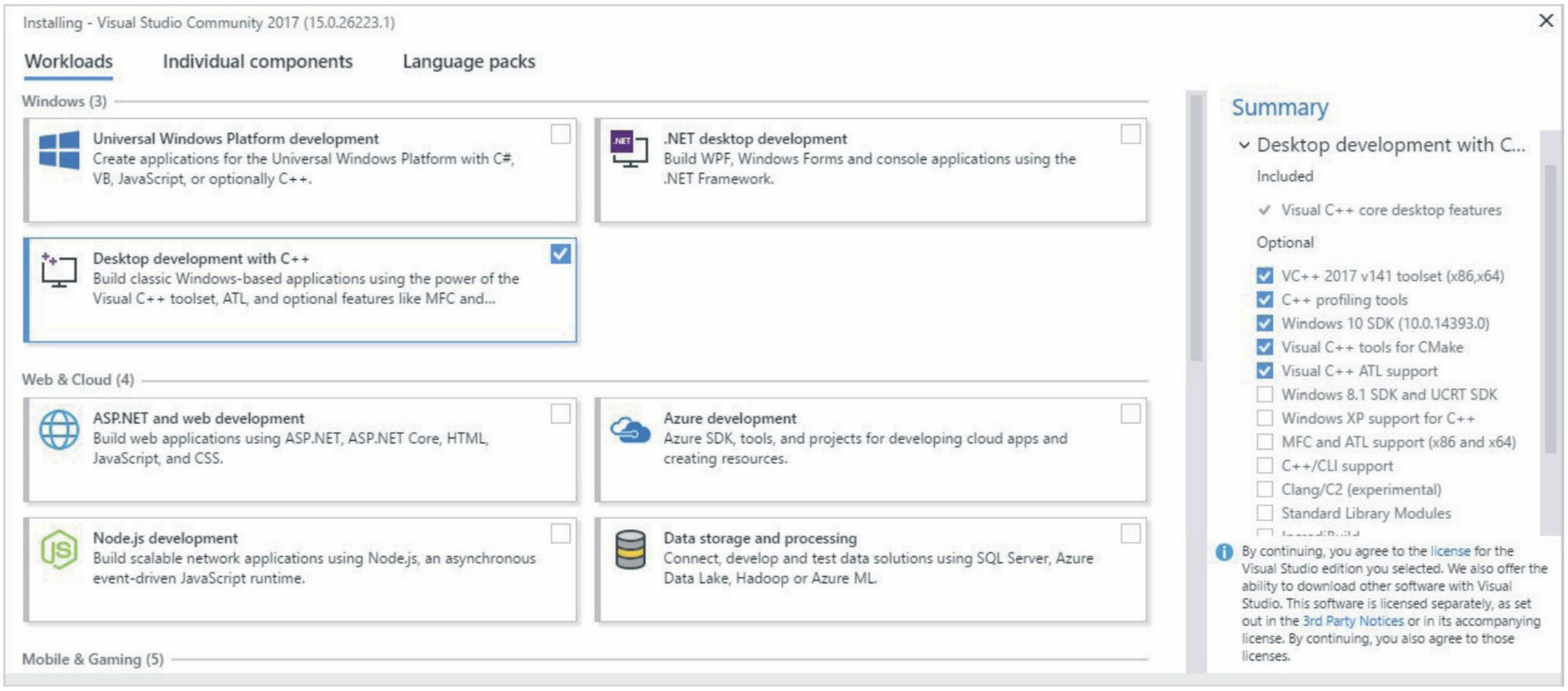
C++ proved to be popular among the developers of the 80s, since it was a much easier environment with which to get to grips, and, more importantly, it was 99% compatible with the original C language. This meant that, beyond the mainstream computing labs, regular people who didn't have access to the mainframes and large computing data centres could use it.

C++'s impact in the digital world is immense. Many of the programs, applications, games, and even operating systems are coded using C++. For example, all of Adobe's major applications, such as Photoshop, InDesign and so on, are developed in C++. You will find that the browser you use to surf the Internet is written in C++, as well as Windows 10, Microsoft Office, and the backbone to Google's search engine. Apple's macOS is written largely in C++ (with some other languages mixed in depending on the function), and the likes of NASA, SpaceX, and even CERN use C++ for various applications, programs, controls, and umpteen other computing tasks.

As well as being an easier addition to the core C language, C++ is also extremely efficient and performs well across the board. This higher level of performance over other languages, such as Python, BASIC and such, makes it an ideal development environment for modern computing; hence the aforementioned companies using it so widely.

C++ code is much faster than other programming languages.





Microsoft's Visual Studio is a great, free environment in which to learn C++.

C++ puts the developer in a much wider world of coding. By mastering C++, you will find yourself being able to develop code for the likes of Microsoft, Apple and so on. Generally, C++ developers enjoy a higher salary than programmers of some other languages, and, due to its versatility, the C++ programmer can move between jobs and companies without the need to re-learn anything specific.

You will discover, as you become a more advanced coder, that many of the developers in various coding jobs around the world tend to use pre-designed development engines. For example, when creating games, the likes of Bethesda, the team behind Oblivion and Skyrim, utilise a 3D game engine called The Creation Engine. This enables the team to quickly create animations, characters, items, terrains, rooms, and just about everything else you'd see in the game. The engine itself has been modified to make the most of the current graphics card hardware, and computer or console processing power. These engines are mostly written in C++, and when making improvements to the engine, or when creating a new game, if the developers want to add something that the engine can't do, they will use C++ to create the new content or link between two different engines. The end result, of course, is a game that contains the latest graphical technology, while being seamlessly bound together with some pretty clever C++ coding.

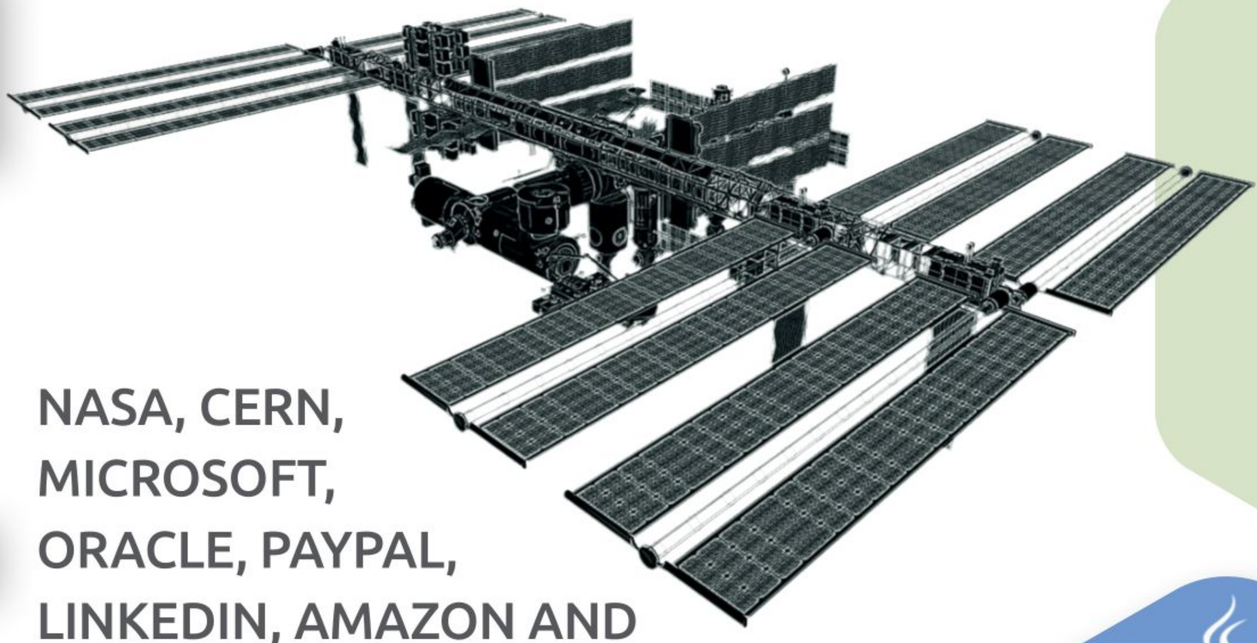
Getting to use C++ is quite easy, all you need is the right set of tools in which to communicate with the computer in C++, and you can start your journey. A C++ IDE is free of charge, even the immensely powerful Visual Studio from Microsoft is freely available to download and use. You can get into C++ from any operating system, be it macOS, Linux, Windows, or even mobile platforms.

So, to answer the question of Why C++, the answer is because it's fast, efficient, and developed by most of the applications you regularly use. It's cutting edge, and a fantastic language to have mastered.

Indeed, the operating system you're using is written in C++.

C++ is one of the top programming languages in the industry. It's quick, powerful, and used by nearly every major tech and gaming company in the world. Here's some interesting facts about the rather wonderful C++.

Facts



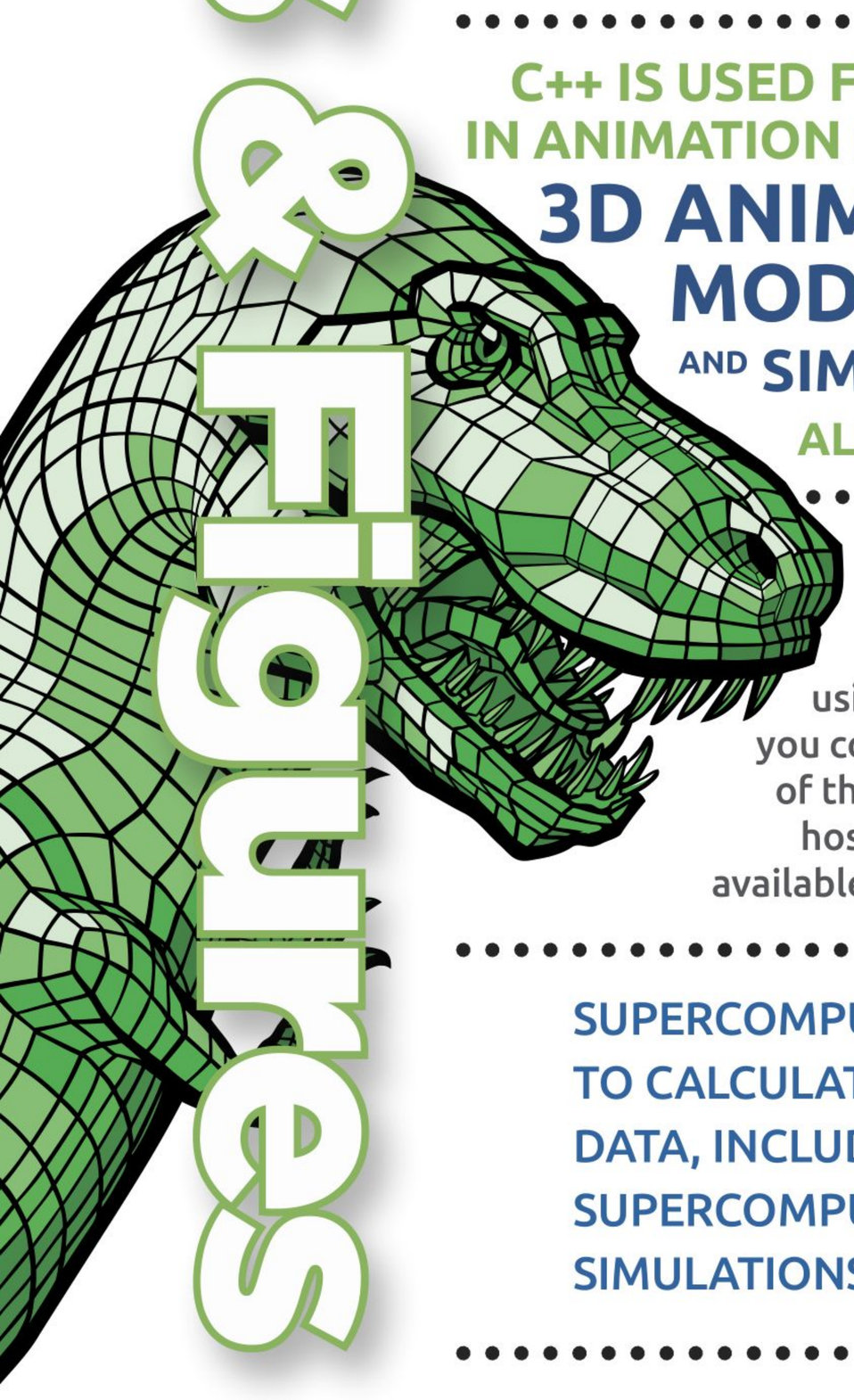
NASA, CERN, MICROSOFT, ORACLE, PAYPAL, LINKEDIN, AMAZON AND THE MILITARY USE C++.

More Facts

C++ IS USED FREQUENTLY IN ANIMATION PROCESSES.

3D ANIMATION, MODELLING, AND SIMULATIONS

ALL UTILISE C++.



A lot of the Linux operating system is coded using C++, therefore you could say that most of the world's Internet hosting servers are available thanks to C++.

SUPERCOMPUTING USES C++ CODE TO CALCULATE VAST AMOUNTS OF DATA, INCLUDING THE NASA-BASED SUPERCOMPUTING FARM THAT RUNS SIMULATIONS OF THE UNIVERSE.

C++ is one of the predominant programming languages for the development of all kinds of technical and commercial software.

C++ has influenced other programming languages, such as C# and Java.

70%

More then 70% of all trading is known as High Frequency Trading (HFT), and the software responsible is written in C++ to make use of its high speed.

C++ Facts & Figures

Sources: ITJobsWatch, Google, Quora, Stack Exchange, eduCBA, StackOverflow, stackShare, AppDynamics

The Xbox operating system uses C++ as its backbone.

Many database applications are built using C++, such as MySQL, it's also used by Wikipedia, Yahoo and YouTube.

Gaming is one of the biggest users of C++. It handles the complexities of 3D games, supports multiplayer options, and enables intensive CPU and GPU hardware functions.

Google Chrome, Mozilla's Firefox, and even Microsoft's Edge web browsers are coded in C++.

C++ is used in computer networking as the main code behind the Programmable Logic Controller, connecting servers, processors, other hardware, and even robotics.

THE **90th** PERCENTILE SALARY FOR A UK-BASED C++ DEVELOPER IS **£120,000**

Most of Adobe's stable of products are developed using C++.

Windows 95, 89, 2000, XP, 7, 8.1 and 10, as well as Microsoft Office, use C++ as the backbone programming language of choice.

MRI scanning machines and Computer Aided Design all use C++ to help with the enhanced imagery produced by these systems.

The Unreal 4 Engine, which is coded in C++, is used for hundreds of games, including Fortnite.

RADAR PROCESSING TECHNOLOGIES USE C++, AS WELL AS ADVANCED MISSILE DETECTION SYSTEMS.

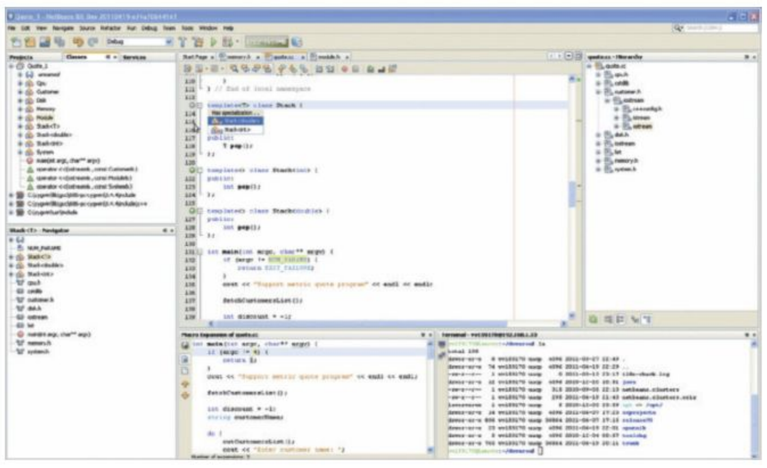
FLIGHT CONTROL SYSTEMS IN MODERN AIRCRAFT, INCLUDING MILITARY AIRCRAFT, USE C++.

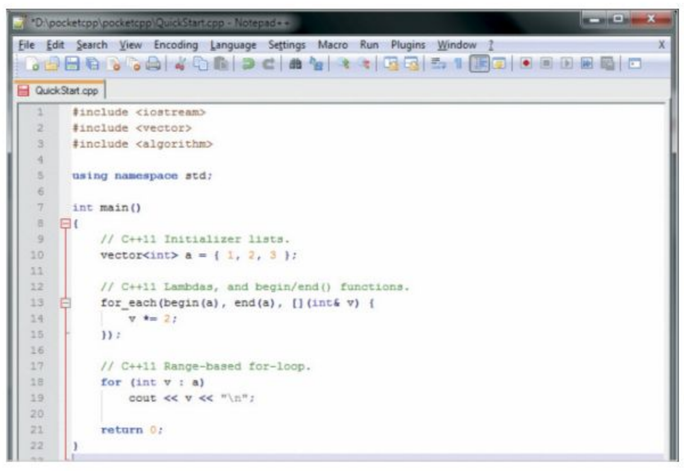
Equipment You Will Need

You don't need to invest a huge amount of money in order to learn C++, and you don't need an entire computing lab at your disposal either. Providing you have a fairly modern computer, everything else is freely available.

C++ SETUPS

As most, if not all, operating systems have C++ at their code, it stands to reason that you can learn to program in C++ no matter what OS you're currently using.





☐ COMPUTER

Unless you fancy writing out your C++ code by hand on a sheet of paper (which is something many older coders used to do), then a computer is an absolute must have component. PC users can have any recent Linux distro or Windows OS, Mac users the latest macOS.

☐ AN IDE

An IDE is used to enter and execute your C++ code. Many IDEs come with extensions and plugins that help make it work better, or add an extra level of functionality. Often, an IDE will provide enhancements depending on the core OS being used, such as enhancements for Windows 10.

☐ COMPILER

A compiler is a program that converts the C++ language into binary that the computer can understand. While some IDEs come with a compiler built in, others don't. Code::Blocks is our favourite IDE that comes with a C++ compiler as part of the package. More on this later.

☐ TEXT EDITOR

Some programmers much prefer to use a text editor to assemble their C++ code before running it through a compiler. Essentially, you can use any text editor to write code, just save it with a .cpp extension. However, Notepad++ is one of the best code text editors available.

☐ INTERNET ACCESS

While it's entirely possible to learn how to code on a computer that's not attached to the Internet, it's extraordinarily difficult. You will need to install the relevant software, keep it up to date, install any extras or extensions, and look for help when coding. All of which require access to the Internet.

☐ TIME AND PATIENCE

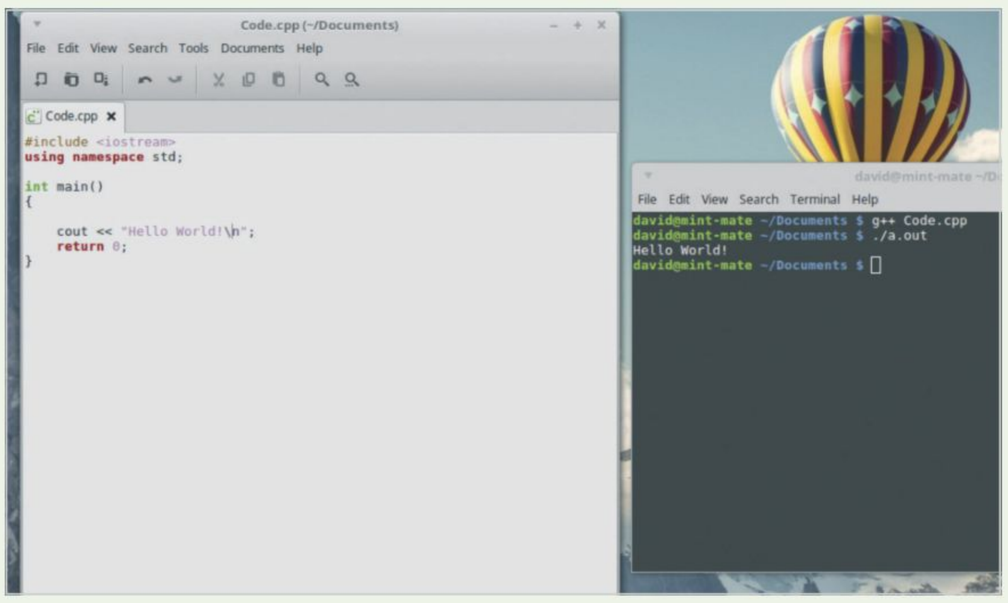
You're going to need to set aside significant time to spend on learning how to code in C++. Sadly, unless you're a genius, it's not going to happen overnight, or even in a week. A good C++ coder has spent many years honing their craft, so be patient, start small and keep learning.

OS SPECIFIC NEEDS

C++ will work in any operating system; however, getting all the necessary pieces together can be confusing to a newcomer. Here's some OS specifics for C++.

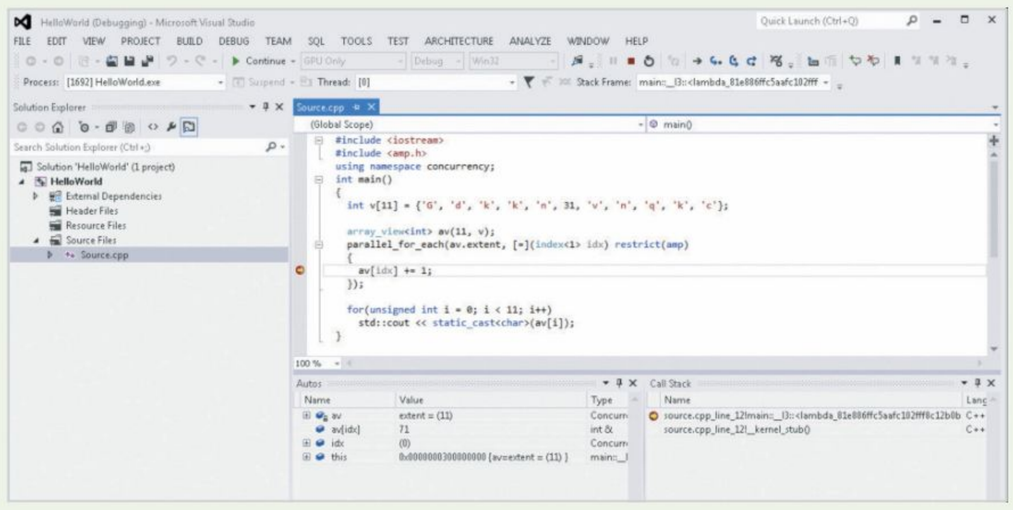
LINUX

Linux users are lucky in that they already have a compiler and text editor built into their operating system. Any text editor will allow you to type out your C++ code, when it's saved with a .cpp extension, use g++ to compile it.



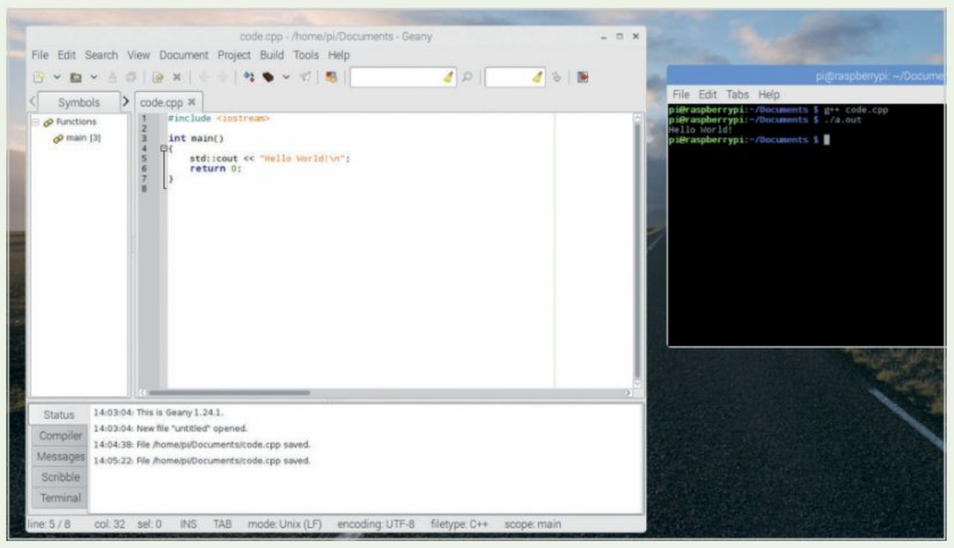
WINDOWS

As we've mentioned previously, one good IDE is Microsoft's Visual Studio. However, a better IDE and compiler is Code::Blocks, which is kept regularly up to date with a new release twice yearly, or so. Otherwise, Windows users can enter their code in Notepad++ then compile it with MinGW – which Code::Blocks uses.



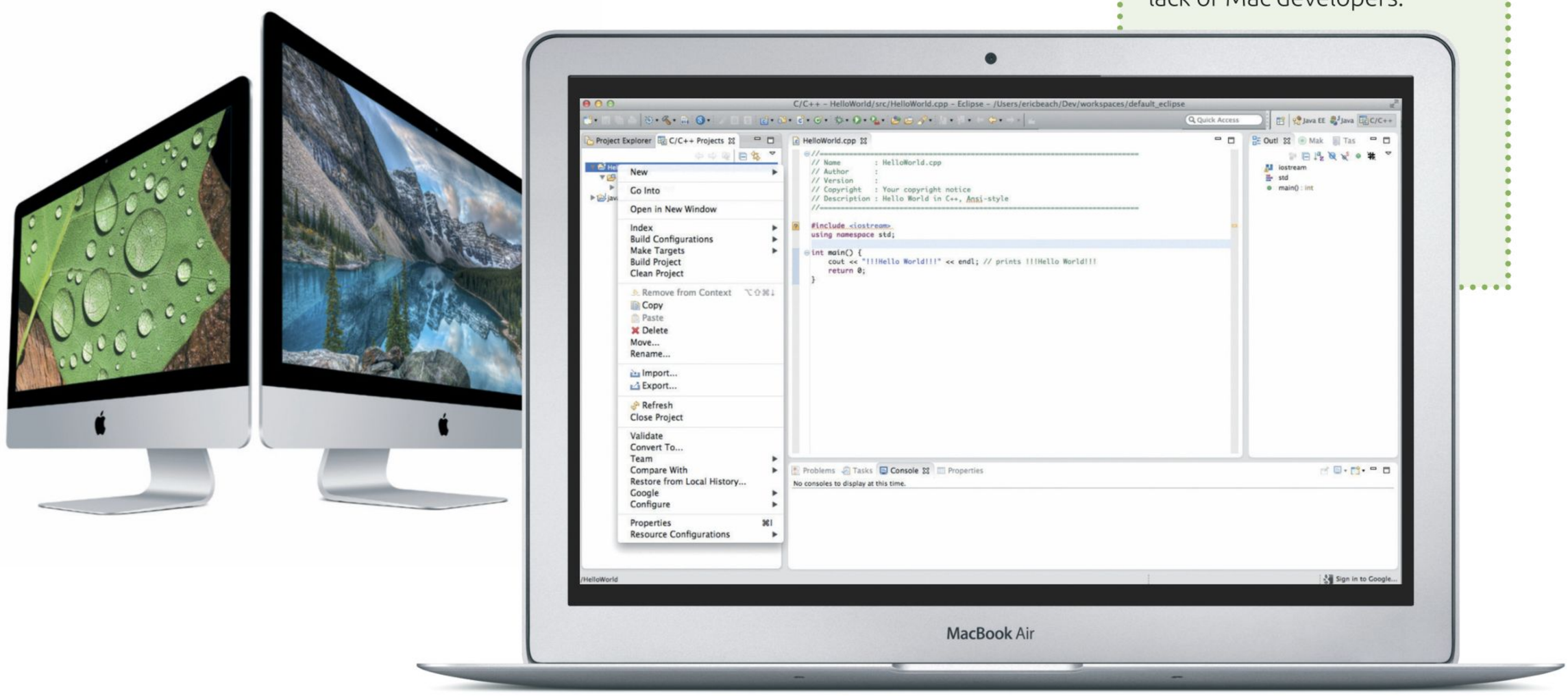
RASPBERRY PI

The Raspberry Pi's operating system is Raspbian, which is Linux based. Therefore, you're able to write your code out using a text editor and then compile it with g++, as you would in any other Linux distro.



MAC

Mac owners will need to download and install Xcode, in order to compile their C++ code natively. Other options for the macOS include Netbeans, Eclipse or Code::Blocks. Note: the latest Code::Blocks isn't available for Mac, due to a lack of Mac developers.



Structure of C++ Code

C++ is an amazing programming language to learn. If your dream is to become a games designer, or work at the cutting edge of science or engineering technology, then being able to code in C++ is a must. Remember, you're never too old to learn how to code.

#INCLUDE <C++ IS ACE!>

As you learn the basics of programming, you will begin to understand the structure of a program. The commands may be different, but you will start to see how the code works.

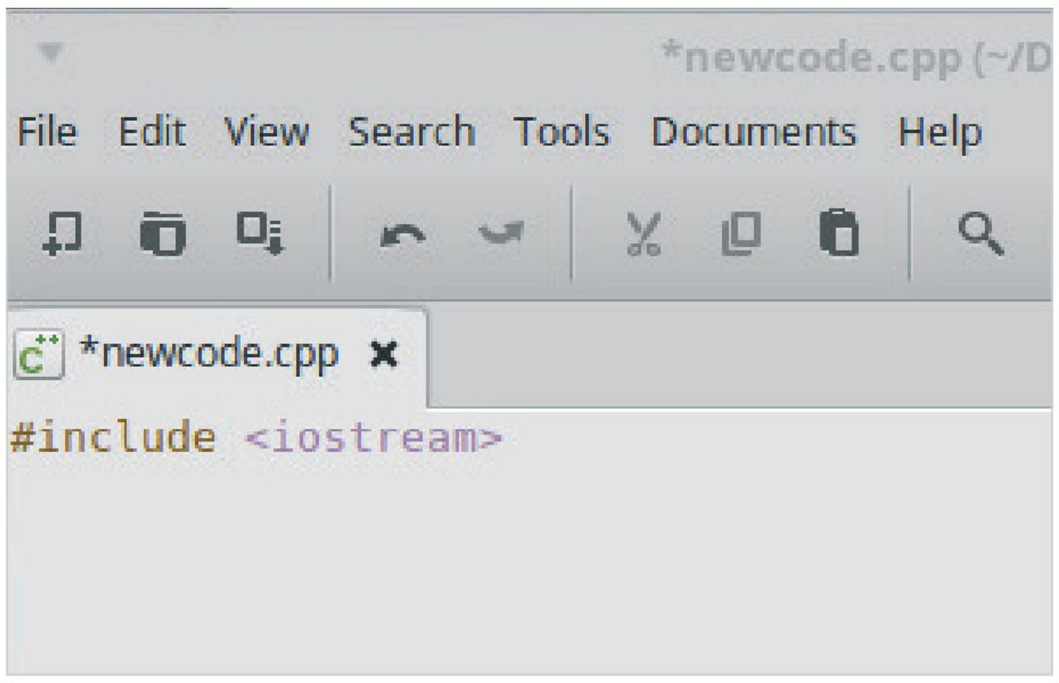
C++

Danish student Bjarne Stroustrup invented C++ in 1979, as a part of his Ph.D thesis. Initially C++ was called C with Classes, which added features to the already popular C programming language while making it a more user-friendly environment.

Bjarne Stroustrup, inventor of C++.

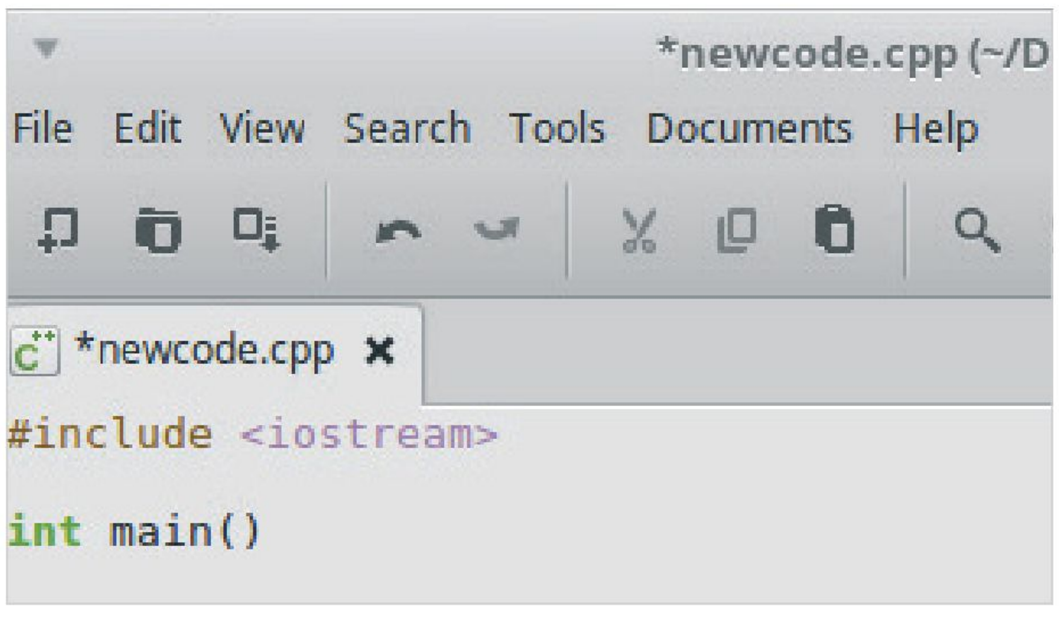
#INCLUDE

The structure of a C++ program can look complex, but once you get familiar with it you'll begin to see how it flows. Every C++ code begins with a directive, #include <>. The directive instructs the pre-processor to include a section of the standard C++ code. For example: `#include <iostream>` includes the iostream header to support input/output operations.



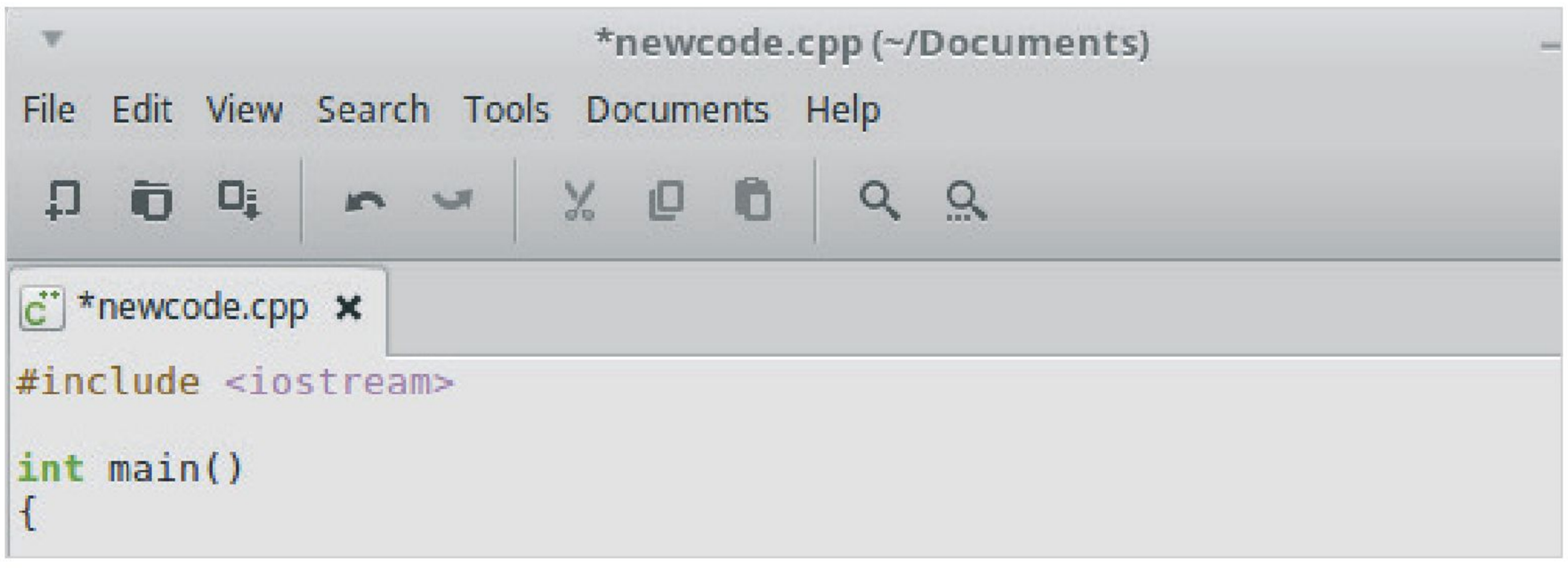
INT MAIN()

int main() initiates the declaration of a function, which is a group of code statements under the name 'main'. All C++ code begins at the main function, regardless of where it lies within the main body of the code.



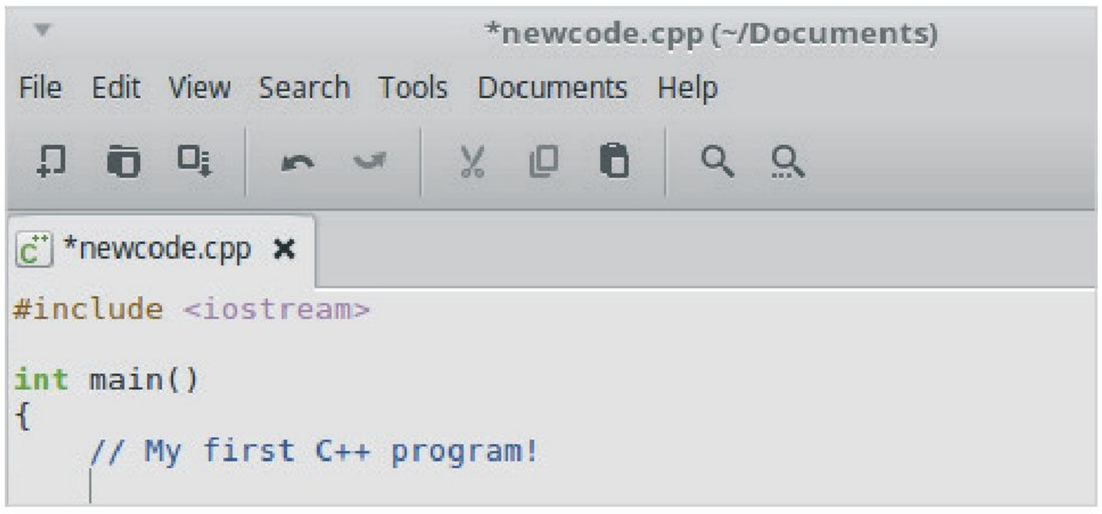
BRACES

The open brace is something that you may not have come across before, especially if you're used to other coding languages. The open brace indicates the beginning of the main function, and contains all the code belonging to that function.



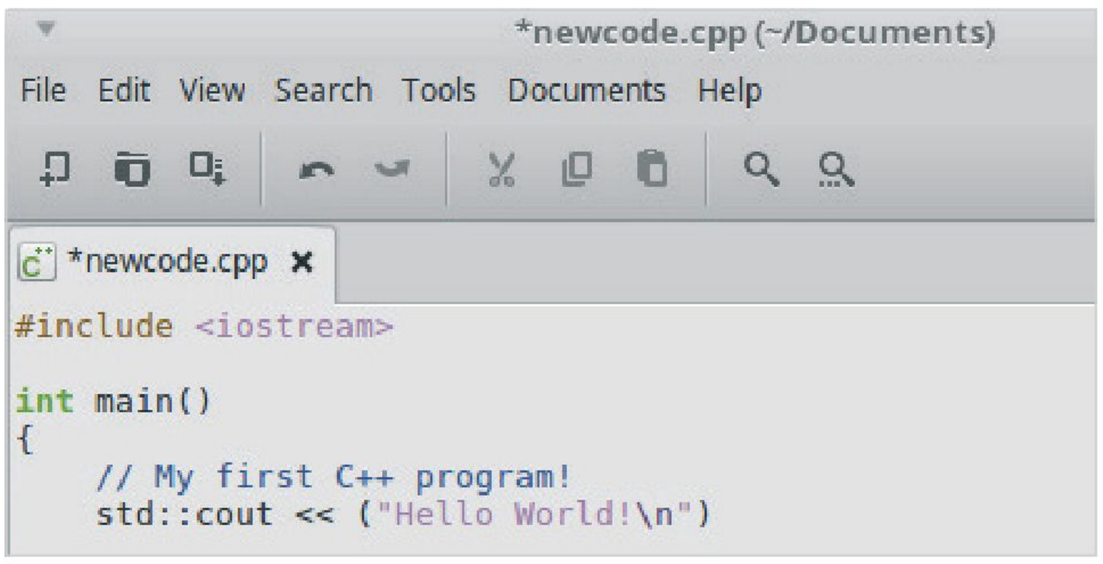
COMMENTS

Lines that begin with a double slash are comments. This means they won't be executed in the code and are ignored by the compiler. Why are they there? Comments are designed to help you, or another programmer looking at your code, explain what's going on. There are two types of comment: /* covers multiple line comments, // a single line.



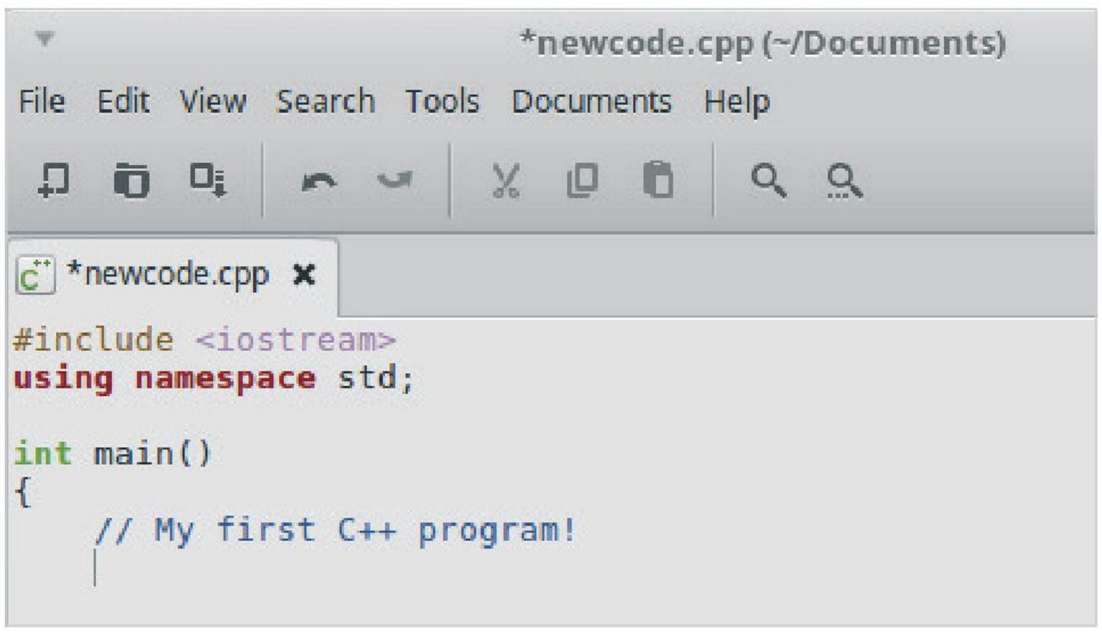
<<

The two chevrons used here are insertion operators. This means that, whatever follows, the chevrons are to be inserted into the std::cout statement. In this case, they are the words 'Hello World', which are to be displayed on the screen when you compile and execute the code.



STD

In C++, STD means Standard. It's a part of the Standard Namespace in C++, which covers a number of different statements and commands. You can leave the std part out of a code, but it must be declared at the start with: `using namespace std`.



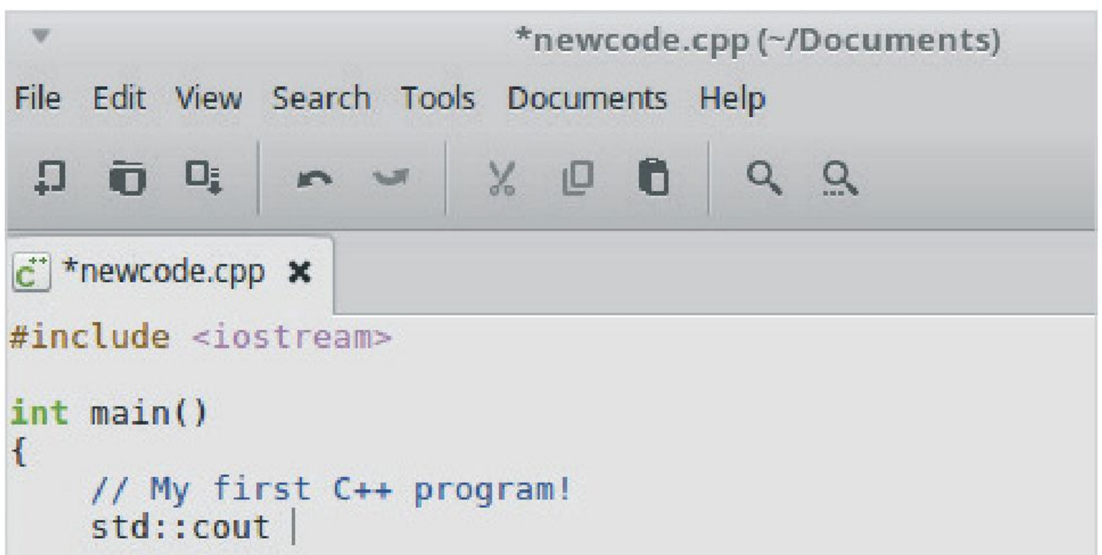
OUTPUTS

Leading on, ("Hello World!") is the part that we want to appear on the screen when the code is executed. You can enter whatever you like, as long as it's inside the quotation marks. The brackets aren't needed, but some compilers insist on them. The \n part indicates a new line is to be inserted.

```
// My first C++ program!
std::cout << ("Hello World!\n")
```

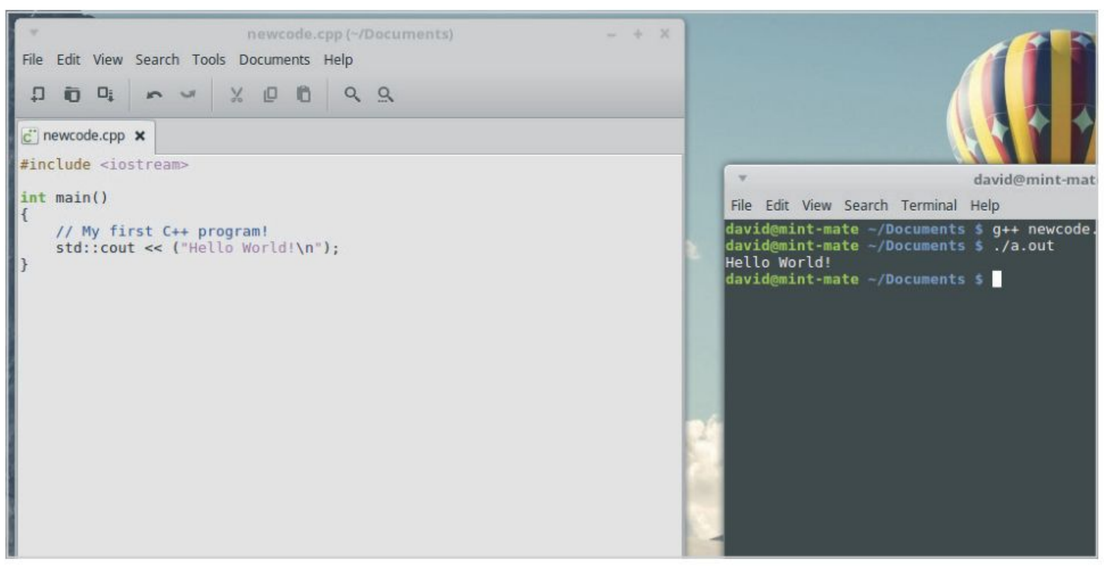
COUT

In this example we're using cout, which is a part of the Standard Namespace – hence why it's there, as you're asking C++ to use it from that particular namespace. Cout means Character OUTput, which displays, or prints, something to the screen. If we leave `std::` out we have to declare it at the start of the code; as mentioned previously.



; AND }

Finally you will notice that lines within a function code block (except comments) end with a semicolon. This marks the end of the statement, and all statements in C++ must have one at the end or the compiler will fail to build the code. The very last line has the closing brace to indicate the end of the main function.



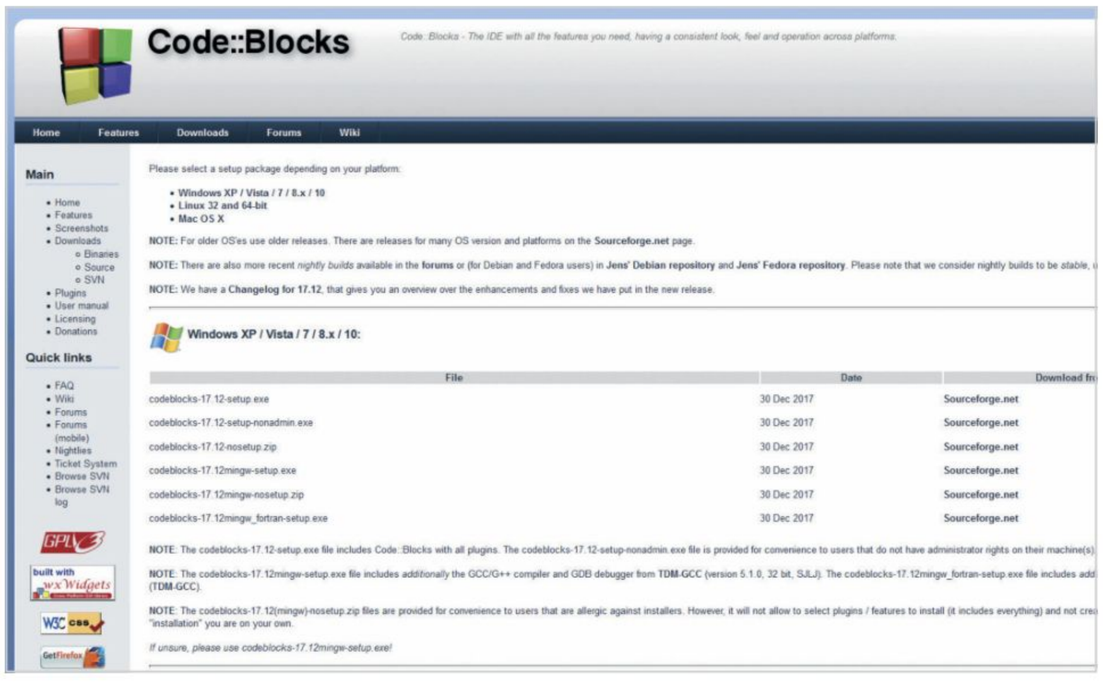
How to Set Up C++ in Windows

Windows users have a wealth of choice when it comes to programming in C++. There are loads of IDEs and compilers available, including Visual Studio from Microsoft. However, in our opinion, the best C++ IDE to begin with is Code::Blocks.

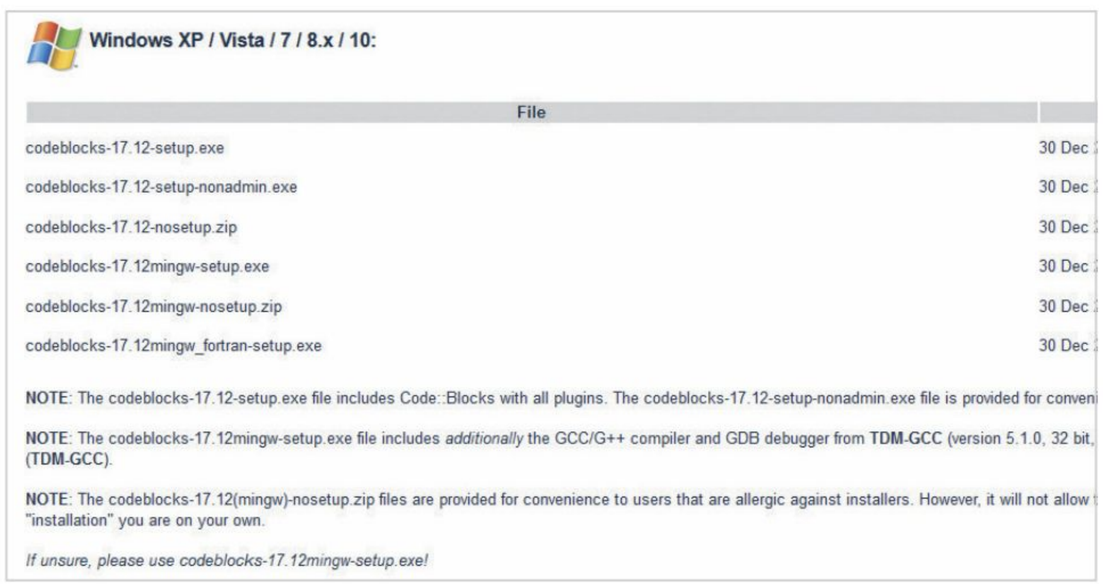
CODE::BLOCKS

Code::Blocks is a free C++, C and Fortran IDE that is feature rich and easily extendible with plugins. It's easy to use, comes with a compiler and has a vibrant community behind it too.

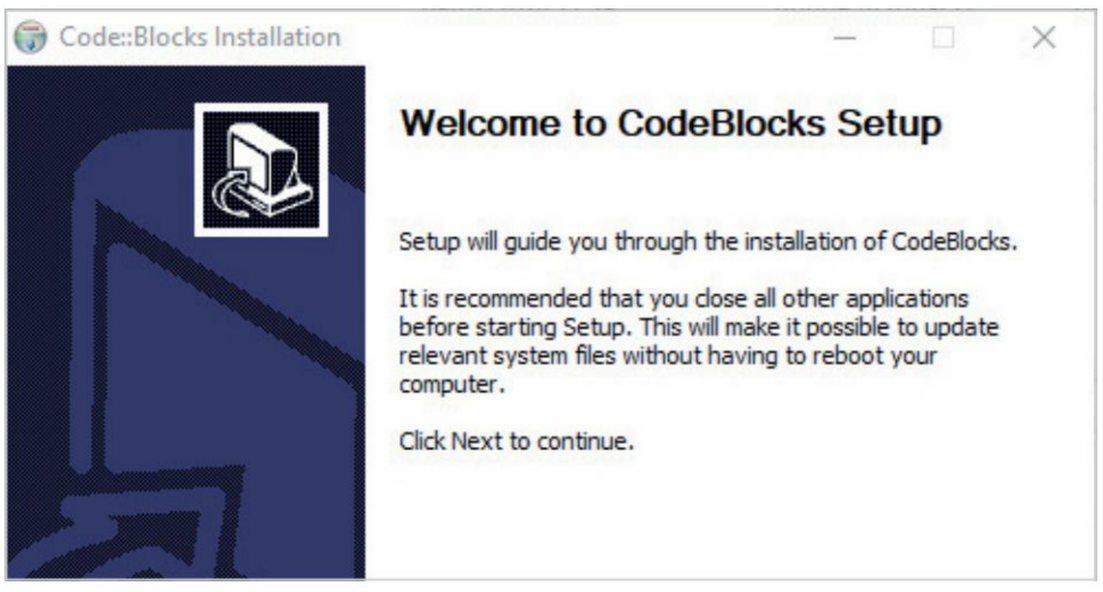
STEP 1 Start by visiting the Code::Blocks download site, at **www.codeblocks.org/downloads**. From there, click on the 'Download the binary releases' link to be taken to the latest downloadable version for Windows.



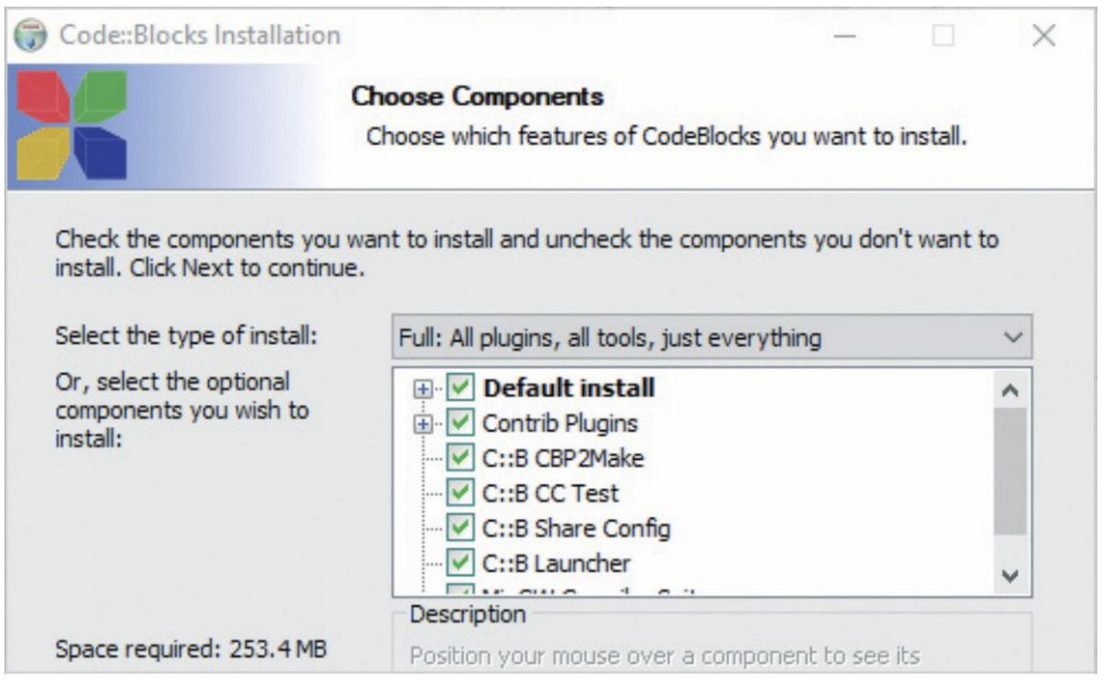
STEP 2 There you can see, there are several Windows versions available. The one you want to download has mingw-setup.exe at the end of the current version number. At the time of writing this is: codeblocks-17.12mingw-setup.exe. The difference is that the mingw-setup version includes a C++ compiler and debugger from TDM-GCC (a compiler suite).



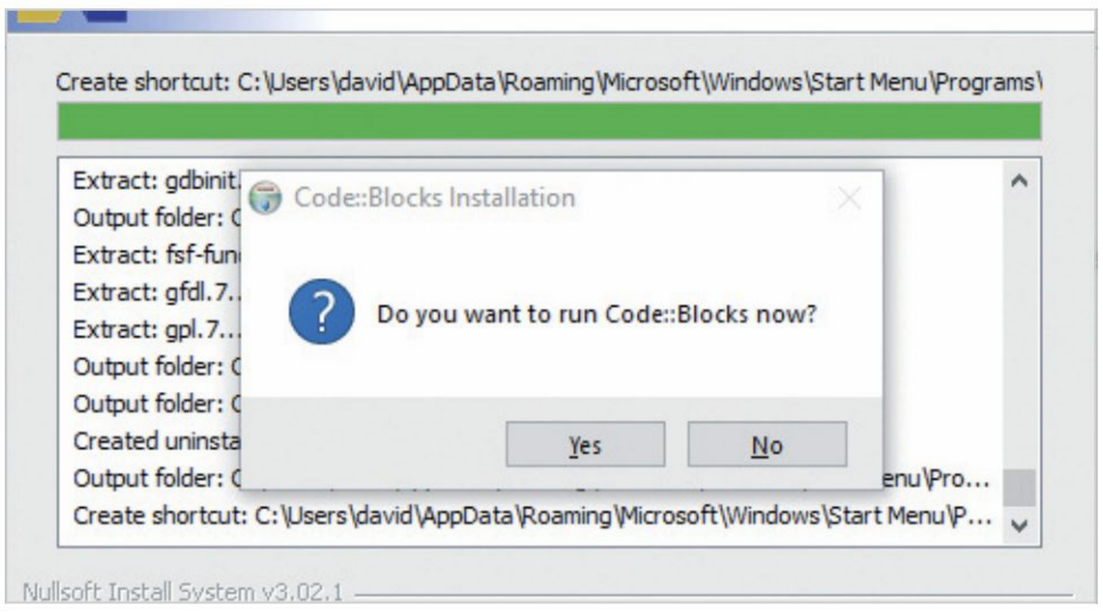
STEP 3 When you've located the file, click on the Sourceforge.net link at the end of the line and a download notification window appears; click on Save File to start the download and save the executable to your PC. Locate the downloaded Code::Blocks installer and double-click to start. Follow the on-screen instructions to begin the installation.



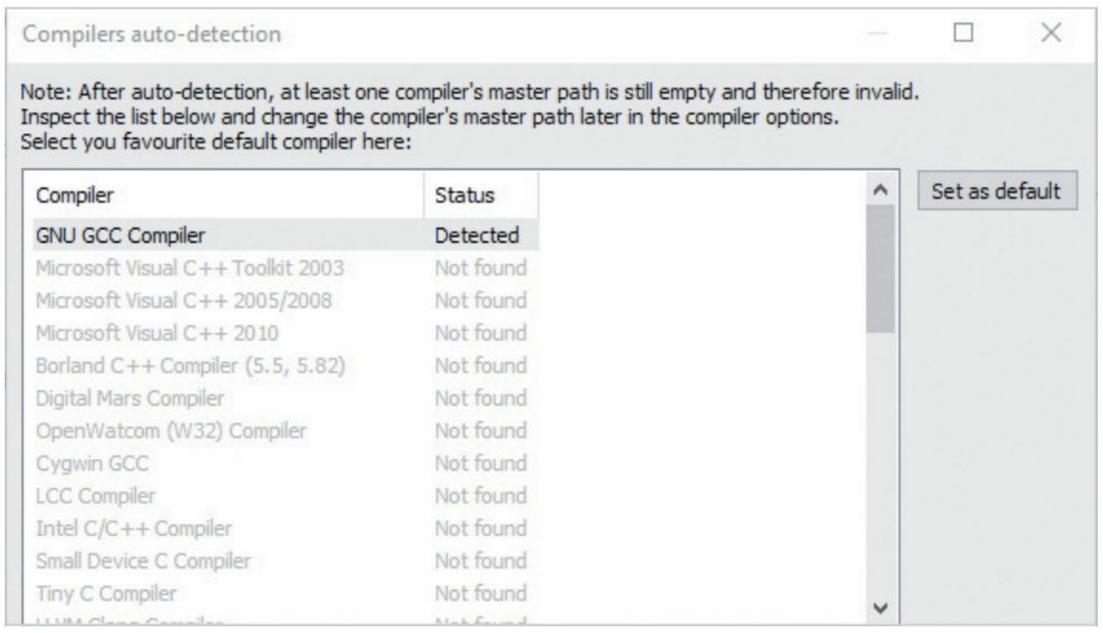
STEP 4 Once you agree to the licencing terms, a choice of installation options becomes available. You can opt for a smaller install, missing out on some of the components but we recommend that you opt for the Full option, as default.



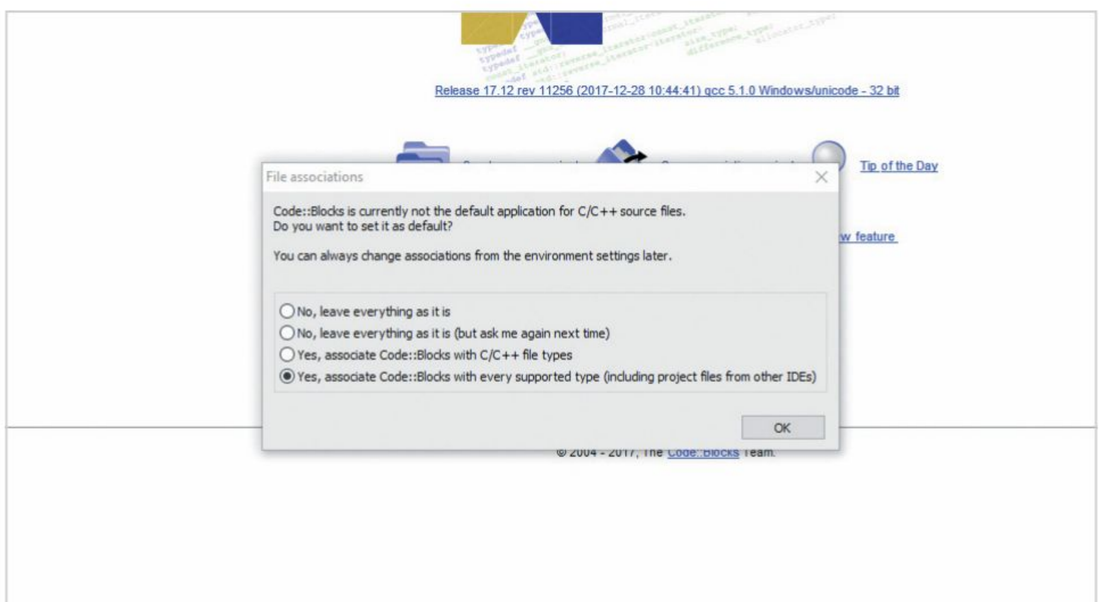
STEP 5 Next choose an install location for the Code::Blocks files. It's your choice but the default is generally sufficient (unless you have any special requirements of course). When you click Next, the install begins; when it's finished a notification pops up asking you if you want start Code::Blocks now, so click Yes.



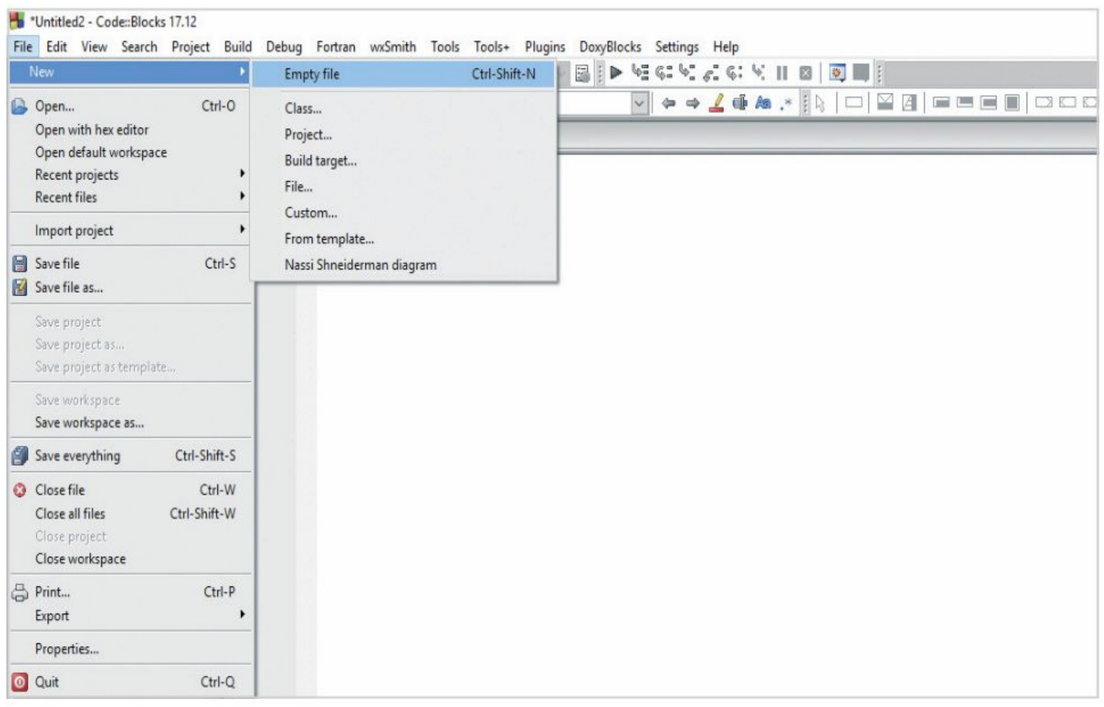
STEP 6 The first time Code::Blocks loads it runs an autodetect for any C++ compilers you may already have installed on your system. If you don't have any, click on the first detected option: GNU GCC Compiler and click the Default button to set it as the system's C++ compiler. Click OK when you're ready to continue.



STEP 7 The program starts and another message appears informing you that Code::Blocks is currently not the default application for C++ files. You have two options, to leave everything as it is or allow Code::Blocks to associate all C++ file types. Again, we would recommend you opt for the last choice, to associate Code::Blocks with every supported file type.



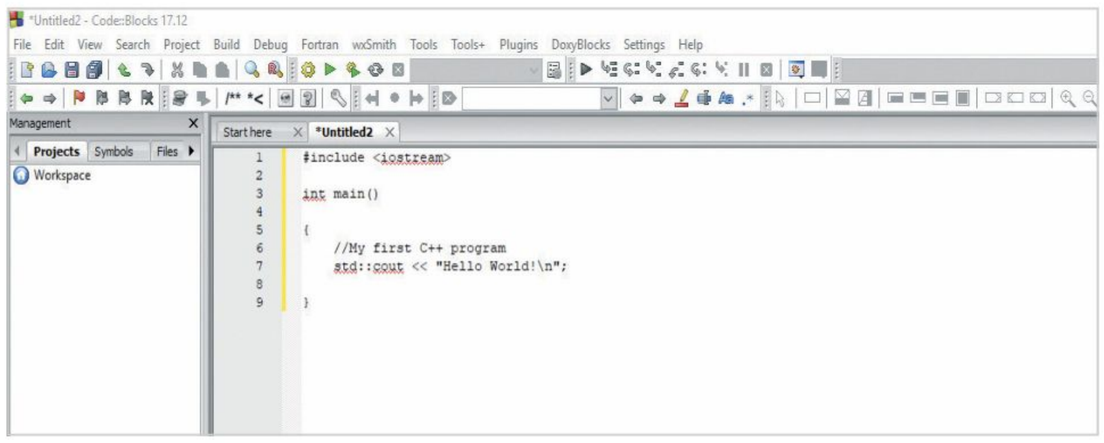
STEP 8 There's a lot you can do in Code::Blocks, so you need to dig in and find a good C++ tutorial to help you get the most from it. However, to begin with, click on File > New > Empty File. This creates a new, blank window for you to type in.



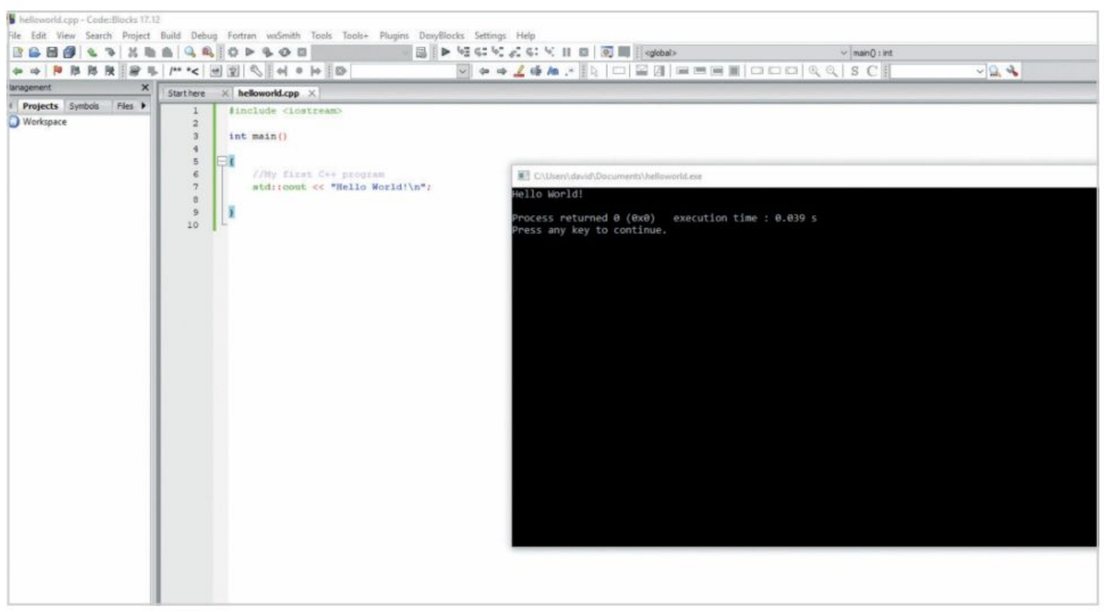
STEP 9 In the new window, enter the following:

```
#include <iostream>

Int main()
{
//My first C++ program
Std::cout << “Hello World!\n”;
}
```

Notice how Code::Blocks auto-inserts the braces and speech quotes.



STEP 10 Click File > Save as and save the code with a .cpp extension (helloworld.cpp, for example). Code::Blocks changes the view to colour code according to C++ standards. To execute the code, click on the Build and Run icon along the top of the screen. It's a green play icon together with a yellow cog.



How to Set Up C++ on a Mac

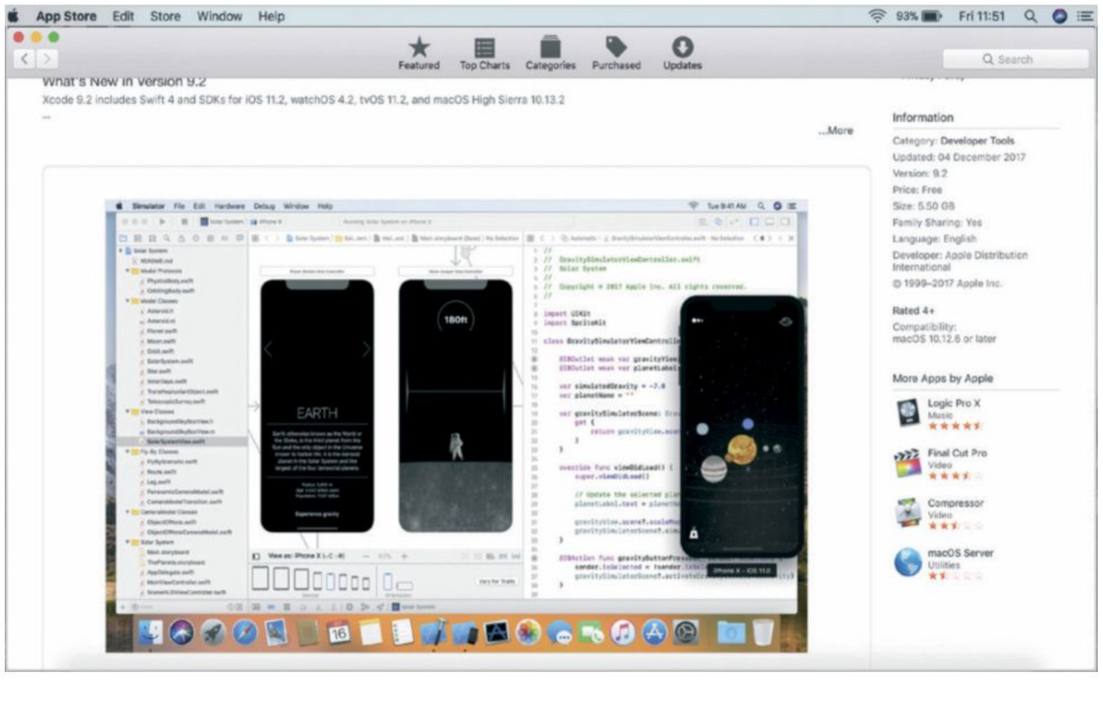
To start C++ coding on a Mac you need to install Apple's Xcode. This is a free, full featured IDE that's designed to create native Apple apps. However, it can also be used to create C++ code relatively easily.

XCODE

Apple's Xcode is primarily designed for users to develop apps for macOS, iOS, iPadOS, tvOS and watchOS applications in Swift or Objective-C, but you can use it for C++ too.

STEP 1 Start by opening the App Store on your Mac, Apple Menu > App Store. In the Search box enter Xcode and press Return. There will be many suggestions filling the App Store window but it's the first option, Xcode, that you need to click on.

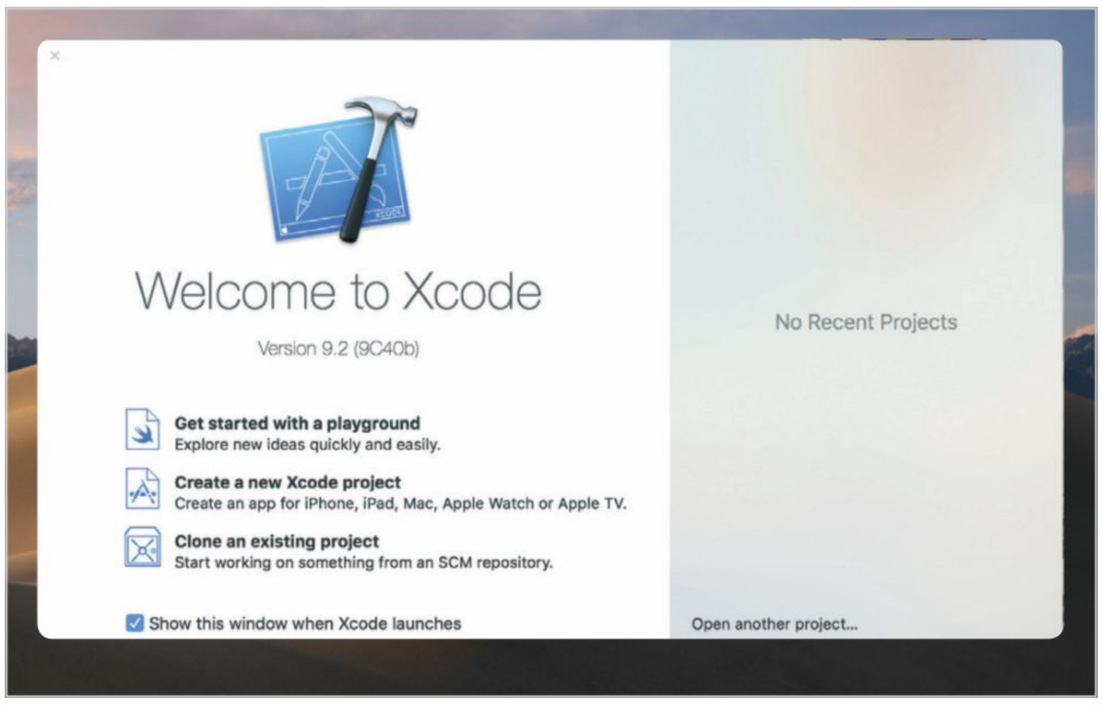
STEP 2 Take a moment to browse through the app's information, including the compatibility to ensure you have the correct version of macOS. Xcode requires macOS 10.12.6 or later to install and work.



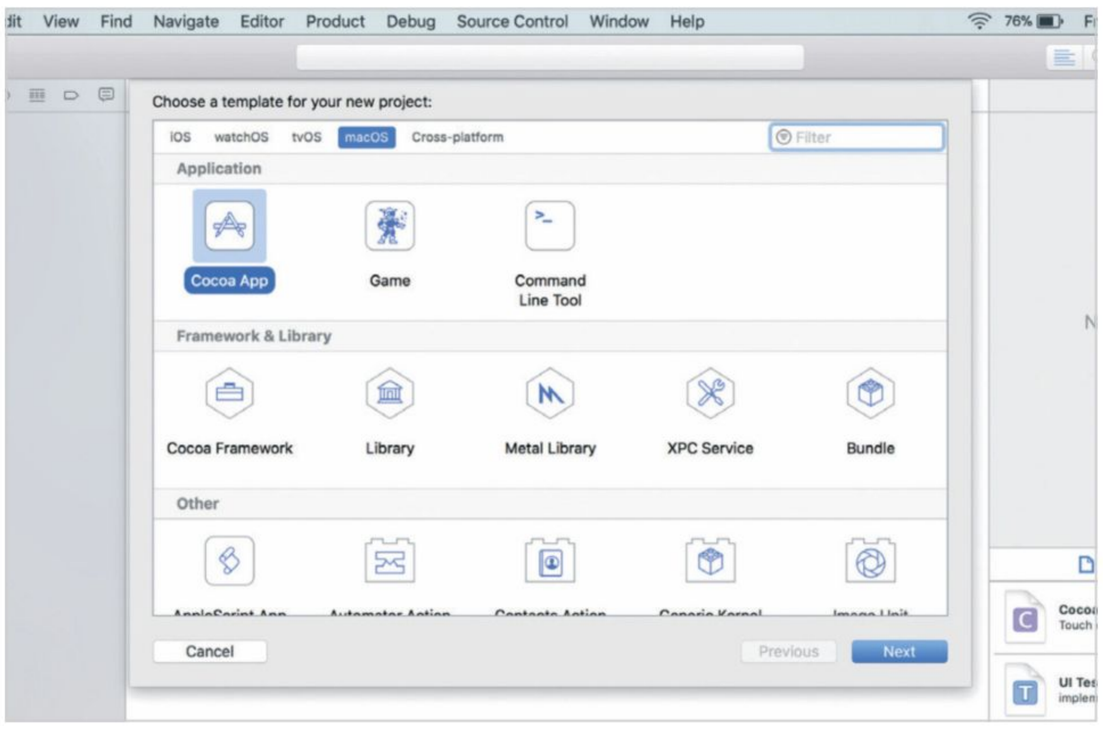
STEP 3 When you're ready, click on the Get button which then turns into 'Install App'. Enter your Apple ID and Xcode begins to download and install. It may take some time depending on the speed of your Internet connection.

STEP 4 When the installation is complete, click on the Open button to launch Xcode. Click Agree to the licence terms and enter your password to allow Xcode to make changes to the system. When you've done that, Xcode begins to install additional components.

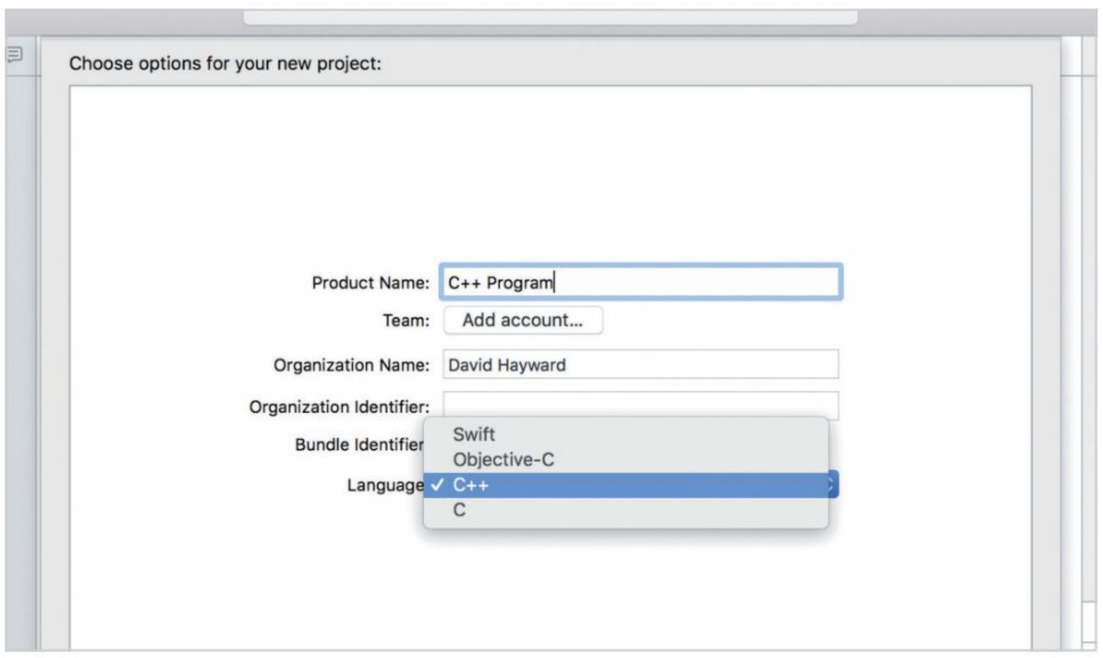
STEP 5 With everything now installed, including the additional components, Xcode launches, displaying the version number along with three choices and any recent projects that you've worked on; although for a fresh install, this shows blank.



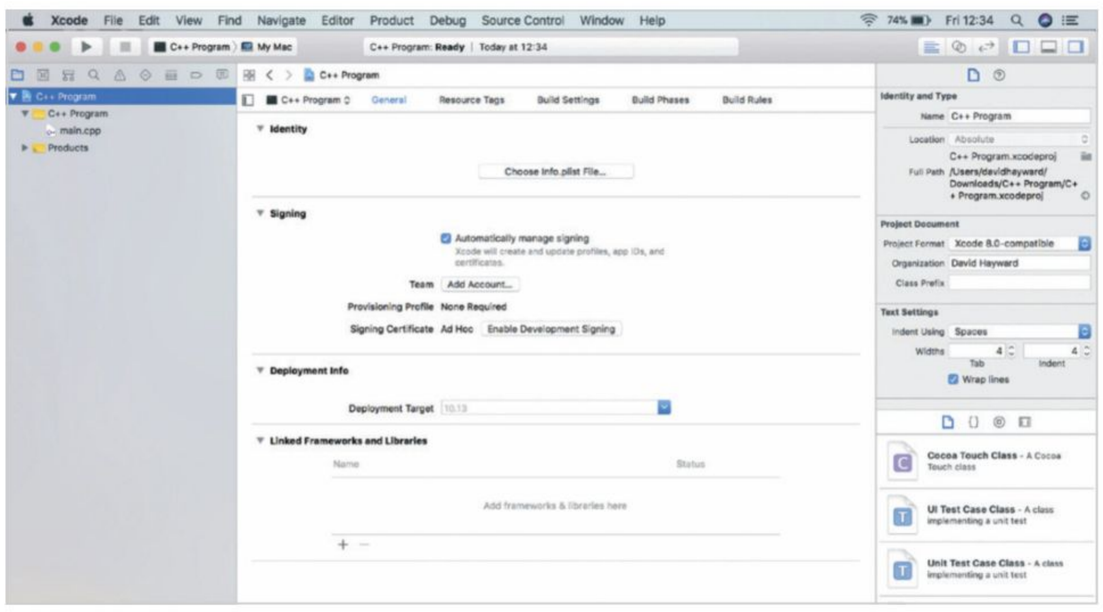
STEP 6 Start by clicking on Create New Xcode Project; this opens a template window from which to choose the platform you're developing code for. Click the macOS tab, then the Command Line Tool option and finally, Next to continue.



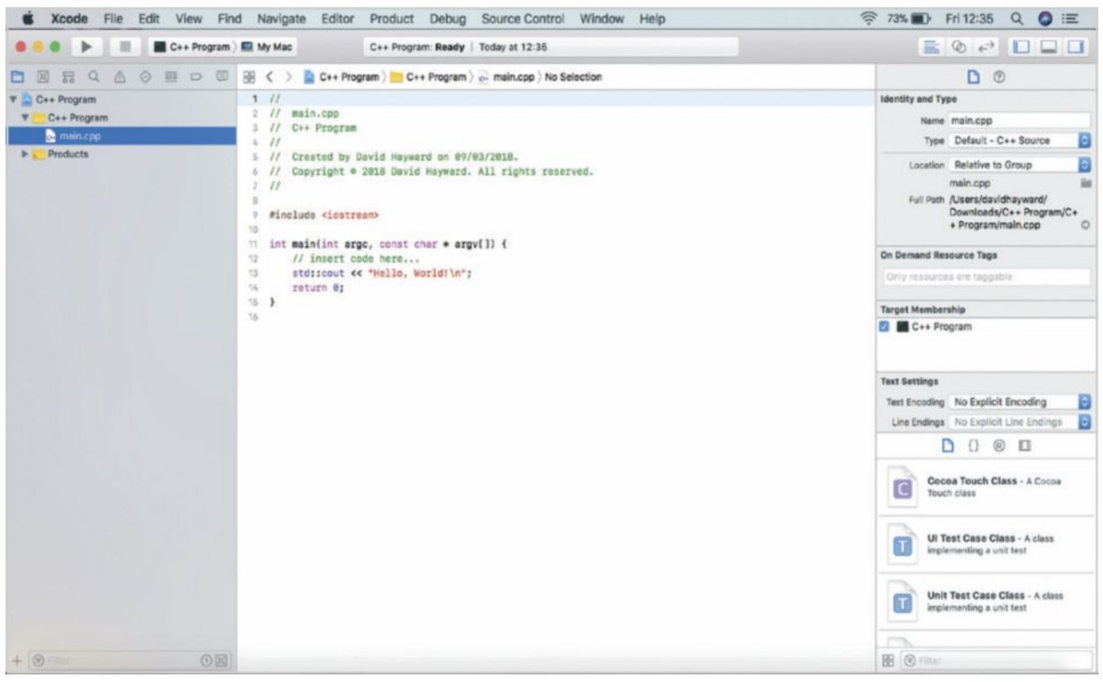
STEP 7 Fill in the various fields but ensure that the Language option at the bottom is set to C++. Simply choose it from the drop-down list. When you've filled in the fields, and made sure that C++ is the chosen language, click on the Next button to continue.



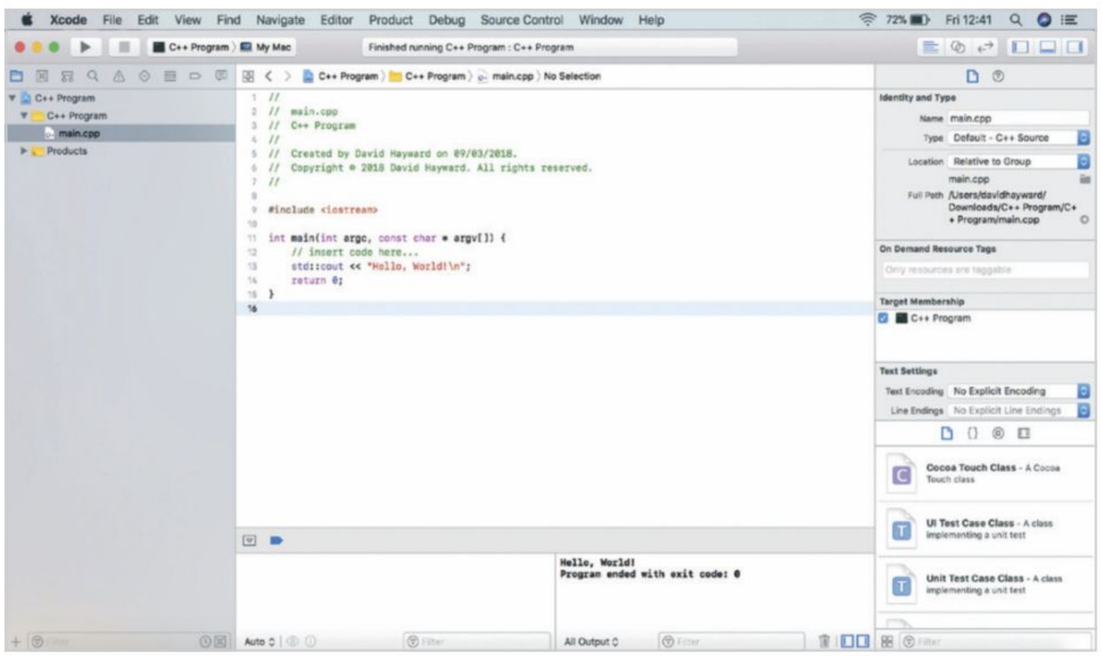
STEP 8 The next step asks where to create a Git Repository for all your future code. Choose a location on your Mac, or a network location, and click the Create button. When you've done all that, you can start to code. The left-hand pane details the files used in the C++ program you're coding. Click on the main.cpp file in the list.



STEP 9 You can see that Xcode has automatically completed a basic Hello World program for you. The differences here are that the int main () function now contains multiple functions and the layout is slightly different. This is just Xcode utilising the content that's available to your Mac.



STEP 10 When you want to run the code, click on Product > Run. You may be asked to enable Developer Mode on the Mac; this is to authorise Xcode to perform functions without needing your password every session. When the program executes, the output is displayed at the bottom of the Xcode window.



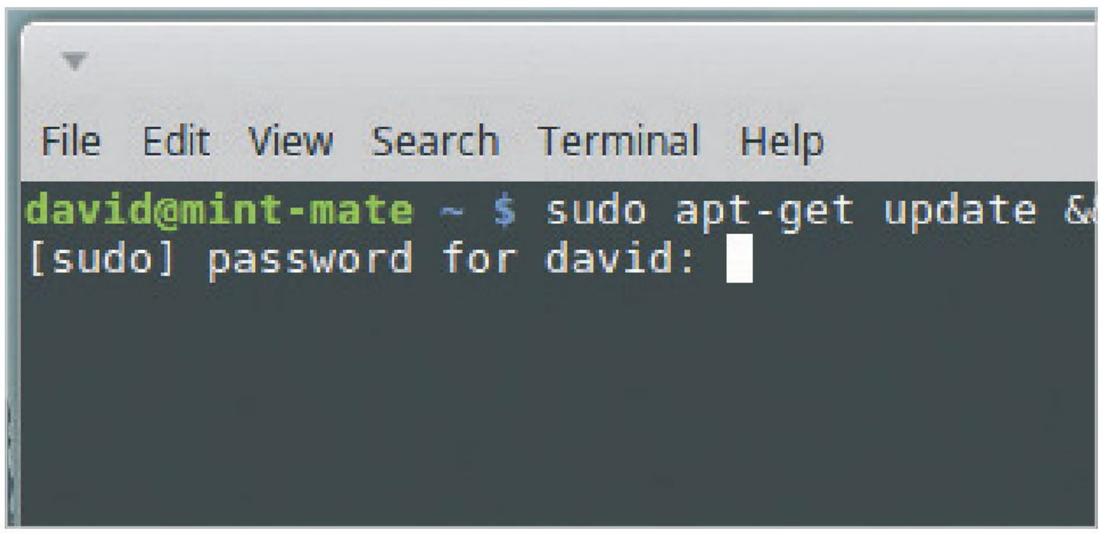
How to Set Up C++ in Linux

Linux is a great C++ coding environment. Most Linux distros already have the essential components preinstalled, such as a compiler and the text editors are excellent for entering code into, including colour coding; there's also tons of extra software available to help you out.

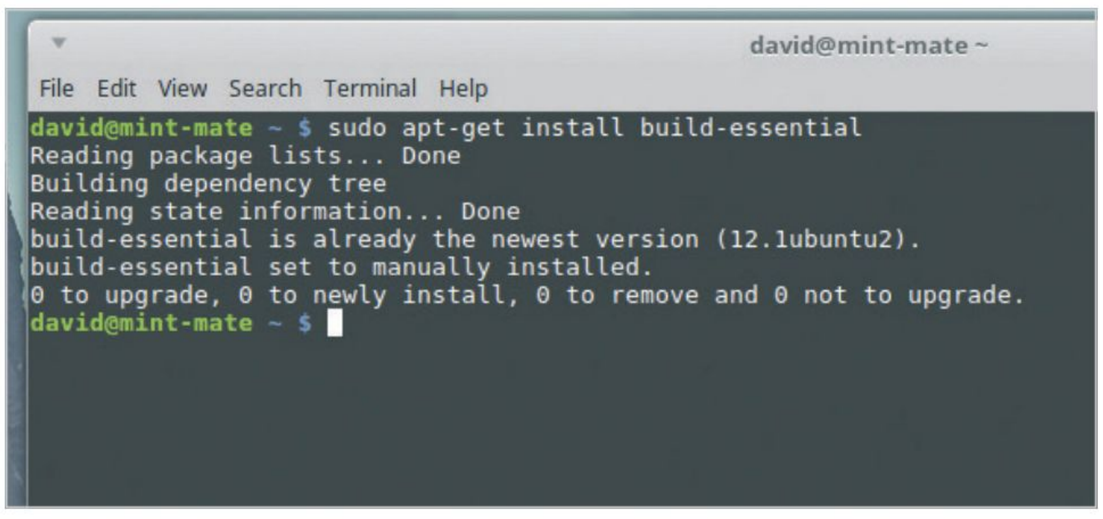
LINUX++

There are many different versions of Linux available, for this example we're using one of the more popular distributions: Linux Mint. However, these steps will work in any Debian-based Linux.

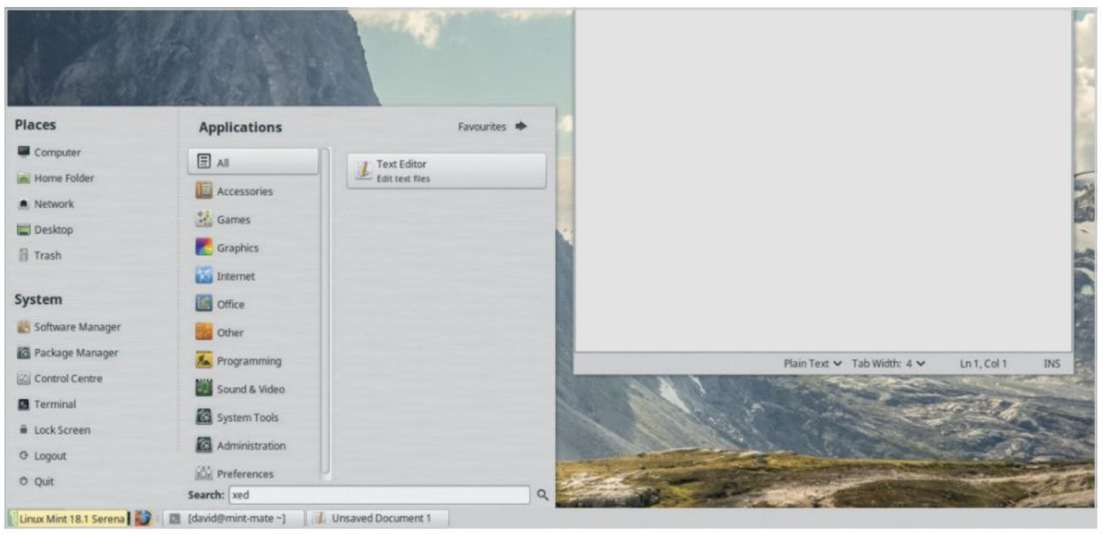
STEP 1 The first step with ensuring Linux is ready for your C++ code is check the system and software are up to date. Open a Terminal and enter: `sudo apt-get update && sudo apt-get upgrade`. Press Return and enter your password. These commands updates the entire system and any installed software.



STEP 2 Most Linux distros come preinstalled with all the necessary components to start coding in C++. However, it's always worth checking to see if everything is present, so still within the Terminal, enter: `sudo apt-get install build-essential` and press Return. If you have the right components, nothing is installed but if you're missing some then they are installed by the command.

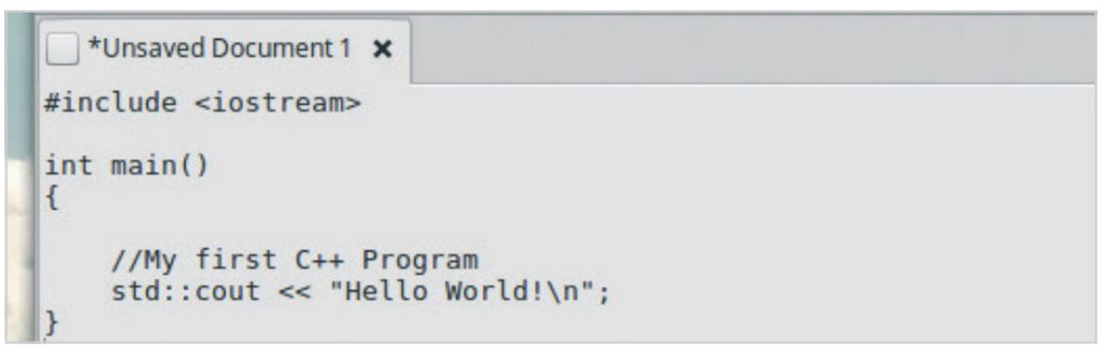


STEP 3 Amazingly, that's it. Everything is all ready for you to start coding. Here's how to get your first C++ program up and running. In Linux Mint the main text editor is Xed can be launched by clicking on the Menu and typing `Xed` into the search bar. Click on the Text Editor button in the right-hand pane to open Xed.

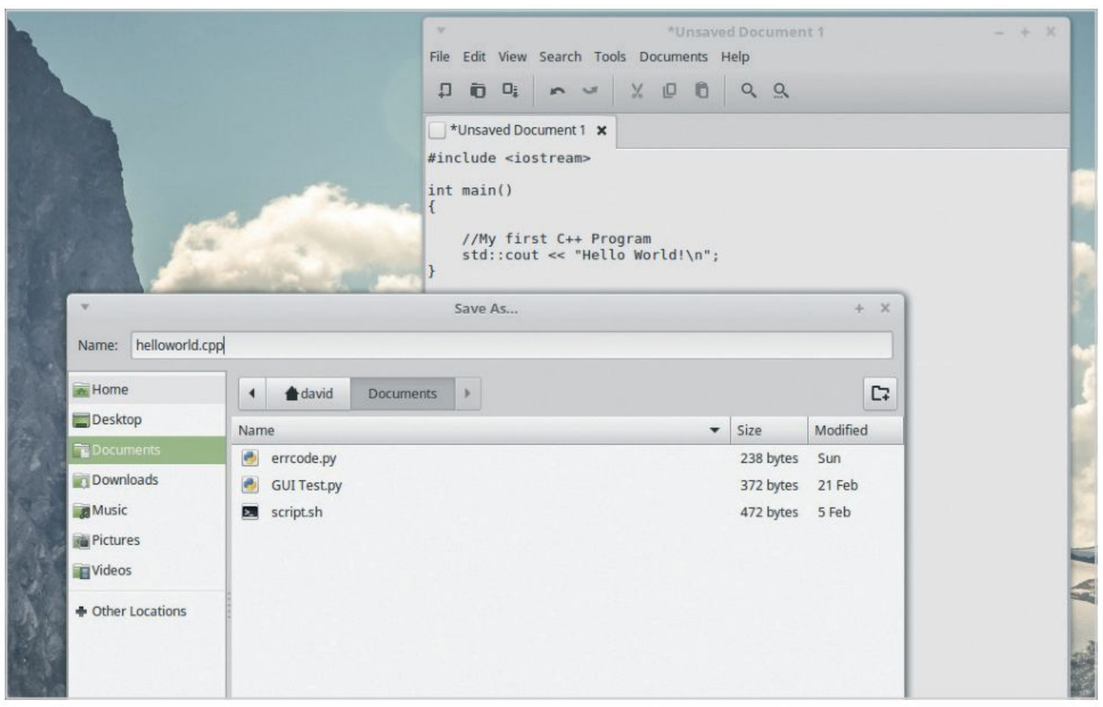


STEP 4 In Xed, or any other text editor you may be using, enter the lines of code that make up your C++ Hello World program. To remind you, it's:

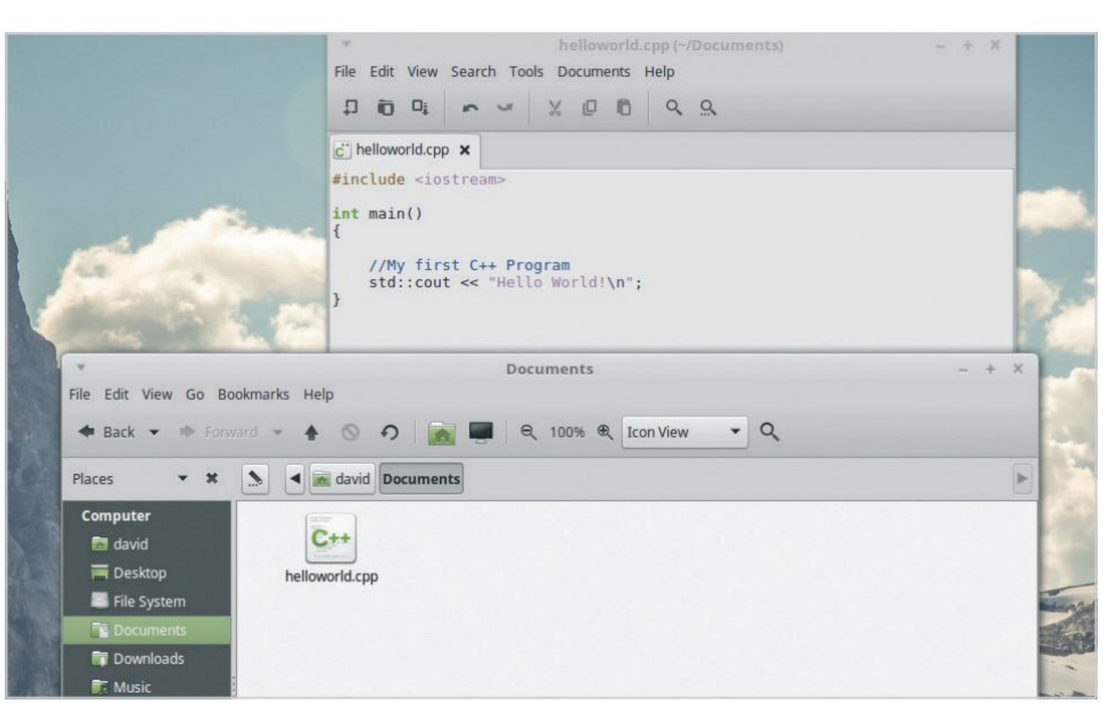
```
#include <iostream>

int main()

{

//My first C++ program

std::cout <<  "Hello World!\n";
```



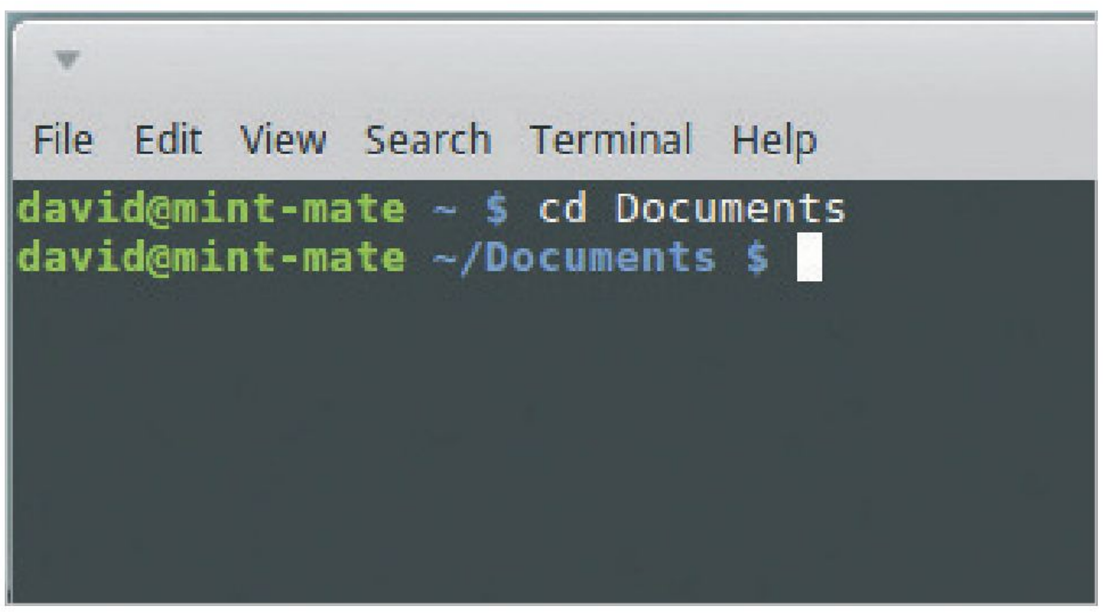
STEP 5 When you've entered your code, click File > Save As and choose a folder where you want to save your program. Name the file as helloworld.cpp, or any other name just as long as it has .cpp as the extension. Click Save to continue.



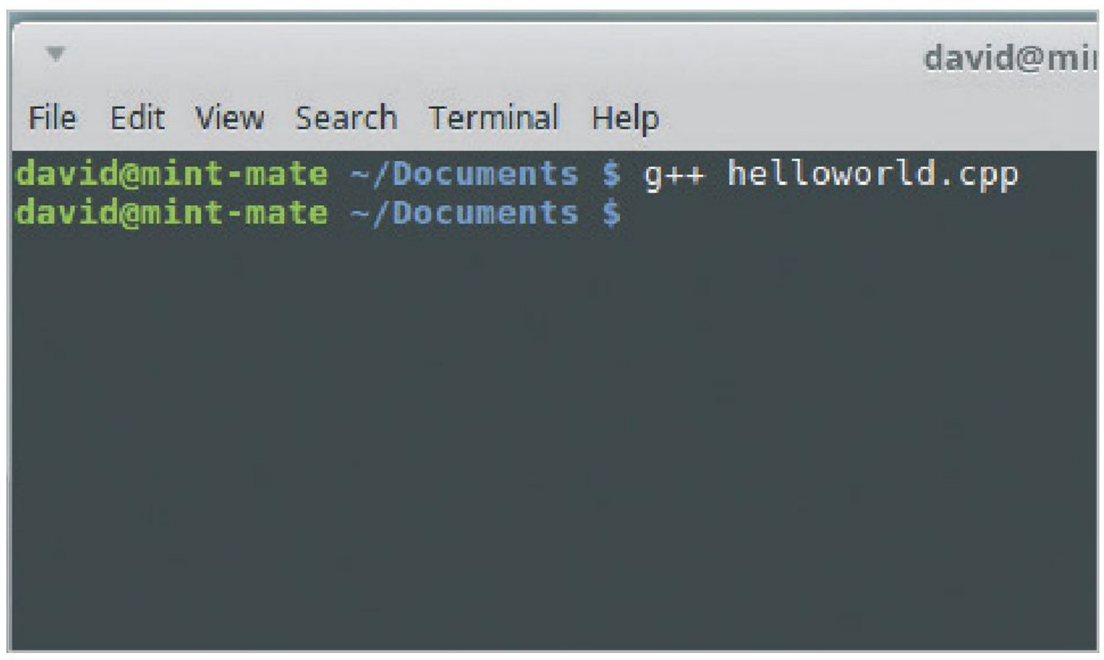
STEP 6 The first thing you can see is that Xed has automatically recognised this as a C++ file, since the file extension is now set to .cpp. The colour coding is present in the code and if you open up the file manager you can also see that the file's icon has C++ stamped on it.



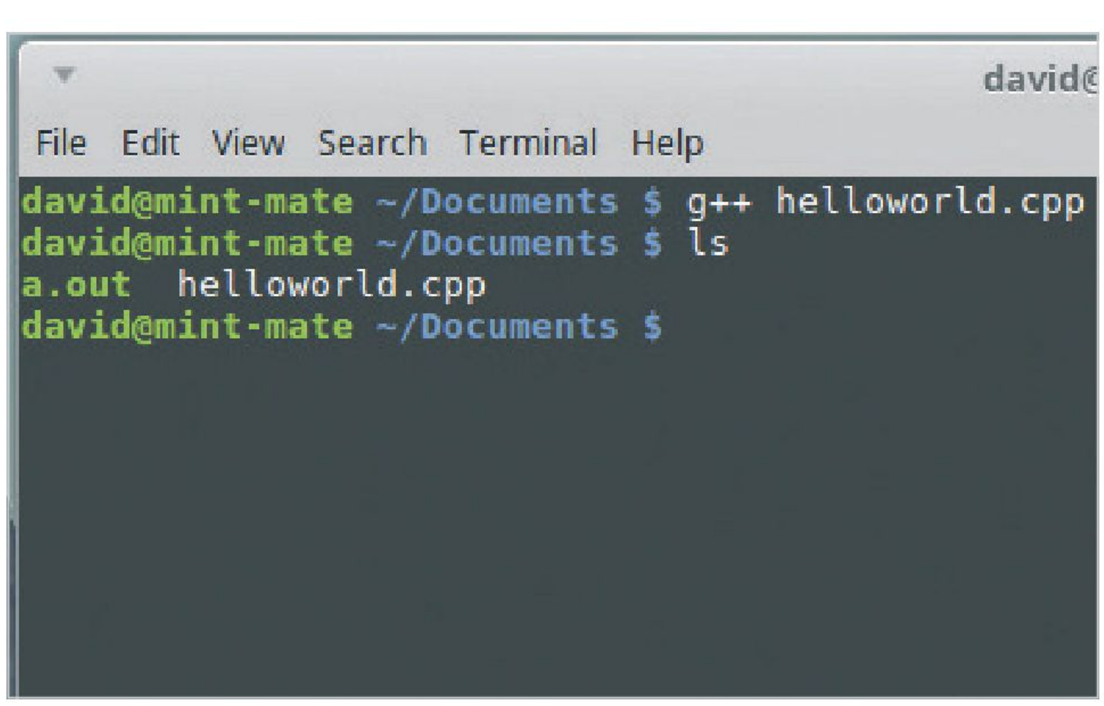
STEP 7 With your code now saved, drop into the Terminal again. You need to navigate to the location of the C++ file you've just saved. Our example is in the Documents folder, so we can navigate to it by entering: `cd Documents`. Remember, the Linux Terminal is case sensitive, so any capitals must be entered correctly.



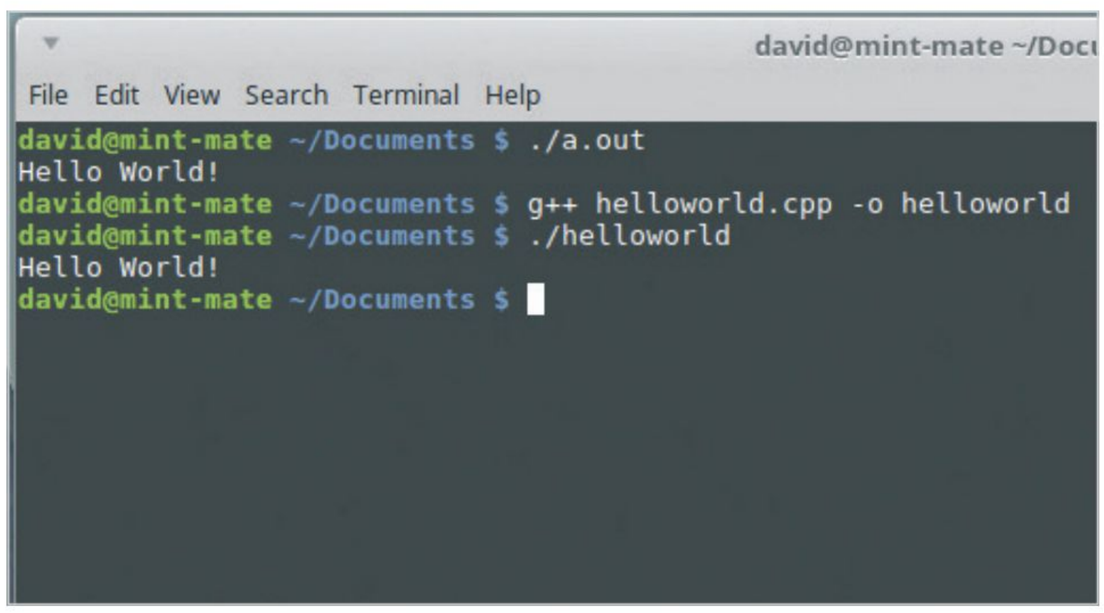
STEP 8 Before you can execute the C++ file you need to compile it. In Linux it's common to use g++, an open source C++ compiler and as you're now in the same folder as the C++ file, go to the Terminal, enter: `g++ helloworld.cpp` and press return.



STEP 9 There will be a brief pause as the code is compiled by g++ and providing there are no mistakes or errors in the code you are returned to the command prompt. The compiling of the code has created a new file. If you enter `ls` into the Terminal you can see that alongside your C++ file is a.out.



STEP 10 The a.out file is the compiled C++ code. To run the code enter: `./a.out` and press Return. The words 'Hello World!' appears on the screen. However, a.out isn't very friendly. To name it something else post-compiling, you can recompile with: `g++ helloworld.cpp -o helloworld`. This creates an output file called helloworld which can be run with: `./helloworld`.



Other C++ IDEs to Install

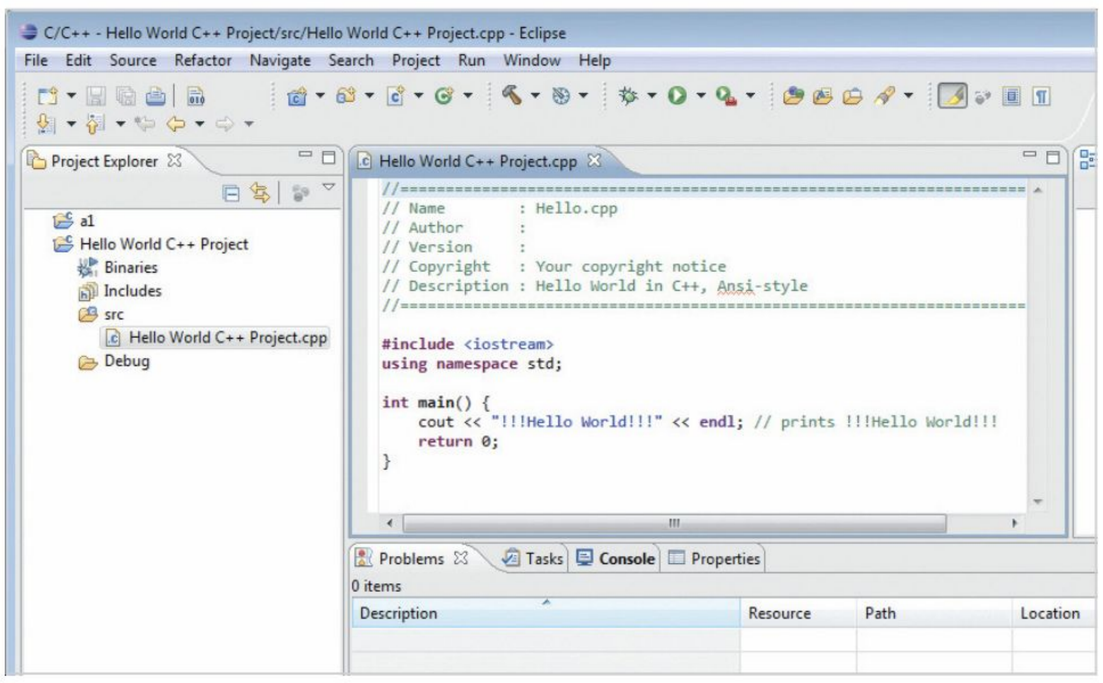
If you want to try a different approach to working with your C++ code, then there are plenty of options available to you. Windows is the most prolific platform for C++ IDEs but there are plenty for Mac and Linux users too.

DEVELOPING C++

Here are ten great C++ IDEs that are worth looking into. You can install one or all of them if you like, but find the one that works best for you.

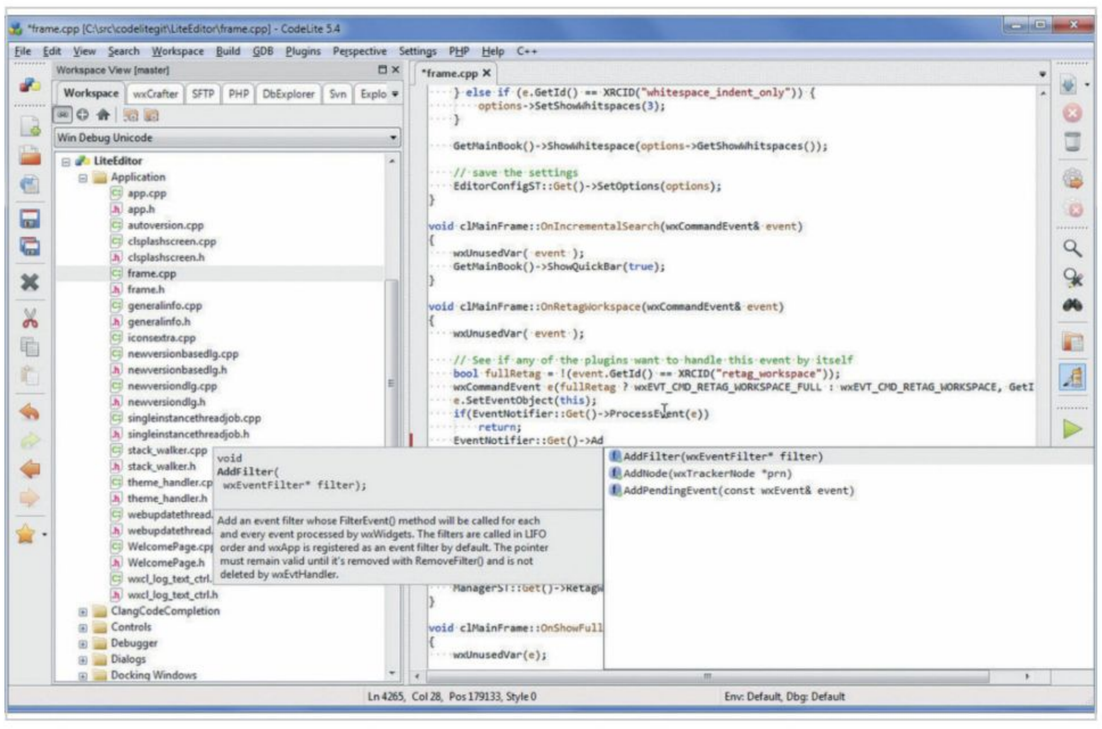
ECLIPSE

Eclipse is a hugely popular C++ IDE that offers the programmer a wealth of features. It has a great, clean interface, is easy to use and available for Windows, Linux and Mac. Head over to **www.eclipse.org/downloads/** to download the latest version. If you're stuck, click the Need Help link for more information.



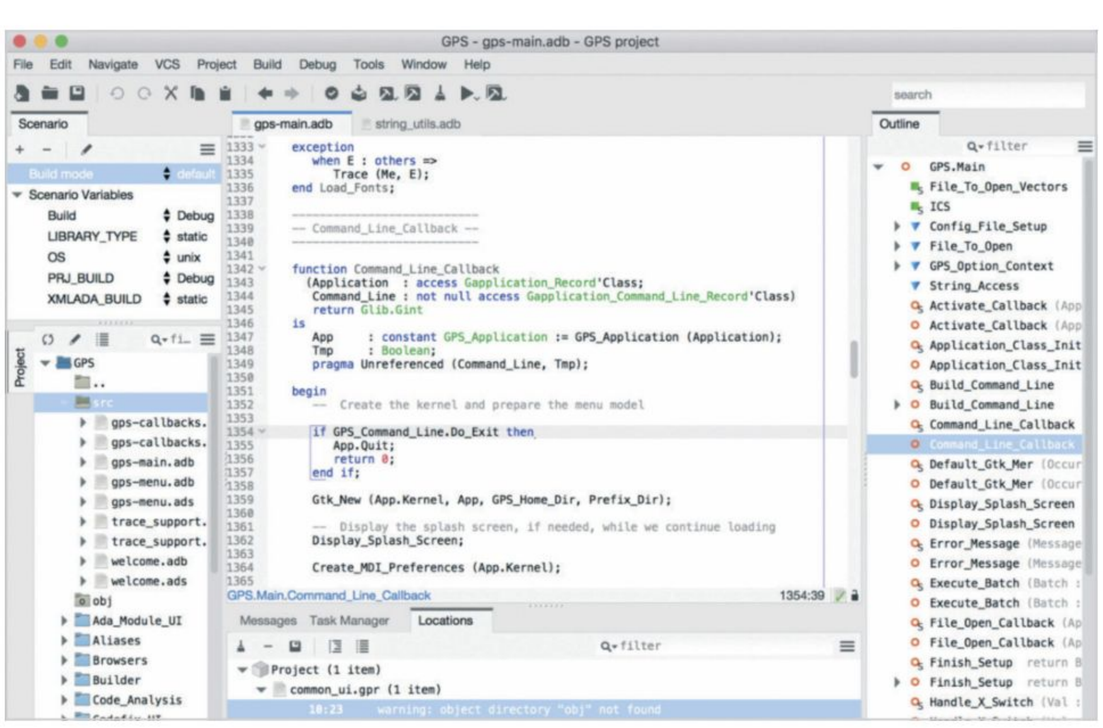
CODELITE

CodeLite is a free and open source IDE that's regularly updated and available for Windows, Linux and macOS. It's lightweight, uncomplicated and extremely powerful. You can find out more information as well as how to download and install it at **www.codelite.org/**.



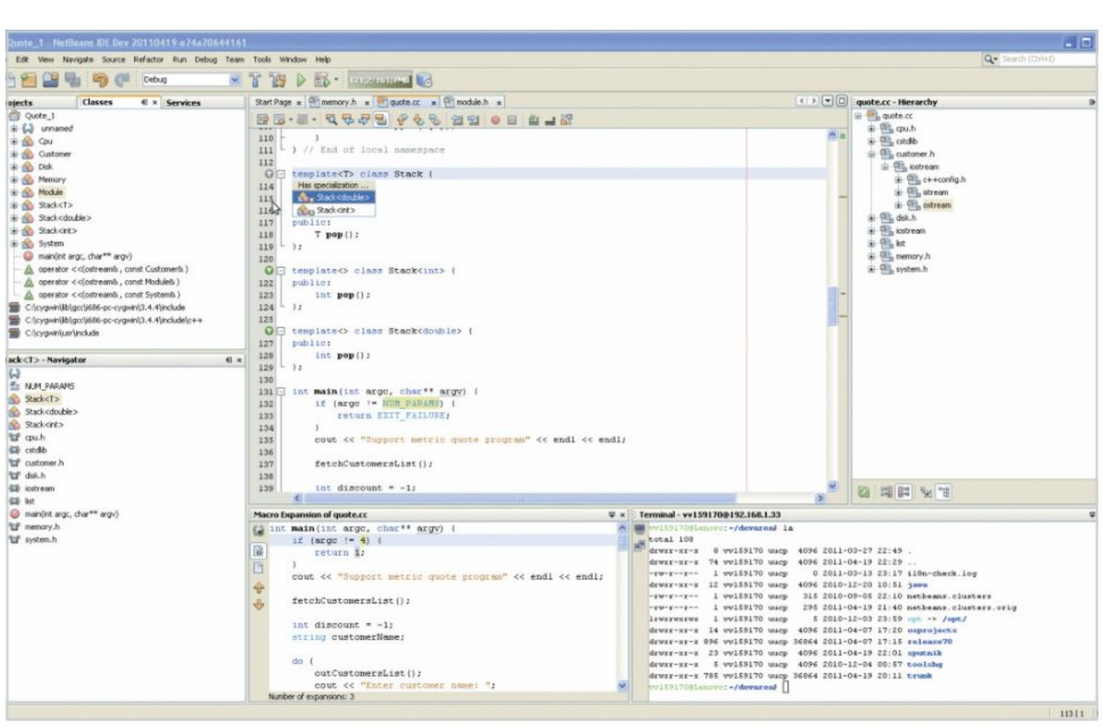
GNAT

The GNAT Programming Studio (GPS) is a powerful and intuitive IDE that supports testing, debugging and code analysis. The Community Edition is free, whereas the Pro version costs; however, the Community Edition is available for Windows, Mac, Linux and even the Raspberry Pi. You can find it at **www.adacore.com/download**.



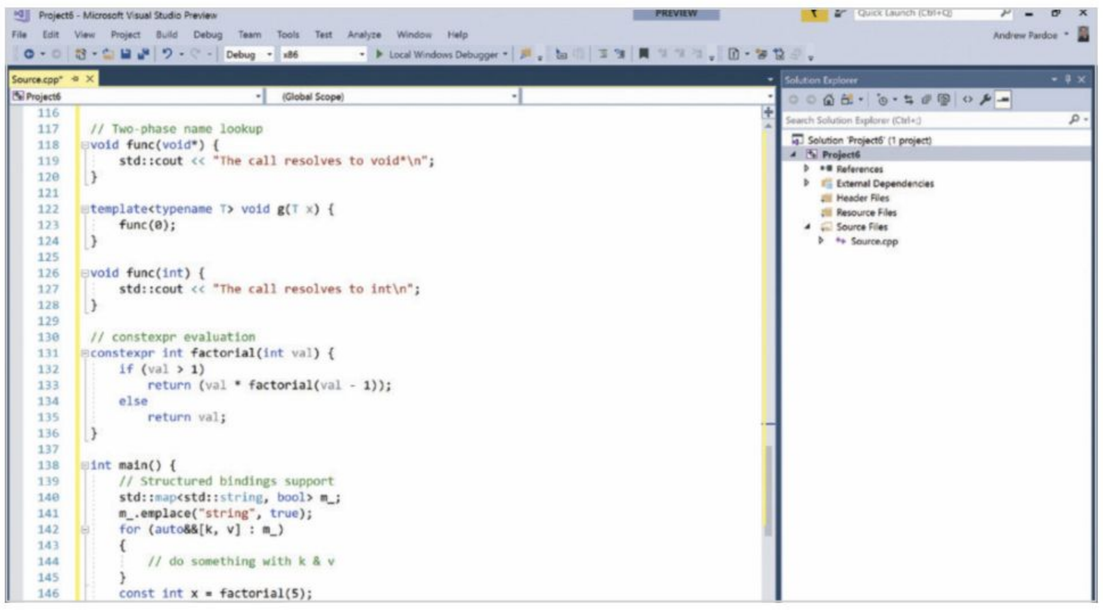
NETBEANS

Another popular choice is NetBeans. This is another excellent IDE that's packed with features and a pleasure to use. NetBeans IDE includes project based templates for C++ that give you the ability to build applications with dynamic and static libraries. Find out more at **www.netbeans.org/features/cpp/index.html.**



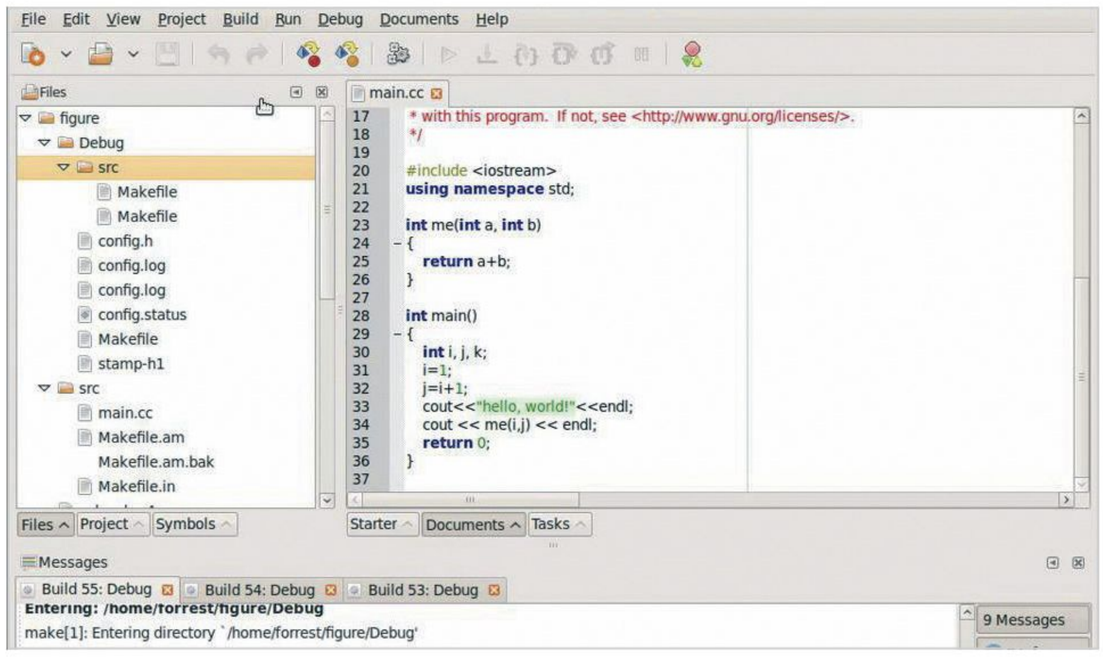
VISUAL STUDIO

Microsoft's Visual Studio is a mammoth C++ IDE that allows you to create applications for Windows, Android, iOS and the web. The Community version is free to download and install but the other versions allow a free trial period. Go to **www.visualstudio.com/** to see what it can do for you.



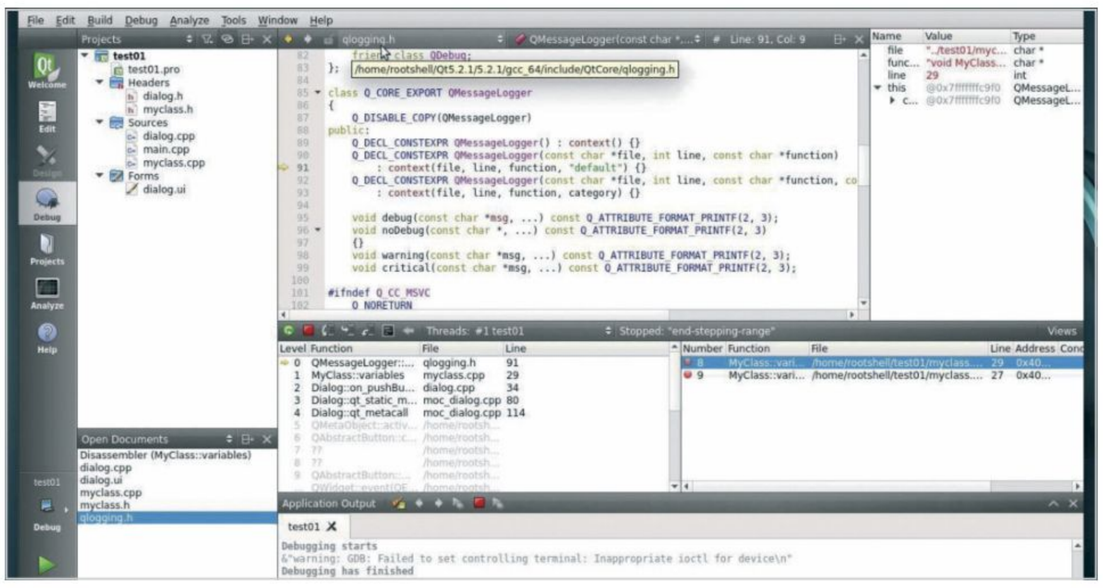
ANJUTA

The Anjuta DevStudio is a Linux-only IDE that features some of the more advanced features you would normally find in a paid software development studio. There's a GUI designer, source editor, app wizard, interactive debugger and much more. Go to **www.anjuta.org/** for more information.



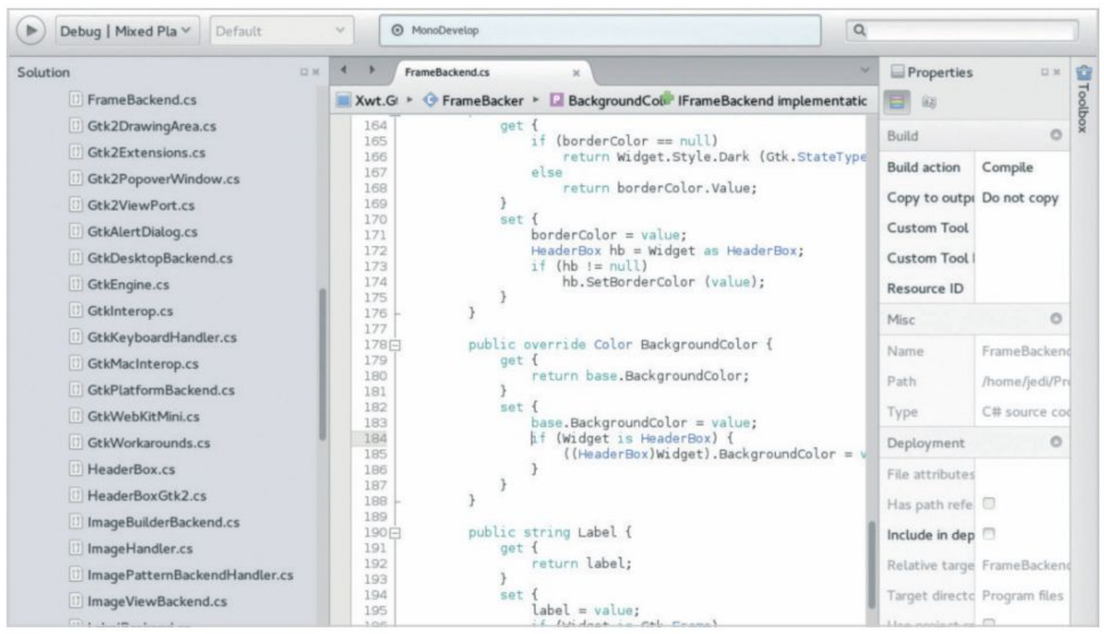
QT CREATOR

This cross-platform IDE is designed to create C++ applications for desktop and mobile environments. It comes with a code editor and integrated tools for testing and debugging, as well as deploying to you chosen platform. It's not free but there is a trial period on offer before requiring purchasing: **www.qt.io/qt-features-libraries-apis-tools-and-ide/**.



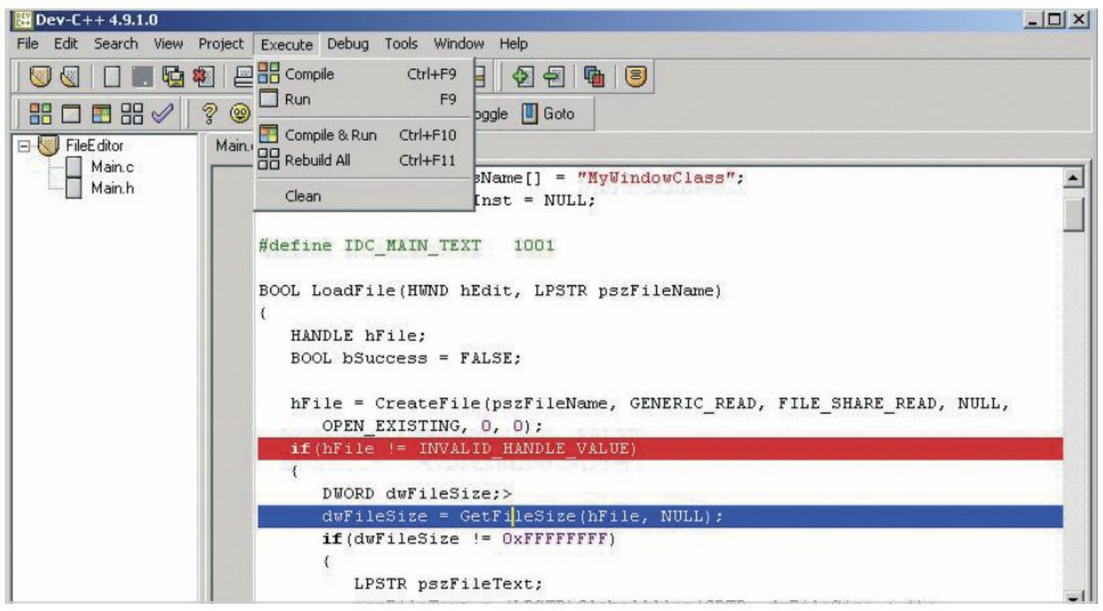
MONODEVELOP

This excellent IDE allows developers to write C++ code for desktop and web applications across all the major platforms. There's an advanced text editor, integrated debugger and a configurable workbench to help you create your code. It's available for Windows, Mac and Linux and is free to download and use: **www.monodevelop.com/**.



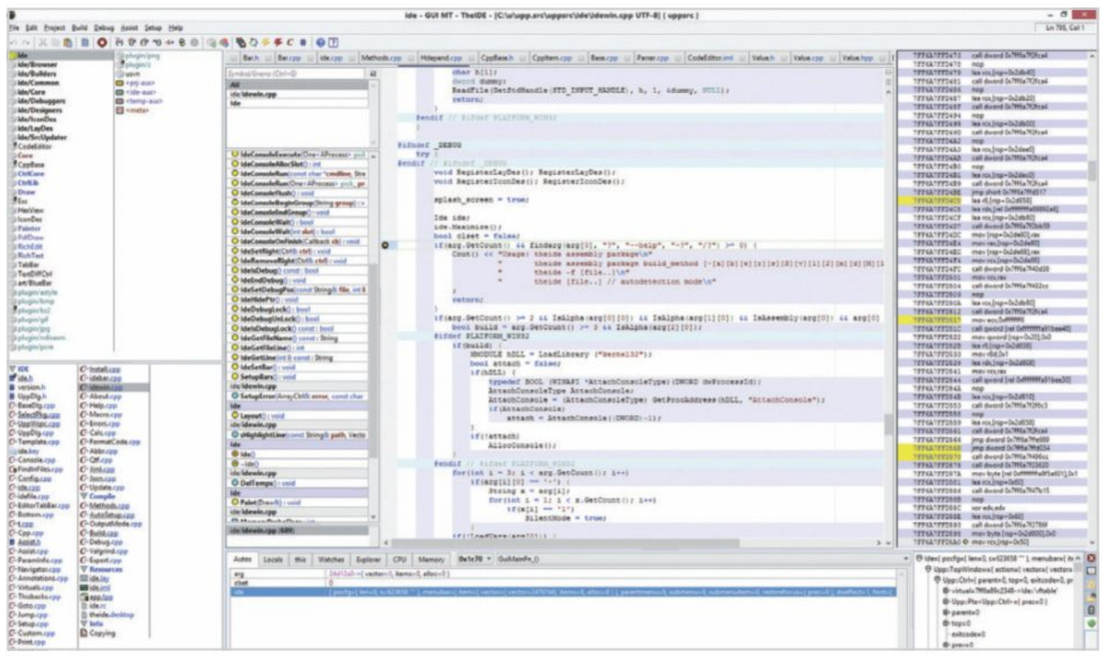
DEV C++

Bloodshed Dev C++, despite its colourful name, is an older IDE that is for Windows systems only. However, many users praise its clean interface and uncomplicated way of coding and compiling. Although there's not been much updating for some time, it's certainly one to consider if you want something different: **www.bloodshed.net/devcpp.html**.



U++

Ultimate++ is a cross-platform C++ IDE that boats a rapid development of code through the smart and aggressive use of C++. For the novice, it's a beast of an IDE but behind its complexity is a beauty that would make a developer's knees go wobbly. Find out more at **www.ultimatepp.org/index.html**.



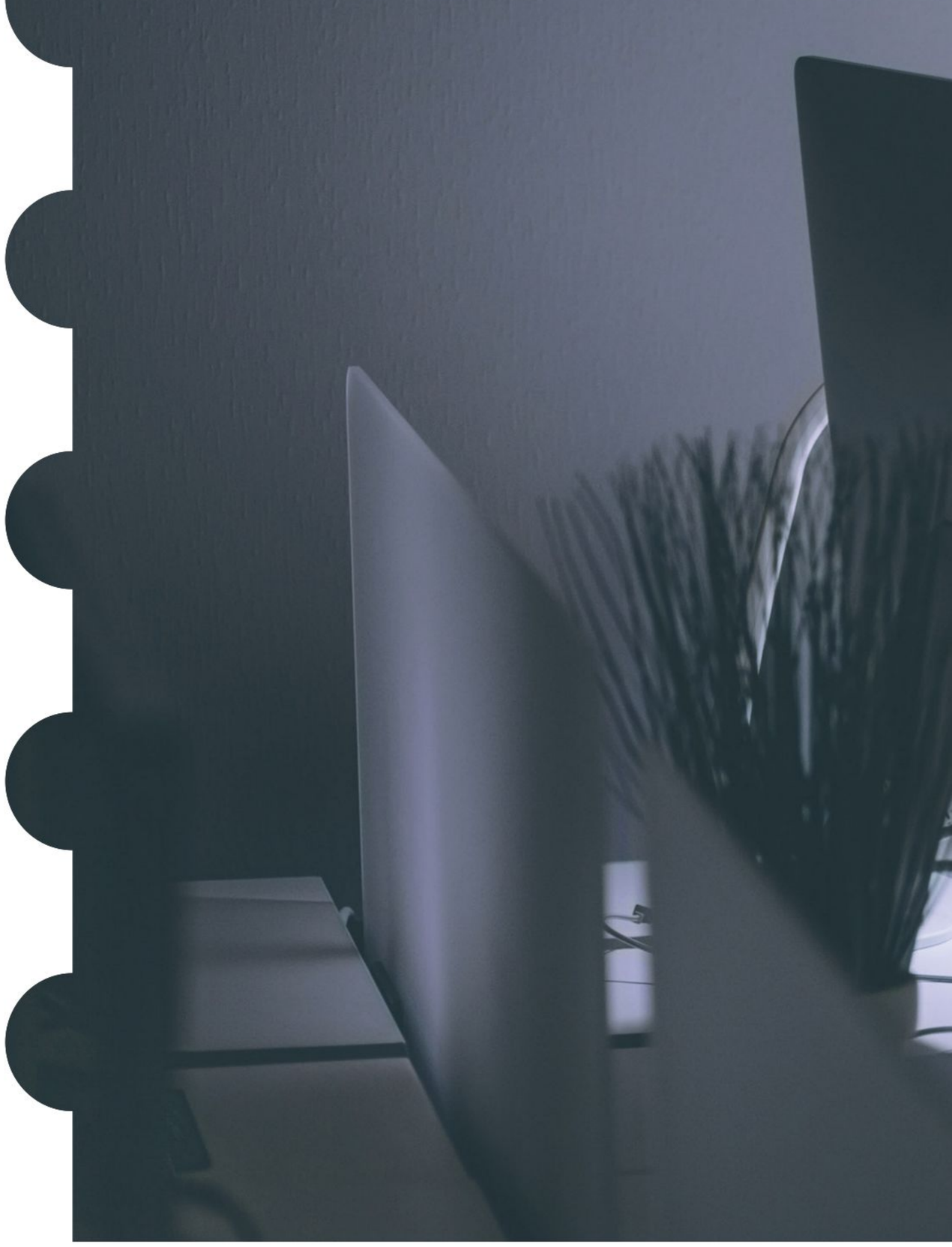
C++ can be a complex language to master, but even the most knowledgeable and professional C-coder had to start somewhere. These C++ developers started by building a solid foundation, and from there began to form their own unique ways of coding in this remarkable language. It takes time and patience, and if you throw in a little imagination, you'll be coding C++ programs before you know it.

This section, therefore, covers the basics of starting to learn C++. You will learn how to compile and execute your C++ code, then move into variables, data types, strings, maths in C++, user interaction and more.

36 Your First C++ Program
38 Compile and Execute
40 Using Comments
42 Variables
44 Data Types
46 Strings
48 C++ Maths
50 User Interaction

"The best programs are written so that computing machines can perform them quickly, and so that human beings can understand them clearly."

– Donald E. Knuth (Computer scientist, mathematician and author)



Coding with C++

Your First C++ Program

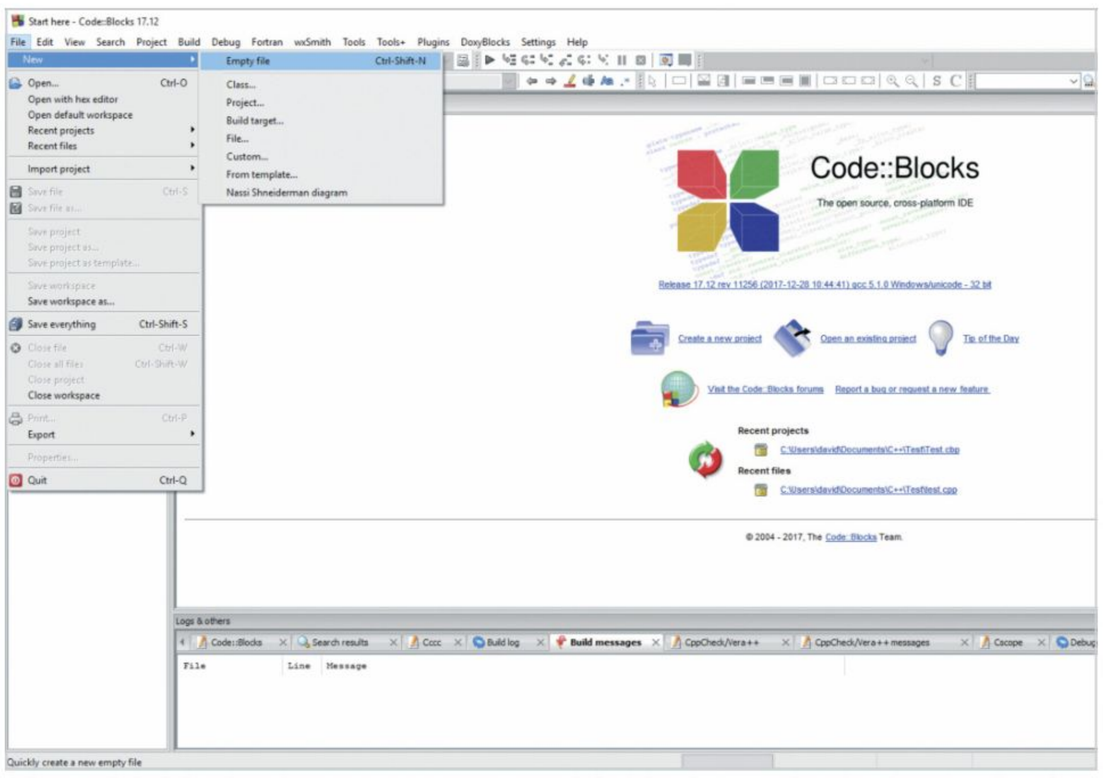
You may have followed the Mac and Linux examples previously but you're going to be working exclusively in Windows and Code::Blocks from here on. Let's begin by writing your first C++ program and taking the first small step into a larger coding world.

HELLO, WORLD!

It's traditional in programming for the first code to be entered to output the words 'Hello, World!' to the screen. Interestingly, this dates back to 1968 using a language called BCPL.

STEP 1

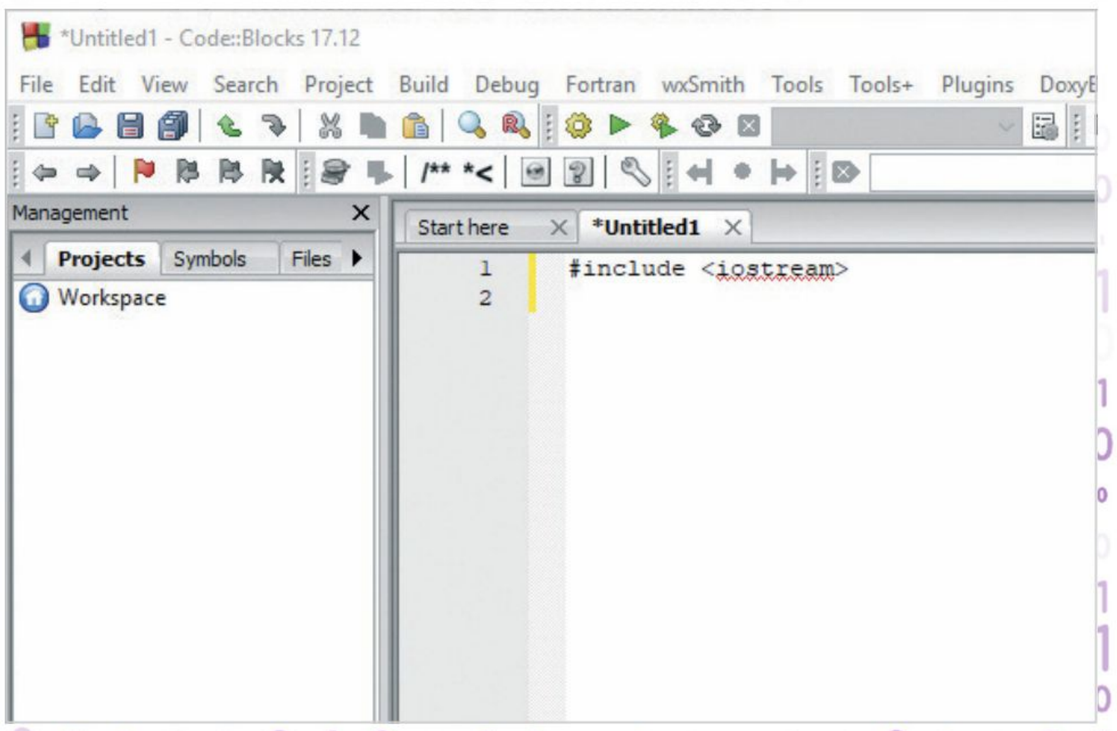
As mentioned, we're using Windows 10 and the latest version of Code::Blocks for the rest of the C++ code in this book. Begin by launching Code::Blocks. When open, click on File > New > Empty File or press Ctrl+Shift+N on the keyboard.



STEP 2

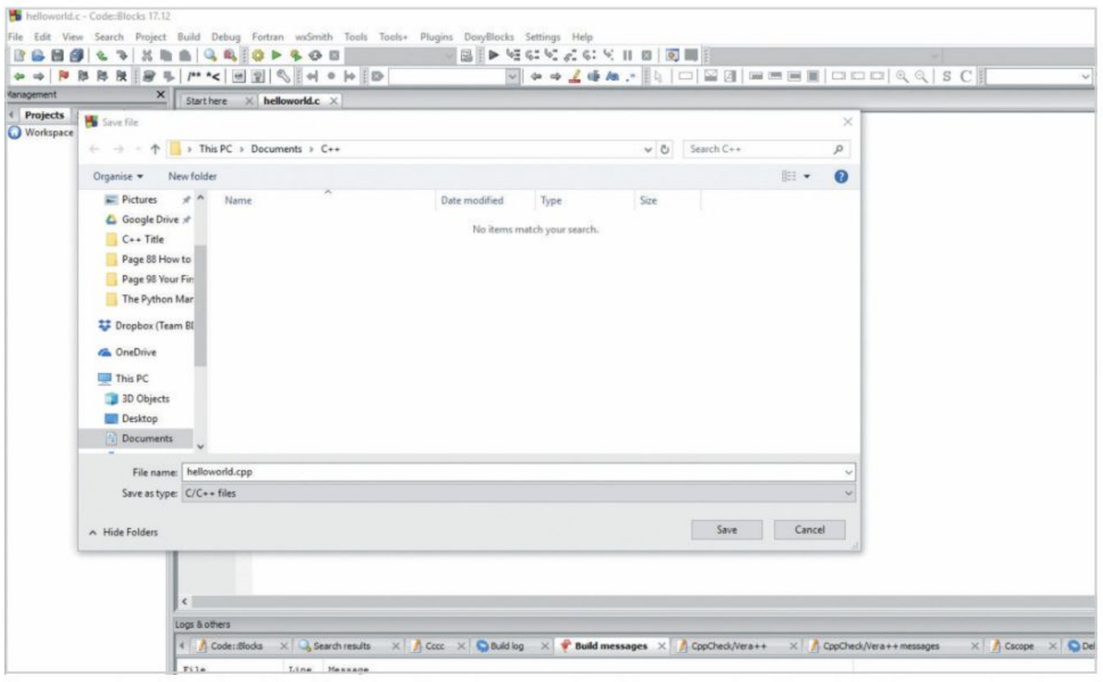
Now you can see a blank screen, with the tab labelled *Untitled1, and the number one in the top left of the main Code::Blocks window. Begin by clicking in the main window, so the cursor is next to the number one, and entering:

```
#include <iostream>
```



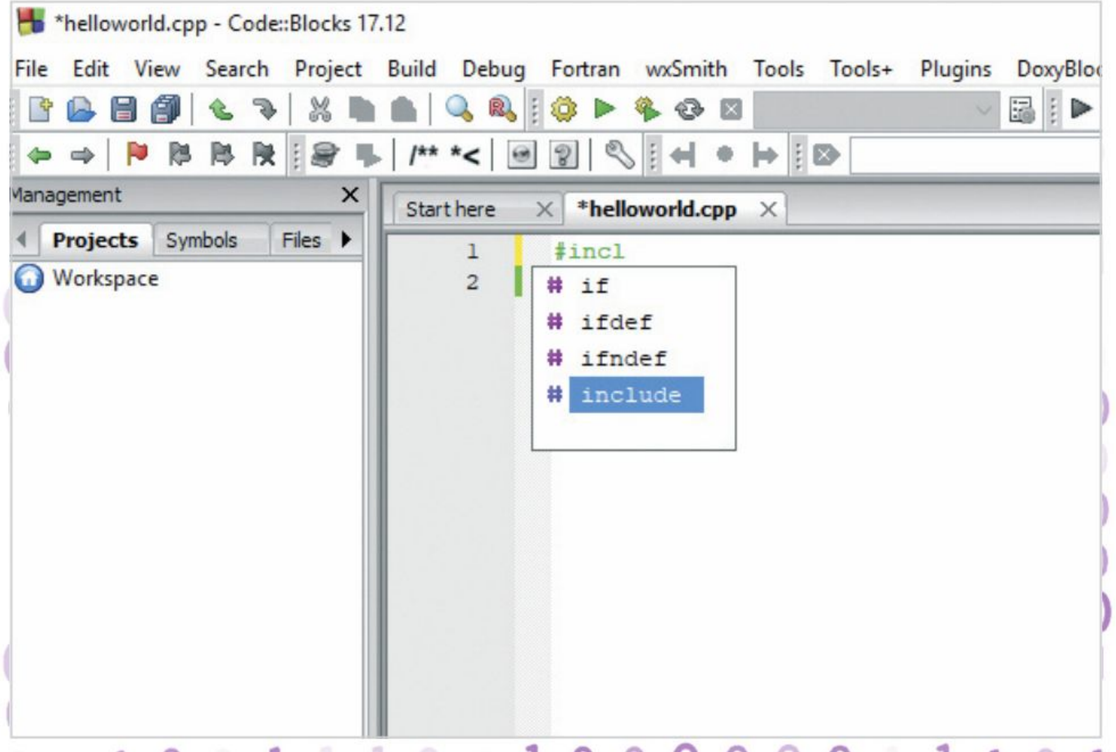
STEP 3

At the moment it doesn't look like much, and it makes even less sense, but we'll get to that in due course. Now click on File > Save File As. Create or find a suitable location on your hard drive and in the File Name box, call it helloworld.cpp. Click the Save as type box and select C/C++ files. Click the Save button.



STEP 4

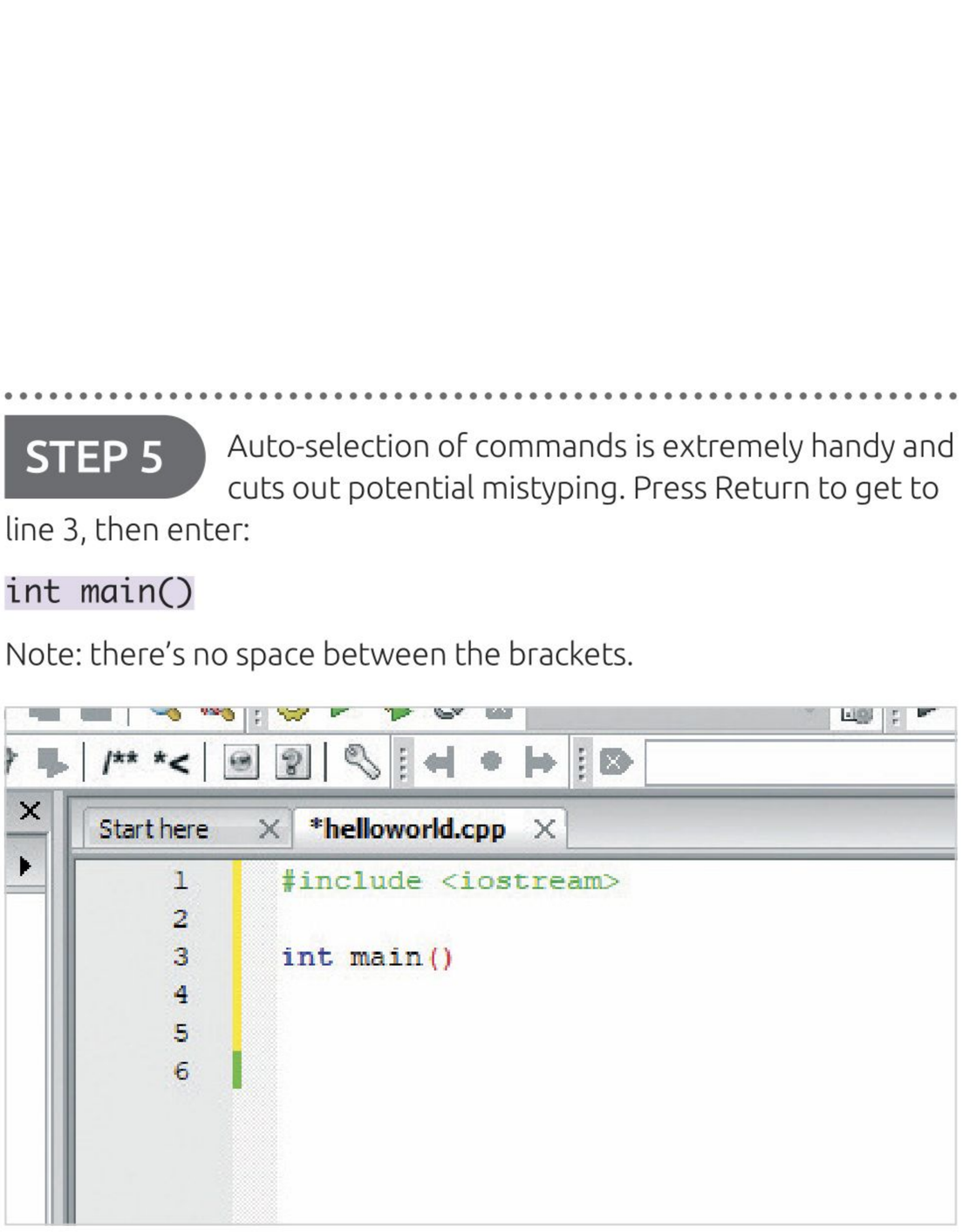
You can see that Code::Blocks has now changed the colour coding, recognising that the file is now C++ code. This means that code can be auto-selected from the Code::Blocks repository. Delete the #include <iostream> line and re-enter it. You can see the auto-select boxes appearing.



STEP 5 Auto-selection of commands is extremely handy and cuts out potential mistyping. Press Return to get to line 3, then enter:

```
int main()
```

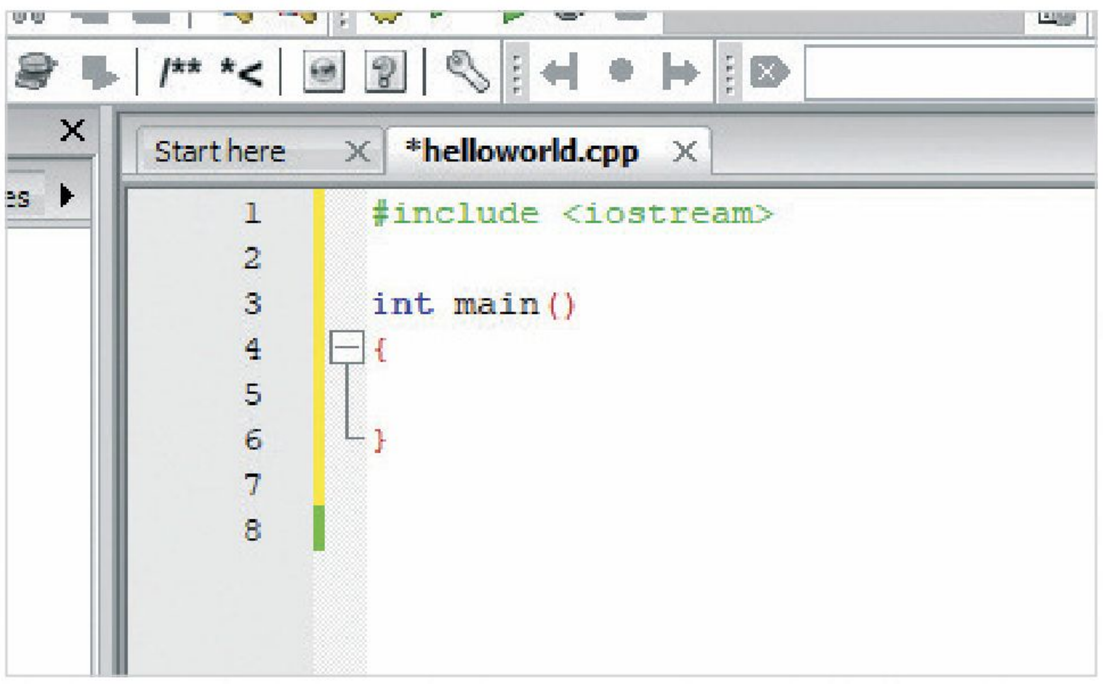
Note: there's no space between the brackets.



STEP 6 On the next line below int main(), enter a curly bracket:

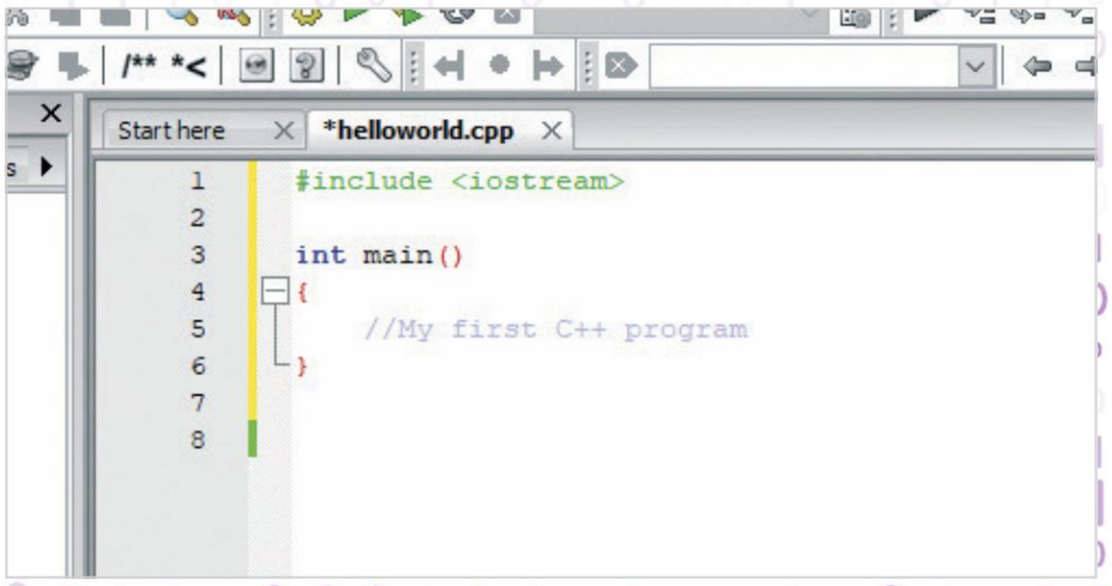
```
{
```

This can be done by pressing Shift and the key to the right of P on an English UK keyboard layout.



STEP 7 Notice that Code::Blocks has automatically created a corresponding closing curly bracket a couple of lines below, linking the pair, as well as a slight indent. This is due to the structure of C++ and it's where the meat of the code is entered. Now enter:

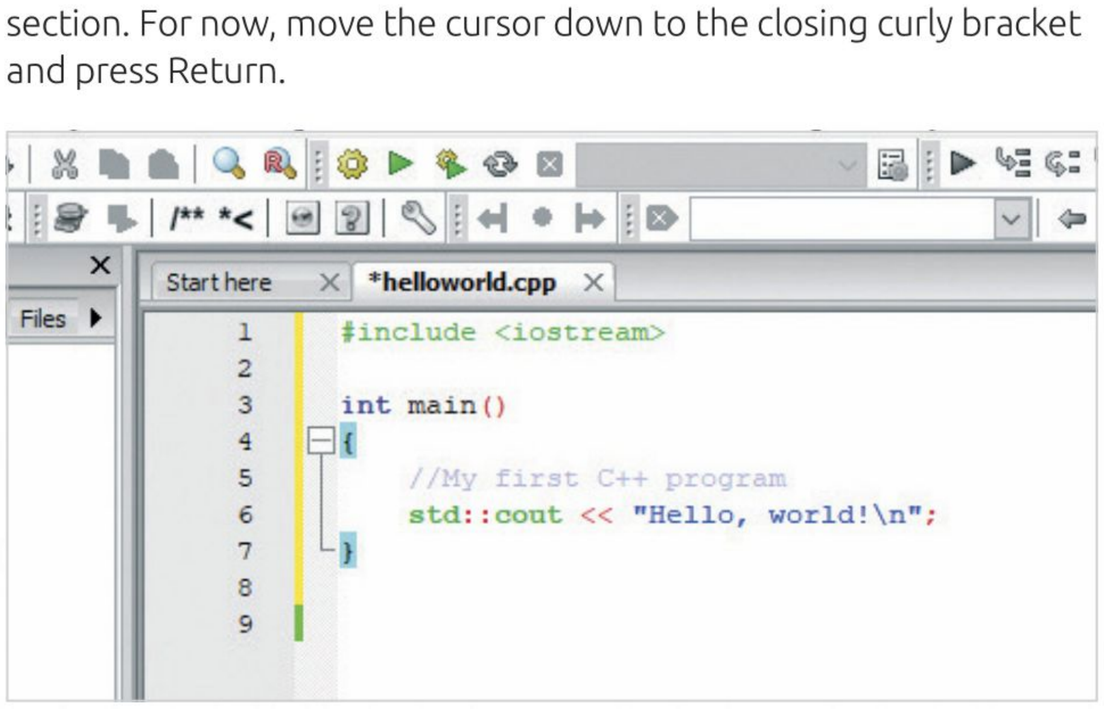
```
//My first C++ program
```



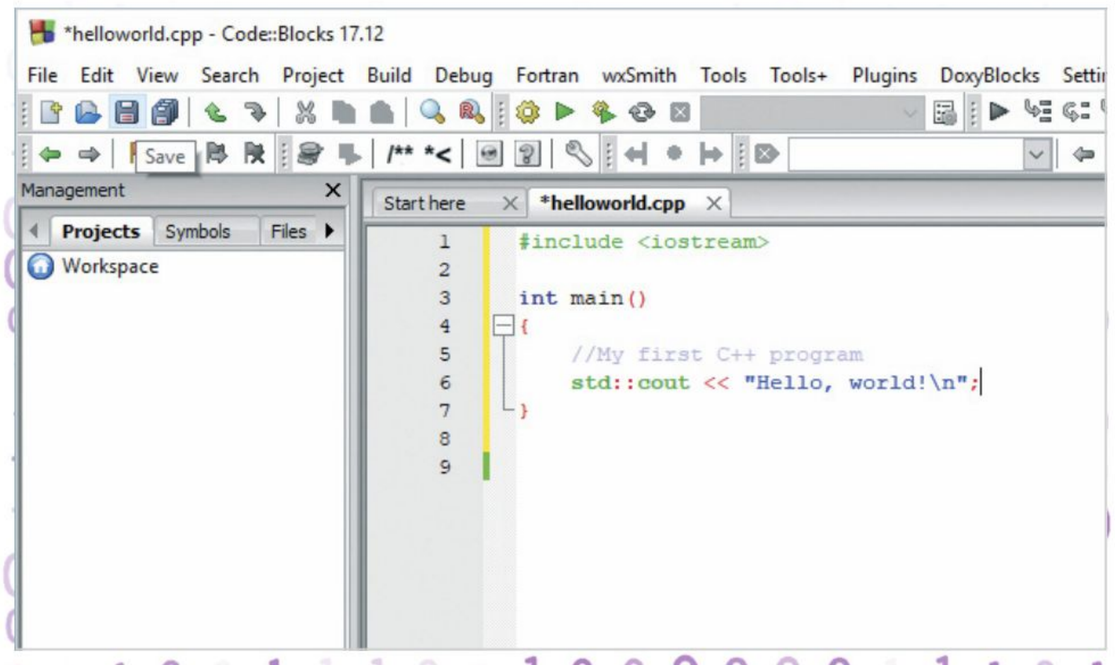
STEP 8 Note again the colour coding change. Press Return at the end of the previous step's line, and then enter:

```
std::cout << "Hello, world!\n";
```

STEP 9 Just as before, Code::Blocks auto-completes the code you're entering, including placing a closing speech mark as soon as you enter the first. Don't forget the semicolon at the end of the line; this is one of the most important elements to a C++ program and we'll tell you why in the next section. For now, move the cursor down to the closing curly bracket and press Return.



STEP 10 That's all you need to do for the moment. It may not look terribly amazing but C++ is best absorbed in small chunks. Don't execute the code at the moment as you need to look at how a C++ program is structured first; then you can build and run the code. For now, click on Save, the single floppy disc icon.



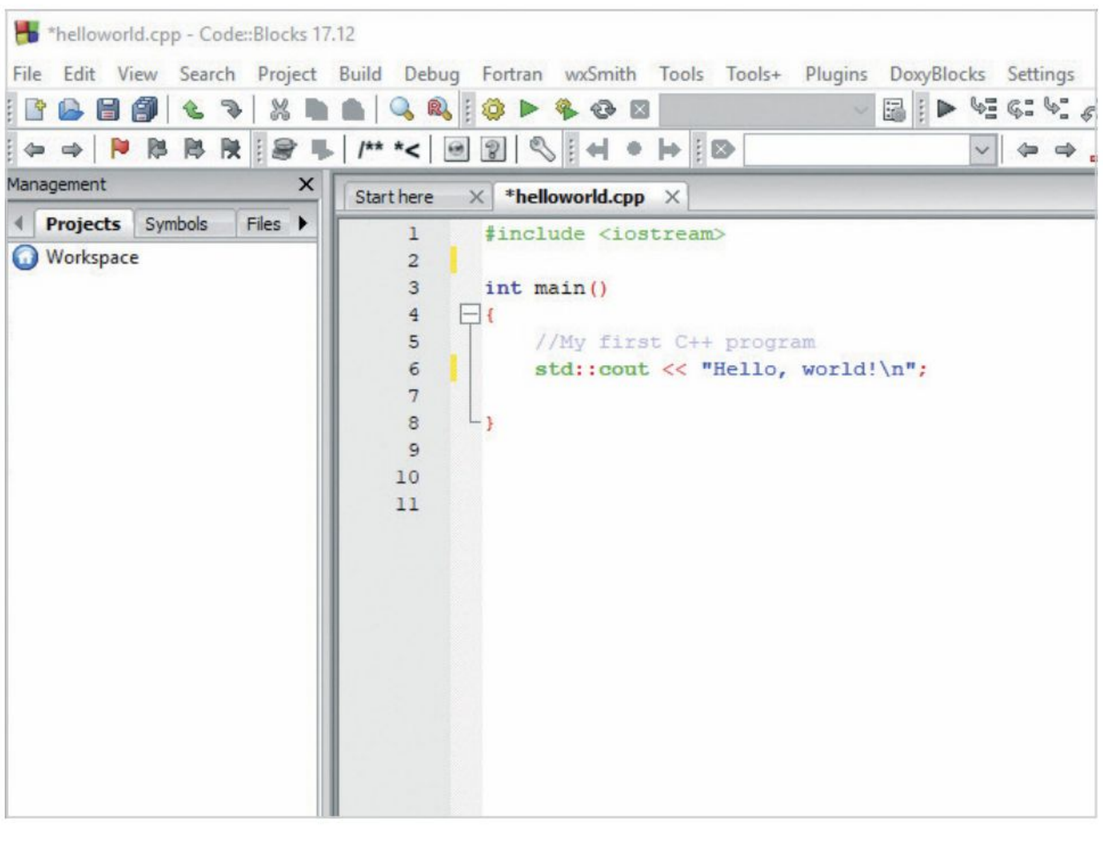
Compile and Execute

You've created your first C++ program and you now understand the basics behind the structure of one. Let's actually get things moving and compile and execute, or run if you prefer, the program and see how it looks.

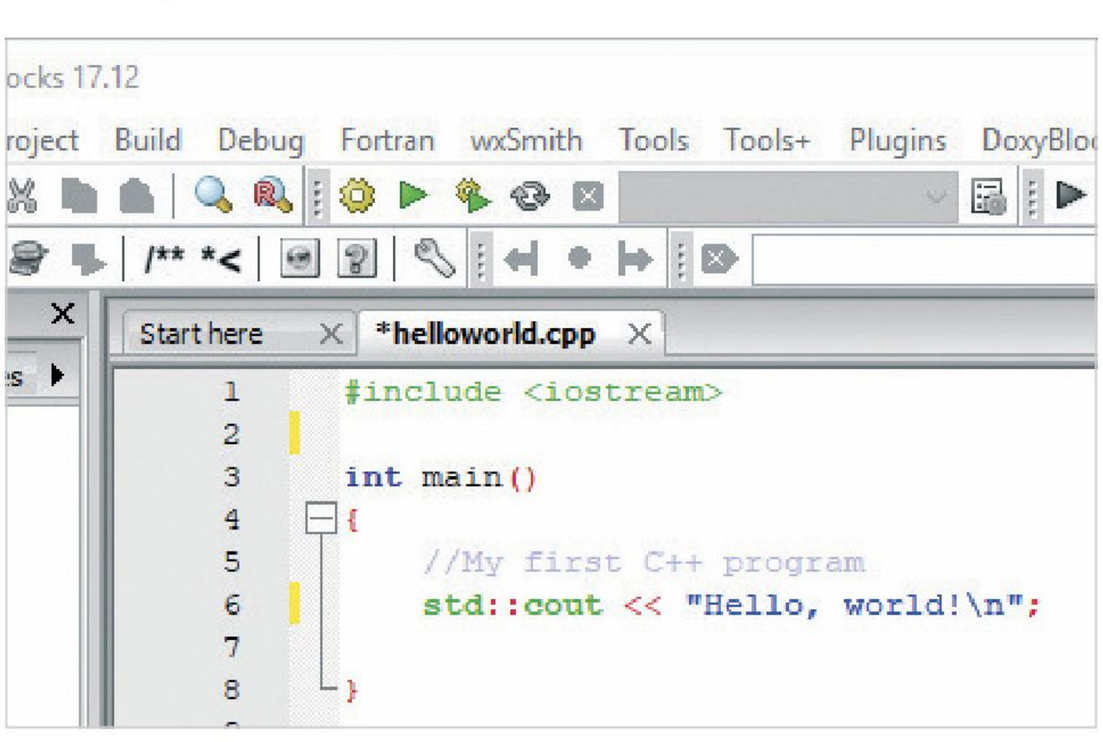
GREETINGS FROM C++

Compiling and executing C++ code from Code::Blocks is extraordinarily easy; it's just a matter of clicking an icon and seeing the result. Here's how it's done.

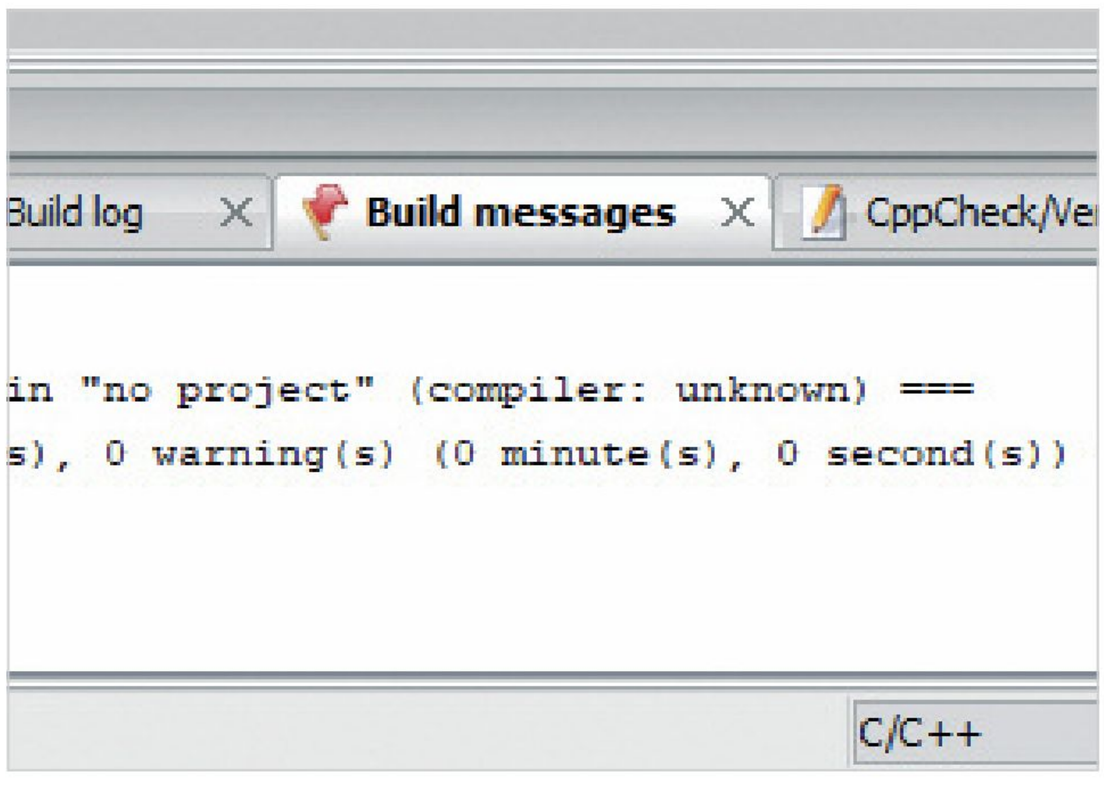
STEP 1 Open Code::Blocks, if you haven't already, and load up the previously saved Hello World code you created. Ensure that there are no visible errors, such as missing semicolons at the end of the std::cout line.



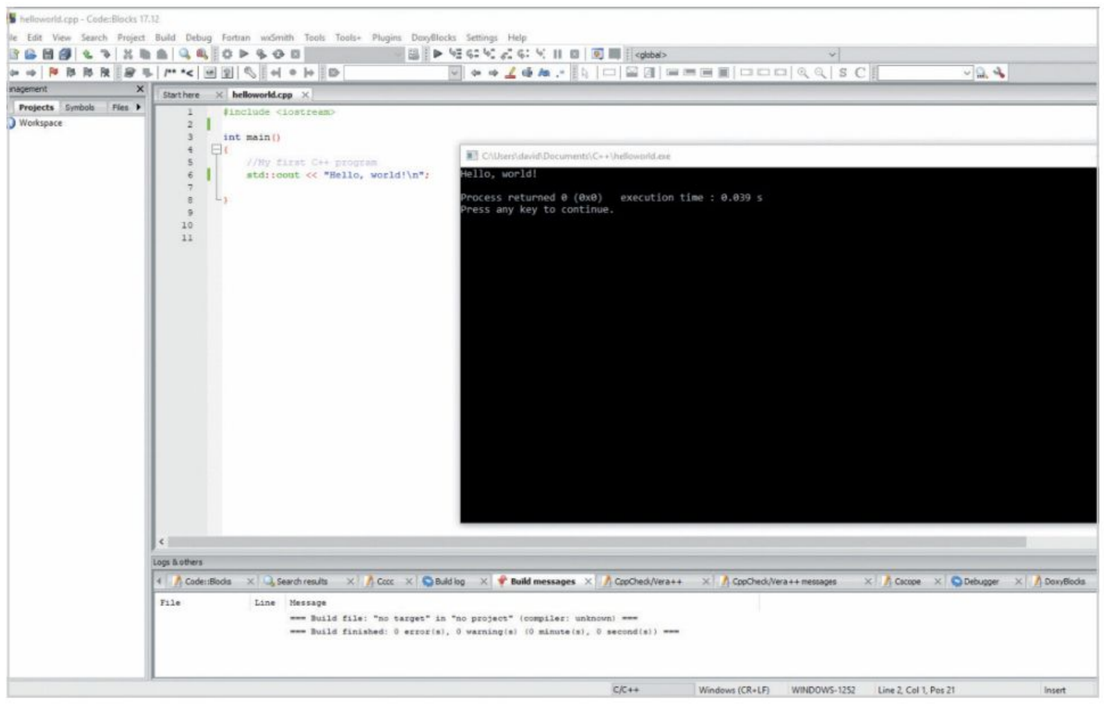
STEP 2 If your code is looking similar to the one in our screenshot, then look to the menu bar along the top of the screen. Under the Fortran entry in the topmost menu you can see a group of icons: a yellow cog, green play button and a cog/play button together. These are Build, Run, Build and Run functions.



STEP 3 Start by clicking on the Build icon, the yellow cog. At this point, your code has now been run through the Code::Blocks compiler and checked for any errors. You can see the results of the Build by looking to the bottom window pane. Any messages regarding the quality of the code are displayed here.



STEP 4 Now click on the Run icon, the green play button. A command line box appears on your screen displaying the words: Hello, world!, followed by the time it's taken to execute the code, and asking you press a key to continue. Well done, you just compiled and executed your first C++ program.

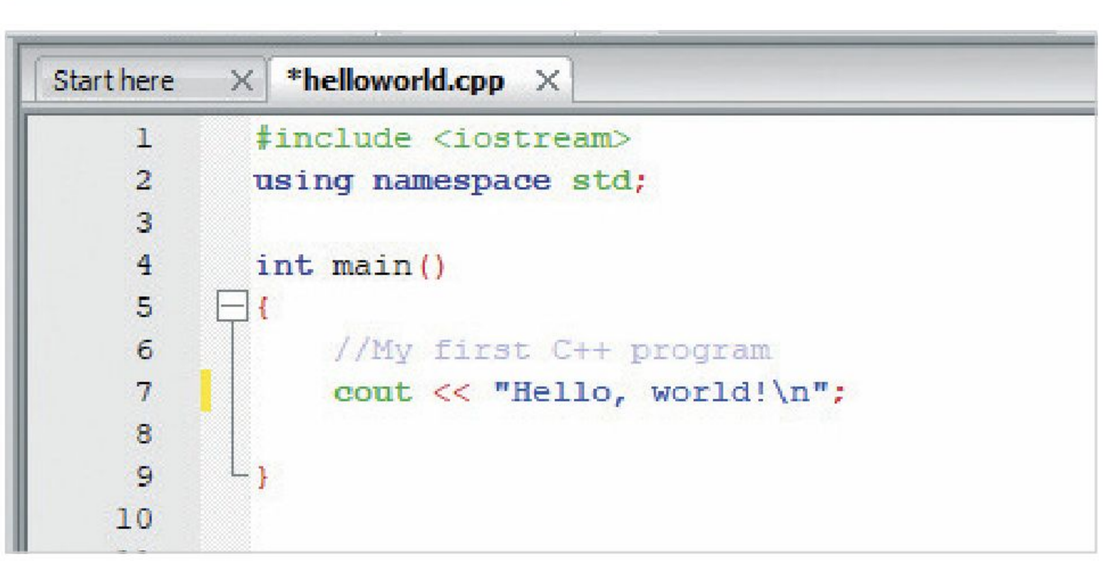


STEP 5 Pressing any key in the command line box closes it, returning you to Code::Blocks. Let's alter the code slightly. Under the #include line, enter:

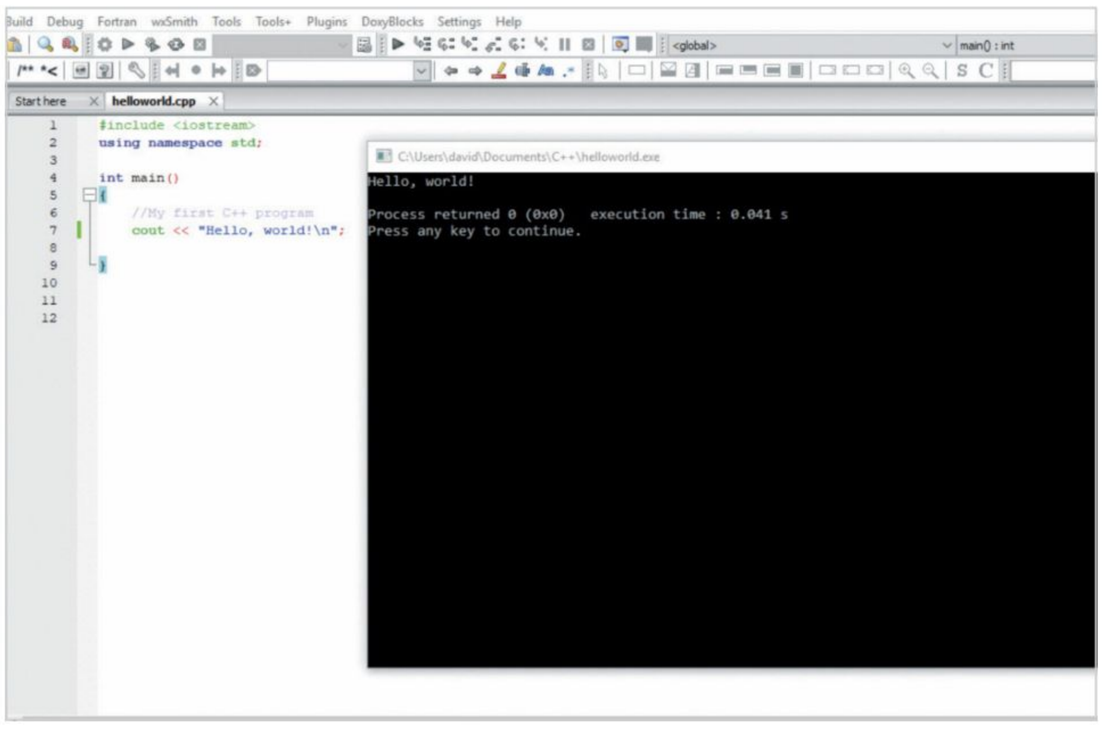
```
using namespace std;
```

Then, delete the std:: part of the Cout line; like so:

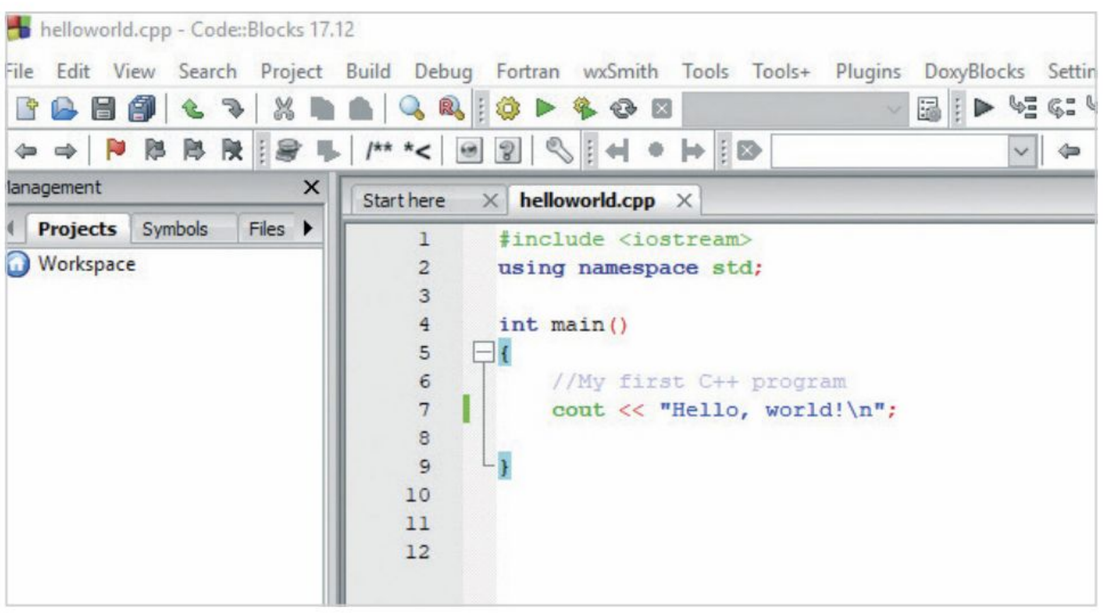
```
cout << "Hello, world\n";
```



STEP 6 In order to apply the new changes to the code, you need to re-compile, build, and run it again. This time, however, you can simply click the Build/Run icon, the combined yellow cog and green play button.

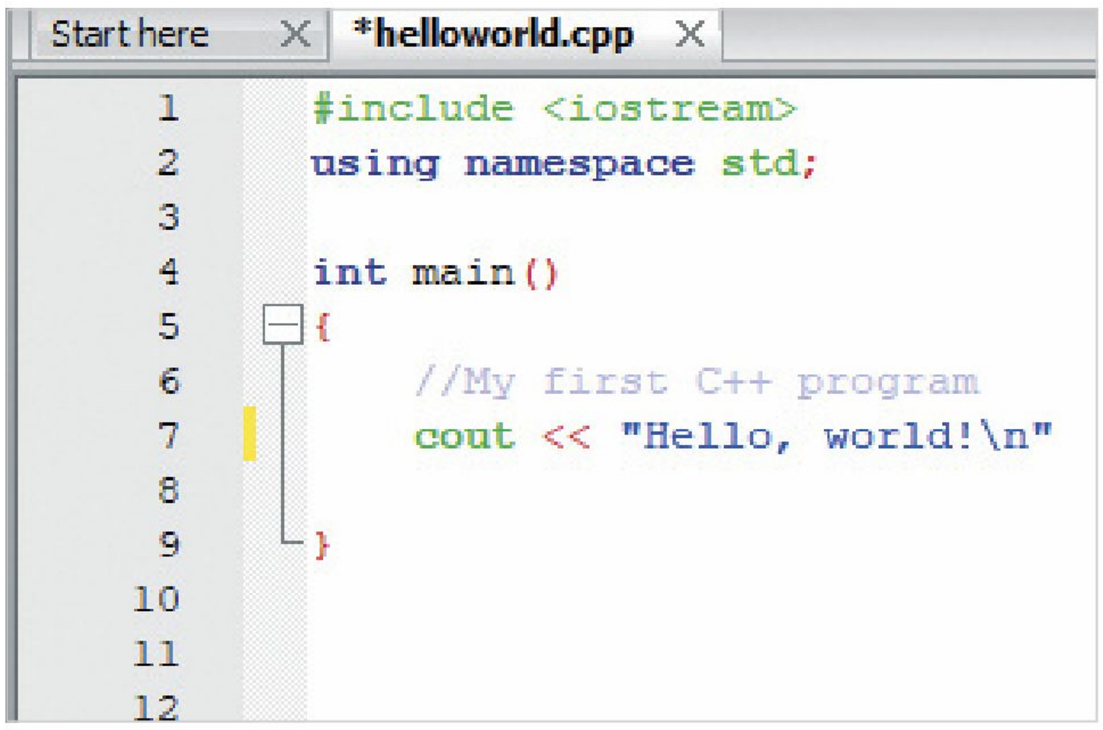


STEP 7 Just as we mentioned in the previous pages, you don't need to have std::cout if you already declare using namespace std; at the beginning of the code. We could have easily clicked the Build/Run icon to begin with but it's worth going through the available options. You can also see that by building and running, the file has been saved.

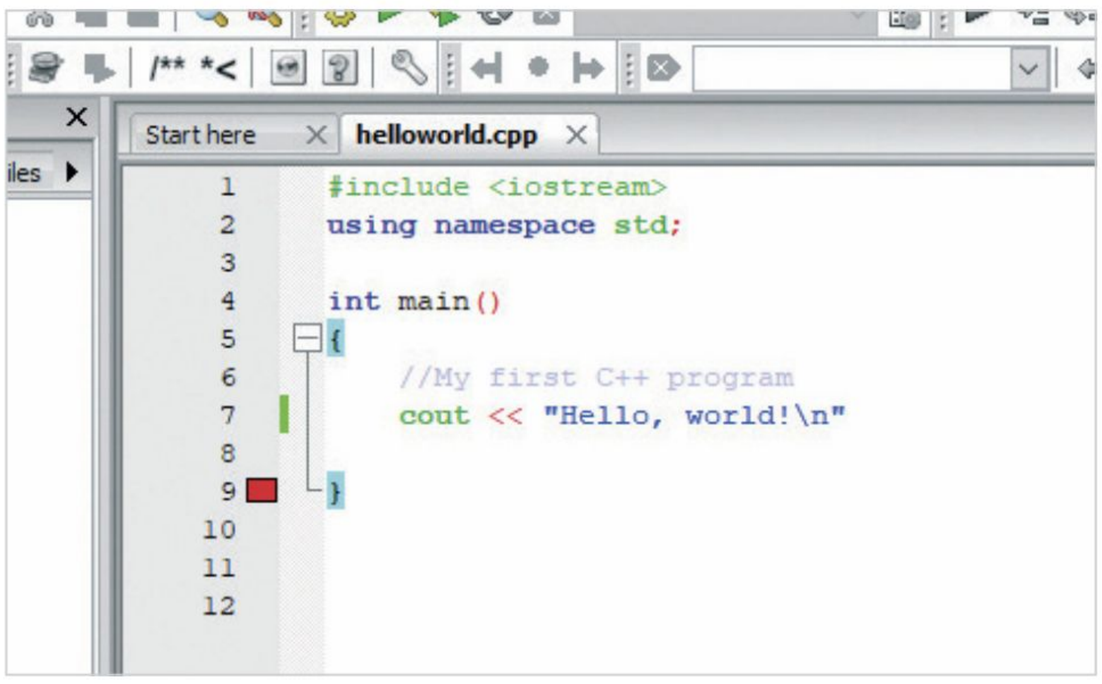


STEP 8 Create a deliberate error in the code. Remove the semicolon from the cout line, so it reads:

```
cout << "Hello, world!\n"
```



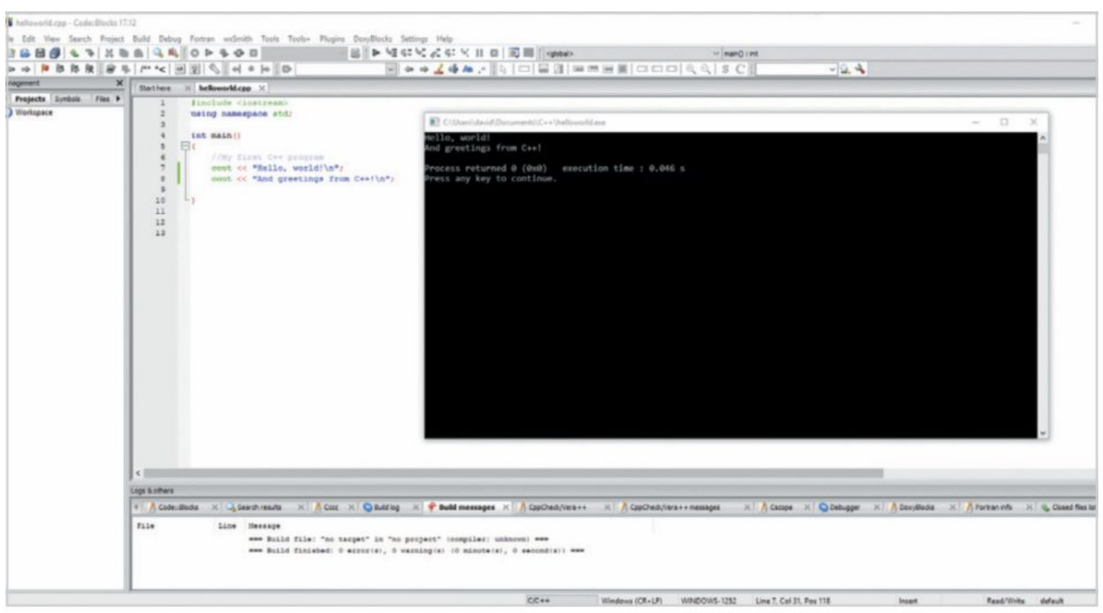
STEP 9 Now click the Build and Run icon again to apply the changes to the code. This time Code::Blocks refuses to execute the code, due to the error you put in. In the Log pane at the bottom of the screen you are informed of the error, in this case: Expected ';' before '}' token, indicating the missing semicolon.



STEP 10 Replace the semicolon and under the cout line, enter a new line to your code:

```
cout << "And greetings from C++!\n";
```

The \n simply adds a new line under the last line of outputted text. Build and Run the code, to display your handiwork.



Using Comments

While comments may seem like a minor element to the many lines of code that combine to make a game, application or even an entire operating system, in actual fact they're probably one of the most important factors.

THE IMPORTANCE OF COMMENTING

Comments inside code are basically human readable descriptions that detail what the code is doing at that particular point. They don't sound especially important but code without comments is one of the many frustrating areas of programming, regardless of whether you're a professional or just starting out.

In short, all code should be commented in such a manner as to effectively describe the purpose of a line, section, or individual elements. You should get in to the habit of commenting as much as possible, by imagining that someone who doesn't know anything about programming can pick up your code and understand what it's going to do simply by reading your comments.

In a professional environment, comments are vital to the success of the code and ultimately, the company. In an organisation, many programmers work in teams alongside engineers, other developers, hardware analysts and so on. If you're a part of the team that's writing a bespoke piece of software for the company, then your comments help save a lot of time should something go wrong, and another team member has to pick up and follow the trail to pinpoint the issue.

Place yourself in the shoes of someone whose job it is to find out what's wrong with a program. The program has in excess of 800,000 lines of code, spread across several different modules. You can soon appreciate the need for a little help from the original programmers in the form of a good comment.

The best comments are always concise and link the code logically, detailing what happens when the program hits this line or section. You don't need to comment on every line. Something along the lines of: if x==0 doesn't require you to comment that if x equals zero then do something; that's going to be obvious to the reader. However, if x equalling zero is something that drastically changes the program for the user, such as, they've run out of lives, then it certainly needs to commented on.

Even if the code is your own, you should write comments as if you were going to publicly share it with others. This way you can return to that code and always understand what it was you did or where it was you went wrong or what worked brilliantly.

Comments are good practise and once you understand how to add a comment where needed, you soon do it as if it's second nature.

```
        DEFB    26h,30h,32h,26h,30h,32h,0,0,32h,72h,73h,32h,72h,73h,32h
        DEFB    60h,61h,32h,4Ch,4Dh,32h,4Ch,99h,32h,4Ch,4Dh,32h,4Ch,4Dh
        DEFB    32h,4Ch,99h,32h,5Bh,5Ch,32h,56h,57h,32h,33h,0CDh,32h,33h
        DEFB    34h,32h,33h,34h,32h,33h,0CDh,32h,40h,41h,32h,66h,67h,64h
        DEFB    66h,67h,32h,72h,73h,64h,4Ch,4Dh,32h,56h,57h,32h,80h,0CBh
        DEFB    19h,80h,0,19h,80h,81h,32h,80h,0CBh,0FFh
T858C:
        DEFB    80h,72h,66h,60h,56h,66h,56h,56h,51h,60h,51h,51h,56h,66h
        DEFB    56h,56h,80h,72h,66h,60h,56h,66h,56h,56h,51h,60h,51h,51h
        DEFB    56h,56h,56h,56h,80h,72h,66h,60h,56h,66h,56h,56h,51h,60h
        DEFB    51h,51h,56h,66h,56h,56h,80h,72h,66h,60h,56h,66h,56h,40h
        DEFB    56h,66h,80h,66h,56h,56h,56h,56h
;
; Game restart point
;
START:  XOR     A
        LD      (SHEET),A
        LD      (KEMP),A
        LD      (DEMO),A
        LD      (B845B),A
        LD      (B8458),A
        LD      A,2             ;Initial lives count
        LD      (NOMEN),A
        LD      HL,T845C
        SET     0,(HL)
        LD      HL,SCREEN
        LD      DE,SCREEN+1
        LD      BC,17FFh        ;Clear screen image
        LD      (HL),0
        LDIR
        LD      HL,0A000h       ;Title screen bitmap
        LD      DE,SCREEN
        LD      BC,4096
        LDIR
        LD      HL,SCREEN + 800h + 1*32 + 29
        LD      DE,MANDAT+64
        LD      C,0
        CALL    DRWFIX
        LD      HL,0FC00h       ;Attributes for the last room
        LD      DE,ATTR         ;(top third)
        LD      BC,256
        LDIR
        LD      HL,09E00h       ;Attributes for title screen
        LD      BC,512          ;(bottom two-thirds)
        LDIR
        LD      BC,31
        DI
        XOR     A
R8621:
        IN      E,(C)
        OR      E
        DJNZ    R8621   ;$-03
        AND     20h
        JR      NZ,R862F ;$+07
        LD      A,1
        LD      (KEMP),A
R862F:
        LD      IY,T846E
        CALL    C92DC
        JP      NZ,L8684
        XOR     A
        LD      (EUGHGT),A
```

C++ COMMENTS

Commenting in C++ involves using a double forward slash '/', or a forward slash and an asterisk, '/*'. You've already seen some brief examples but this is how they work.

STEP 1 Using the Hello World code as an example, you can easily comment on different sections of the code using the double forward slash:

```
//My first C++ program
cout << "Hello, world!\n";
```

```
#include <iostream>
using namespace std;

int main()
{
    //My first C++ program
    cout << "Hello, world!\n";


}
```

STEP 2 However, you can also add comments to the end of a line of code, to describe in a better way what's going on:

```
cout << "Hello, world!\n"; //This line outputs the words 'Hello, world!'. The \n denotes a new line.
```

Note, you don't have to put a semicolon at the end of a comment. This is because it's a line in the code that's ignored by the compiler.

Start here | *helloworld.cpp

```
#include <iostream>
using namespace std;

int main()
{
    //My first C++ program
    cout << "Hello, world!\n"; //This line outputs the words 'Hello, world!'. The /


}
```

STEP 3 You can comment out several lines by using the forward slash and asterisk:

```
/* This comment can
     cover several lines
     without the need to add more slashes */
```

Just remember to finish the block comment with the opposite asterisk and forward slash.

```
int main()
{
    //My first C++ program
    cout << "Hello, world!\n";
    cout << "And greetings from C++";

    /* This comment can
      cover several lines
      without the need to add more slashes */


}
```

STEP 4 Be careful when commenting, especially with block comments. It's very easy to forget to add the closing asterisk and forward slash and thus negate any code that falls inside the comment block.

Start here | *helloworld.cpp

```
#include <iostream>
using namespace std;

int main()
{
    //My first C++ program
    cout << "Hello, world!\n";
    cout << "And greetings from C++";

    /* This comment can
      cover several lines
      without the need to add more slashes

    cout << "This line is now being ignored by the compiler!";


}
```

STEP 5 Obviously if you try and build and execute the code it errors out, complaining of a missing curly bracket '}' to finish off the block of code. If you've made the error a few times, then it can be time consuming to go back and rectify. Thankfully, the colour coding in Code::Blocks helps identify comments from code.

Start here | helloworld.cpp

```
#include <iostream>
using namespace std;

int main()
{
    //My first C++ program
    cout << "Hello, world!\n";
    cout << "And greetings from C++";

    /* This comment can
      cover several lines
      without the need to add more slashes

    cout << "This line is now being ignored by the compiler!";


}
```

STEP 6 If you're using block comments, it's good practise in C++ to add an asterisk to each new line of the comment block. This also helps you to remember to close the comment block off before continuing with the code:

```
/* This comment can
 *   cover several lines
 *   without the need to add more slashes */
```

```
int main()
{
    //My first C++ program
    cout << "Hello, world!\n";
    cout << "And greetings from C++\n";

    /* This comment can
     *   cover several lines
     *   without the need to add more slashes */


    cout << "This line is now being ignored by the compiler!\n";


}
```

Variables

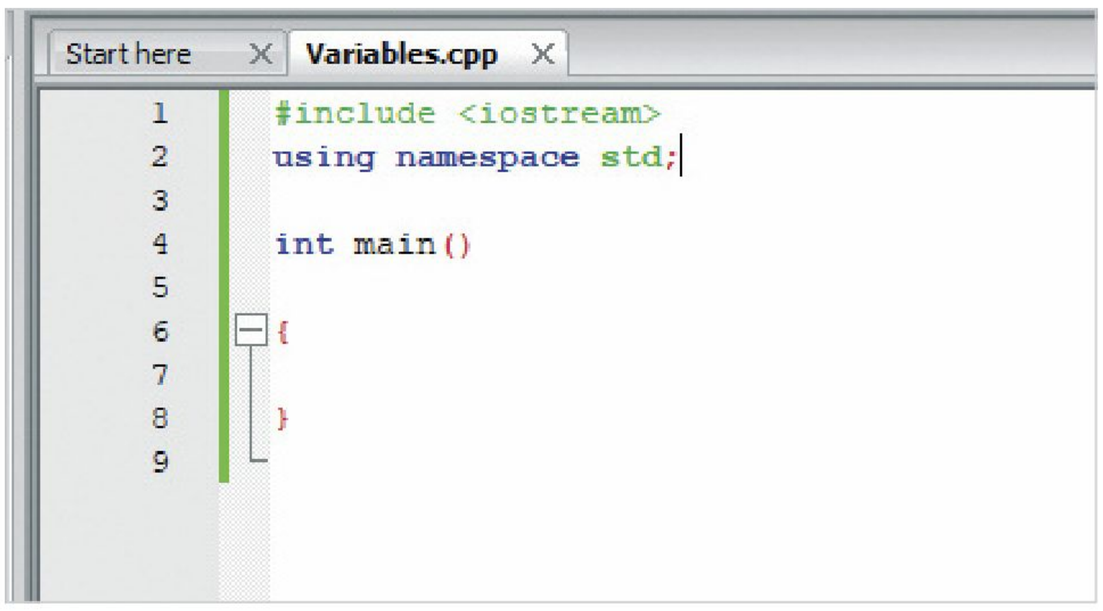
Variables differ slightly when using C++ as opposed to Python. In Python, you can simply state that 'a' equals 10 and a variable is assigned. However, in C++ a variable has to be declared with its type before it can be used.

THE DECLARATION OF VARIABLES

You can declare a C++ variable by using statements within the code. There are several distinct types of variables you can declare. Here's how it works.

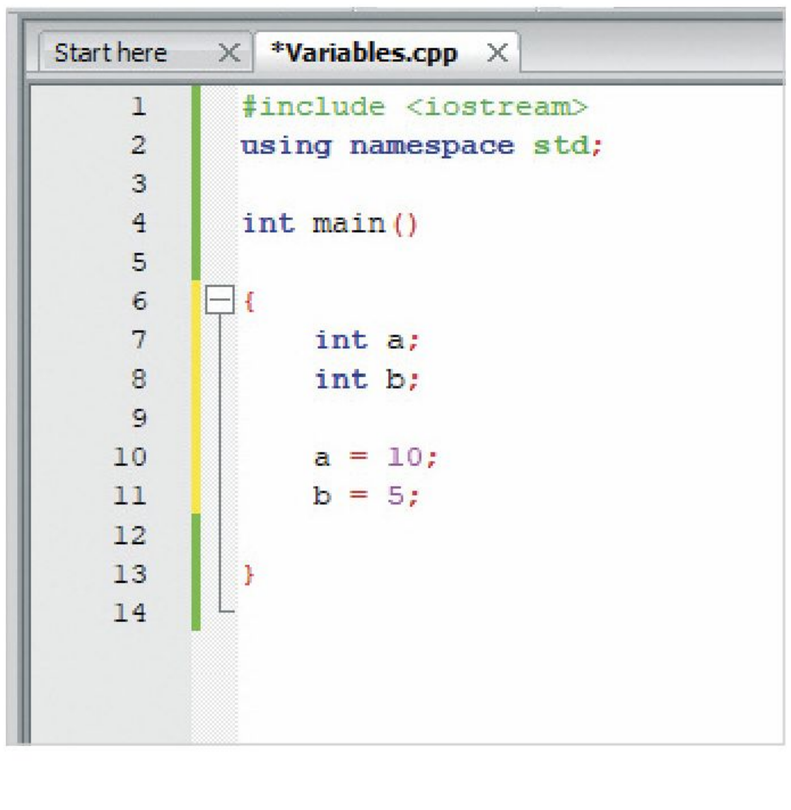
STEP 1 Open up a new, blank C++ file and enter the usual code headers:

```
#include <iostream>
using namespace std;

int main()
{

}
```



STEP 2 Start simple by creating two variables, a and b, with one having a value of 10 and the other 5. You can use the data type int to declare these variables. Within the curly brackets, enter:

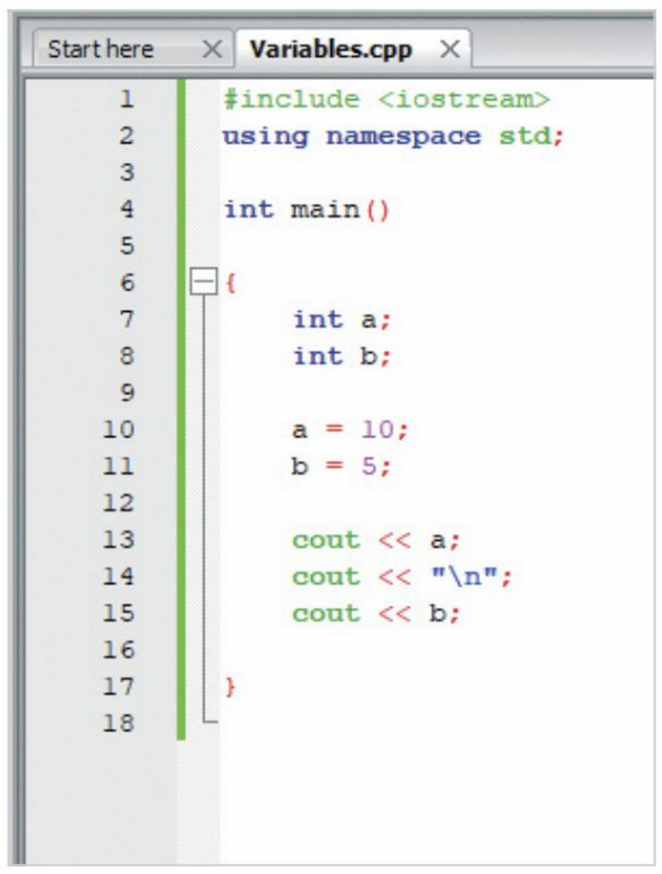
```
int a;
int b;

a = 10;
b = 5;
```



STEP 3 You can build and run the code but it won't do much, other than store the values 10 and 5 to the integers a and b. To output the contents of the variables, add:

```
cout << a;
cout << "\n";
cout << b;
```

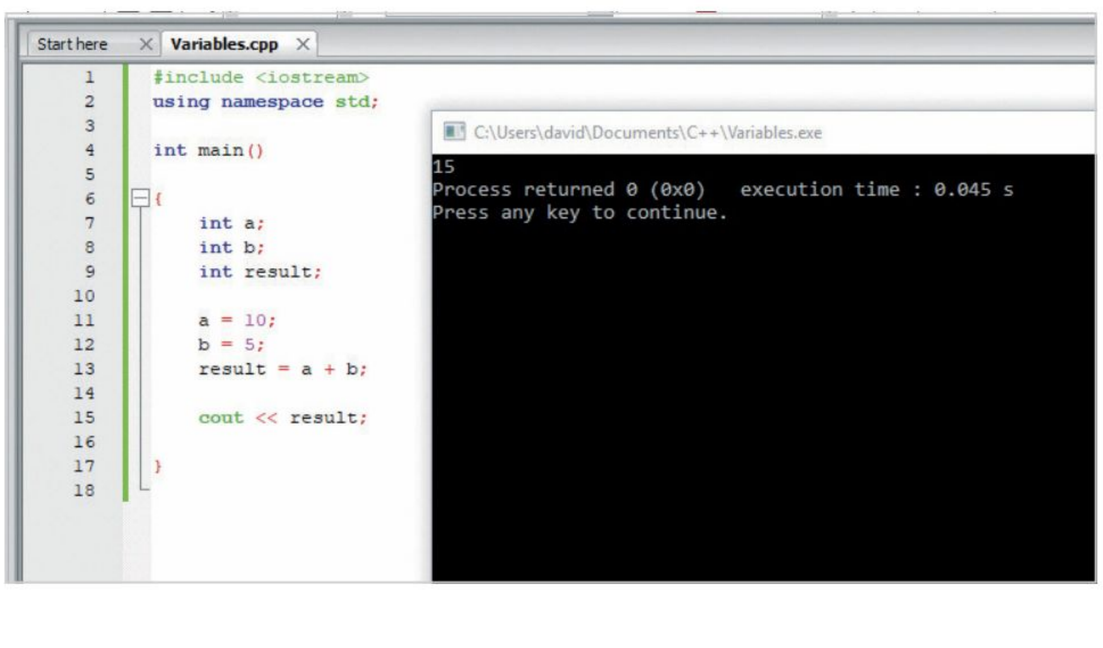
The cout << "\n"; part simply places a new line between the output of 10 and 5.



STEP 4 Naturally you can declare a new variable, call it result and output some simple arithmetic:

```
int result;
result = a + b;
cout << result;
```

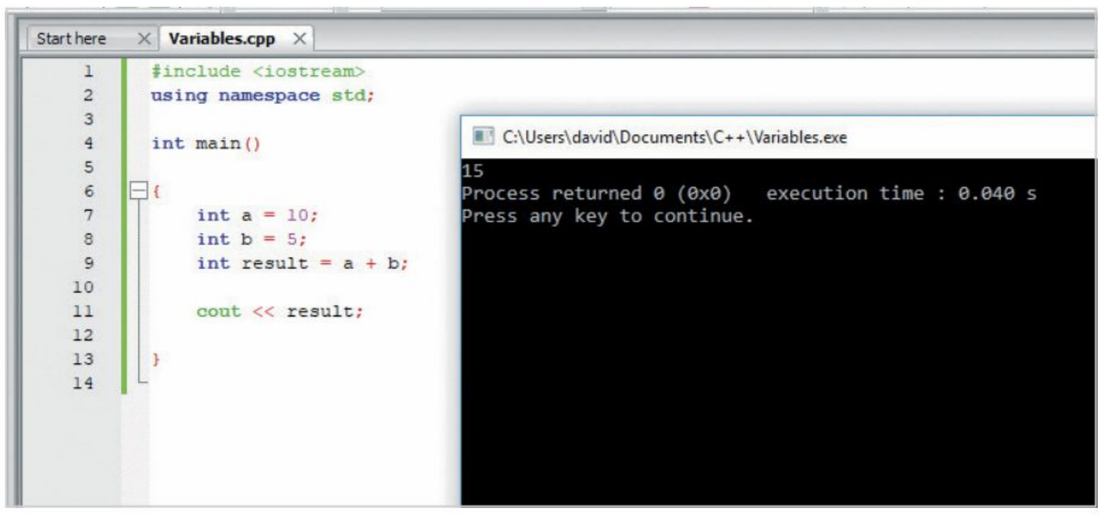
Insert the above into the code as per the screenshot.



STEP 5

You can assign a value to a variable as soon as you declare it. The code you've typed in could look like this, instead:

```
int a = 10;
int b = 5;
int result = a + b;

cout << result;
```



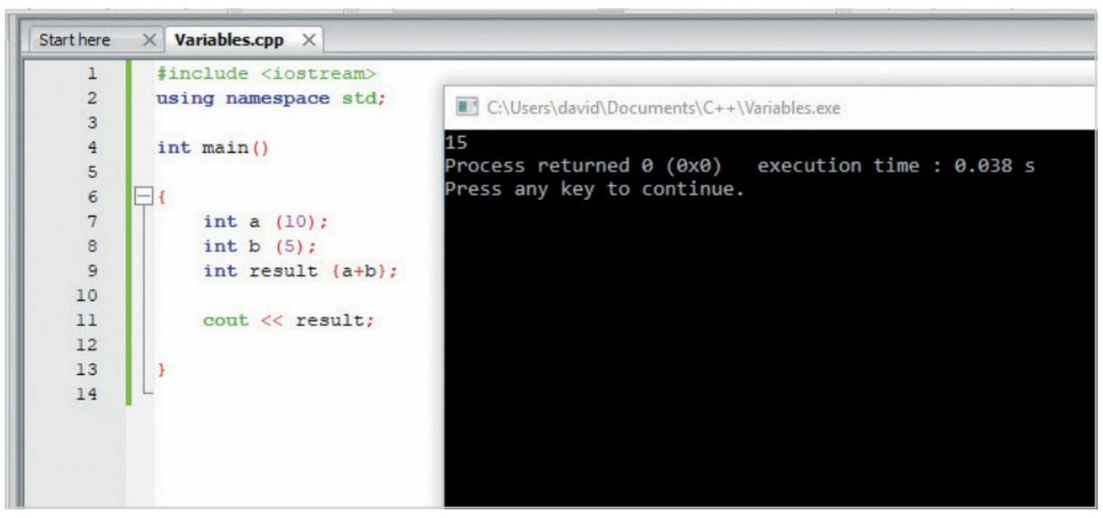
STEP 6

Specific to C++, you can also use the following to assign values to a variable as soon as you declare them:

```
int a (10);
int b (5);
```

Then, from the C++ 2011 standard, using curly brackets:

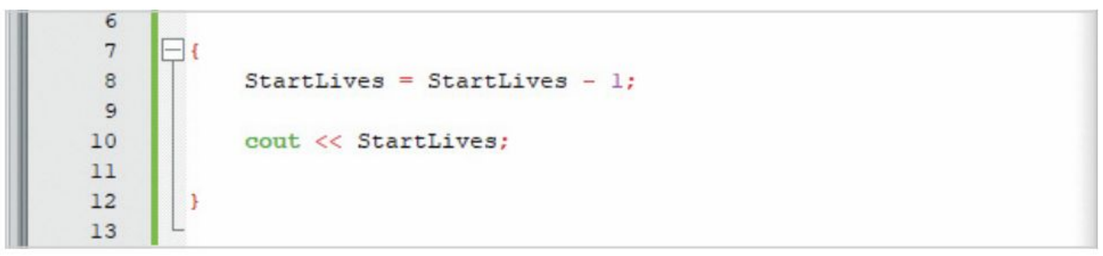
```
int result {a+b};
```



STEP 7

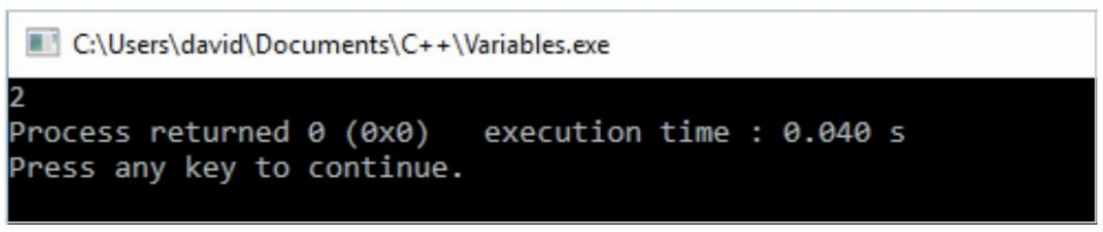
You can create global variables, which are variables that are declared outside any function and used in any function within the entire code. What you've used so far are local variables: variables used inside the function. For example:

```
#include <iostream>
using namespace std;
int StartLives = 3;

int main ()

{
      startLives = StartLives - 1;
      cout << StartLives;
}
```



STEP 8

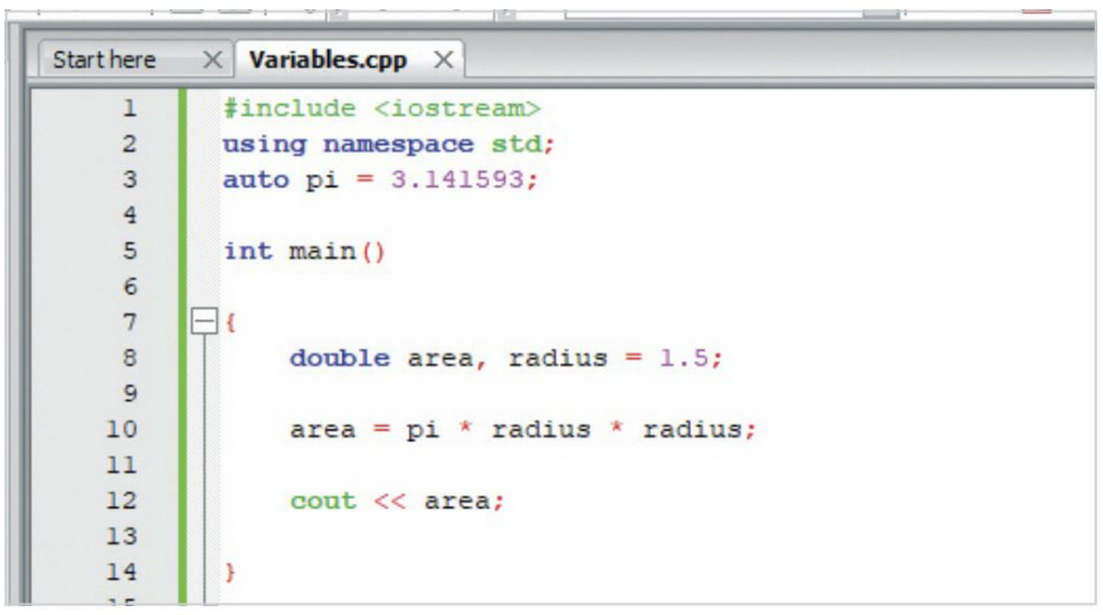
The previous step creates the variable StartLives, which is a global variable. In a game, for example, a player's lives go up or down depending on how well or how bad they're doing. When the player restarts the game, the StartLives returns to its default state: 3. Here we've assigned 3 lives, then subtracted 1, leaving 2 lives left.



STEP 9

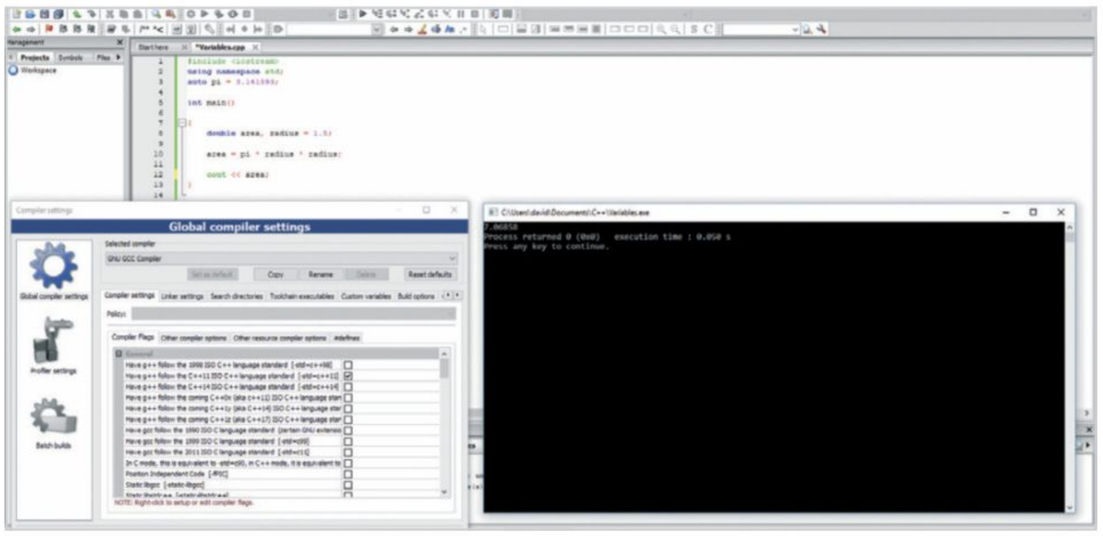
The modern C++ compiler is far more intelligent than most programmers give it credit. While there are numerous data types you can declare for variables, you can in fact use the auto feature:

```
#include <iostream>
using namespace std;
auto pi = 3.141593;

int main()

{
    double area, radius = 1.5;

    area = pi * radius * radius;

    cout << area;

}
```



STEP 10

A couple of new elements here: first, auto won't work unless you go to Settings > Compiler and tick the box labelled 'Have G++ follow the C++11 ISO C++ Language Standard [-std=c++1]'. Then, the new data type, double, which means double-precision floating point value. Enable C++11, then build and run the code. The result should be 7.06858.



Data Types

Variables, as we've seen, store information that the programmer can then later call up, and manipulate if required. Variables are simply reserved memory locations that store the values the programmer assigns, depending on the data type used.

THE VALUE OF DATA

There are many different data types available for the programmer in C++, such as an integer, floating point, Boolean, character and so on. It's widely accepted that there are seven basic data types, often called Primitive Built-in Types; however, you can create your own data types should the need ever arise within your code.

The seven basic data types are:

TYPE	COMMAND
Integer	`Integer`
Floating Point	`float`
Character	`char`
Boolean	`bool`
Double Floating Point	`double`
Wide Character	`wchar_t`
No Value	`void`

These basic types can also be extended using the following modifiers: Long, Short, Signed and Unsigned. Basically this means the modifiers can expand the minimum and maximum range values for each data type. For example, the int data type has a default value range of -2147483648 to 2147483647, a fair value, you would agree.

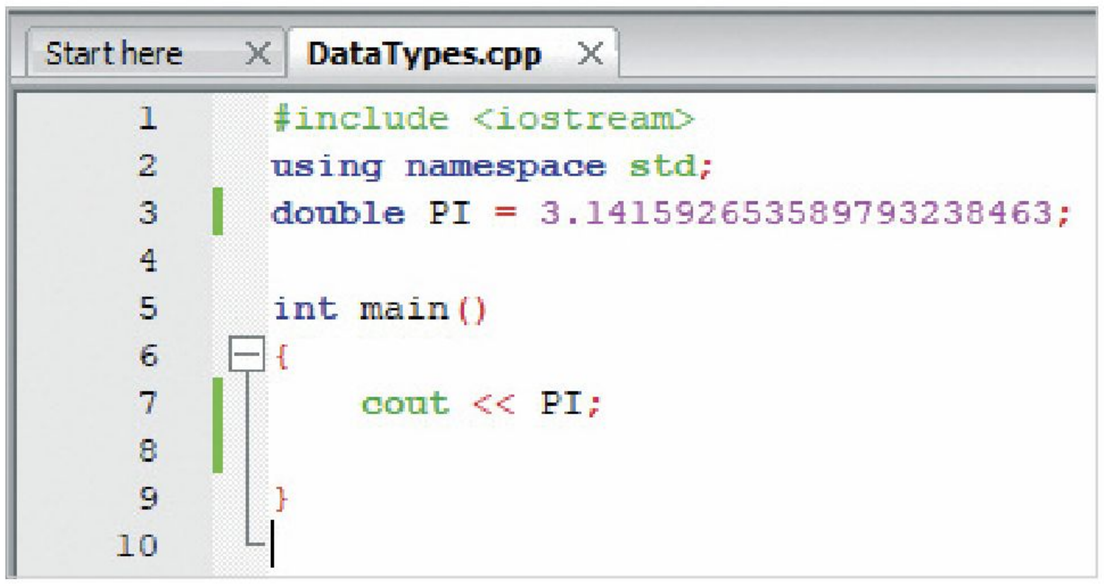
Now, if you were to use one of the modifiers, the range alters:

Unsigned int = 0 to 4294967295
Signed int = -2147483648 to 2147483647
Short int = -32768 to 32767
Unsigned Short int = 0 to 65,535
Signed Short int = -32768 to 32767
Long int = -2147483647 to 2147483647
Signed Long int = -2147483647 to 2147483647
Unsigned Long int = 0 to 4294967295

Naturally you can get away with using the basic type without the modifier, as there's plenty of range provided with each data type. However, it's considered good C++ programming practise to use the modifiers when possible.

There are issues when using the modifiers though. Double represents a double-floating point value, which you can use for incredibly accurate numbers but those numbers are only accurate up to the fifteenth decimal place. There's also the problem when displaying such numbers in C++ using the cout function, in that cout by default only outputs the first five decimal places. You can combat that by adding a cout.precision () function and adding a value inside the brackets, but even then you're still limited by the accuracy of the double data type. For example, try this code:

```
#include <iostream>
using namespace std;
double PI = 3.141592653589793238463;

int main()
{
    cout << PI;
}
```



Build and run the code and as you can see the output is only 3.14159, representing cout's limitations in this example.

You can alter the code including the aforementioned cout.precision function, for greater accuracy. Take precision all the way up to 22 decimal places, with the following code:

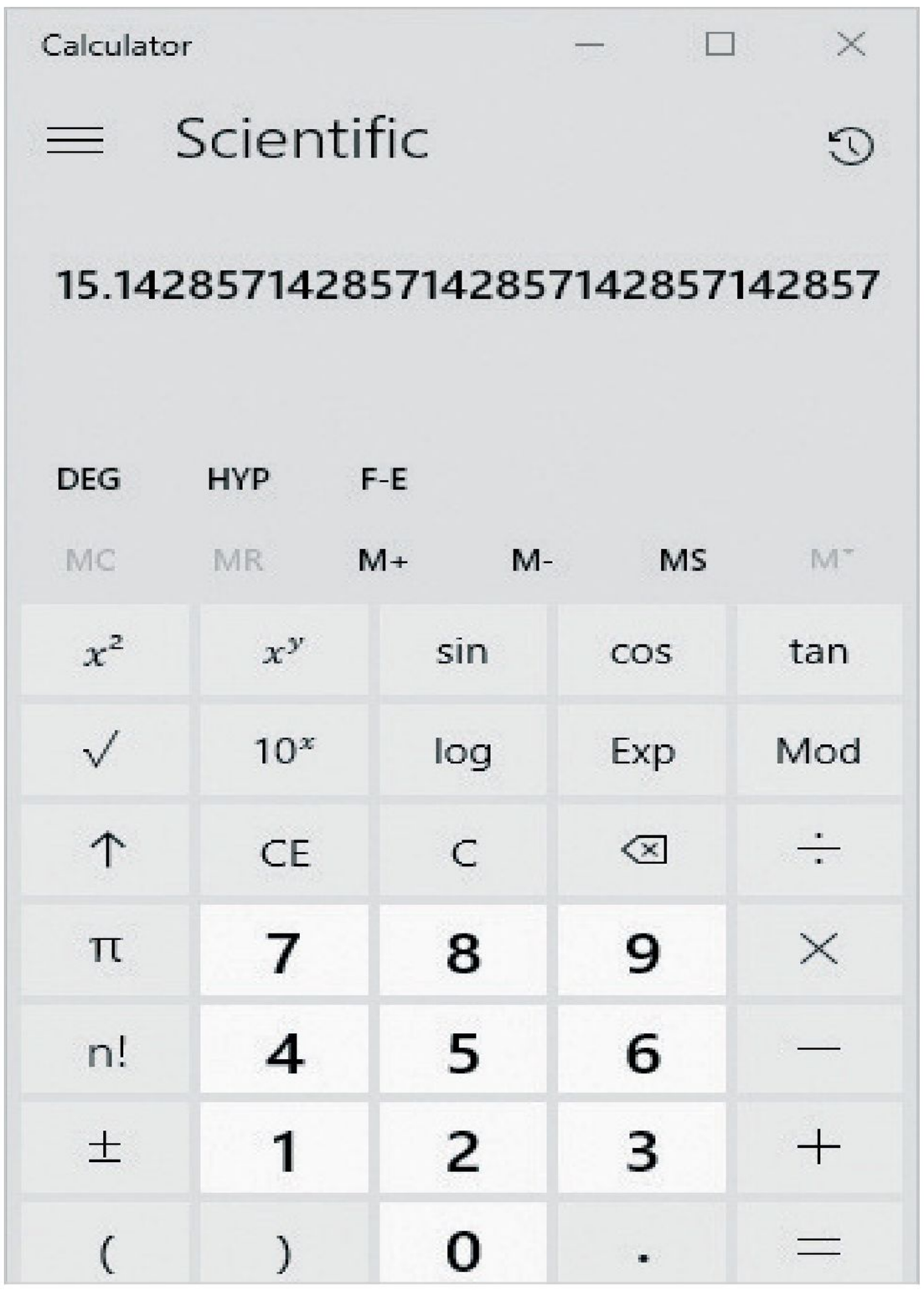
```
#include <iostream>
using namespace std;
double PI = 3.141592653589793238463;

int main()
{
```

```
    cout.precision(22);
    cout << PI;

}
```

```
Start here | DataTypes.cpp

1  #include <iostream>
2  using namespace std;
3  double PI = 3.14159265358979323846;
4
5  int main()
6  {
7      cout.precision(22);
8      cout << PI;
9
10 }
11
```

```
C:\Users\david\Documents\C++\DataTypes.exe
3.141592653589793115998
Process returned 0 (0x0)   execution time : 0.047 s
Press any key to continue.
```

Again, build and run the code; as you can see from the command line window, the number represented by the variable PI is different to the number you've told C++ to use in the variable. The output reads the value of PI as 3.141592653589793115998, with the numbers going awry from the fifteenth decimal place.



This is mainly due to the conversion from binary in the compiler and that the IEEE 754 double precision standard occupies 64-bits of data, of which 52-bits are dedicated to the significant (the significant digits in a floating-point number) and roughly 3.5-bits are taken holding the values 0 to 9. If you divide 53 by 3.5, then you arrive at 15.142857 recurring, which is 15-digits of precision.

To be honest, if you're creating code that needs to be accurate to more than fifteen decimal places, then you wouldn't be using C++, you would use some scientific specific language with C++ as the connective tissue between the two languages.

You can create your own data types, using an alias-like system called typedef. For example:

```
tart here | DataTypes.cpp

1  #include <iostream>
2  using namespace std;
3  typedef int metres;
4
5  int main()
6  {
7      metres distance;
8      distance = 15;
9      cout << "distance in metres is: " << distance;
10
11 }
12
```

```
#include <iostream>
using namespace std;
typedef int metres;

int main()
{
    metres distance;
    distance = 15;
    cout << “distance in metres is: “ << distance;

}
```

```
C:\Users\david\Documents\C++\DataTypes.exe
distance in metres is: 15
Process returned 0 (0x0)   execution time : 0.041 s
Press any key to continue.
```

This code when executed creates a new int data type called metres. Then, in the main code block, there's a new variable called distance, which is an integer; so you're basically telling the compiler that there's another name for int. We assigned the value 15 to distance and displayed the output: distance in metres is 15.

It might sound a little confusing to begin with but the more you use C++ and create your own code, the easier it becomes.

Strings

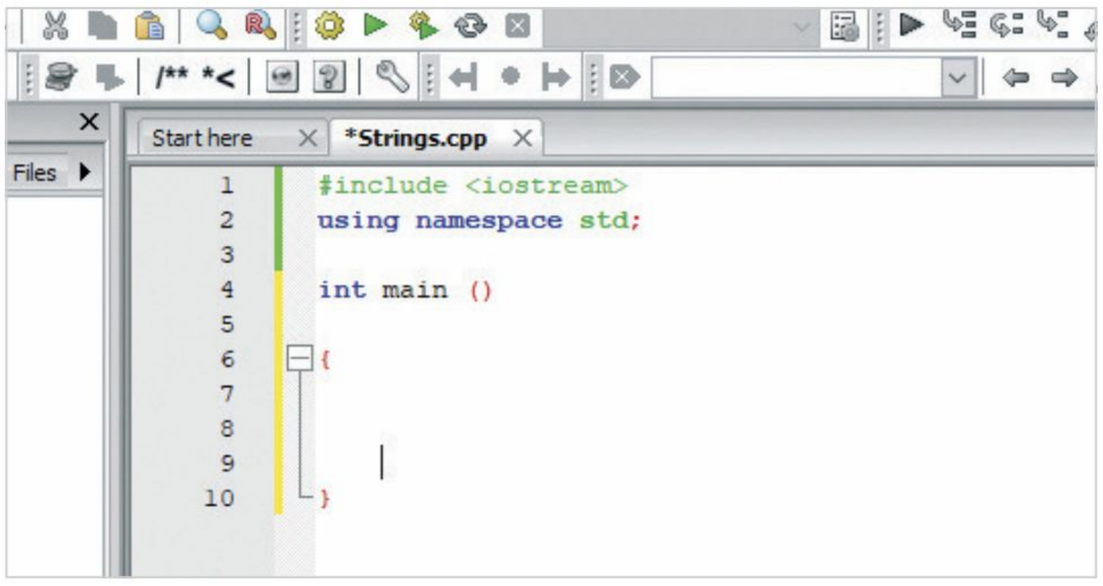
Strings are objects that represent and hold sequences of characters. For example, you could have a universal greeting in your code 'Welcome' and assign that as a string to be called up wherever you like in the program.

STRING THEORY

There are different ways in which you can create a string of characters, which historically are all carried over from the original C language, and are still supported by C++.

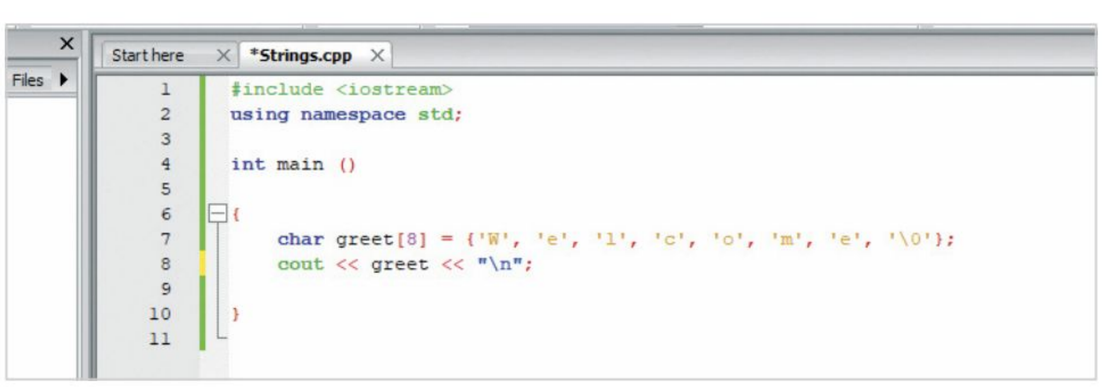
STEP 1 To create a string you use the char function. Open a new C++ file and begin with the usual header:

```
#include <iostream>
using namespace std;

int main ()

{

}
```



STEP 2 It's easy to confuse a string with an array. Here's an array, which can be terminated with a null character:

```
#include <iostream>
using namespace std;

int main ()

{
    char greet[8] = {'W', 'e', 'l', 'c', 'o', 'm',
'e', '\0'};
    cout << greet << "\n";

}
```

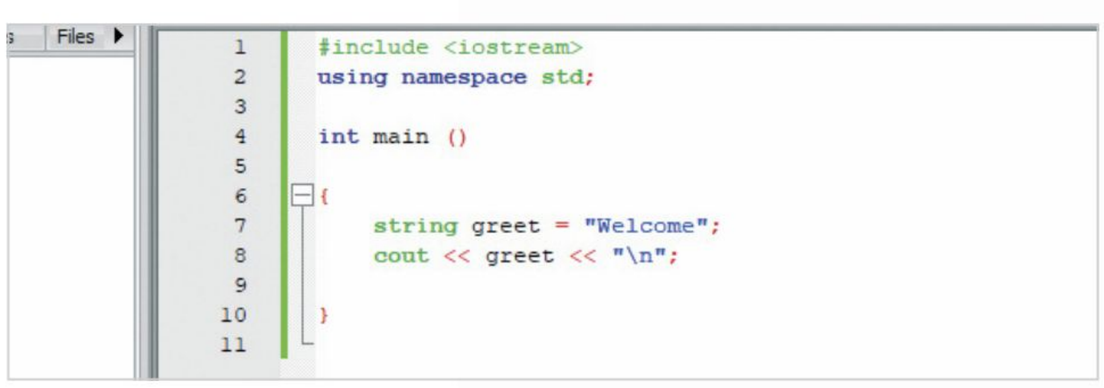


STEP 3 Build and run the code, and 'Welcome' appears on the screen. While this is perfectly fine, it's not a string. A string is a class, which defines objects that can be represented as a stream of characters and doesn't need to be terminated like an array. The code can therefore be represented as:

```
#include <iostream>
using namespace std;

int main ()

{
    char greet[] = "Welcome";
    cout << greet << "\n";

}
```

STEP 4 In C++ there's also a string function, which works in much the same way. Using the greeting code again, you can enter:

```
#include <iostream>
using namespace std;

int main ()

{
    string greet = "Welcome";
    cout << greet << "\n";

}
```



STEP 5 There are also many different operations that you can apply with the string function. For instance, to get the length of a string you can use:

```
#include <iostream>
using namespace std;

int main ()

{
    string greet = “Welcome”;
    cout << “The length of the string is: “;
    cout << greet.size() << “\n”;

}
```

```
1   #include <iostream>
2   using namespace std;
3
4   int main ()
5
6   {
7       string greet = "Welcome";
8       cout << "The length of the string is: ";
9       cout << greet.size() << "\n";
10
11  }
12
```

STEP 6 You can see that we used greet.size() to output the length, the number of characters there are, of the contents of the string. Naturally, if you call your string something other than greet, then you need to change the command to reflect this. It’s always stringname.operation. Build and run the code to see the results.

```
C:\Users\david\Documents\C++\Strings.exe
The length of the string is: 7

Process returned 0 (0x0)   execution time : 0.044 s
Press any key to continue.
```

STEP 7 You can of course add strings together, or rather combine them to form longer strings:

```
#include <iostream>
using namespace std;

int main ()

{
    string greet1 = “Hello”;
    string greet2 = “, world!”;
    string greet3 = greet1 + greet2;
    cout << greet3 << “\n”;

}
```

```
Start here | Strings.cpp
Files
1   #include <iostream>
2   using namespace std;
3
4   int main ()
5
6   {
7       string greet1 = "Hello";
8       string greet2 = ", world!";
9       string greet3 = greet1 + greet2;
10
11      cout << greet3 << "\n";
12
13  }
14
```

STEP 8 Just as you might expect, you can mix in an integer and store something to do with the string. In this example, we created int length, which stores the result of string. size() and outputs it to the user:

```
#include <iostream>
using namespace std;

int main ()

{
    int length;
    string greet1 = “Hello”;
    string greet2 = “, world!”;
    string greet3 = greet1 + greet2;

    length = greet3.size();

    cout << “The length of the combined strings
is: “ << length << “\n”;

}
```

STEP 9 Using the available operations that come with the string function, you can manipulate the contents of a string. For example, to remove characters from a string you could use:

```
#include <iostream>
using namespace std;

int main ()

{
  string strg (“Here is a long sentence in a
string.”);
  cout << strg << ‘\n’;

  strg.erase (10,5);
  cout << strg << ‘\n’;

  strg.erase (strg.begin()+8);
  cout << strg << ‘\n’;

  strg.erase (strg.begin()+9, strg.end()-9);
  cout << strg << ‘\n’;

}
```

STEP 10 It’s worth spending some time playing around with the numbers, which are the character positions in the string. Occasionally, it can be hit and miss whether you get it right, so practice makes perfect. Take a look at the screenshot to see the result of the code.

```
C:\Users\david\Documents\C++\Strings.exe
Here is a long sentence in a string.
Here is a sentence in a string.
Here is  sentence in a string.
Here is  a string.

Process returned 0 (0x0)   execution time : 0.051 s
Press any key to continue.
```

C++ Maths

Programming is mathematical in nature and as you might expect, there's plenty of built-in scope for some quite intense maths. C++ has a lot to offer someone who's implementing mathematical models into their code. It can be extremely complex or relatively simple.

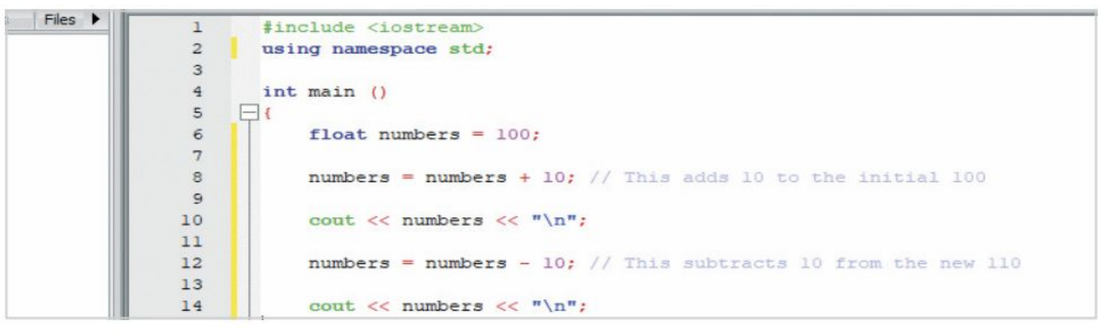
C++ = MC²

The basic mathematical symbols apply in C++ as they do in most other programming languages. However, by using the C++ Math Library, you can also calculate square roots, powers, trig and more.

STEP 1

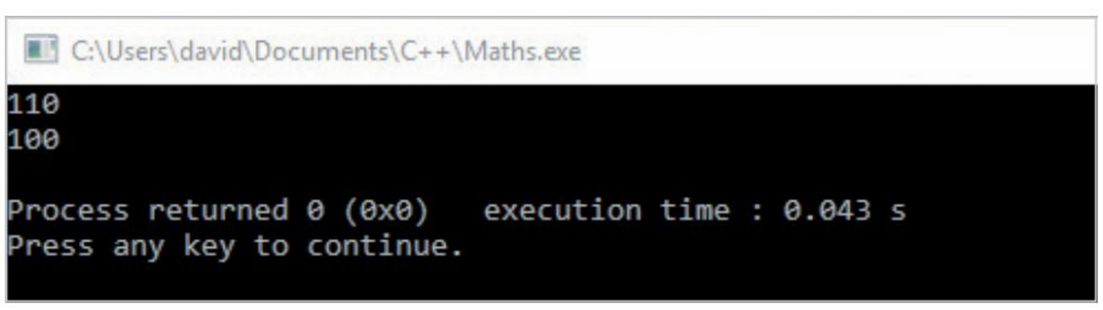
C++'s mathematical operations follow the same patterns as those taught in school, in that multiplication and division take precedence over addition and subtraction. You can alter that though. For now, create a new file and enter:

```
#include <iostream>
using namespace std;

int main ()
{
    float numbers = 100;

    numbers = numbers + 10; // This adds 10 to the initial 100

    cout << numbers << “\n”;

    numbers = numbers - 10; // This subtracts 10 from the new 110

    cout << numbers << “\n”;

}
```



STEP 2

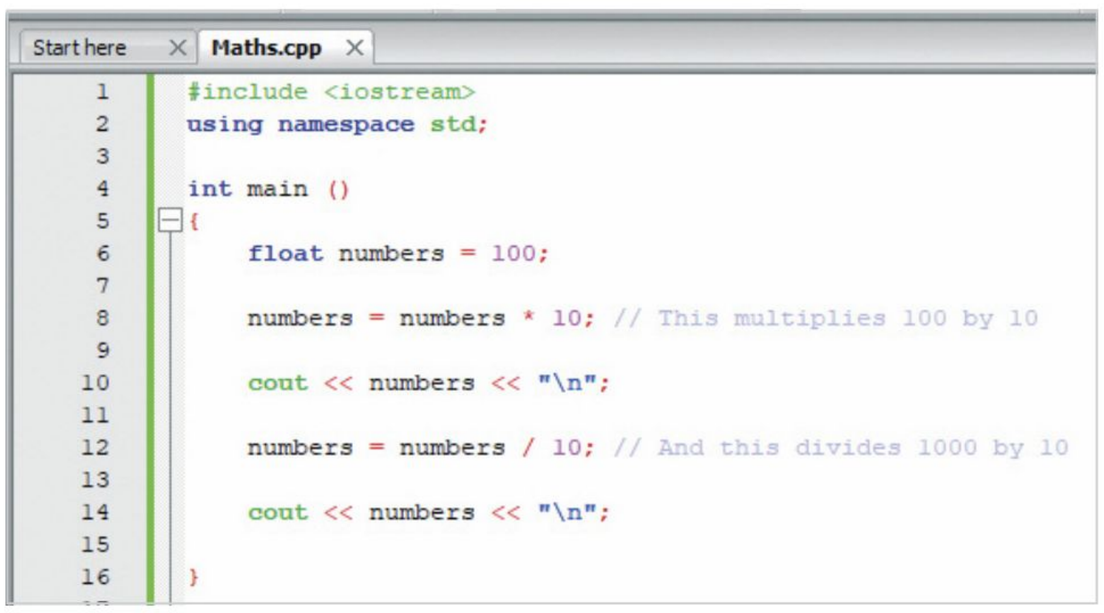
While simple, it does get the old maths muscle warmed up. Note that we used a float for the numbers variable. While you can happily use an integer, if you suddenly started to use decimals, you would need to change to a float or a double, depending on the accuracy needed. Run the code and see the results.



STEP 3

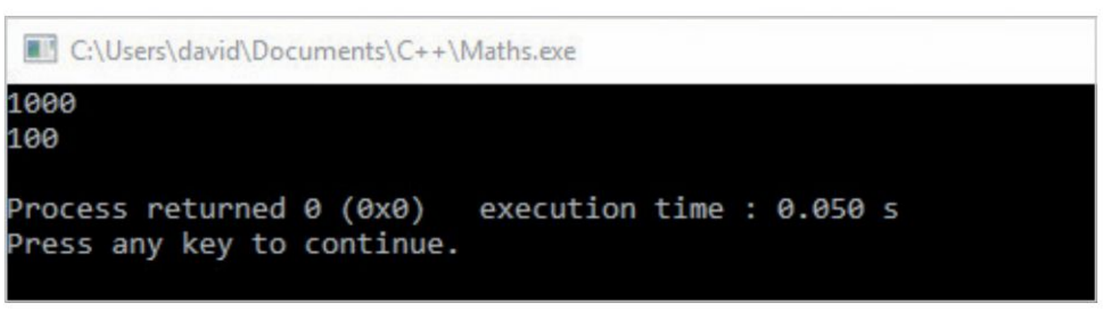
Multiplication and division can be applied as such:

```
#include <iostream>
using namespace std;

int main ()
{
    float numbers = 100;

    numbers = numbers * 10; // This multiplies 100 by 10

    cout << numbers << “\n”;

    numbers = numbers / 10; // And this divides 1000 by 10

    cout << numbers << “\n”;

}
```



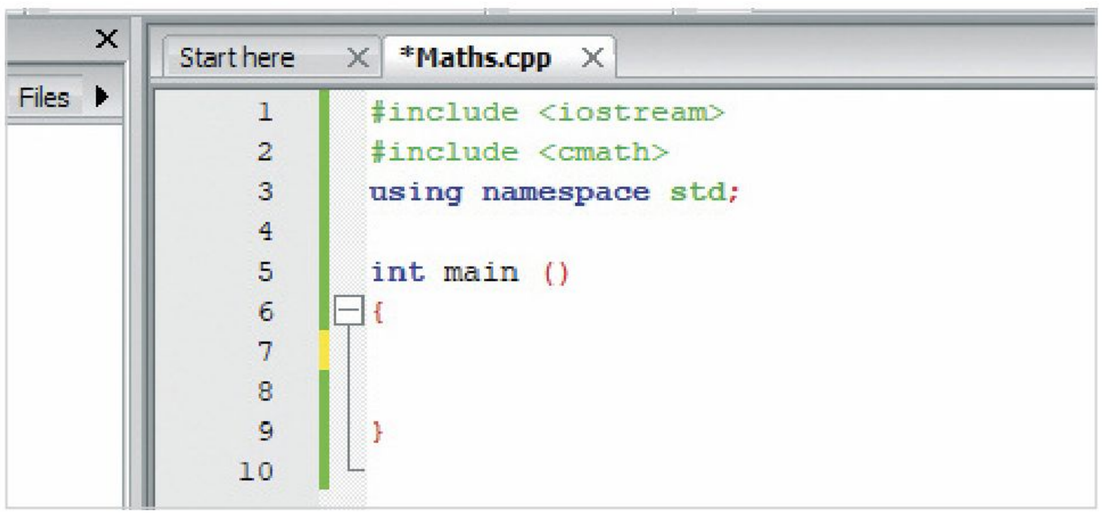
STEP 4

Again, execute the simple code and see the results. While not particularly interesting, it's a start into C++ maths. We used a float here, so you can play around with the code and multiply by decimal places, as well as divide, add and subtract.



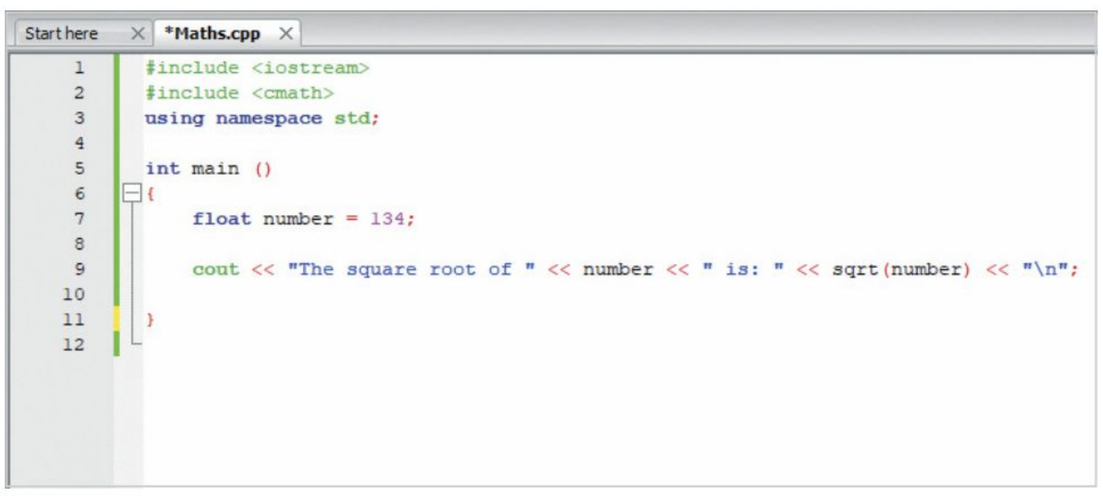
STEP 5 The interesting maths content comes when you call upon the C++ Math Library. Within this header are dozens of mathematical functions along with further operations. Everything from computing cosine to arc tangent with two parameters, to the value of PI. You can call the header with:

```
#include <iostream>
#include <cmath>
using namespace std;

int main ()
{

}
```

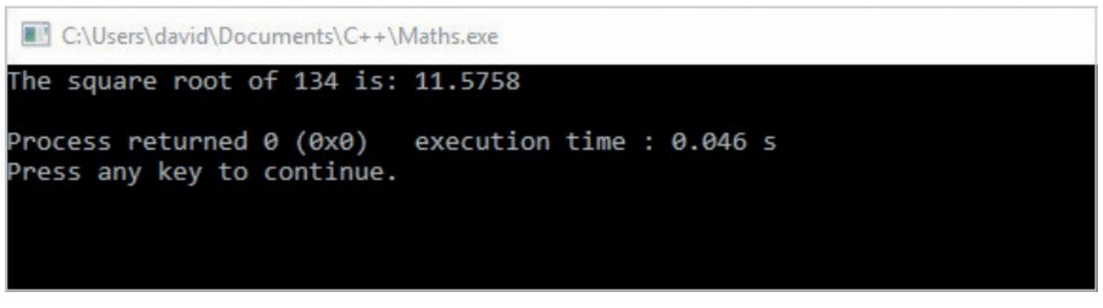


STEP 6 Start by getting the square root of a number:

```
#include <iostream>
#include <cmath>
using namespace std;

int main ()
{
    float number = 134;

    cout << “The square root of “ << number << “ is: “ << sqrt(number) << “\n”;

}
```

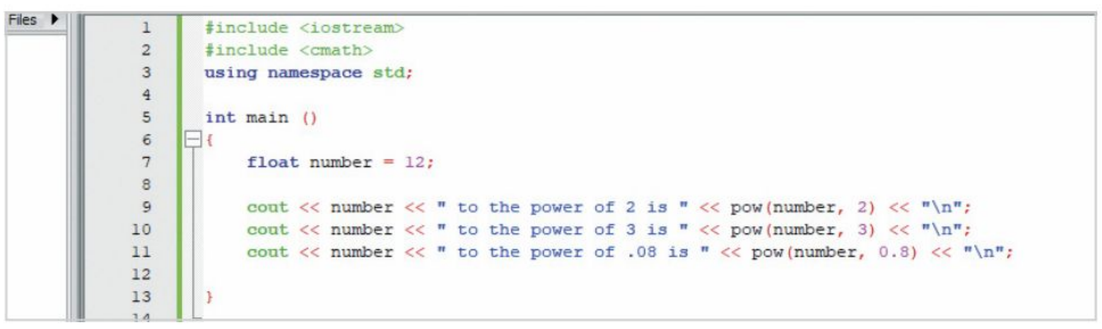


STEP 7 Here we created a new float called number and used the sqrt(number) function to display the square root of 134, the value of the variable, number. Build and run the code, and your answer reads 11.5758.

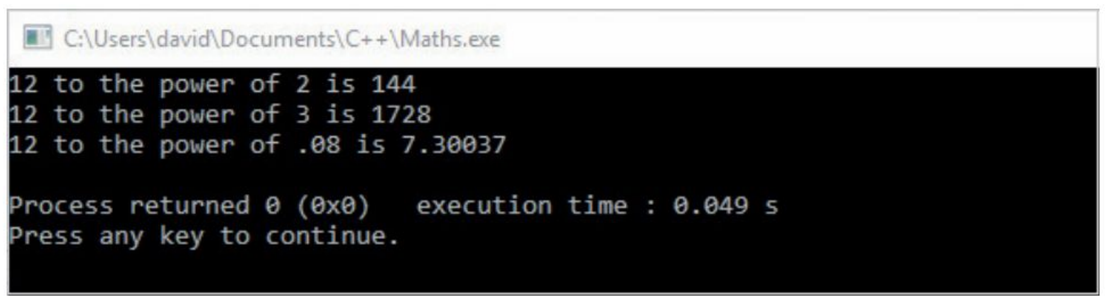


STEP 8 Calculating powers of numbers can be done with:

```
#include <iostream>
#include <cmath>
using namespace std;

int main ()
{
    float number = 12;

    cout << number << “ to the power of 2 is “ << pow(number, 2) << “\n”;
    cout << number << “ to the power of 3 is “ << pow(number, 3) << “\n”;
    cout << number << “ to the power of .08 is “ << pow(number, 0.8) << “\n”;

}
```

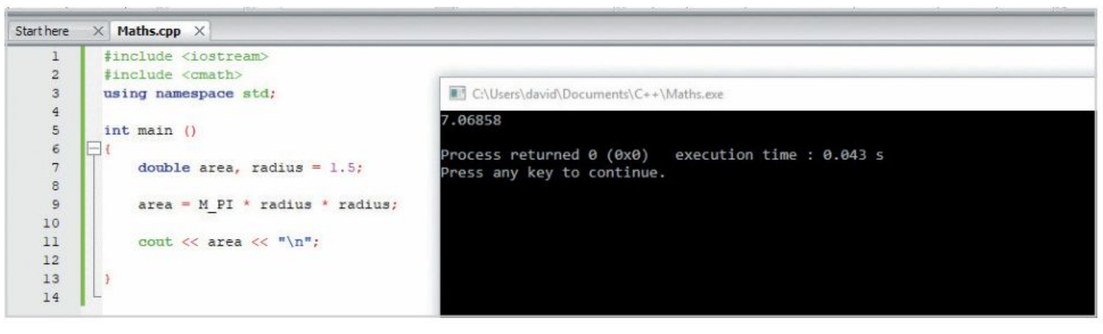


STEP 9 Here we created a float called number with the value of 12, and the pow(variable, power) is where the calculation happens. Of course, you can calculate powers and square roots without using variables. For example, pow (12, 2) outputs the same value as the first cout line in the code.



STEP 10 The value of Pi is also stored in the cmath header library. It can be called up with the M_PI function. Enter cout << M_PI; into the code and you get 3.14159; or you can use it to calculate:

```
#include <iostream>
#include <cmath>
using namespace std;

int main ()
{
    double area, radius = 1.5;

    area = M_PI * radius * radius;

    cout << area << “\n”;

}
```



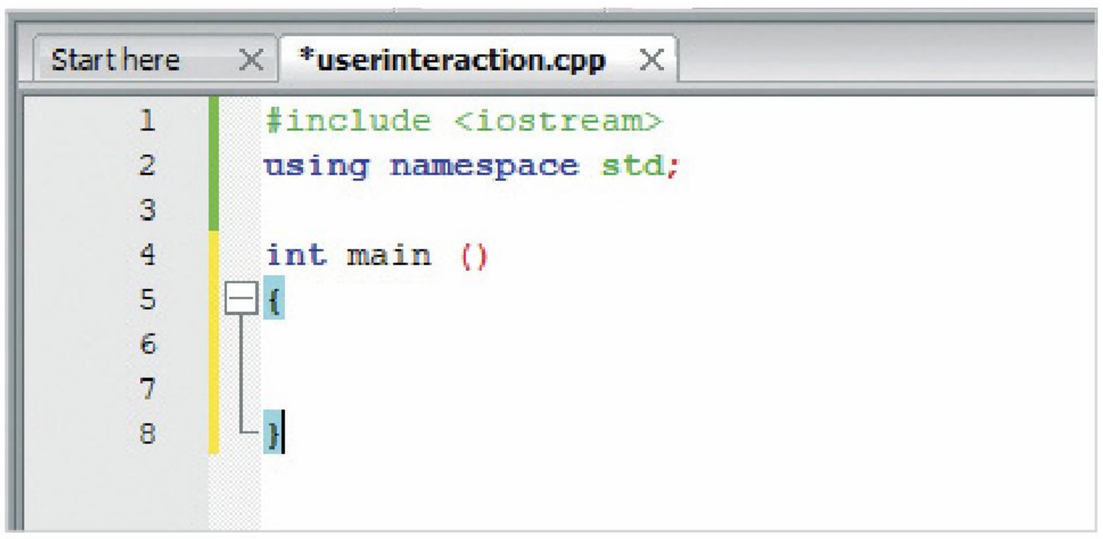
User Interaction

There’s nothing quite as satisfying as creating a program that responds to you. This basic user interaction is one of the most taught aspects of any language and with it you’re able to do much more than simply greet the user by name.

HELLO, DAVE

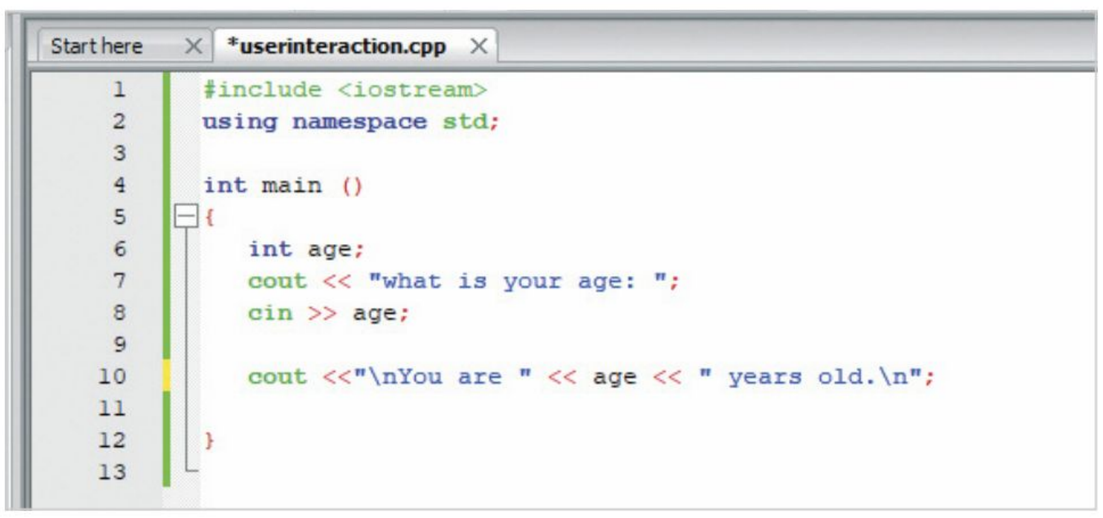
You have already used cout, the standard output stream, throughout our code. Now you’re going to be using cin, the standard input stream, to prompt a user response.

STEP 1 Anything that you want the user to input into the program needs to be stored somewhere in the system memory, so it can be retrieved and used. Therefore, any input must first be declared as a variable, so it’s ready to be used by the user. Start by creating a blank C++ file with headers.

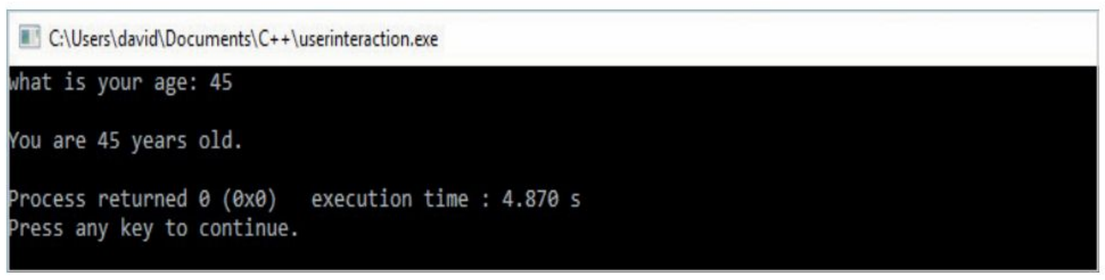


STEP 2 The data type of the variable must also match the type of input you want from the user. For example, to ask a user their age, you would use an integer like this:

```
#include <iostream>
using namespace std;

int main ()
{
   int age;
   cout << “what is your age: “;
   cin >> age;
   cout <<”\nYou are “ << age << “ years old.\n”;
}
```

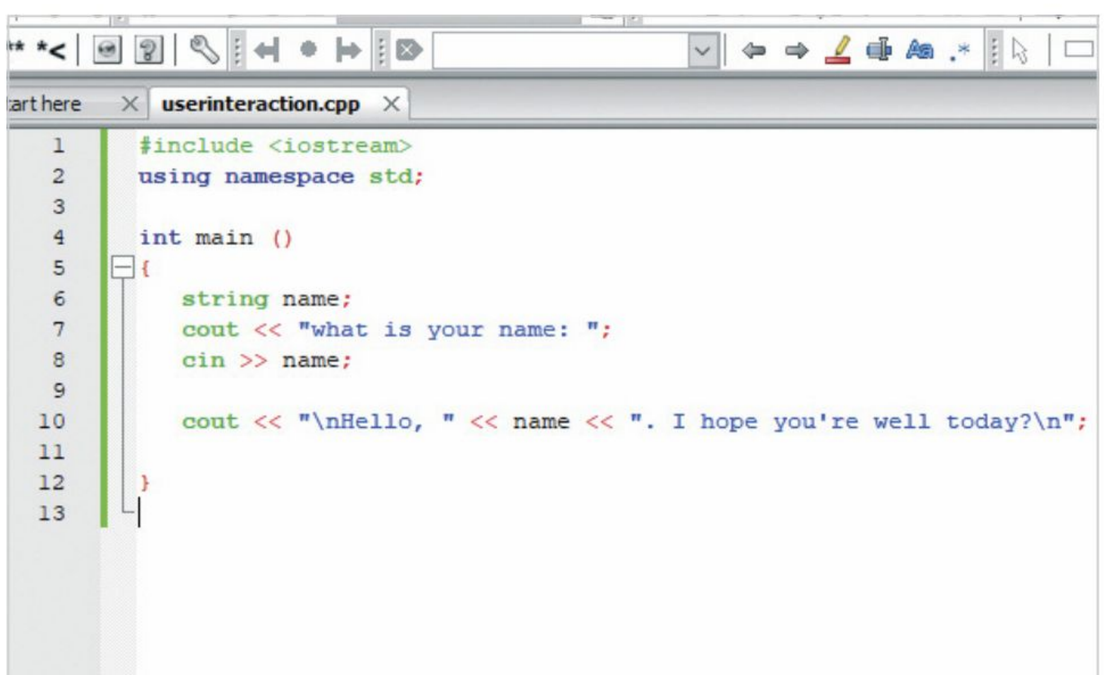


STEP 3 The cin command works in the opposite way from the cout command. With the first cout line you’re outputting ‘What is your age’ to the screen, as indicated with the chevrons. Cin uses opposite facing chevrons, indicating an input. The input is put into the integer age and called up in the second cout command. Build and run the code.



STEP 4 If you’re asking a question, you need to store the input as a string; to ask the user their name, you would use:

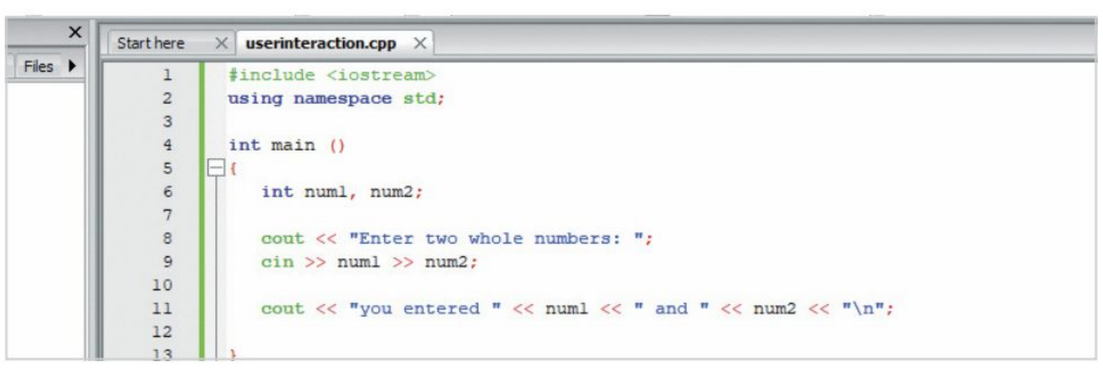
```
#include <iostream>
using namespace std;

int main ()
{
   string name;
   cout << “what is your name: “;
   cin >> name;

   cout << “\nHello, “ << name << “. I hope you’re well today?\n”;

}
```



STEP 5 The principal works the same as the previous code. The user's input, their name, is stored in a string, because it contains multiple characters, and retrieved in the second cout line. As long as the variable 'name' doesn't change, then you can recall it wherever you like in your code.

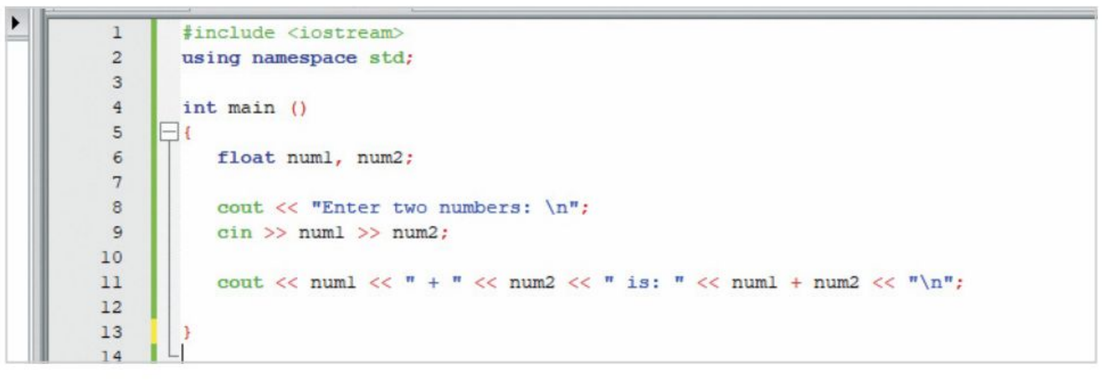
STEP 6 You can chain input requests to the user but just make sure you have a valid variable to store the input to begin with. Let's assume you want the user to enter two whole numbers:

```
#include <iostream>
using namespace std;

int main ()
{
   int num1, num2;

   cout << "Enter two whole numbers: ";
   cin >> num1 >> num2;

   cout << "you entered " << num1 << " and " << num2 << "\n";

}
```



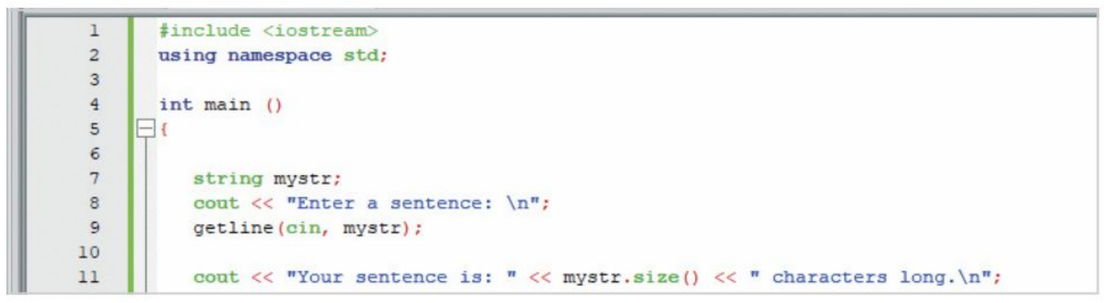
STEP 7 Likewise, inputted data can be manipulated once you have it stored in a variable. For instance, ask the user for two numbers and do some maths on them:

```
#include <iostream>
using namespace std;

int main ()
{
   float num1, num2;
   cout << "Enter two numbers: \n";
   cin >> num1 >> num2;

   cout << num1 << " + " << num2 << " is: " << num1 + num2 << "\n";

}
```

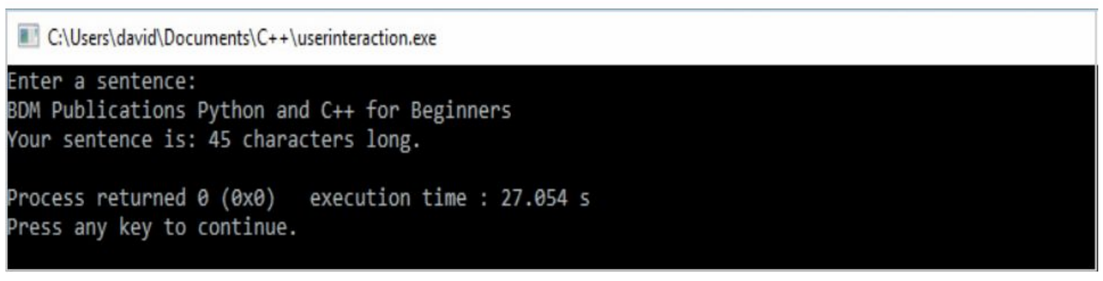


STEP 8 While cin works well for most input tasks, it does have a limitation. Cin always considers spaces as a terminator, so it's designed for just single words not multiple words. However, getline takes cin as the first argument and the variable as the second:

```
#include <iostream>
using namespace std;

int main ()
{

   string mystr;
   cout << "Enter a sentence: \n";
   getline(cin, mystr);

   cout << "Your sentence is: " << mystr.size() <<
" characters long.\n";

}
```

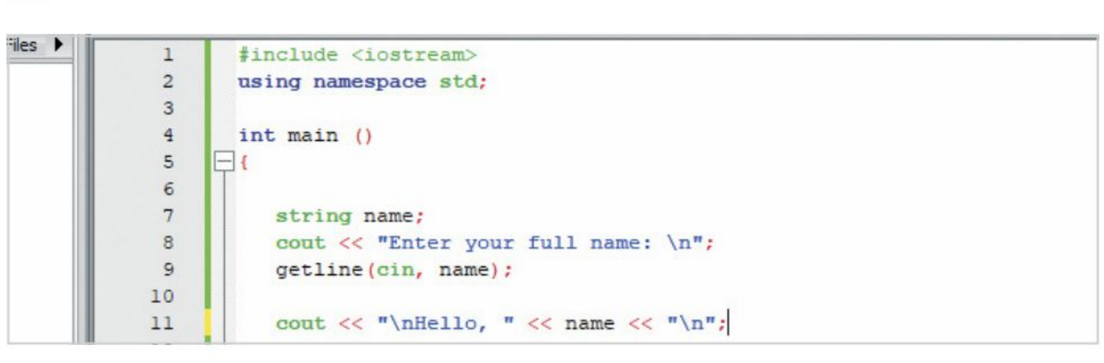


STEP 9 Build and execute the code, then enter a sentence with spaces. When you're done the code reads the number of characters. If you remove the getline line and replace it with cin >> mystr and try again, the result displays the number of characters up to the first space.



STEP 10 Getline is usually a command that new C++ programmers forget to include. The terminating white space is annoying when you can't figure out why your code isn't working. In short, it's best to use getline(cin, variable) in future:

```
#include <iostream>
using namespace std;

int main ()
{

   string name;
   cout << "Enter your full name: \n";
   getline(cin, name);

   cout << "\nHello, " << name << "\n";

}
```



Introducing Python

Python is one of the most popular modern programming languages available today. It's easy to learn, but is also powerful enough to be employed within engineering, science, the space industry and more. You can go a long way with a little Python knowledge.

This section covers what you will need to get up and running with Python, what version to install and use, and how to set everything up in Windows and Linux. There's a lot you can do with Python, and this is just the beginning.

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Introducing Python

> **"The purpose of software engineering is to control complexity, not to create it."**
>
> *– Pamela Zave (Developer, scientist and telecommunications expert)*

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.

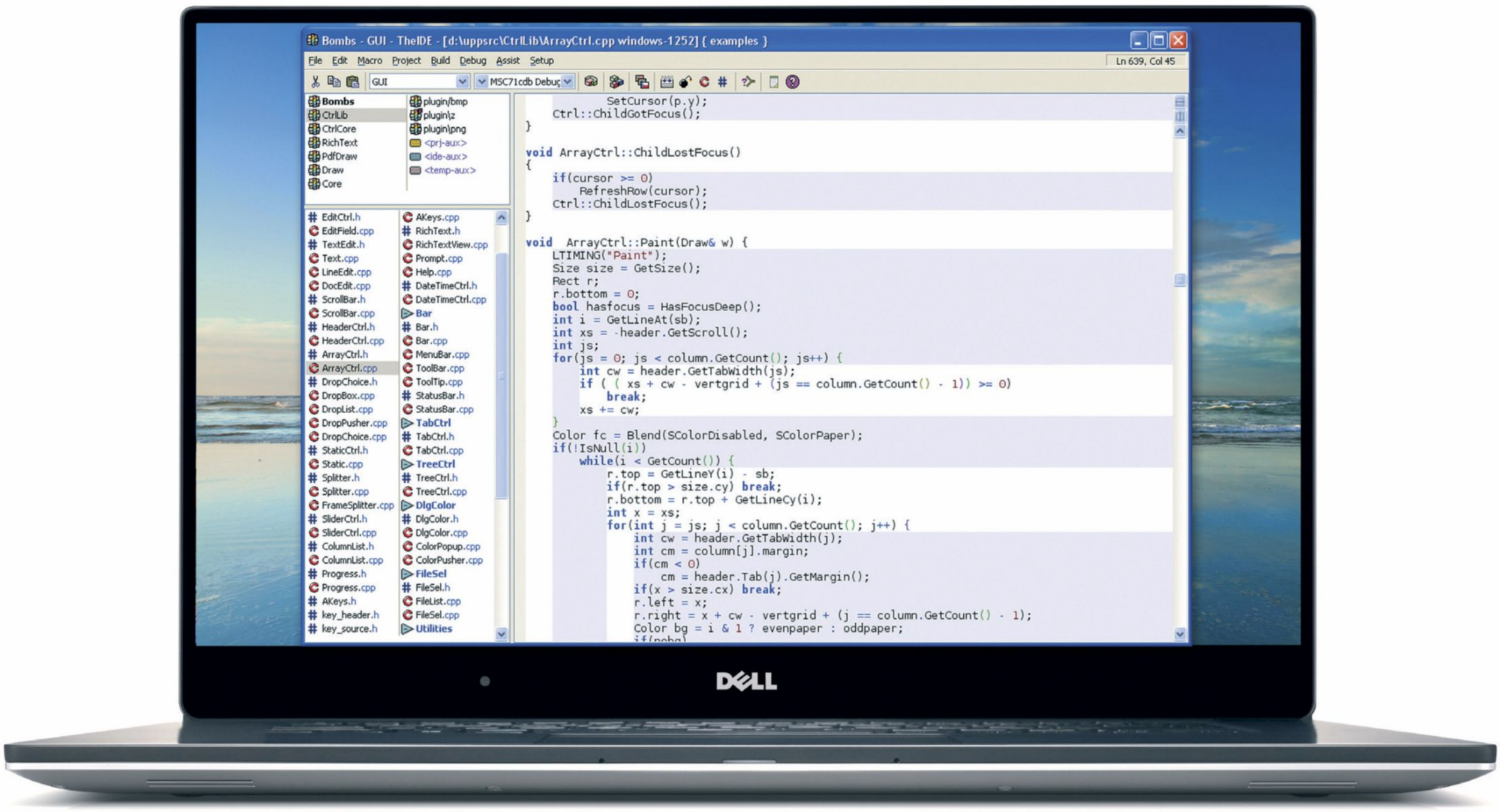
These pioneers of programming carved their way into a new frontier, forging small routines that enabled the letter 'A' to scroll across the screen. It may not sound terribly exciting to a generation that's used to ultra high-definition graphics and open world, multi-player online gaming. However, forty-something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

```
1  //file: Invoke.java
2  import java.lang.reflect.*;
3
4  class Invoke {
5    public static void main( String [] args ) {
6      try {
7        Class c = Class.forName( args[0] );
8        Method m = c.getMethod( args[1], new Class
         [] { } );
9        Object ret =  m.invoke( null, null );
10       System.out.println(
11           "Invoked static method: " + args[1]
12           + " of class: " + args[0]
13           + " with no args\nResults: " + ret );
14     } catch ( ClassNotFoundException e ) {
15       // Class.forName(  ) can't find the class
16     } catch ( NoSuchMethodException e2 ) {
17       // that method doesn't exist
18     } catch ( IllegalAccessException e3 ) {
19       // we don't have permission to invoke that
         method
20     } catch ( InvocationTargetException e4 ) {
21       // an exception ocurred while invoking that
         method
22       System.out.println(
23           "Method threw an: " + e4.
             getTargetException(  ) );
24     }
25   }
26 }
```

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.

```
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.

What can you do with Python?

Python is an open-source, object-oriented programming language that's simple to understand and write with, 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 being an ideal first programmers' choice through to being able to create interactive stories and games; from scientific applications through 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.

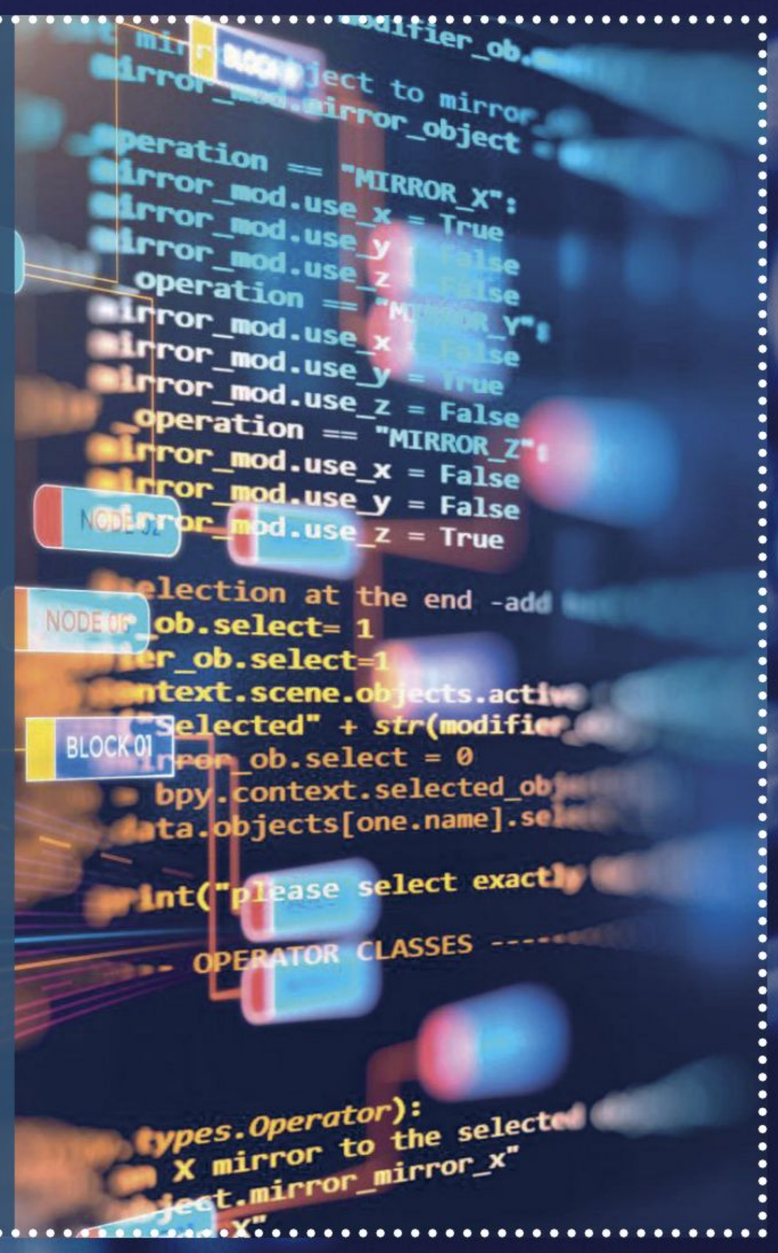
```
Beautiful is better than ugly.
Explicit is better than implicit.
Simple is better than complex.
Complex is better than complicated.
Flat is better than nested.
Sparse is better than dense.
Readability counts.
Special cases aren't special enough to break the rules.
Although practicality beats purity.
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.



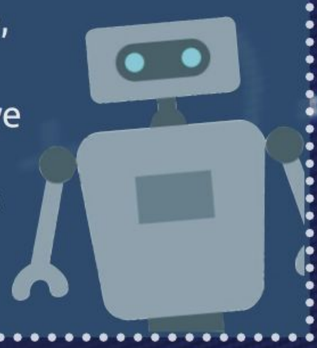
ARTIFICIAL INTELLIGENCE

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.

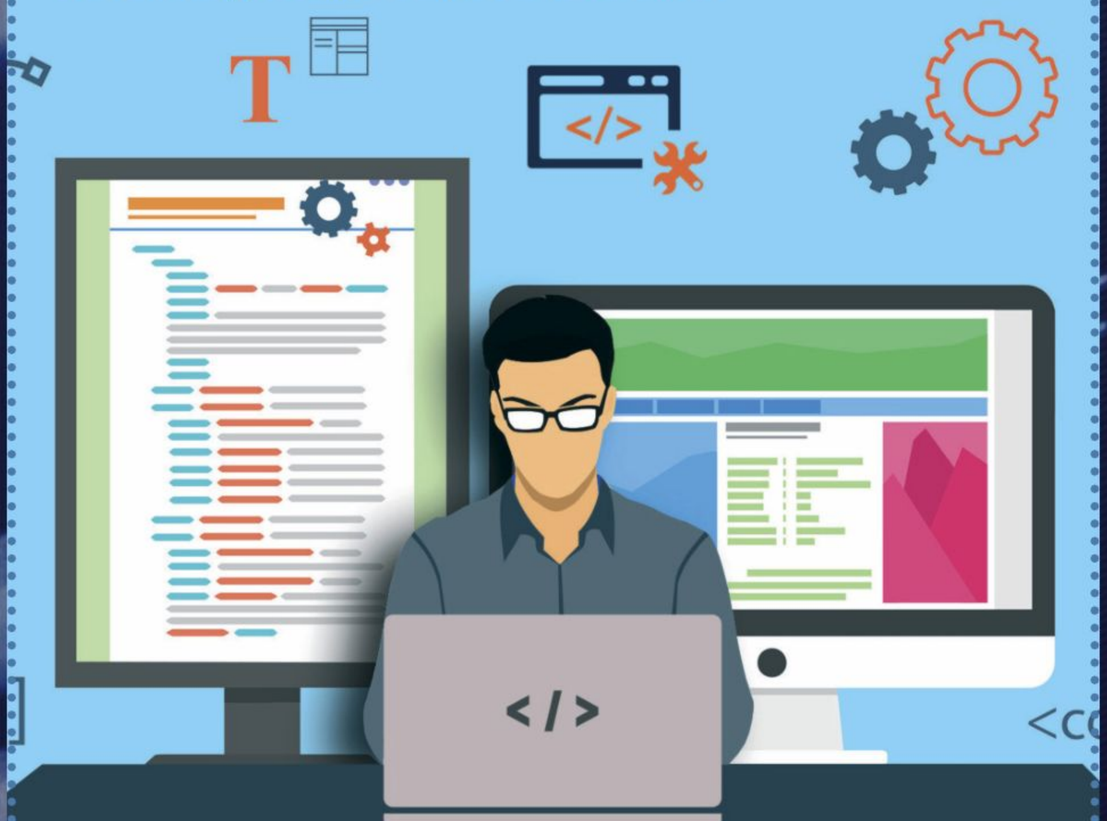
Spotify, for example, uses Python based code, among other things, to analyse your musical habits and offer playlists based on what you've listened to in the past. It's all clever stuff and moving forward, Python is at the forefront of the way the Internet will work in the future.

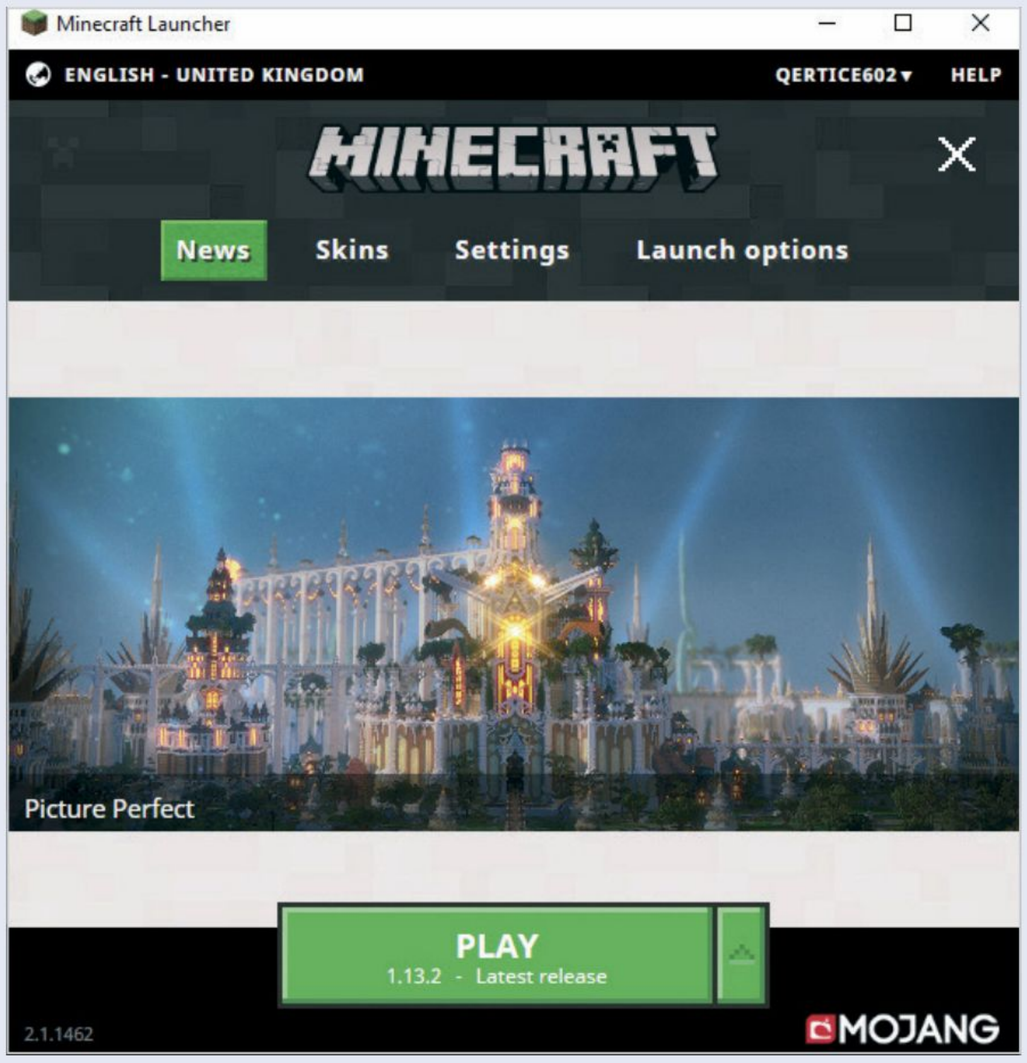


WEB DEVELOPMENT

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.

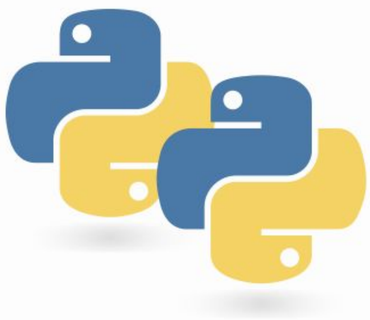
Whatever route you decide to take on your coding journey, you will do well to have Python in your corner.

PYTHON in NUMBERS

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.

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

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 2018, Python was the most discussed language on the Internet.

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

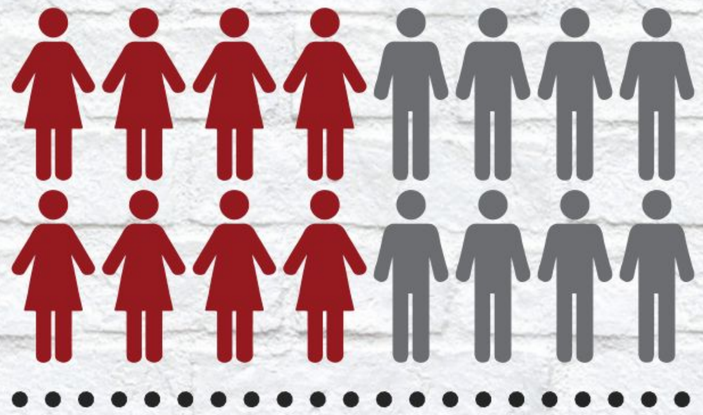
Disney Pixar uses Python in its Renderman software to operate between other graphics packages.

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

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

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.

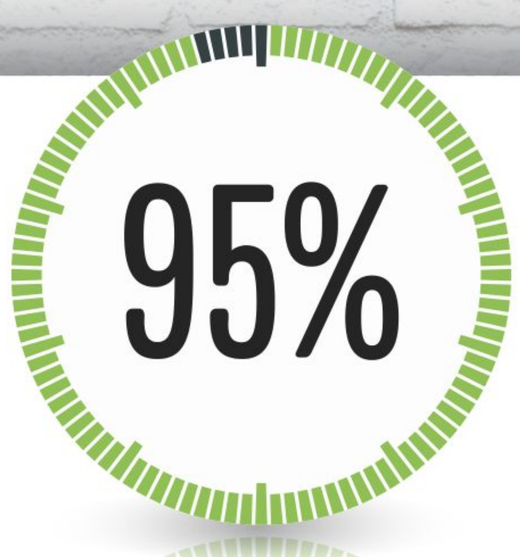
Google is the top company for hiring Python developers, closely followed by Microsoft.

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

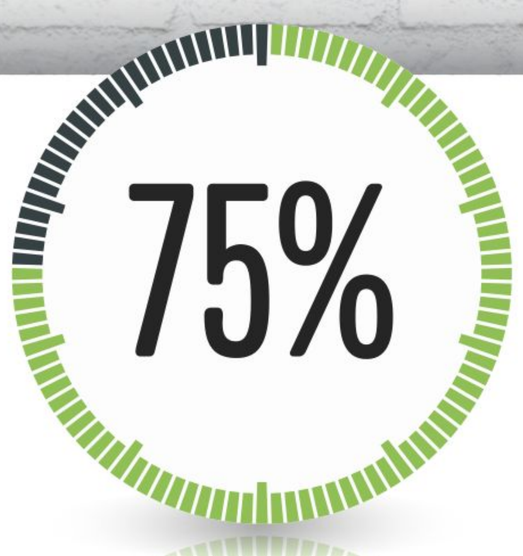
New York and San Francisco are the top Python developer cities in the world.

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 REGULARLY, 21% USE IT AS A SECONDARY LANGUAGE.

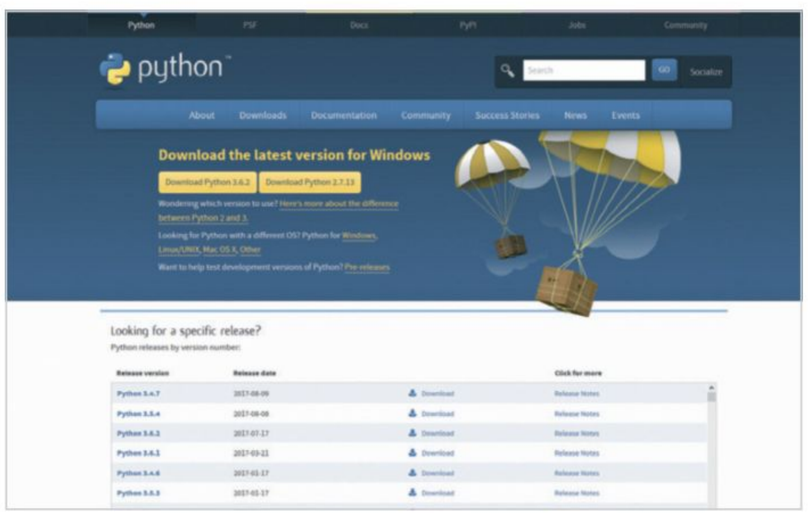
49% OF WINDOWS 10 DEVELOPERS USE PYTHON 3 AS THEIR MAIN PROGRAMMING LANGUAGE.

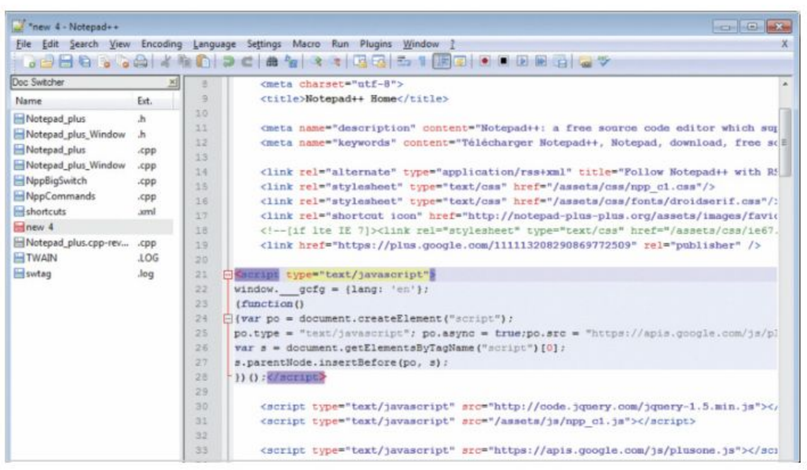
Equipment You Will Need

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

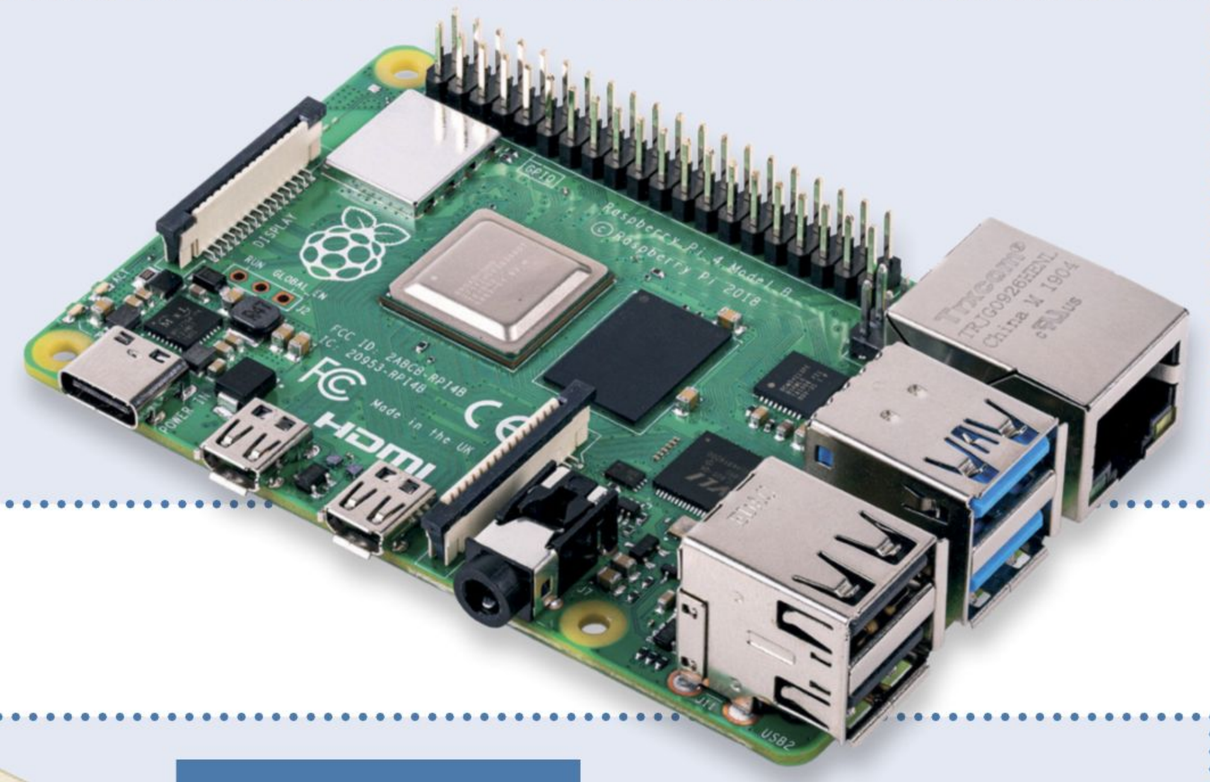
Despite what other books may lead you to believe, you won't become a programmer in 24-hours. Learning to code in Python takes time, and patience. You may become stuck at times and other times the code will flow like water. Understand you're learning something entirely new, and you will get there.

THE RASPBERRY PI

Why use a Raspberry Pi? The Raspberry Pi is a tiny computer that's very cheap to purchase, but offers the user a fantastic learning platform. Its main operating system, Raspbian, comes preinstalled with the latest Python along with many modules and extras.

RASPBERRY PI

The Raspberry Pi 4 Model B is the latest version, incorporating a more powerful CPU, a choice of 1GB, 2GB or 4GB memory versions and Wi-Fi and Bluetooth support. You can pick up a Pi from around £34, increasing up to £54 for the 4GB memory version, or as a part of kit for £50+, depending on the kit you're interested in.



FUZE PROJECT

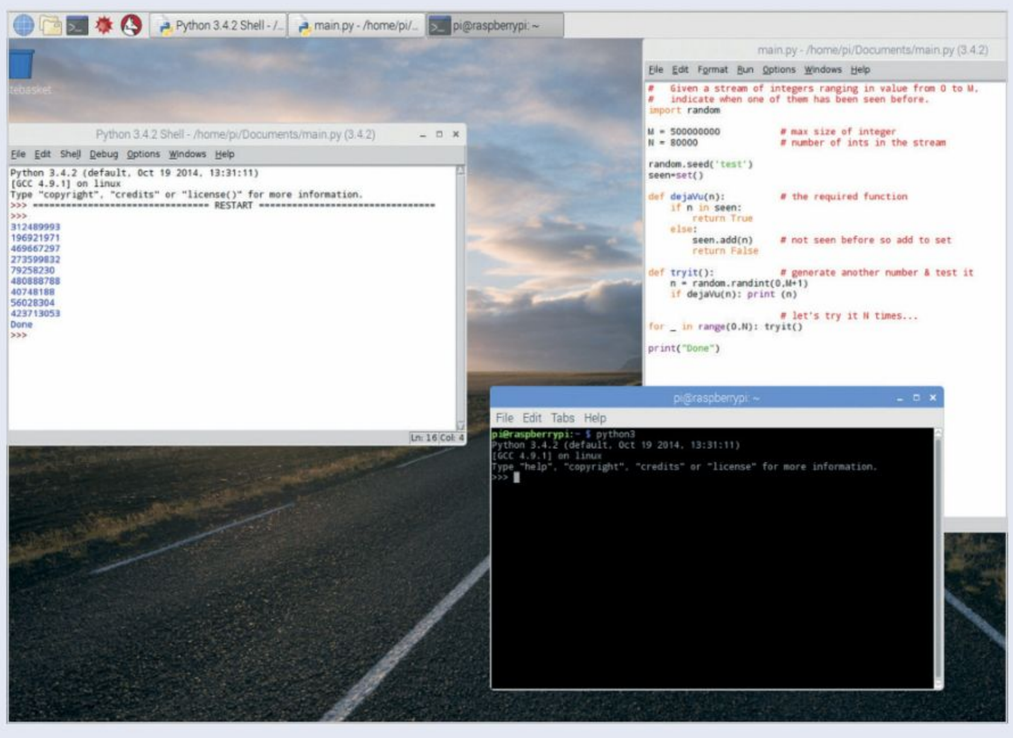
The FUZE is a learning environment built on the latest model of the Raspberry Pi. You can purchase the workstations that come with an electronics kit and even a robot arm for you to build and program. You can find more information on the FUZE at **www.fuze.co.uk.**

BOOKS

We have several great Raspberry Pi titles available via **www.bdmpublications.com**. Our Pi books cover how to buy your first Raspberry Pi, set it up and use it; there are some great step-by-step project examples and guides to get the most from the Raspberry Pi too.

RASPBIAN

The Raspberry Pi's main operating system is a Debian-based Linux distribution that comes with everything you need in a simple to use package. It's streamlined for the Pi and is an ideal platform for hardware and software projects, Python programming and even as a desktop computer.



Getting to Know Python

Python is one of the most used and popular programming languages. It's a great language on which to learn how to code, but it's also powerful enough to be used by companies when trawling through petabytes of raw data.

PYTHON POWER

Python is a high-level, general-purpose programming language that was designed by Guido van Rossum in the late '80s, as a successor to the ABC Programming Language, and became available to use in 1990.

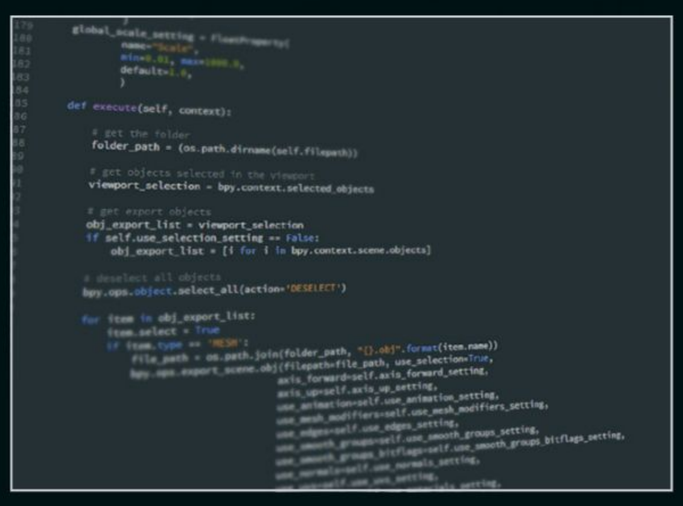
Guido van Rossum, the designer of Python.

Made up from over 5 Petabytes of data, spread across a ton of hard drives, Python helped science to unveil the first image of a black hole.

The Python Software Foundation, a non-profit organisation devoted to both furthering and improving Python, currently develops the language. The foundation's purpose is to "promote, protect, and advance the Python programming language, and to support and facilitate the growth of a diverse and international community of Python programmers."

The structure of Python code has been designed to flow easily, allowing those who are just beginning to code to follow it without too much difficulty. Yet, despite its ease of use, Python is regularly used throughout a number of industries in real-world scenarios.

Big Data and AI are the two fastest growing Python-backed technologies at the moment. Big Data is simply a modern term used to describe huge amounts of data, such as sequences of numbers collated during a day's worth of trading on the Stock Exchange. Python code is used to dig into the voluminous collection of numbers, and then feed back with reports on the highs and lows, what's trending, and so on.



Python code is both elegant and easy to read (when you know how).

As a side note, it's not just the likes of the Stock Exchange that use Python to study large quantities of data; in April 2019 the first image of a black hole was released, the supermassive black hole in the galaxy called M87, located roughly 55 million light years away. Thanks to the collaboration of over 200 scientists, using an array of telescopes spanning the world (called the Event Horizon Telescope Project), the combined power of the telescopes formed an impressive five petabytes of data, spread across tens of hard drives weighing in at nearly one ton. Five petabytes, by the way, equates to around 5,000 years' worth of MP3 files. Once all those hard drives were gathered together and shipped to a central supercomputer cluster, the team then used Python to painstakingly stitch together all the fragments of data from the five petabytes to finally form the most talked about astronomic event of the decade.

AI, if you're not familiar with the term, stands for Artificial Intelligence. Although we're still a long way off from the visionary stories of Arthur C. Clarke, AI is fast becoming one of the most influential technologies of our modern age. Rather than controlling robots, the AI that Python drives is designed to create autonomous ways of interacting with people online. For example, when you search for something on the Amazon website you will usually notice that similar products start to appear, whether within Amazon itself,

PYTHON 3 VS PYTHON 2

In a typical computing scenario, Python is complicated somewhat by the existence of two active versions of the language: Python 2 and Python 3.

Python 3 is the best option to download, or update to.

Python 3 is the newest release of the programming language. However, if you dig a little deeper into the Python site and investigate Python code online, you will undoubtedly come across Python 2. Crucially, although you can run Python 3 and Python 2 alongside each other, it's not recommended. Always opt for the latest stable release, as posted by the Python website. You will find, when using macOS or Linux, that Python 2 is already installed. This is because both these operating systems utilise elements of code necessary to the core functionality of the OS. Linux users tend to be better off, as most distributions package the latest version of Python 3 out-of-the-box, whereas macOS often has Python 3, it's usually an older version. Microsoft doesn't use any Python code for its core Windows systems, which is why you won't find Python inherent to Windows and therefore need to install it from scratch.

You need to be careful when you look up Python code online, although there are countless websites that offer quick tutorials, code snippets and support – and 99% of these site are a great help to those starting out with Python – a lot of the sites haven't been updated for some time, and as such use Python 2. If you enter Python 2 code into the Python 3 IDLE, the chances are it won't work due to incompatibilities between the older version and the newer. Python 2 is good, but Python 3 is better. You can obviously spend time converting the Python 2 code into version 3, but, to begin with, it's best to make sure that the code you're looking at is for the Python 3 libraries. Don't worry, though, all the code in this book is designed for Python 3, and that includes all the sub versions from Python 3.1 to the latest 3.x.

Python 3's growing popularity has meant that it's now prudent to start learning to develop with the new features and begin to phase out the previous version. Many development companies, such as SpaceX and NASA, use Python 3 for snippets of important code.

However, support for Python 2 is set to end on January 1st 2020, but this doesn't mean it'll be the last you see of it. Many Linux distros use Python 2 libraries, as does macOS, and to be fair, for the developers to transfer the existing Python 2 content to Python 3 may take more time than they have available, i.e. before the start of 2020. It's likely then, that we will still be seeing Python 2 long after it has had the final nail hammered into its coffin – in fact, expect to see that cut-off date extend further into the future.

or from a search engine, or even Facebook. The code behind these targeted snippets is Python, and it's using a form of AI to help determine what it is you would likely search for.

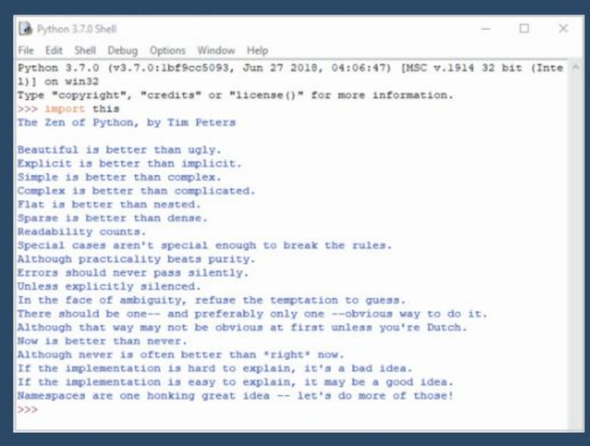
Despite the fact that many people find the targeting of advertising intrusive, or even an invasion of privacy, you have to admit that the code technology behind it all is rather impressive. With some very clever techniques, a Python developer is able to create a machine thinking script that not only displays items, news stories, books, other websites and ideas relating to what you've searched for, but it can also predict what you may be interested in looking for in the future. Another element to consider, with regards to AI, is that Python code can be used to help a computer learn how to do something more efficiently. In the case of neural networks in AI, the Python code is designed to return a result, then, as the code is run over and over again, the AI portion will begin to learn how to obtain a more accurate result, or do the maths behind the code quicker. It all depends on what the developer wants from their AI Python code.

An example of Python AI code, using a feedforward neural network.

```
import random
import numpy as np
class Network(object):
    def __init__(self, sizes):
        self.num_layers = len(sizes)
        self.sizes = sizes
        self.biases = [np.random.randn(y, 1) for y in sizes[1:]]
        self.weights = [np.random.randn(y, x)
                        for x, y in zip(sizes[:-1], sizes[1:])]
    def feedforward(self, a):
        for b, w in zip(self.biases, self.weights):
            a = sigmoid(np.dot(w, a)+b)
        return a
    def SGD(self, training_data, epochs, mini_batch_size, eta,
            test_data=None):
```

ZEN OF PYTHON

Python lets you access all the power of a computer in a language that humans can understand. Behind all this is an ethos called "The Zen of Python". This is a collection of 20 software principles that influences the design of the language. Principles include "Beautiful is better than ugly" and "Simple is better than complex." Type `import this` into Python and it will display all the principles.



The Zen of Python, as seen when entering: import this, into the Python IDLE.

As you will discover over the coming pages, Python is a fantastic language to learn. Get to grips with the basics, and before long, you'll be creating your own Python code for games, tools, and maybe even something in AI. The only limit with Python is your own imagination.

How to Set Up Python in Windows

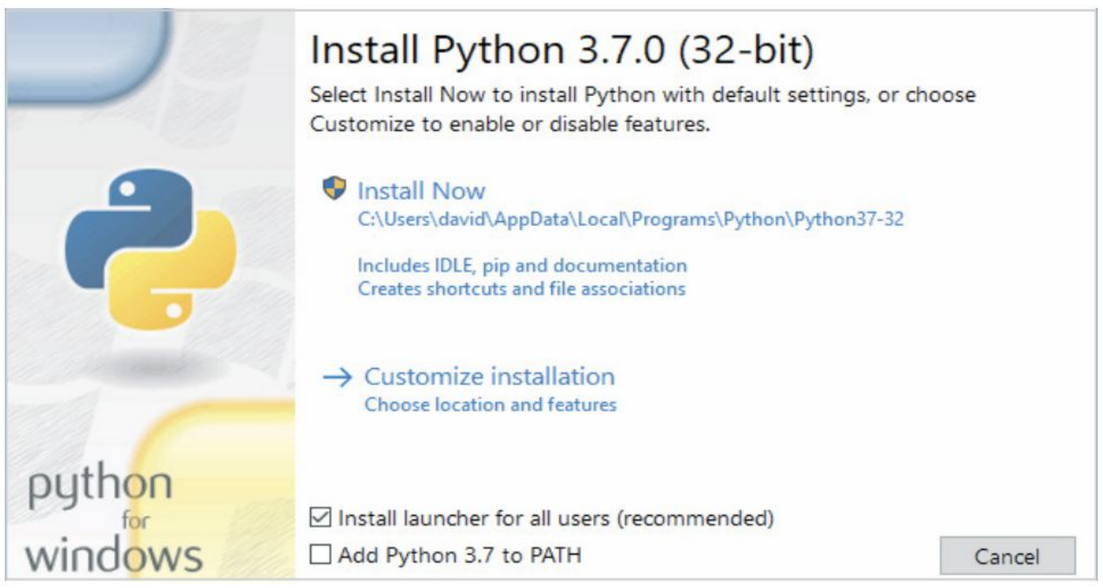
Windows users can easily install the latest version of Python via the main Python Downloads page. Whilst most seasoned Python developers may shun Windows as the platform of choice for building their code, it's still an ideal starting point for beginners.

INSTALLING PYTHON 3.X

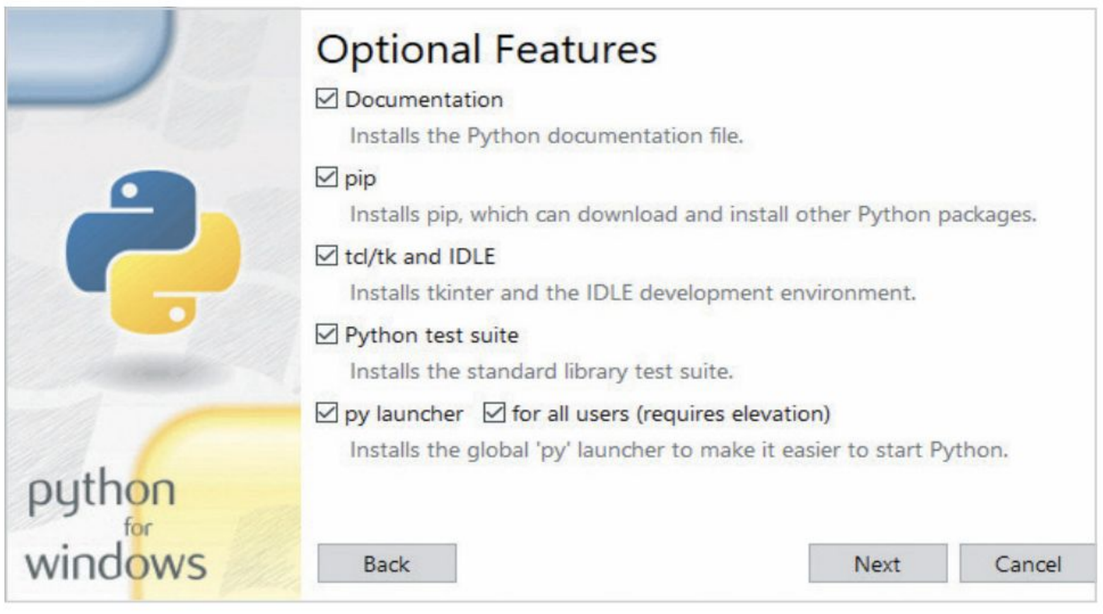
Microsoft Windows doesn't come with Python preinstalled as standard, so you're going to have to install it yourself manually. Thankfully, it's an easy process to follow.

STEP 1 Start by opening your web browser to www.python.org/downloads/. Look for the button detailing the download link for Python 3.x. Python is regularly updated, changing the last digit for each bug fix and update. Therefore, don't worry if you see Python 3.7.3, or more, as long as it's Python 3, the code in this book will work fine.

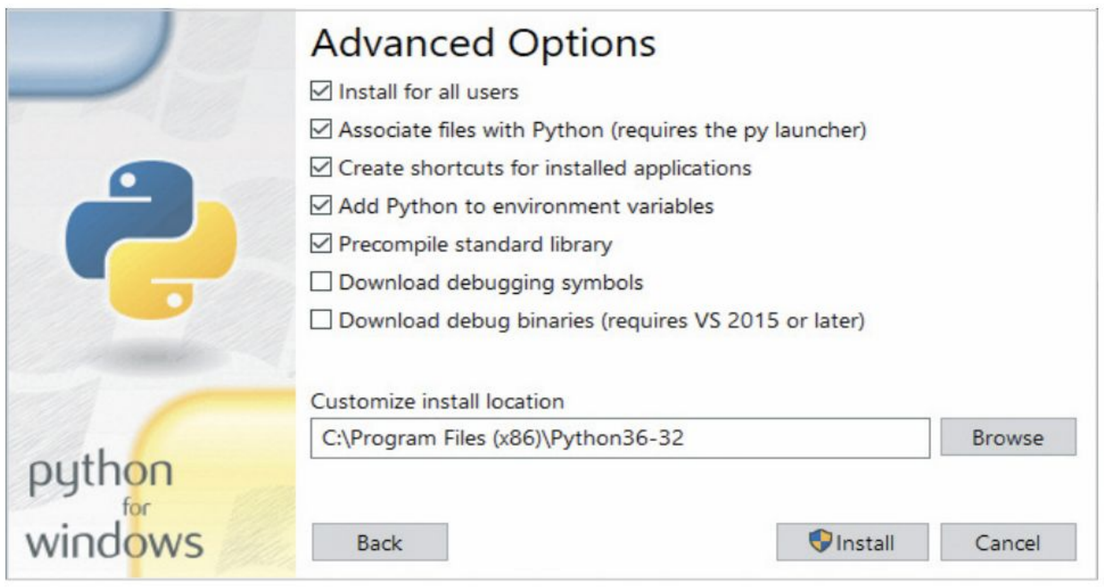
STEP 2 Click the download button for version 3.x, and save the file to your Downloads folder. When the file is downloaded, double-click the executable and the Python installation wizard will launch. From here you have two choices: Install Now and Customise Installation. We recommend opting for the Customise Installation link.



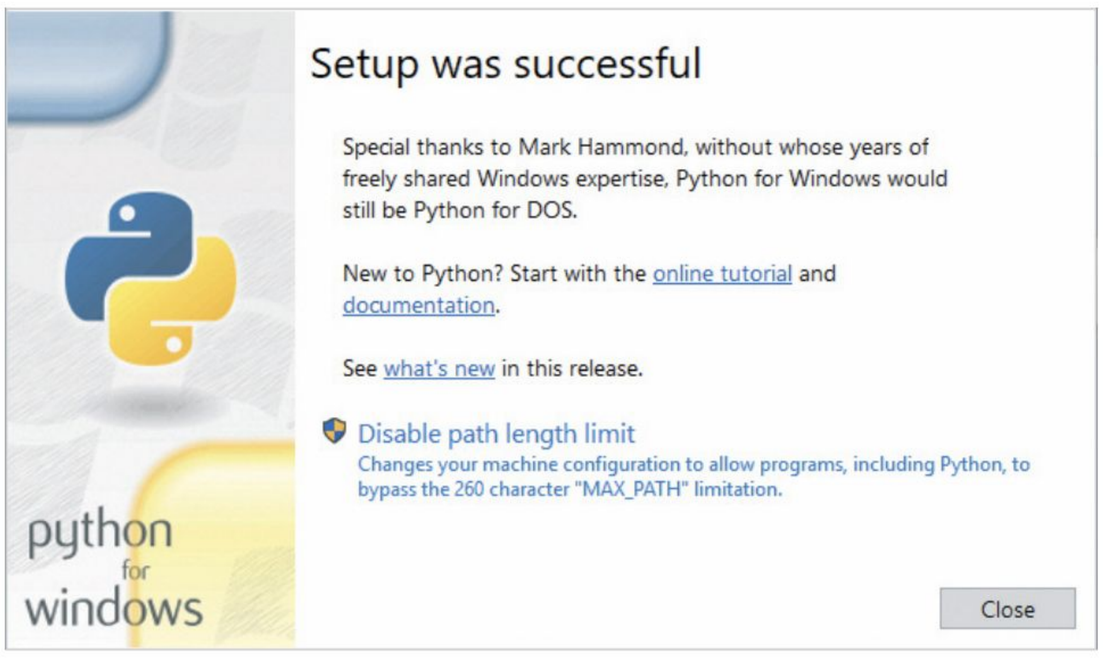
STEP 3 Choosing the Customise option allows you to specify certain parameters, and whilst you may stay with the defaults, it's a good habit to adopt as sometimes (not with Python, thankfully) installers can include unwanted additional features. On the first screen available, ensure all boxes are ticked and click the Next button.



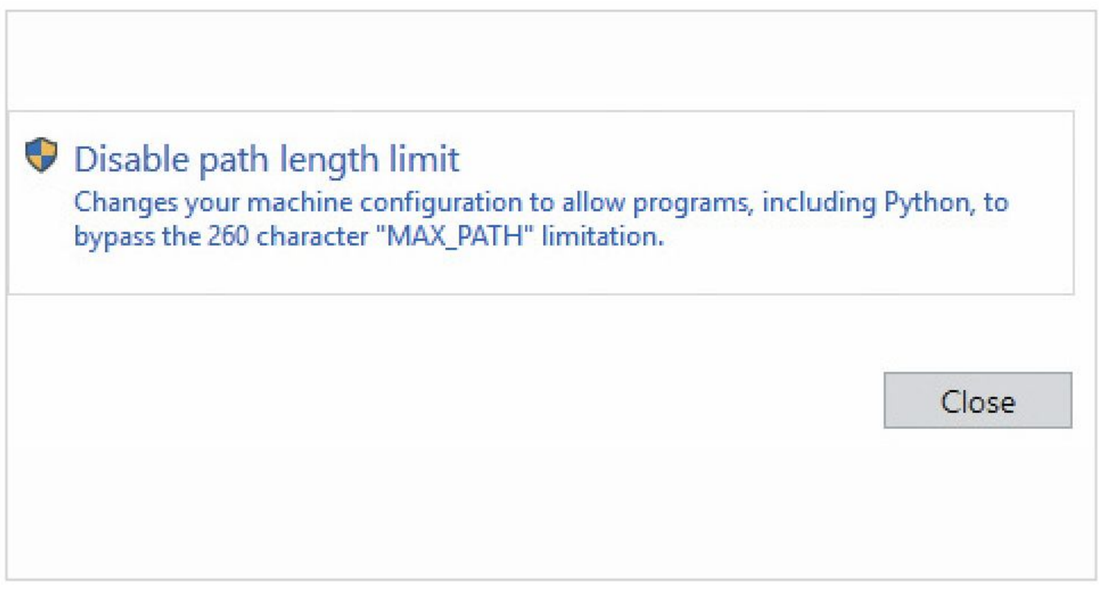
STEP 4 The next page of options include some interesting additions to Python. Ensure the Associate file with Python, Create Shortcuts, Add Python to Environment Variables, Precompile Standard Library and Install for All Users options are ticked. These make using Python later much easier. Click Install when you're ready to continue.



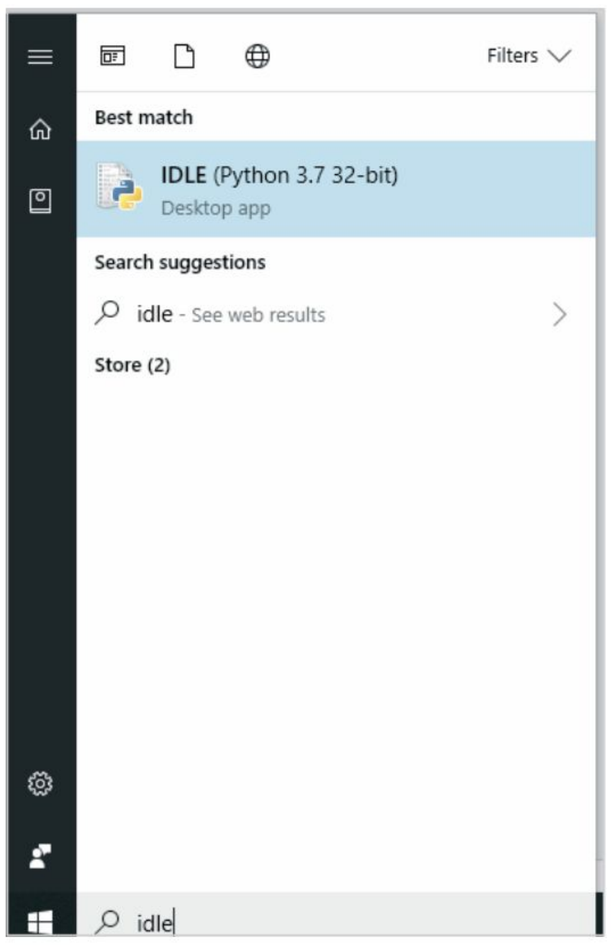
STEP 5 You may need to confirm the installation with the Windows authentication notification. Simply click Yes and Python will begin to install. Once the installation is complete the final Python wizard page will allow you to view the latest release notes, and follow some online tutorials.



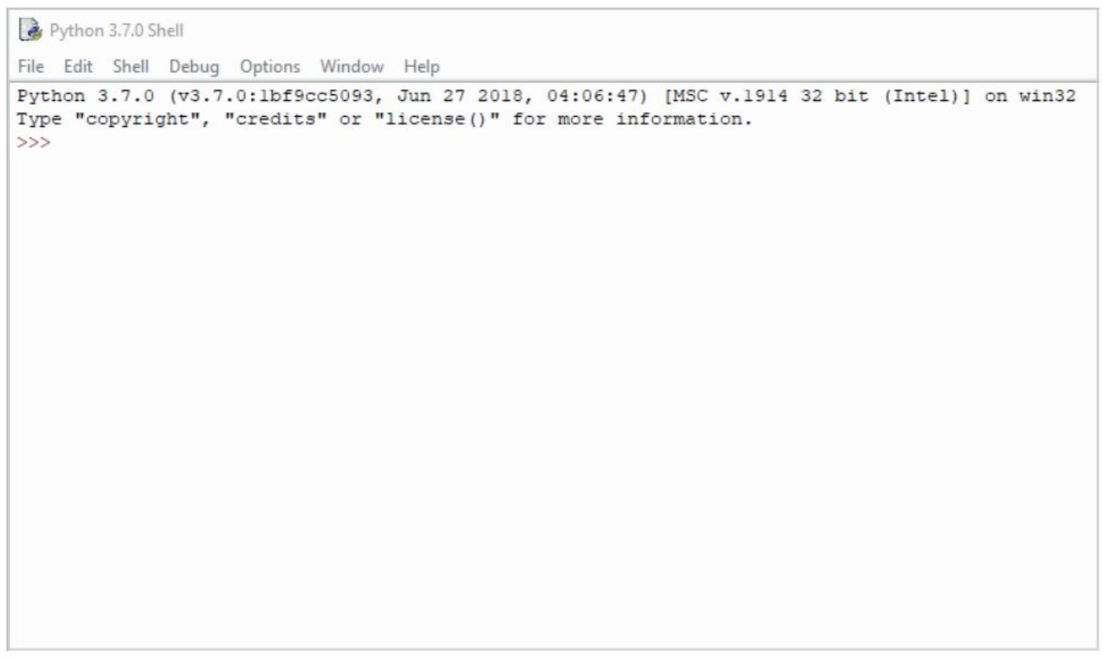
STEP 6 Before you close the install wizard window, however, it's best to click on the link next to the shield detailed Disable Path Length Limit. This will allow Python to bypass the Windows 260 character limitation, enabling you to execute Python programs stored in deep folders arrangements. Again, click Yes to authenticate the process; then you can Close the installation window.



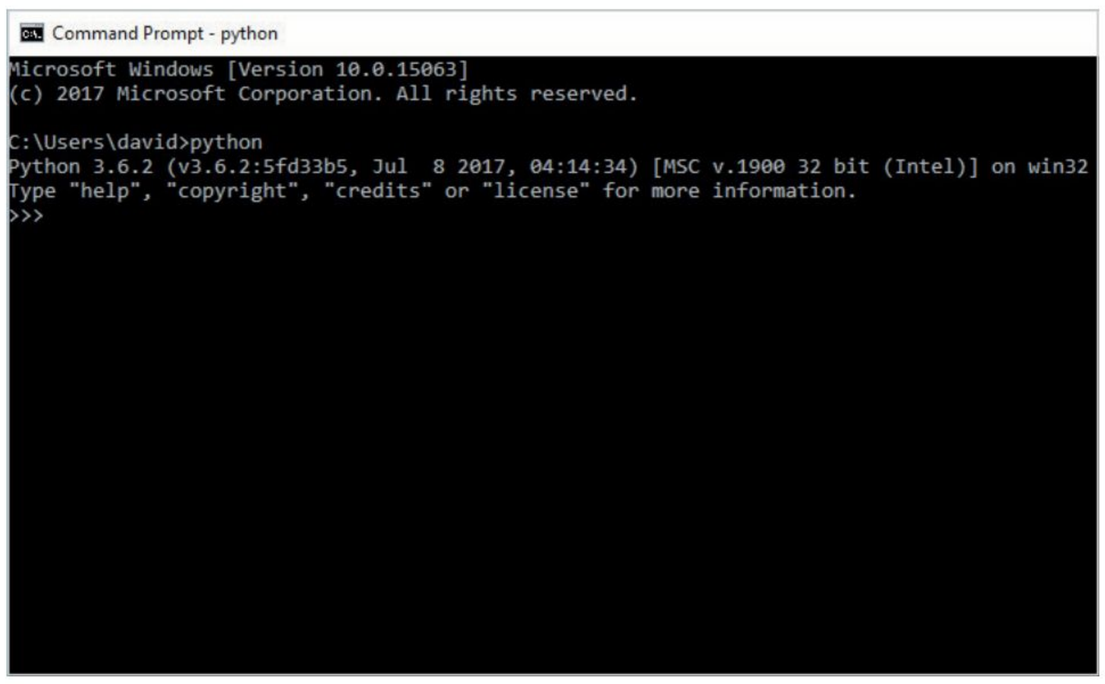
STEP 7 Windows 10 users can now find the installed Python 3.x within the Start button Recently Added section. The first link, Python 3.7 (32-bit) will launch the command line version of Python when clicked (more on that in a moment). To open the IDLE, type IDLE into Windows start.



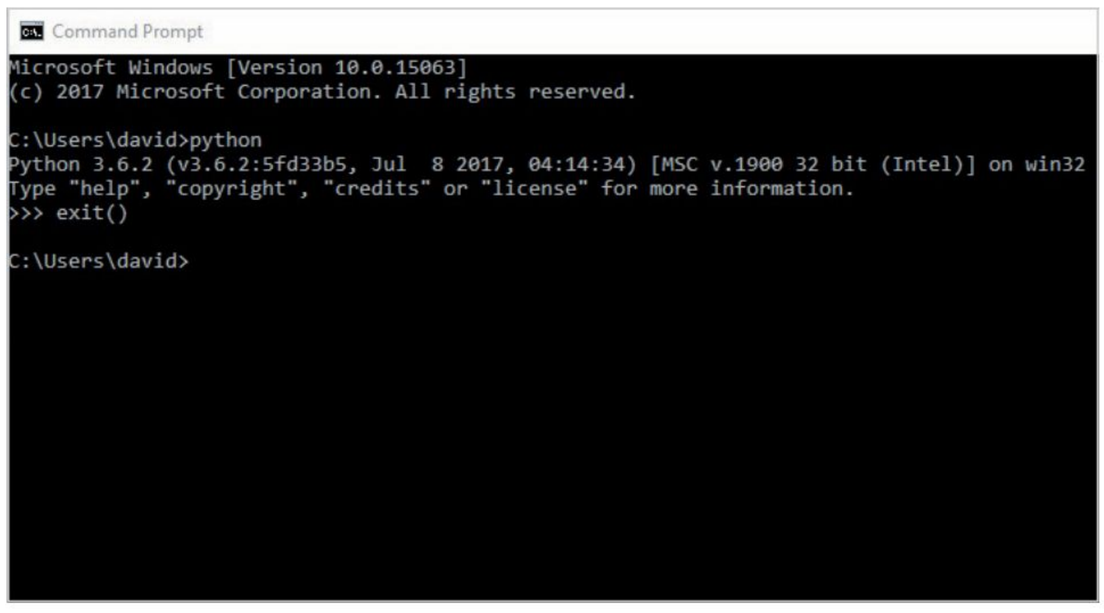
STEP 8 Clicking on the IDLE (Python 3.7 32-bit) link will launch the Python Shell, where you can begin your Python programming journey. Don't worry if your version is newer as long as it's Python 3.x our code works inside your Python 3 interface.



STEP 9 If you now click on the Windows Start button again, and this time type: `CMD`, you'll be presented with the Command Prompt link. Click it to get to the Windows command line environment. To enter Python within the command line, you need to type: `python` and press Enter.



STEP 10 The command line version of Python works in much the same way as the Shell you opened in Step 8; note the three left-facing arrows (>>>). Whilst it's a perfectly fine environment, it's not too user-friendly, so leave the command line for now. Enter: `exit()` to leave and close the Command Prompt window.



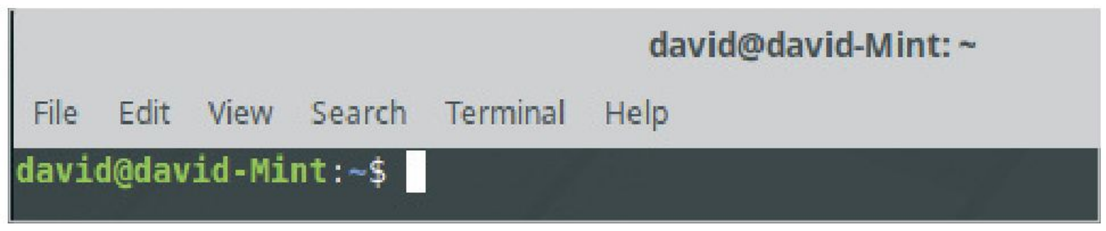
How to Set Up Python in Linux

While the Raspberry Pi's operating system contains the latest, stable version of Python, other Linux distros don't come with Python 3 pre-installed. If you're not going down the Pi route, then here's how to check and install Python for Linux.

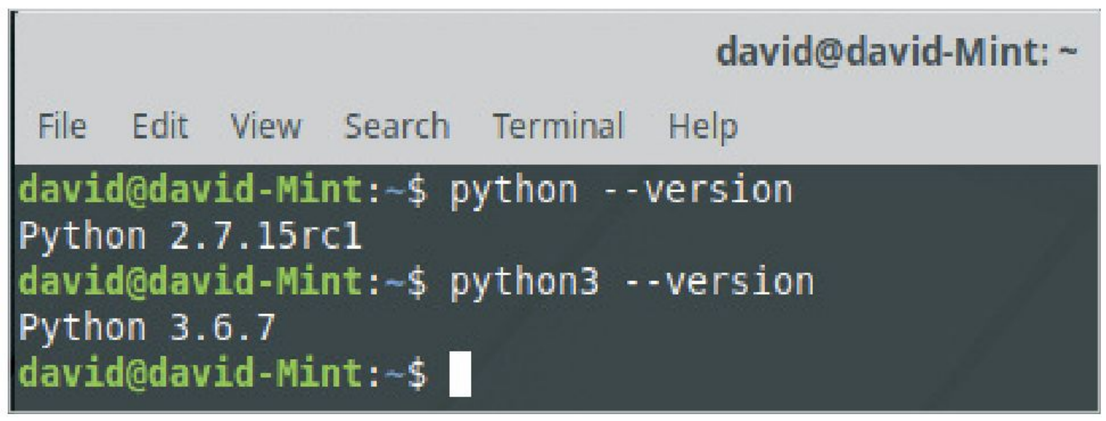
PYTHON PENGUIN

Linux is such a versatile operating system that it's often difficult to nail down just one-way of doing something. Different distributions go about installing software in different ways, so for this particular tutorial we will stick to Linux Mint.

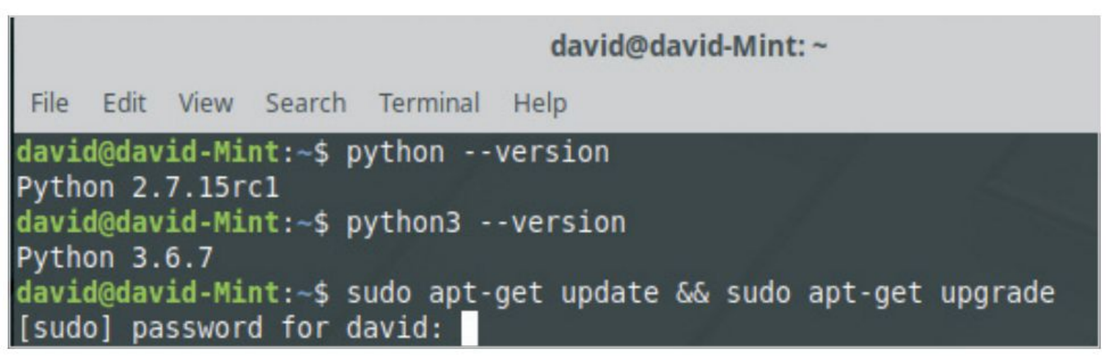
STEP 1 First you need to ascertain which version of Python is currently installed in your Linux system. To begin with, drop into a Terminal session from your distro's menu, or hit the Ctrl+Alt+T keys.



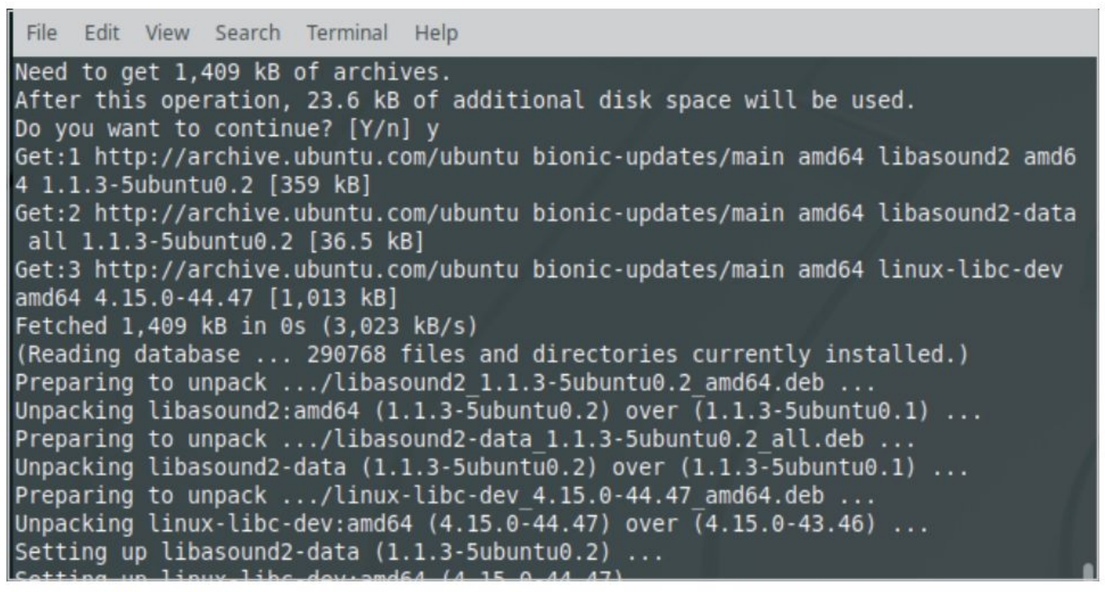
STEP 2 Next, enter: `python --version` into the Terminal screen. You should have the output relating to version 2.x of Python in the display. Most Linux distro come with both Python 2 and 3 by default, as there's plenty of code out there still available for Python 2. Now enter: `python3 --version`.



STEP 3 In our case we have both Python 2 and 3 installed. As long as Python 3.x.x is installed, then the code in our tutorials will work. It's always worth checking to see if the distro has been updated with the latest versions, enter: `sudo apt-get update && sudo apt-get upgrade` to update the system.

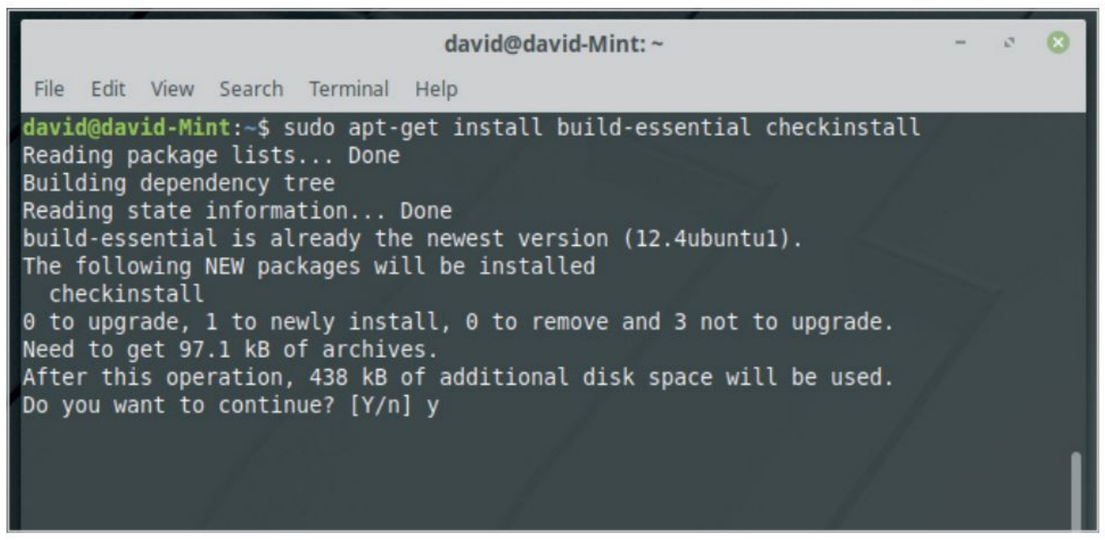


STEP 4 Once the update and upgrade completes, enter: `python3 --version` again to see if Python 3.x is updated, or even installed. As long as you have Python 3.x, you're running the most recent major version, the numbers after the 3. indicate patches plus further updates. Often they're unnecessary, but they can contain vital new elements.

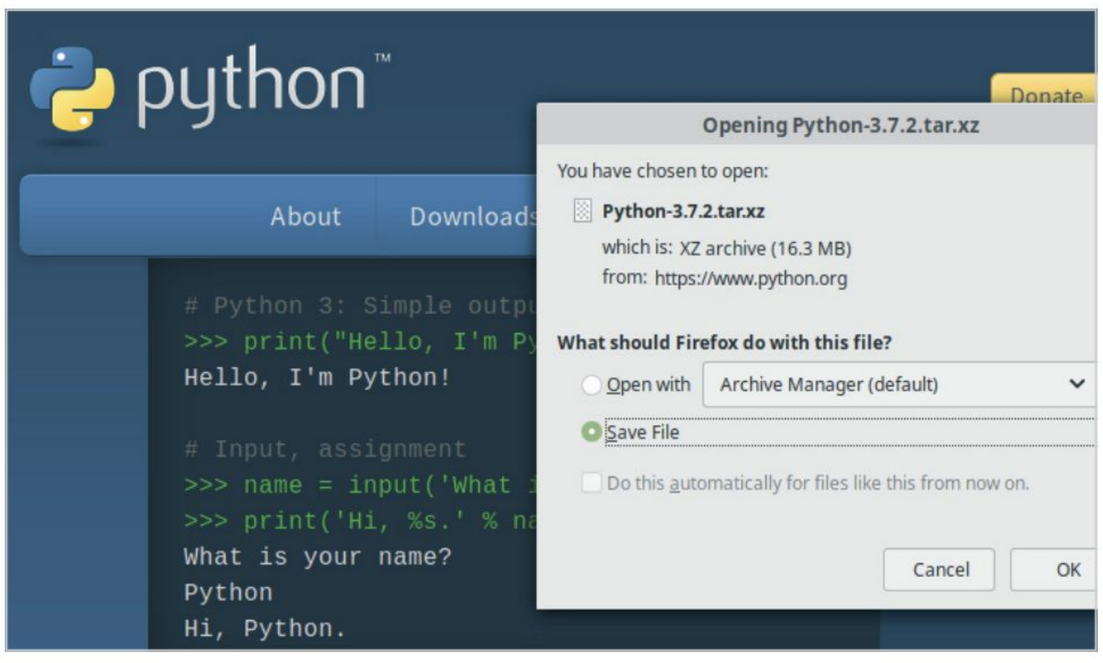


STEP 5 However, if you want the latest, cutting edge version, you'll need to build Python from source. Start by entering these commands into the Terminal:

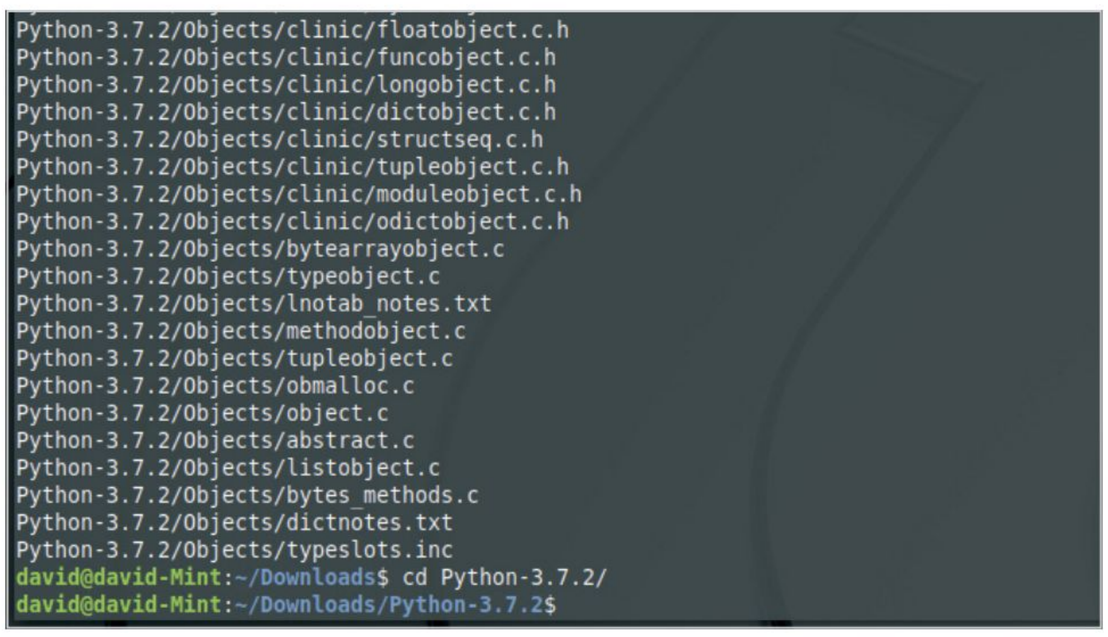
```
sudo apt-get install build-essential checkinstall
sudo apt-get install libreadline-gplv2-dev
libncursesw5-dev libssl-dev libsqlite3-dev tk-dev
libgdbm-dev libc6-dev libbz2-dev
```



STEP 6 Open up your Linux web browser and go to the Python download page: **https://www.python.org/downloads**. Click on the Downloads, followed by the button under the Python Source window. This opens a download dialogue box, choose a location, then start the download process.



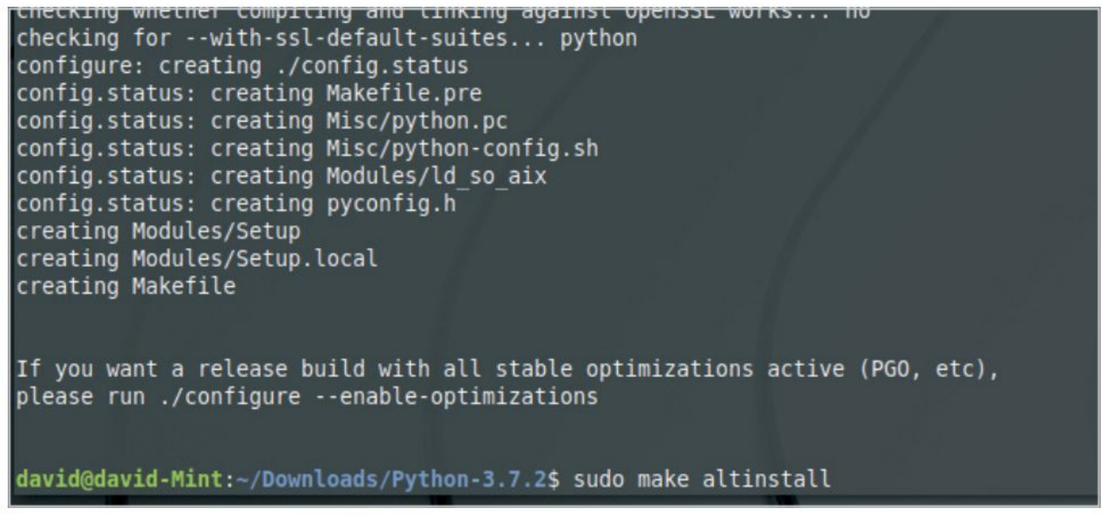
STEP 7 In the Terminal, go to the Downloads folder by entering: `cd Downloads/`. Then unzip the contents of the downloaded Python source code with: `tar -xvf Python-3.Y.Y.tar.xz` (replace the Y's with the version numbers you've downloaded). Now enter the newly unzipped folder with: `cd Python-3.Y.Y/`.



STEP 8 Within the Python folder, enter:

```
./configure
sudo make altinstall
```

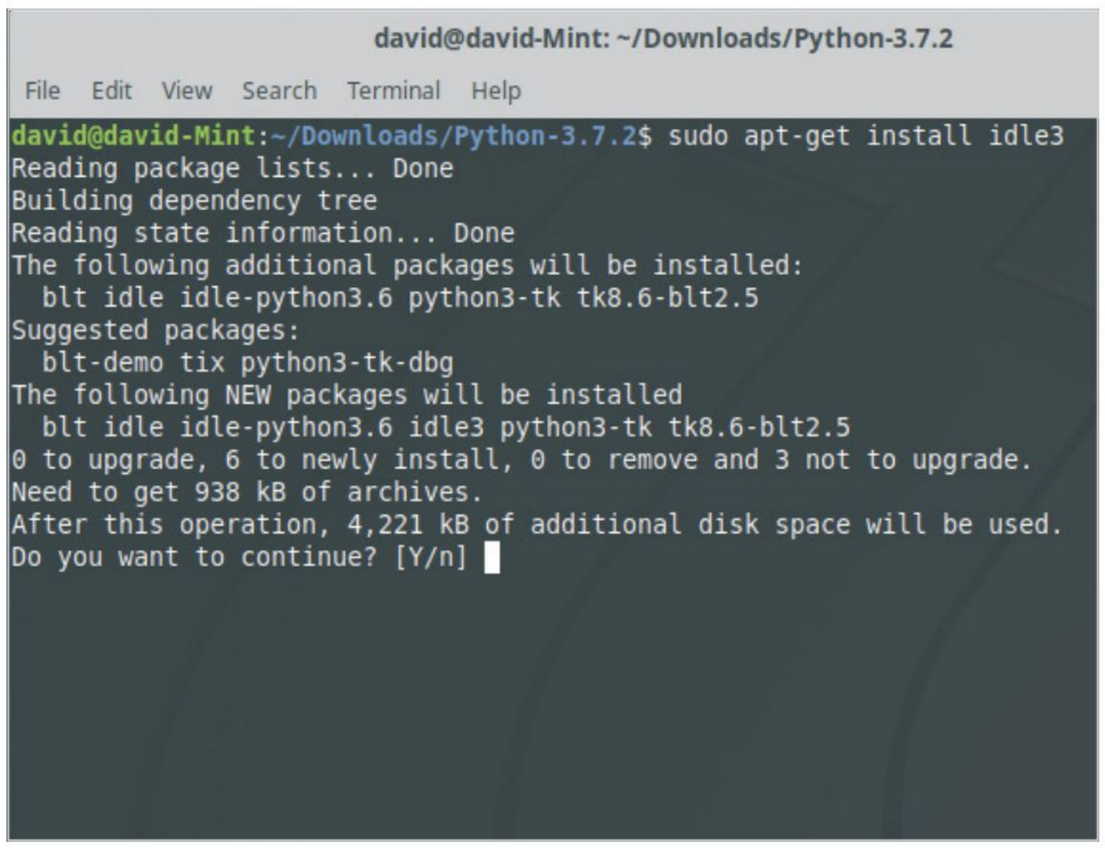
This could take a while, depending on the speed of your computer. Once finished, enter: `python3.7 --version` to check the latest installed version. You now have Python 3.7 installed, alongside older Python 3.x.x and Python 2.



STEP 9 For the GUI IDLE, you'll need to enter the following command into the Terminal:

```
sudo apt-get install idle3
```

The IDLE can then be started with the command: `idle3`. Note, that IDLE runs a different version to the one you installed from source.

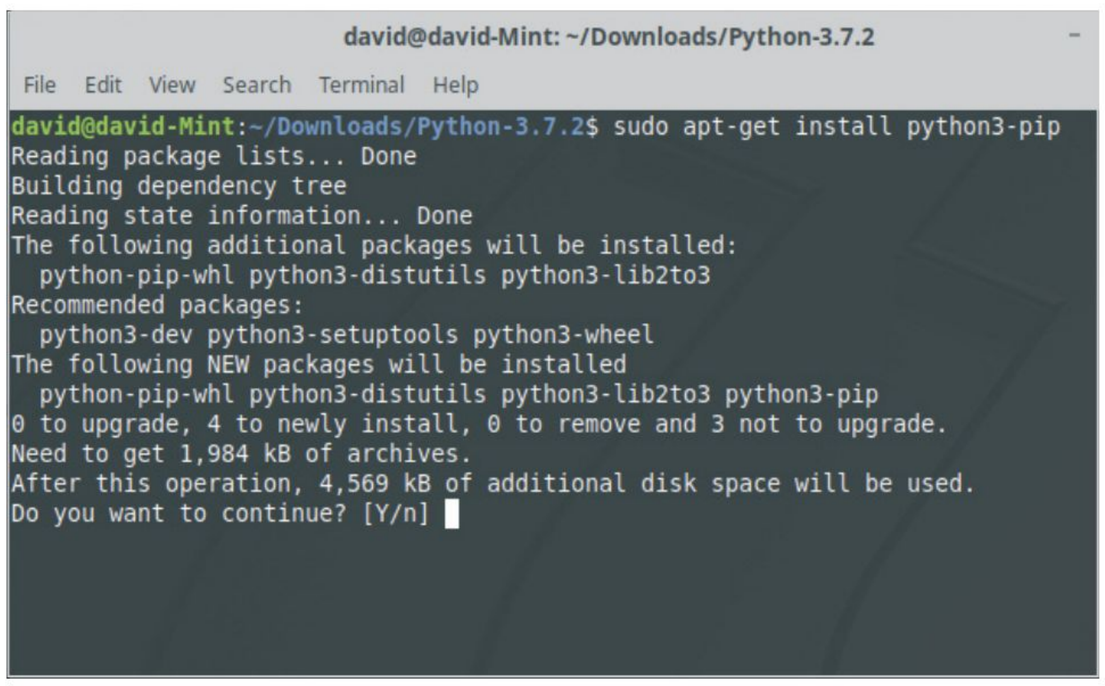


STEP 10 You'll also need PIP (Pip Installs Packages), which is a tool to help you install more modules and extras. Enter: `sudo apt-get install python3-pip`

Once PIP is installed, check for the latest update with:

```
pip3 install --upgrade pip
```

When complete, close the Terminal and Python 3.x will be available via the Programming section in your distro's menu.



PYTHON ON macOS

Installation of Python on macOS can be done in much the same way as the Windows installation. Simply go to the Python webpage, hover your mouse pointer over the Downloads link and select Mac OS X from the options. You will then be guided to the Python releases for Mac versions, along with the necessary installers for macOS 64-bit for OS X 10.9 and later.

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.

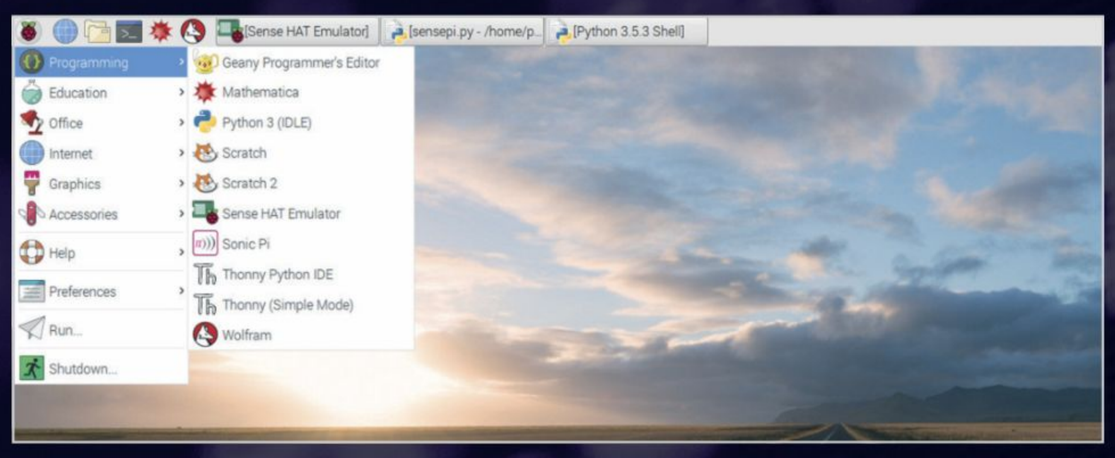
Using this method saves a lot of money, as you don't need another keyboard, mouse and monitor, plus, you won't need to allocate sufficient space to accommodate those extras either. If you're pushed for space and money, then for around £60, buying one of the many kits available will provide the Pi with 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.

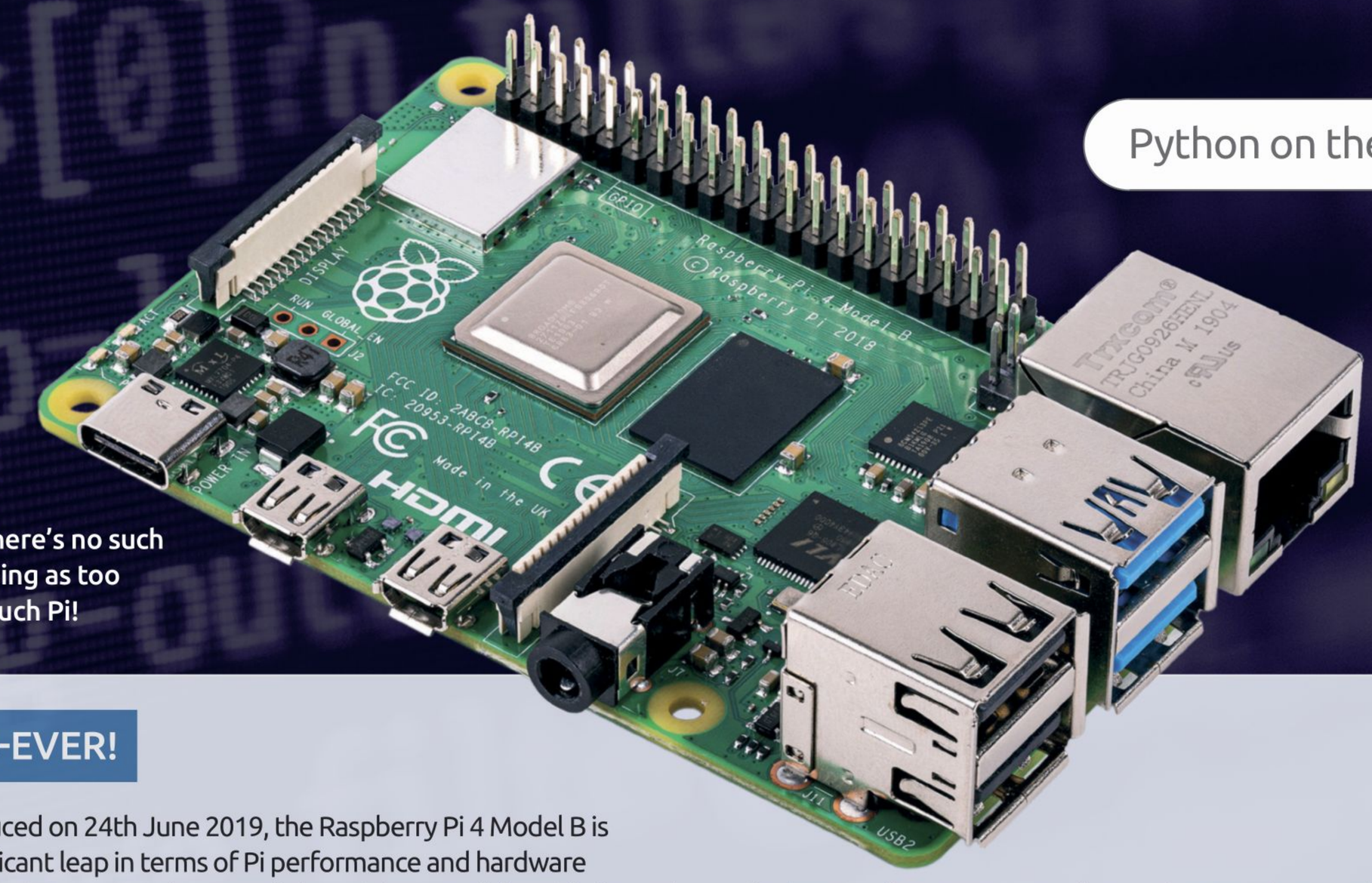
The main advantage is, of course, the extra content that the Raspberry Pi Foundation has included out of the box. The reason for this is that the Raspberry Pi's goal is to help educate the user, whether that's coding, electronics, or some other aspect of computing. To achieve that goal the Pi Foundation 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.

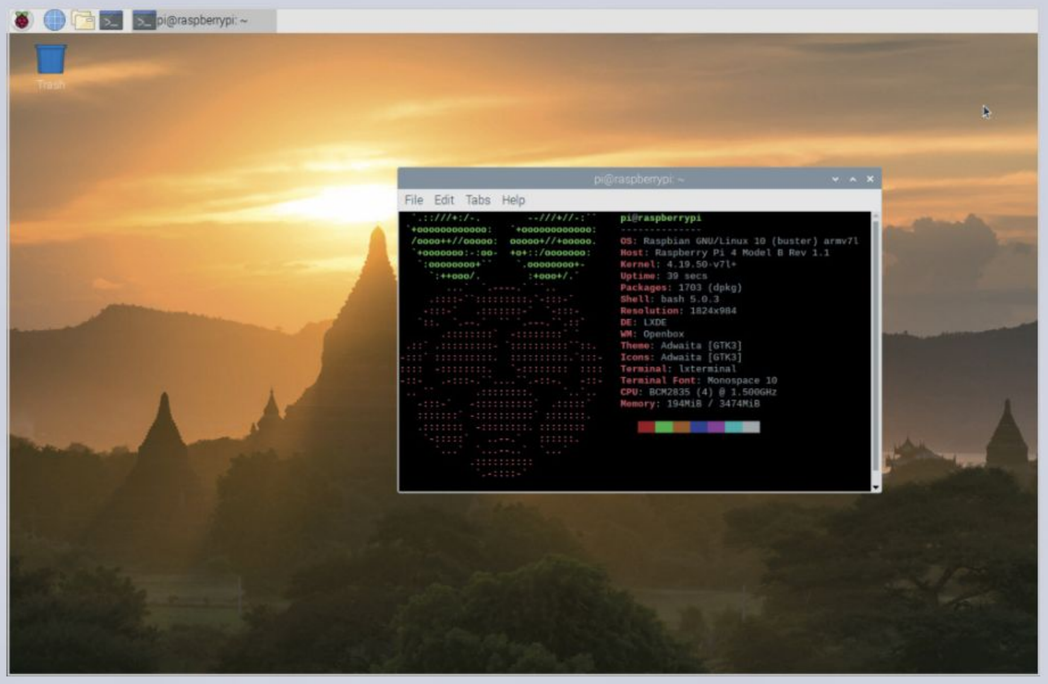
In short, the Pi 4 is the most powerful of the current Raspberry Pi models. However, the different memory versions have an increased cost. The 1GB version costs £34, 2GB is £44, and the 4GB version will set you back £54. Remember to also factor in one or two micro-HDMI cables with your order.

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.

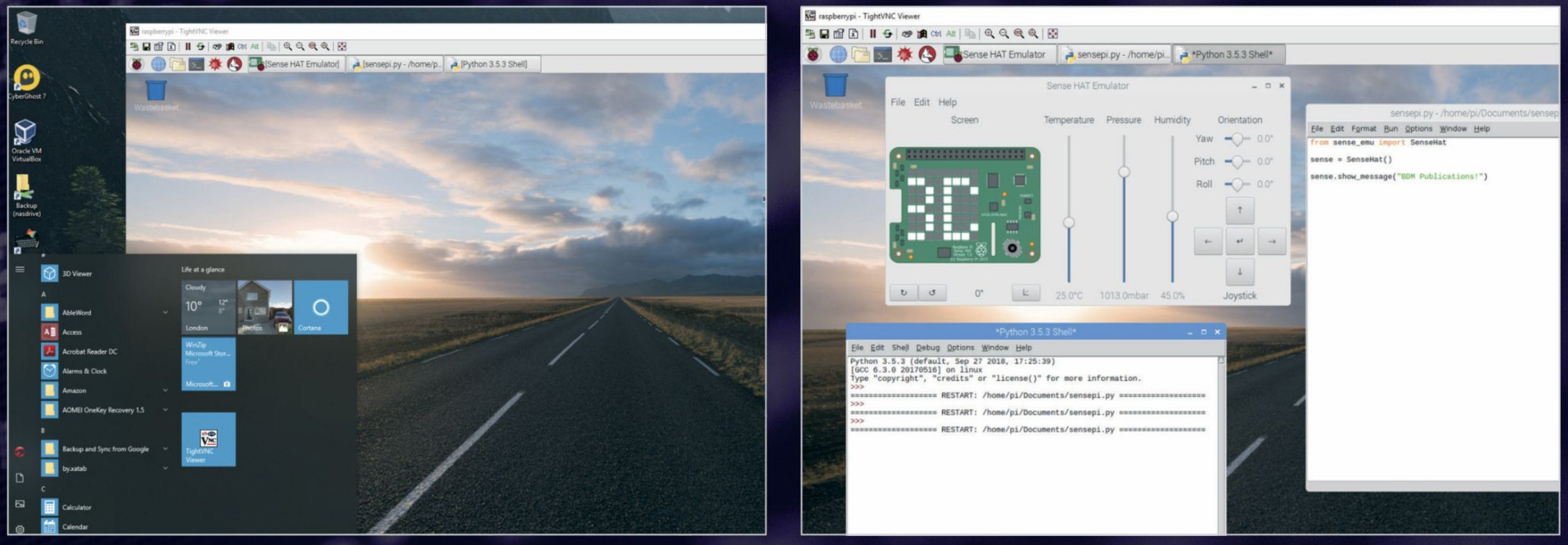
In conjunction with the new hardware the Pi 4 boasts, Buster does offer a few updates. Although on the whole it's very similar in appearance and operation to the previous version of Raspbian. The updates are mainly in-line with the 4K's display and playback, giving the Pi 4 a new set of graphical drivers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

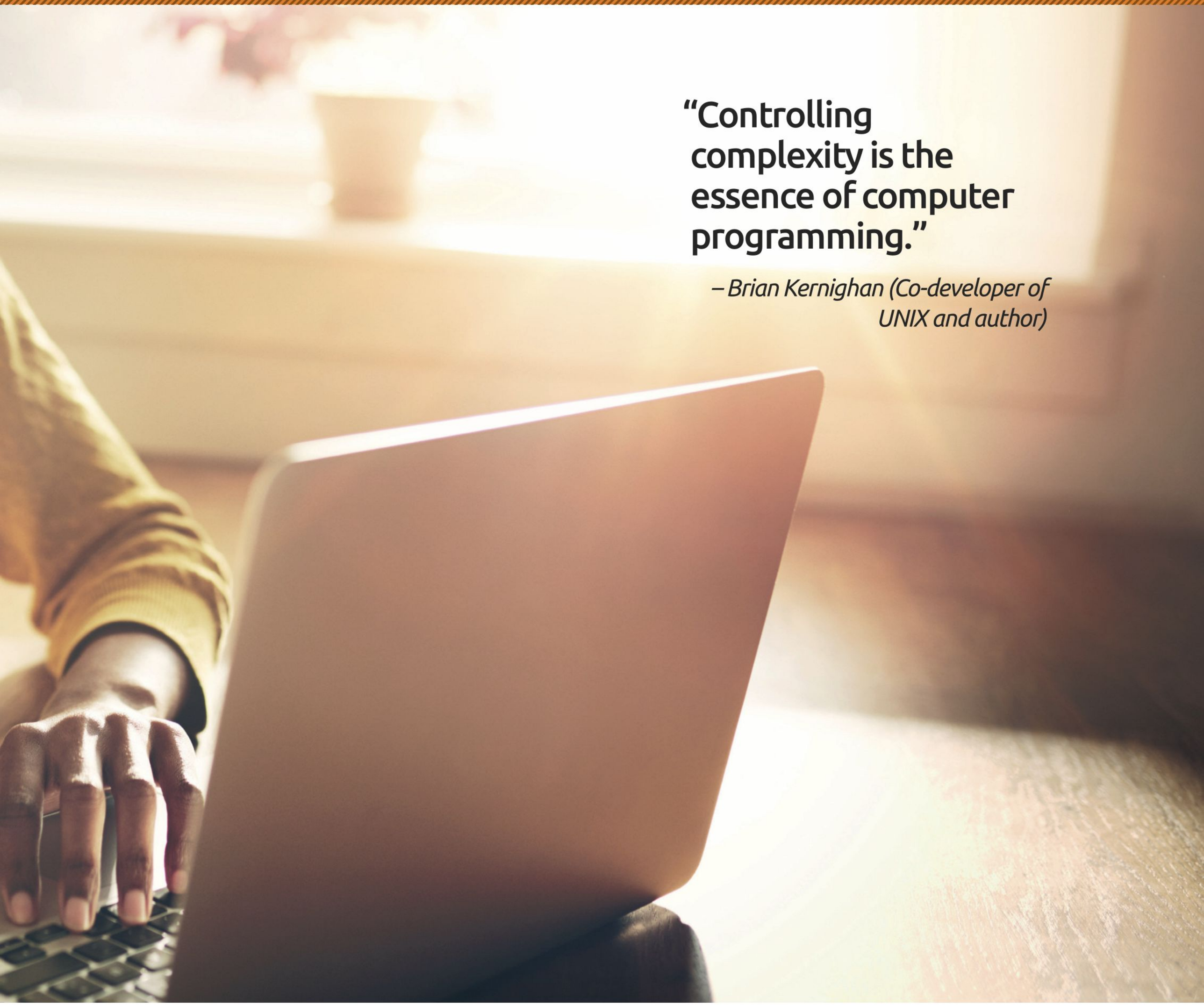


You've had your introduction to Python, so let's start learning some of the basics and how to code in this remarkable programming language.

Within this section are the essential building blocks to learning Python. You will create your first piece of code, then extend your skills to using numbers and expressions, variables, user input, functions, conditions, and loops and modules. You will even look at how you can execute Python code from the command line, which can then be utilised in other code, such as C++ or scripting within Linux and Windows.

72 Starting Python for the First Time
74 Your First Code
76 Saving and Executing Your Code
78 Executing Code from the Command Line
80 Numbers and Expressions
82 Using Comments
84 Working with Variables
86 User Input
88 Creating Functions
90 Conditions and Loops
92 Python Modules

Coding with Python



"Controlling complexity is the essence of computer programming."

– Brian Kernighan (Co-developer of UNIX and author)

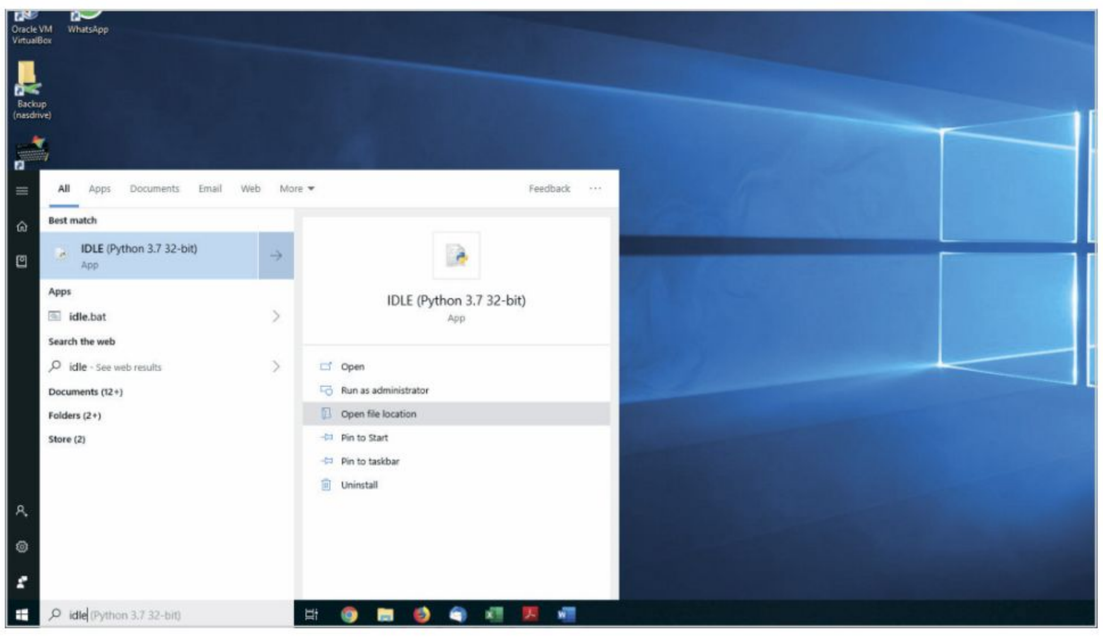
Starting Python for the First Time

We're using Python 3 under Windows 10 for these following examples. Don't worry if your version of Python is 3.4.2, or something lesser than the current version, as long as you're using Python 3, the code will work.

STARTING PYTHON

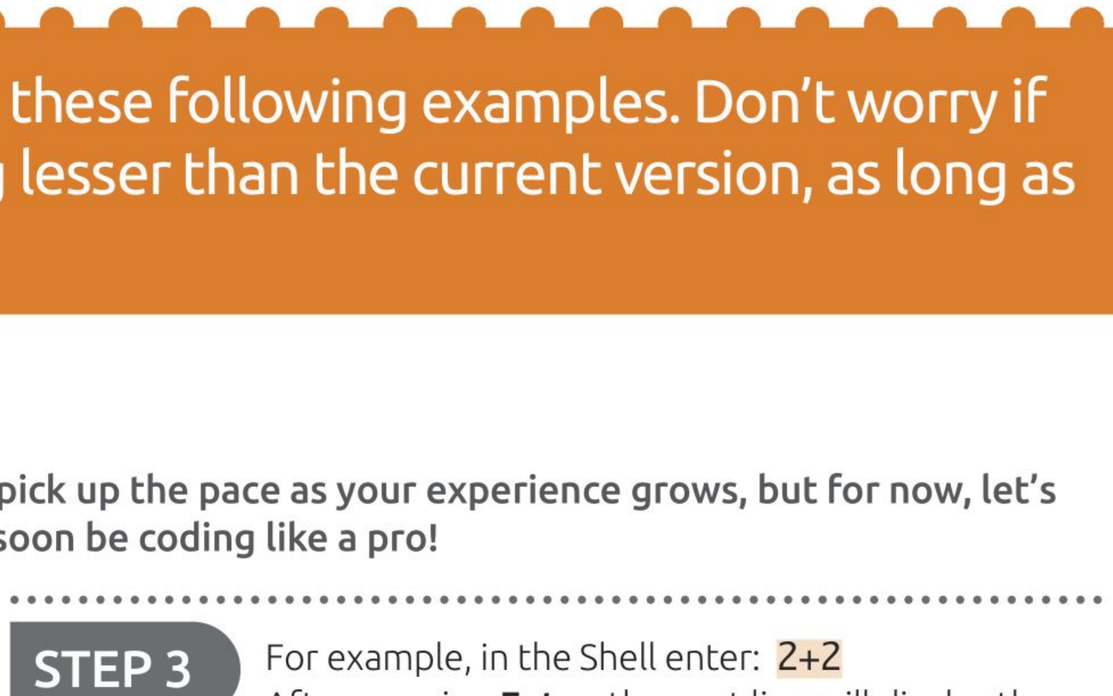
As when learning anything new, you need to start slow. You can pick up the pace as your experience grows, but for now, let's just get something appearing on the screen. Don't worry, you'll soon be coding like a pro!

STEP 1 Click on the Windows Start button, and start typing 'idle'. The result will be the currently installed version of Python, **IDLE (Python 3.7 32-bit)**, for example. You can Pin it to the Start for convenience, otherwise simply click the icon to launch the Python Shell.



STEP 2 The Shell is where you can enter code and see the responses and output of code you've programmed into Python. This is a kind of sandbox, if you will, where you're able to try out some simple code and processes.

STEP 3 For example, in the Shell enter: `2+2`
After pressing **Enter**, the next line will display the answer: 4. Basically, Python has taken the 'code' and produced the relevant output.



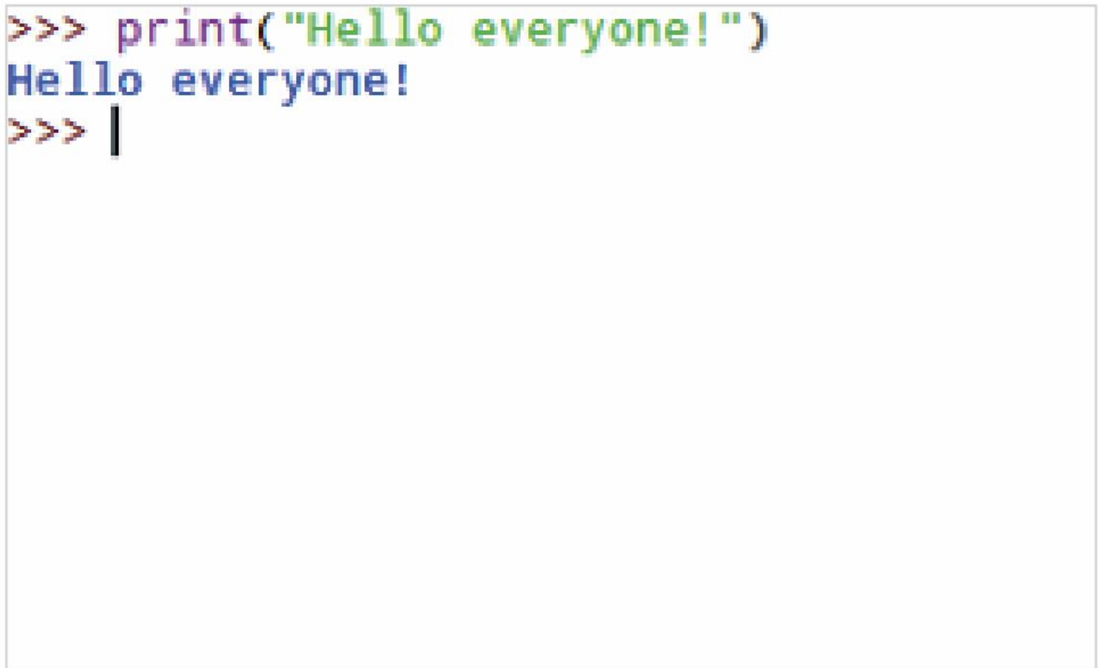
STEP 4 The Python Shell acts very much like a calculator, since code is basically a series of mathematical interactions with the system. Integers, which are the infinite sequence of whole numbers, can easily be added, subtracted, multiplied, and so on.

STEP 5 While that's very interesting, it's not particularly exciting. Instead, try this:

```
print("Hello everyone!")
```

Just enter it into the IDLE as you've done in the previous steps.

STEP 6 This is a little more like it, since you've just produced your first bit of code. The Print command is fairly self-explanatory, it prints things. Python 3 requires the parentheses as well as quotes in order to output content to the screen, in this case the 'Hello everyone!' bit.



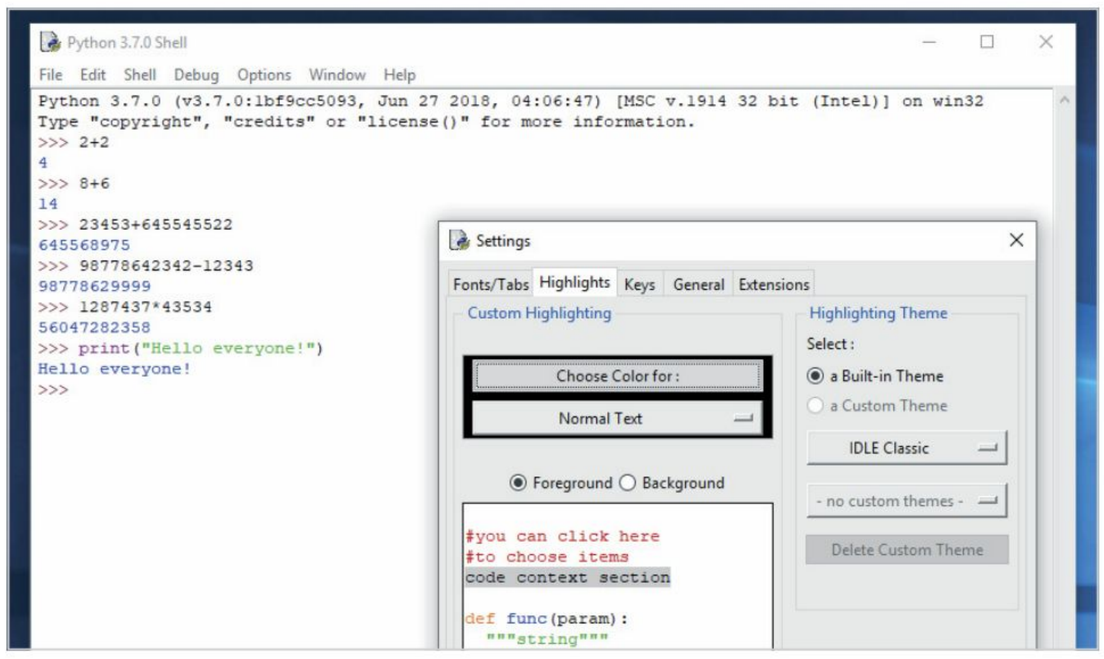
STEP 7 You'll have noticed the colour coding within the Python IDLE. The colours represent different elements of Python code. They are:

Black – Data and Variables
Green – Strings
Purple – Functions
Orange – Commands
Blue – User Functions
Dark Red – Comments
Light Red – Error Messages

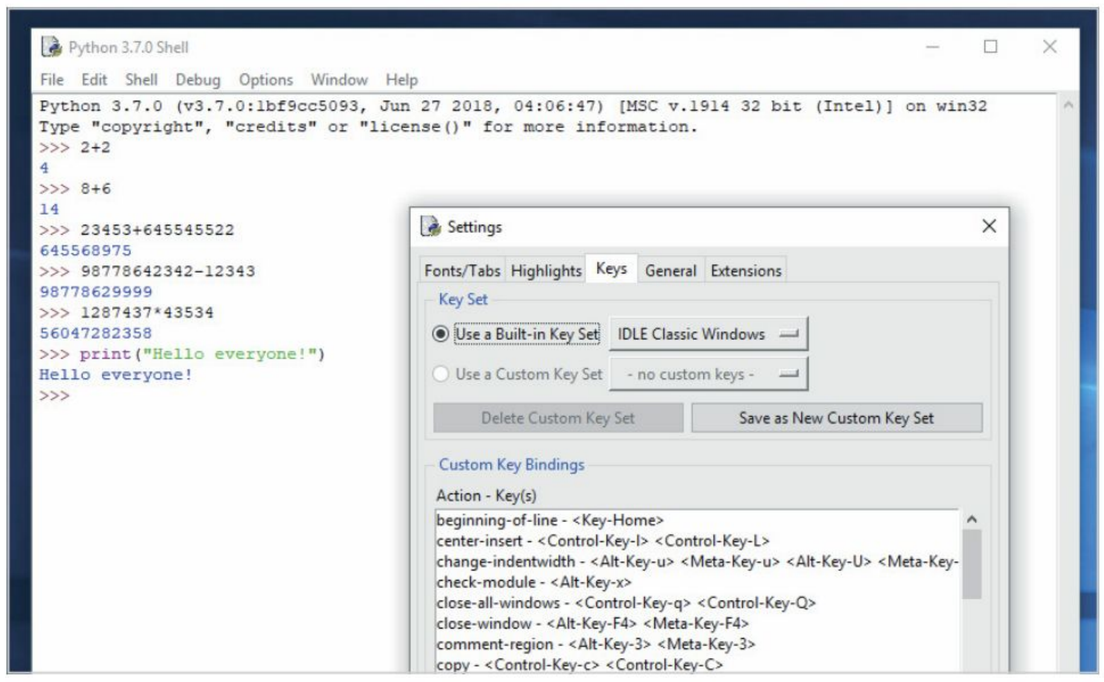
IDLE Colour Coding

Colour	Use for	Examples
Black	Data & variables	`23.6 area`
Green	Strings	`"Hello World"`
Purple	Functions	`len() print()`
Orange	Commands	`if for else`
Blue	User functions	`get_area()`
Dark red	Comments	`#Remember VAT`
Light red	Error messages	`SyntaxError:`

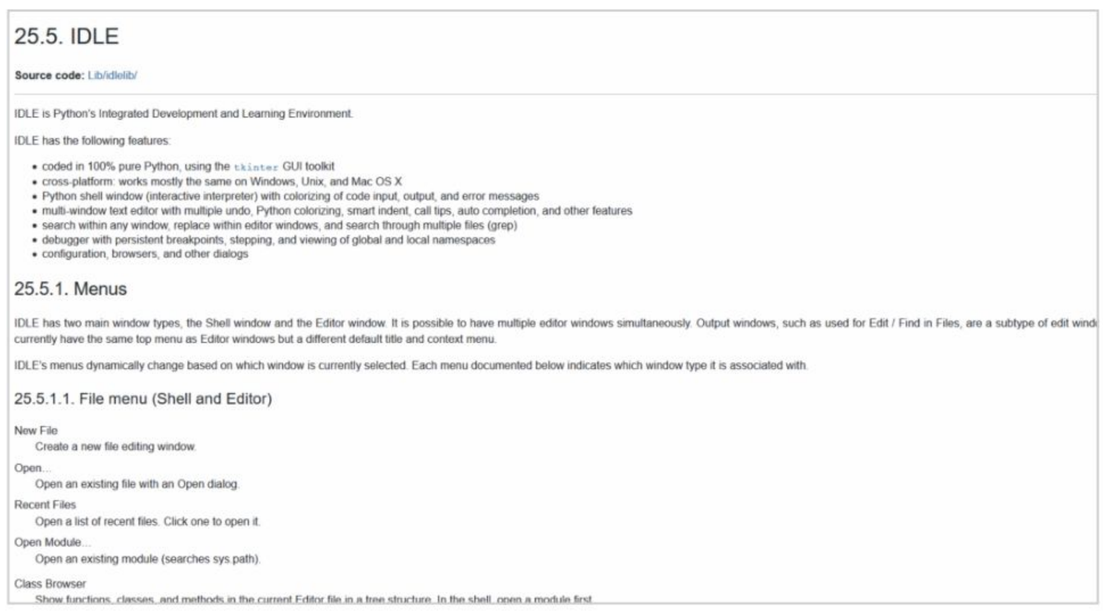
STEP 8 The Python IDLE is a configurable environment. If you don't like the way the colours are represented, then you can always change them via **Options > Configure IDLE**, and clicking on the **Highlighting** tab. However, we don't recommend that as you won't be seeing the same as our screenshots.



STEP 9 As with most programs available, regardless of the operating system, there are numerous shortcut keys. We don't have room for them all here, but within the Options > Configure IDLE and under the **Keys** tab, you'll see a list of the current bindings.



STEP 10 The Python IDLE is a power interface, and one that's actually been written in Python using one of the available GUI toolkits. If you want to know the many ins and outs for the Shell, we recommend you take a few moments to view **https://docs.python.org/3/library/idle.html**, which details many of the IDLE's features.



25.5. IDLE

Source code: Lib/idlelib/

IDLE is Python's Integrated Development and Learning Environment.

IDLE has the following features:

- coded in 100% pure Python, using the `tkinter` GUI toolkit
- cross-platform: works mostly the same on Windows, Unix, and Mac OS X
- Python shell window (interactive interpreter) with colorizing of code input, output, and error messages
- multi-window text editor with multiple undo, Python colorizing, smart indent, call tips, auto completion, and other features
- search within any window, replace within editor windows, and search through multiple files (grep)
- debugger with persistent breakpoints, stepping, and viewing of global and local namespaces
- configuration, browsers, and other dialogs

25.5.1. Menus

IDLE has two main window types, the Shell window and the Editor window. It is possible to have multiple editor windows simultaneously. Output windows, such as used for Edit / Find in Files, are a subtype of edit windo currently have the same top menu as Editor windows but a different default title and context menu.

IDLE's menus dynamically change based on which window is currently selected. Each menu documented below indicates which window type it is associated with.

25.5.1.1. File menu (Shell and Editor)

New File
Create a new file editing window.

Open...
Open an existing file with an Open dialog.

Recent Files
Open a list of recent files. Click one to open it.

Open Module...
Open an existing module (searches sys.path).

Class Browser
Show functions, classes, and methods in the current Editor file in a tree structure. In the shell, open a module first.

Your First Code

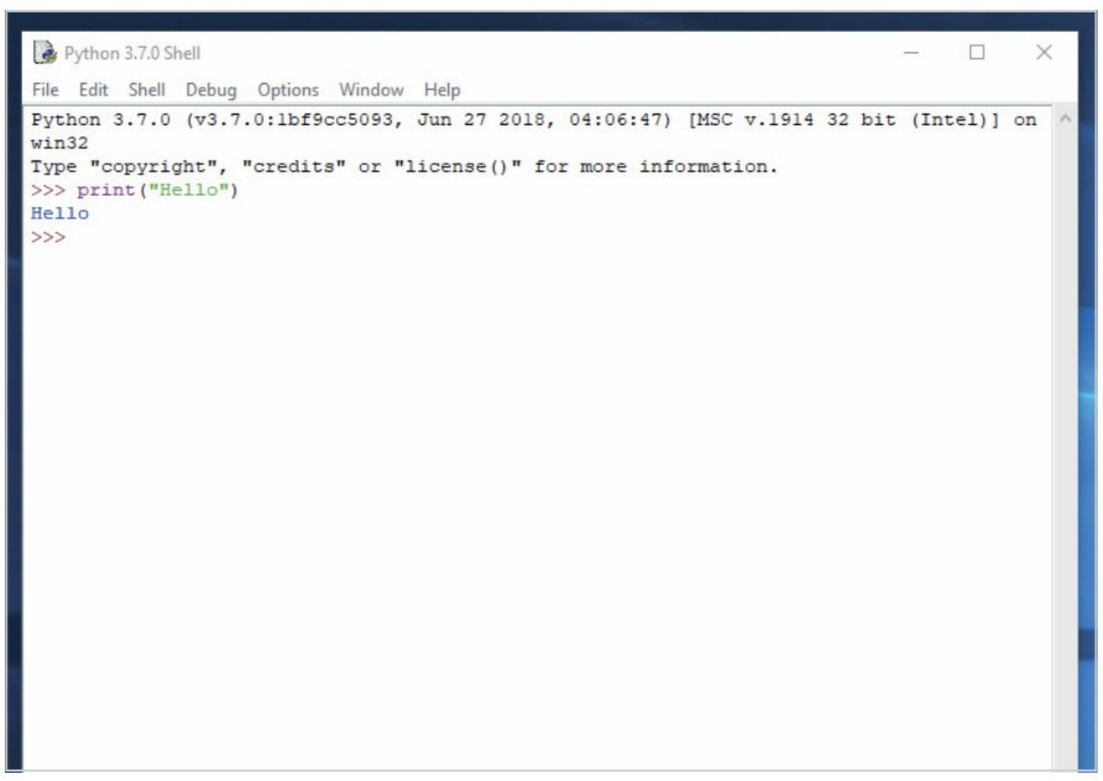
Essentially, you've already written your first piece of code with the print("Hello everyone!") function from the previous tutorial. However, let's expand that and look at entering your code and playing around with some other Python examples.

PLAYING WITH PYTHON

As with most languages, computer or human, it's all about remembering and applying the right words to the right situation. You're not born knowing these words, so you need to learn them.

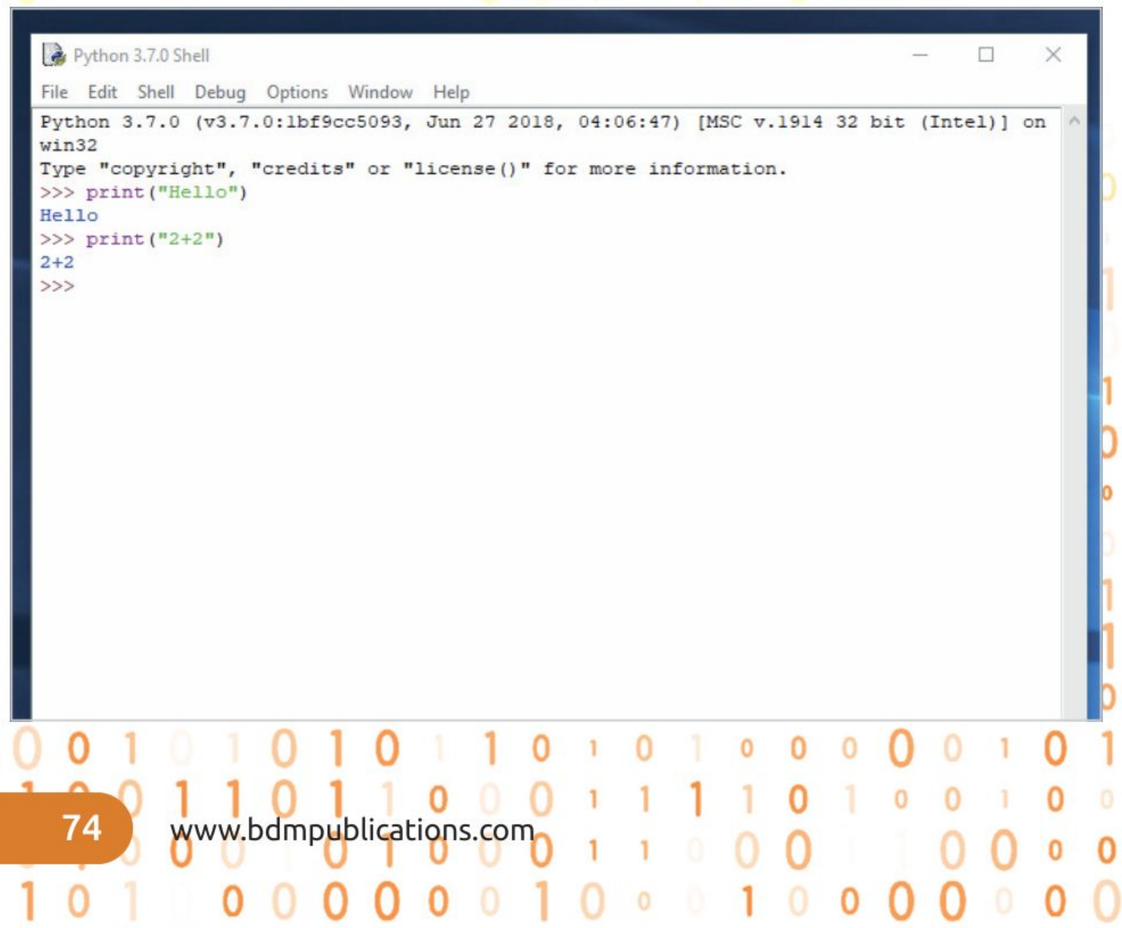
STEP 1 If you've closed Python 3 IDLE, re-open it as you did in the previous page. In the Shell, enter the familiar following:

```
print("Hello")
```



STEP 2 As predicted, the word Hello appears in the Shell as blue text indicating output from a string. It's fairly straightforward, and doesn't require too much explanation. Now try:

```
print("2+2")
```

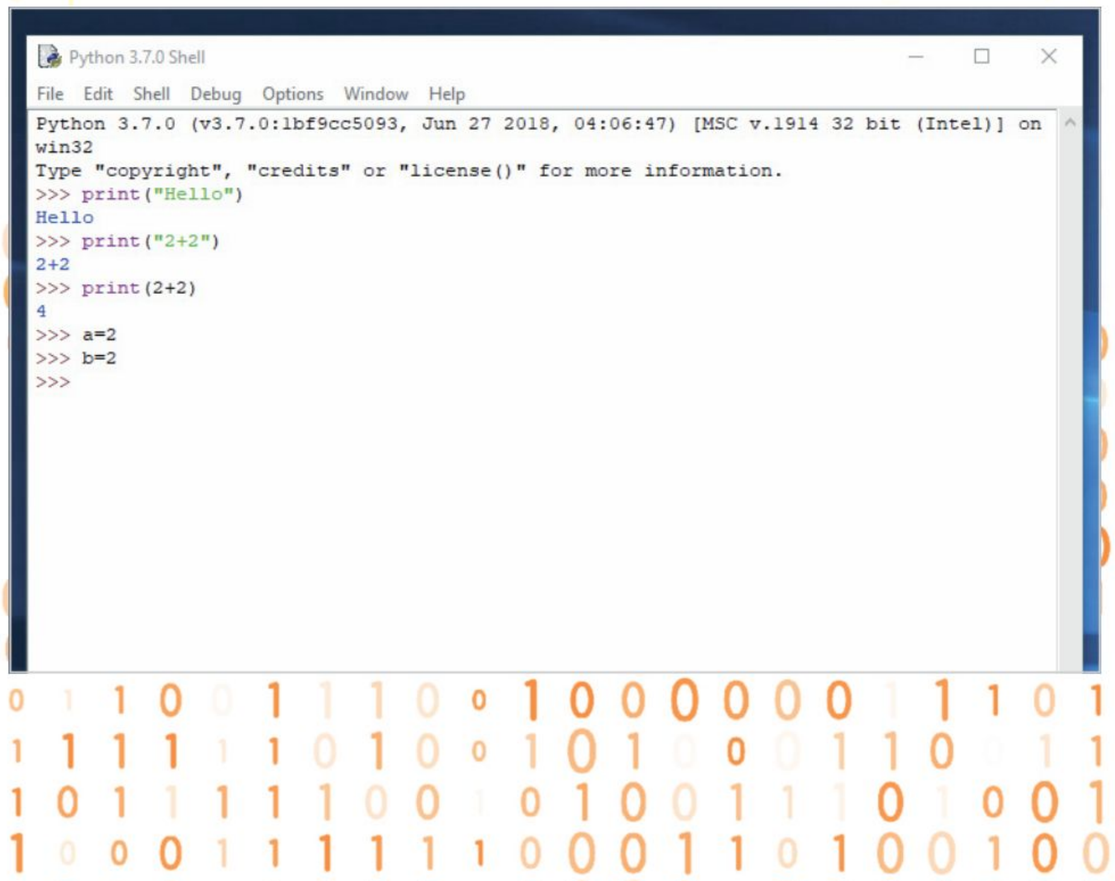


STEP 3 You'll notice that instead of the number 4, the output is the 2+2 you asked to be printed to the screen. The quotation marks are defining what's being outputted to the IDLE Shell, to print the total of 2+2 you'll need to remove the quotes:

```
print(2+2)
```

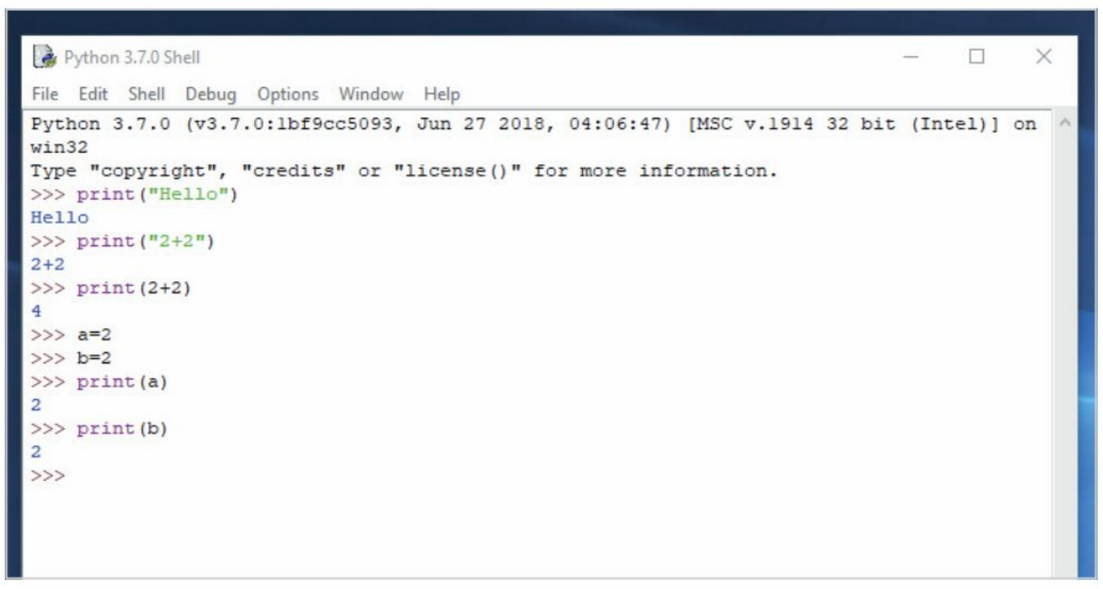
STEP 4 You can continue as such, printing 2+2, 464+2343 and so on to the Shell. An easier way is to use a variable, which is something we will cover in more depth later. For now, enter:

```
a=2
b=2
```

STEP 5 What you have done here is assign the letters a and b two values: 2 and 2. These are now variables, which can be called upon by Python to output, add, subtract, divide and so on, for as long as their numbers stay the same. Try this:

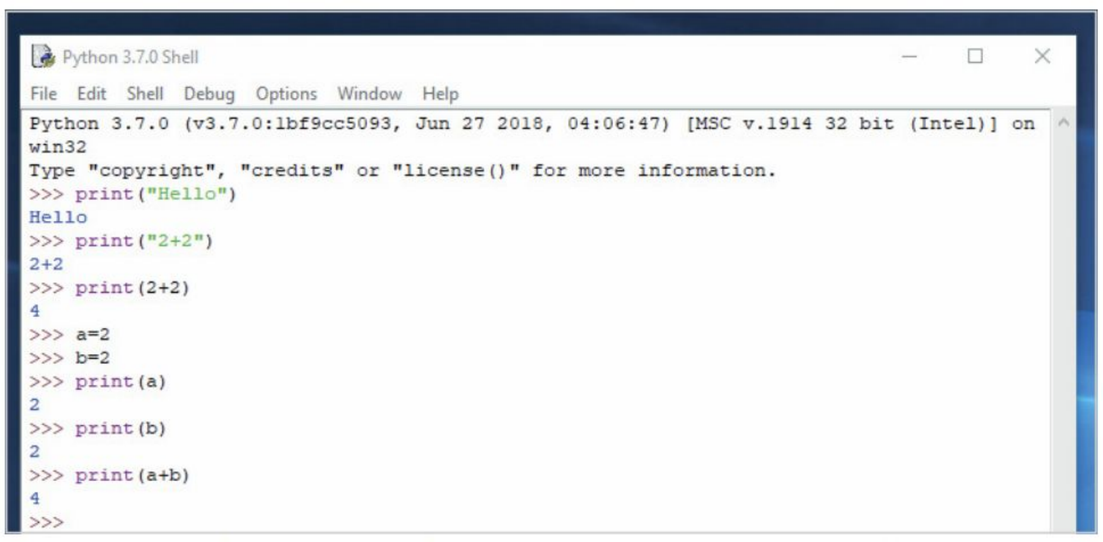
```
print(a)
print(b)
```



STEP 6 The output of the last step displays the current values of a and b individually, as essentially you've asked them to be printed separately. If you want to add them up, you can use the following:

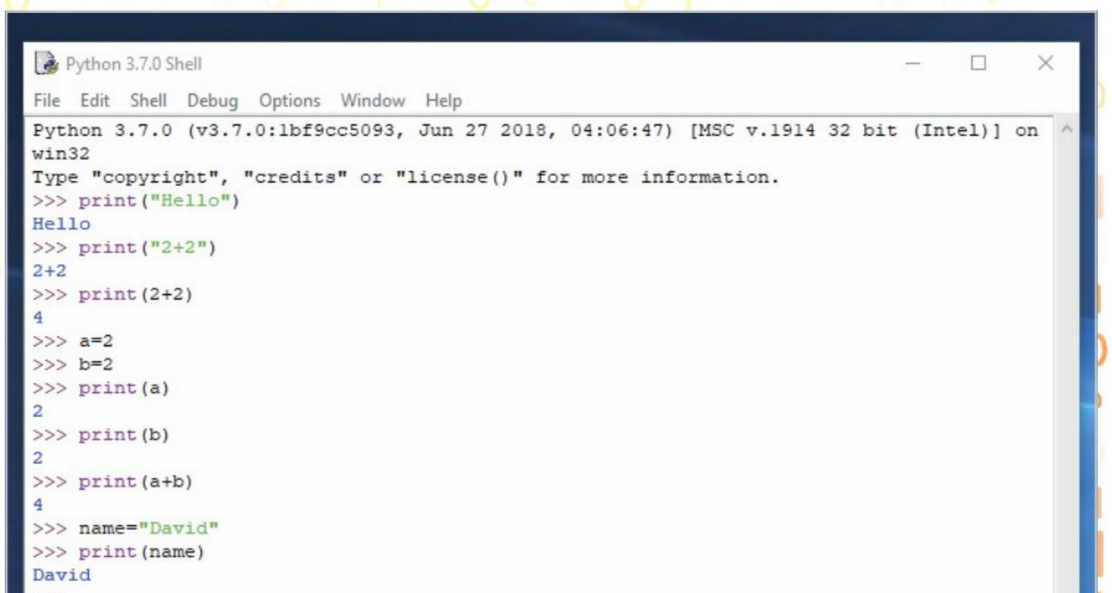
```
print(a+b)
```

This code takes the value of both a and b, adds them together, and outputs the result.



STEP 7 You can play around with different kinds of variables together with the Print function. For example, we could assign variables for someone's name:

```
name=”David”
print(name)
```



STEP 8 Now let's add a surname:

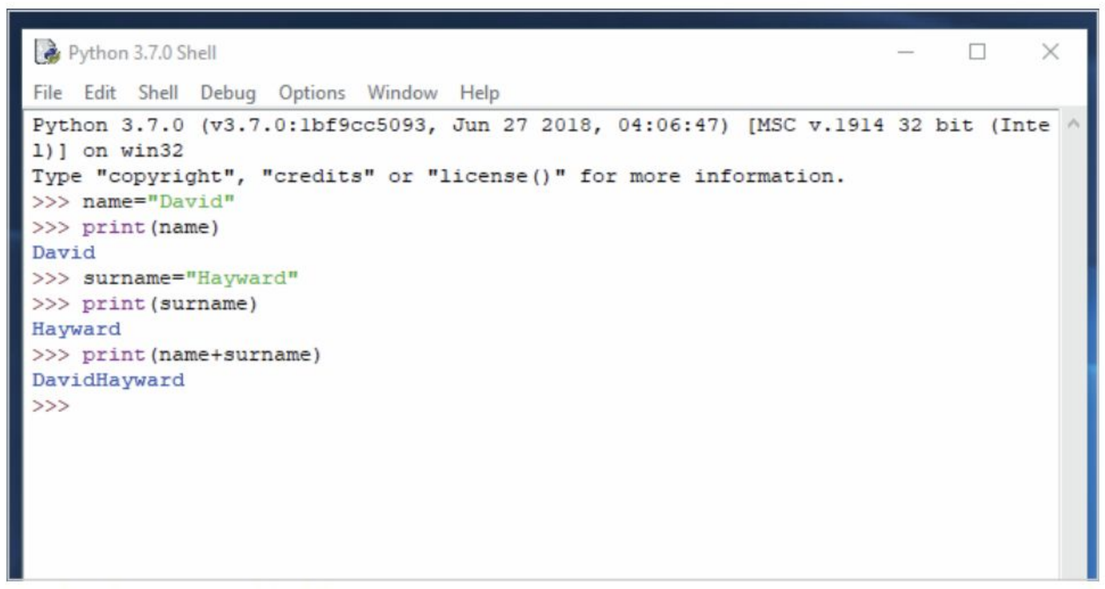
```
surname=”Hayward”
print(surname)
```

We now have two variables containing both a first name and a surname, and we can print them independently.

STEP 9 If we were to apply the same routine as before, using the + symbol, the name wouldn't appear correctly in the output in the Shell. Try it:

```
print(name+surname)
```

We need a space between the two, defining them as two separate values and not something you mathematically play around with.



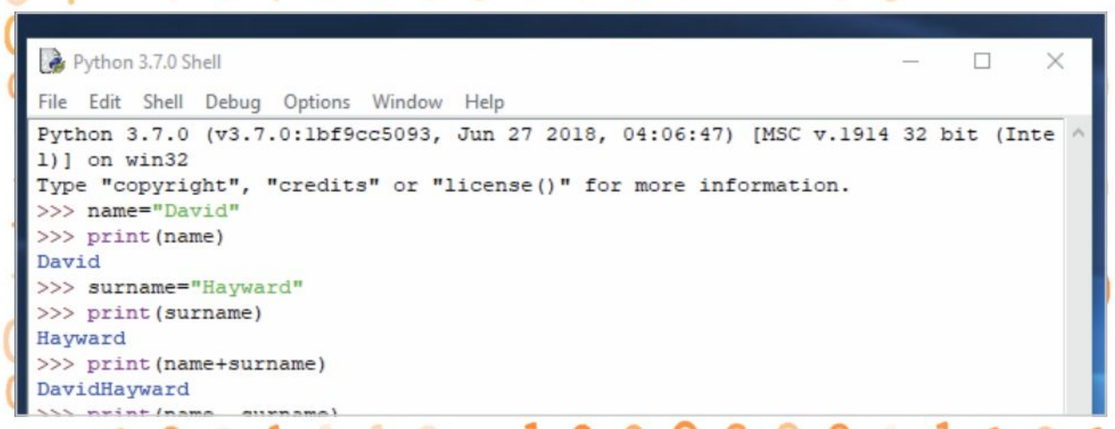
STEP 10 In Python 3 we can separate the two variables with a space by using a comma:

```
print(name, surname)
```

Alternatively, you can add the space yourself:

```
print(name+” “+surname)
```

As you can see, the use of the comma is much neater. Congratulations, you've just taken your first steps into the wide world of Python.



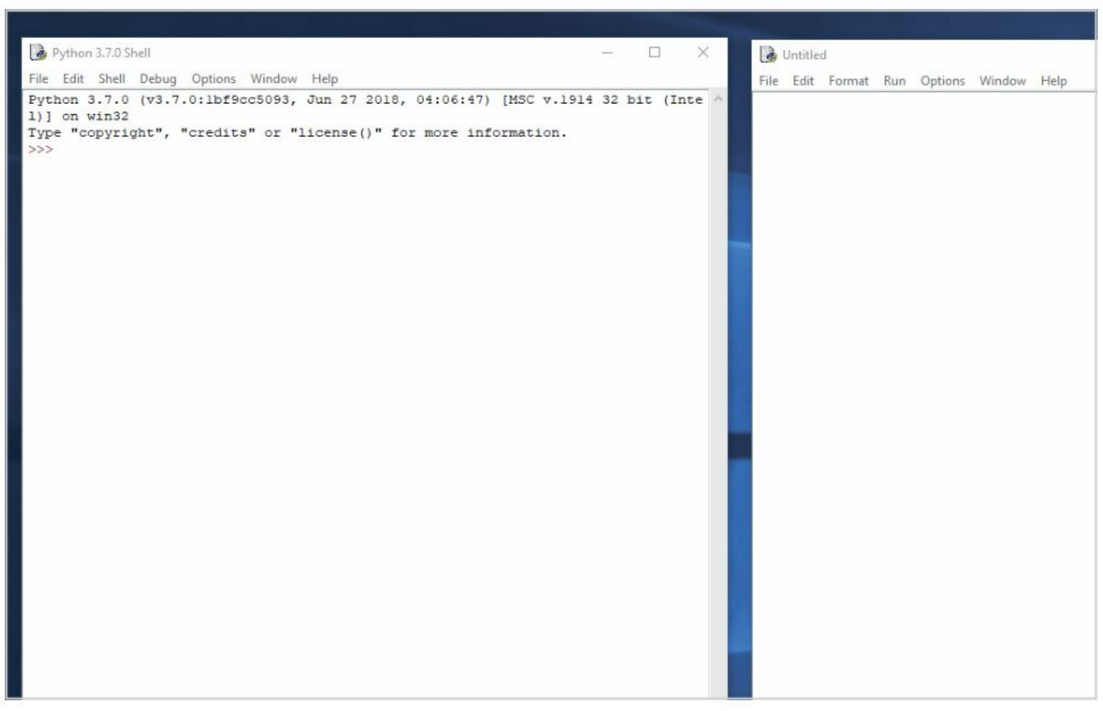
Saving and Executing Your Code

While working in the IDLE Shell is perfectly fine for snippets of code, it's not designed for entering longer program listings. In this section, we'll introduce you to the IDLE Editor, where most of our code will be entered from now on.

EDITING CODE

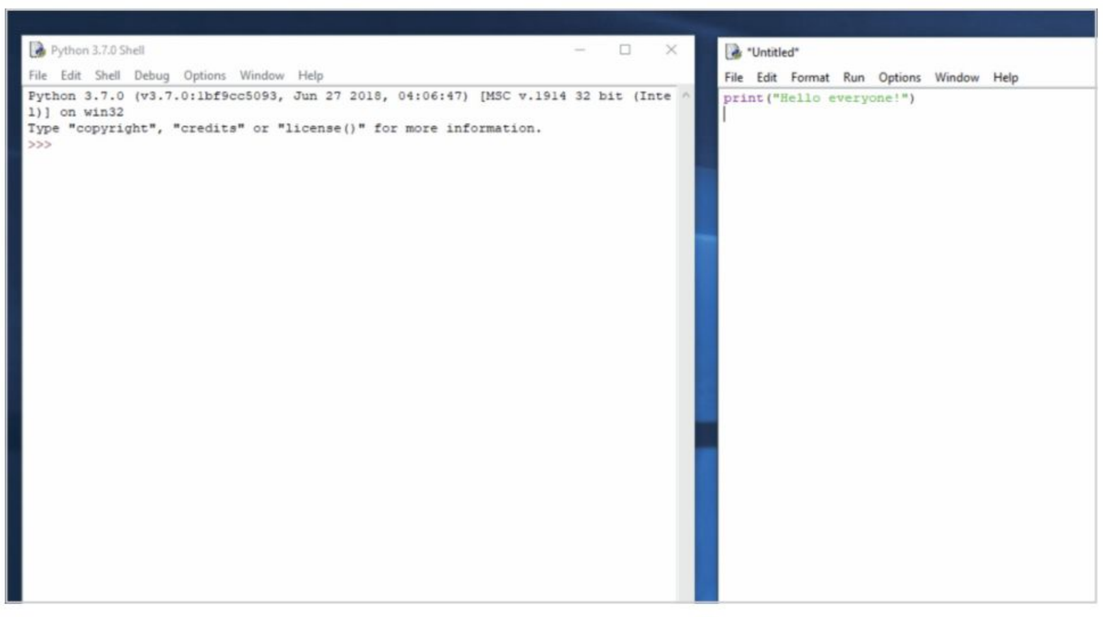
You will eventually reach a point where you have to move on from inputting single lines of code into the Shell. Instead, the IDLE Editor will allow you to save and execute your Python code.

STEP 1 First, open the Python IDLE Shell. When it's up, click on **File > New File**, this will open a new window with Untitled as its name. This is the Python IDLE Editor, and within it, you can enter the code you need to create your future programs.

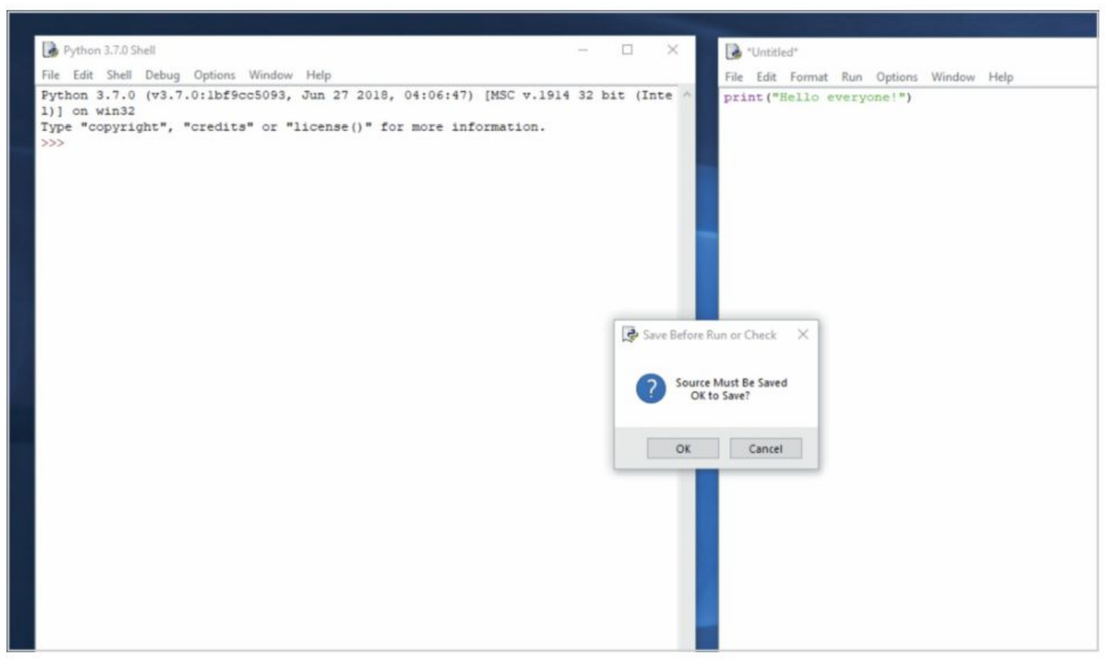


STEP 2 The IDLE Editor is, for all intents and purposes, a simple text editor with Python features, colour coding and so on. You enter code as you would within the Shell, so taking an example from the previous tutorial, enter:

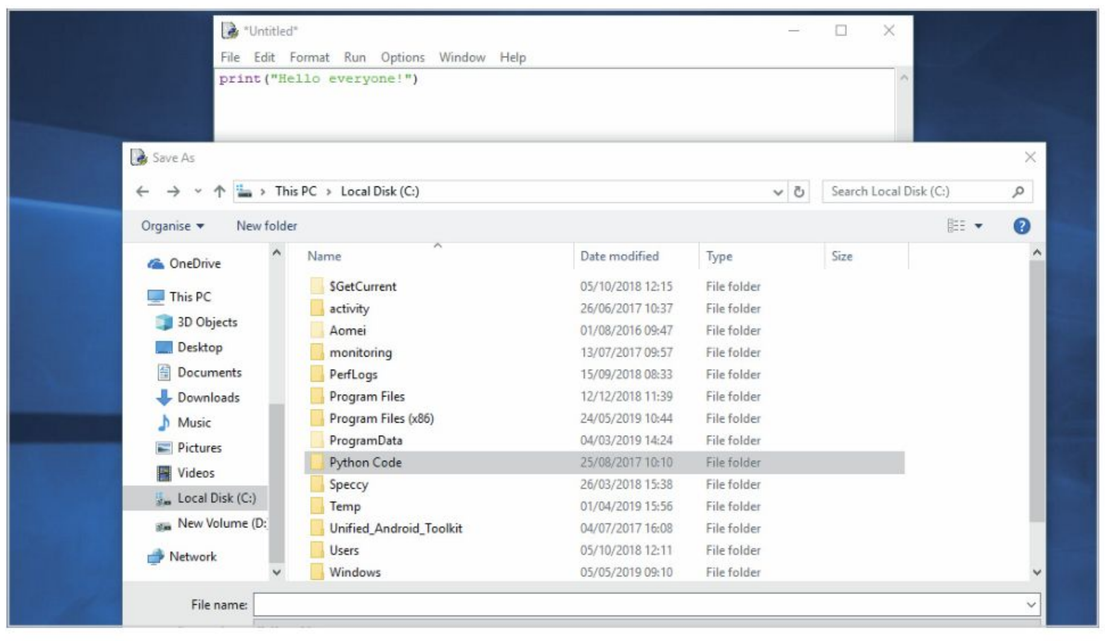
```
print("Hello everyone!")
```



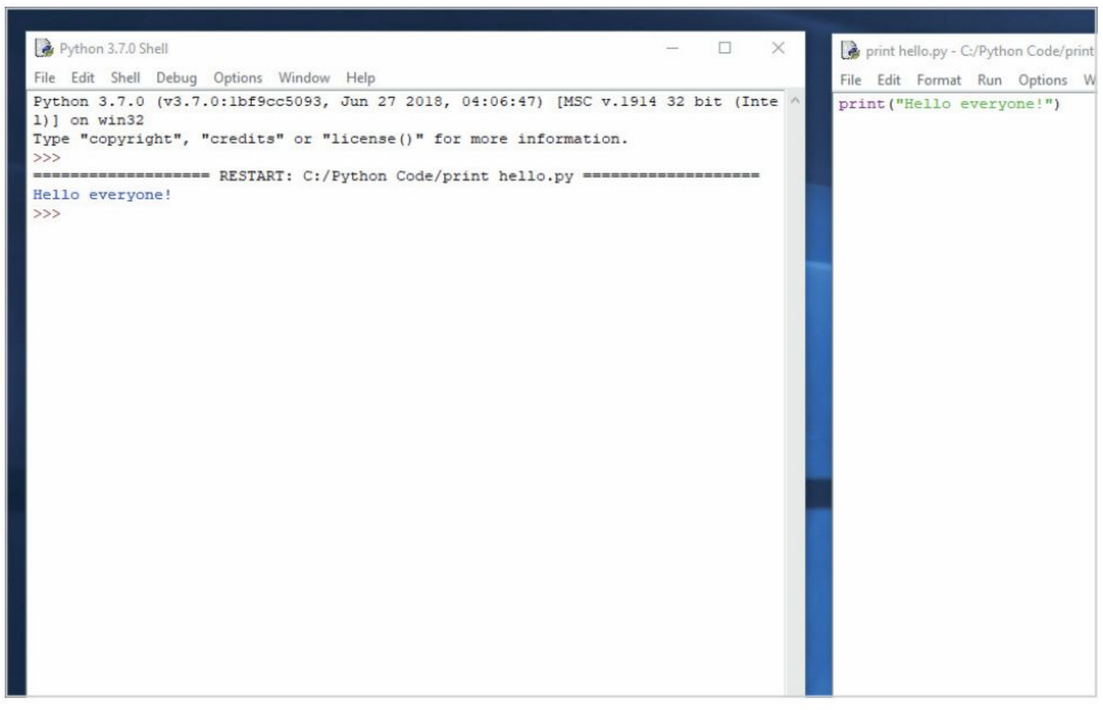
STEP 3 As you can see the same colour coding is in place in the IDLE Editor as it is in the Shell, enabling you to better understand what's going on with your code. To execute the code, however, you need to first save it. Press **F5** and you'll have a Save…Check box open.



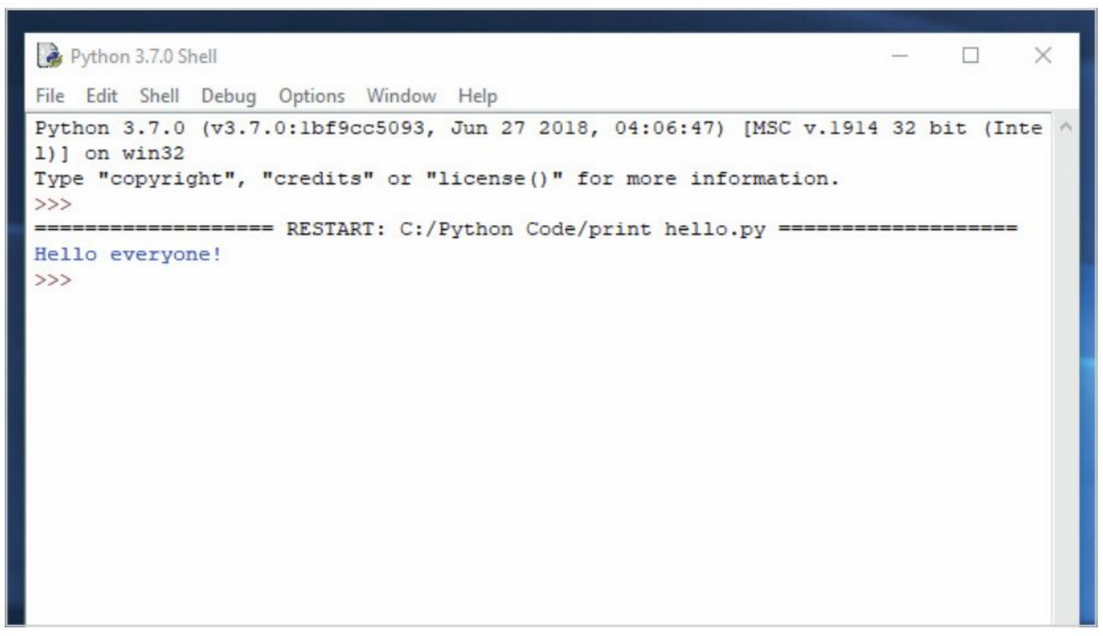
STEP 4 Click on the **OK** button in the Save box, and select a destination where you'll save all your Python code. The destination can be a dedicated folder called Python, or you can just dump it wherever you like. Remember to keep a tidy file system, though, it'll help you out in the future.



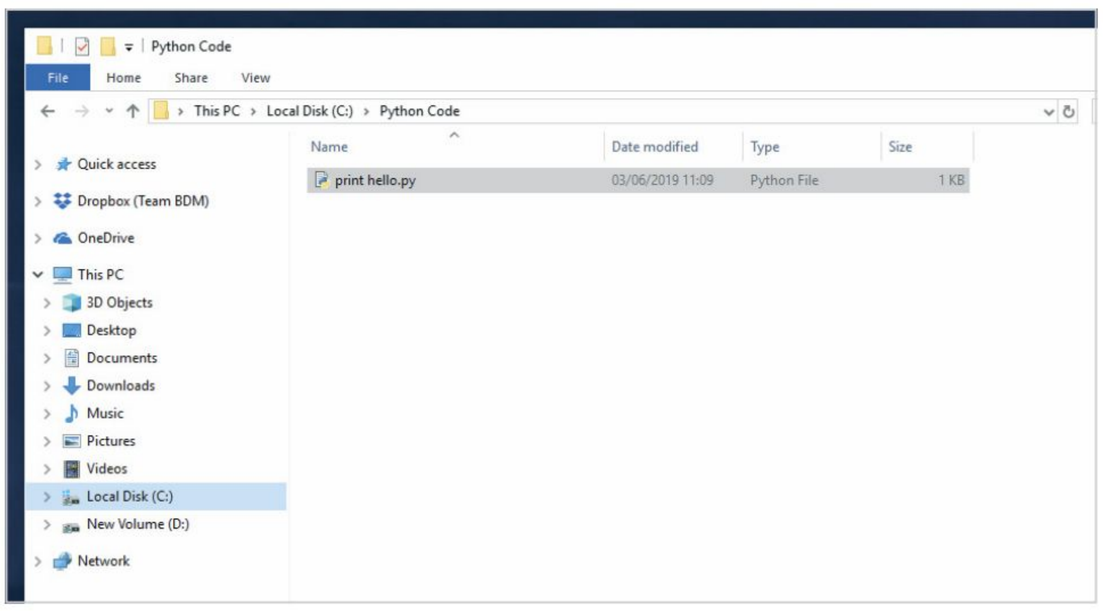
STEP 5 Enter a name for your code, 'print hello' for example, and click on the Save button. As soon as the Python code is saved, it's executed and the output will be detailed in the IDLE Shell; In this case, the words 'Hello everyone!'.



STEP 6 This is how the vast majority of your Python code will be conducted. Enter it into the Editor, hit F5, save the code, and look at the output in the Shell. Sometimes things will differ, depending on whether you've requested a separate window, but essentially that's the process and, unless otherwise stated, this is the method we will use.



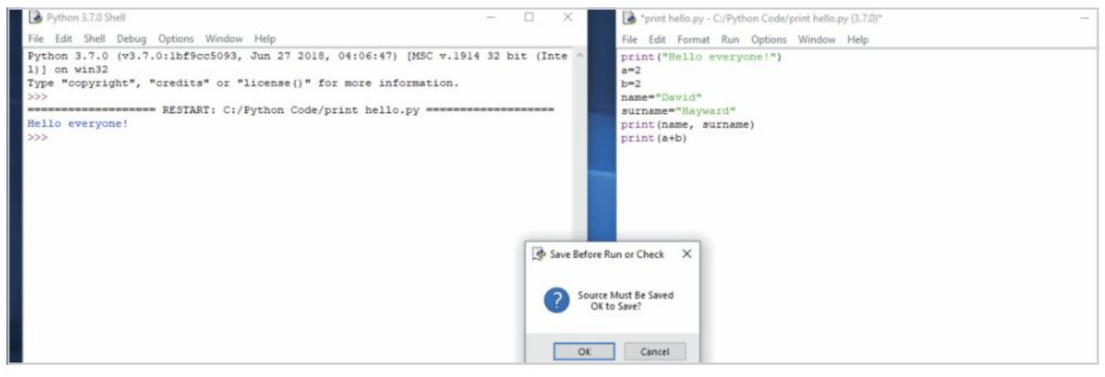
STEP 7 If you open the file location of the saved Python code, you'll notice that it ends in a .py extension. This is the default Python filename, any code you create will be whatever.py, and any code downloaded from the many Internet Python resource sites will be .py. Just ensure that the code is written for Python 3.



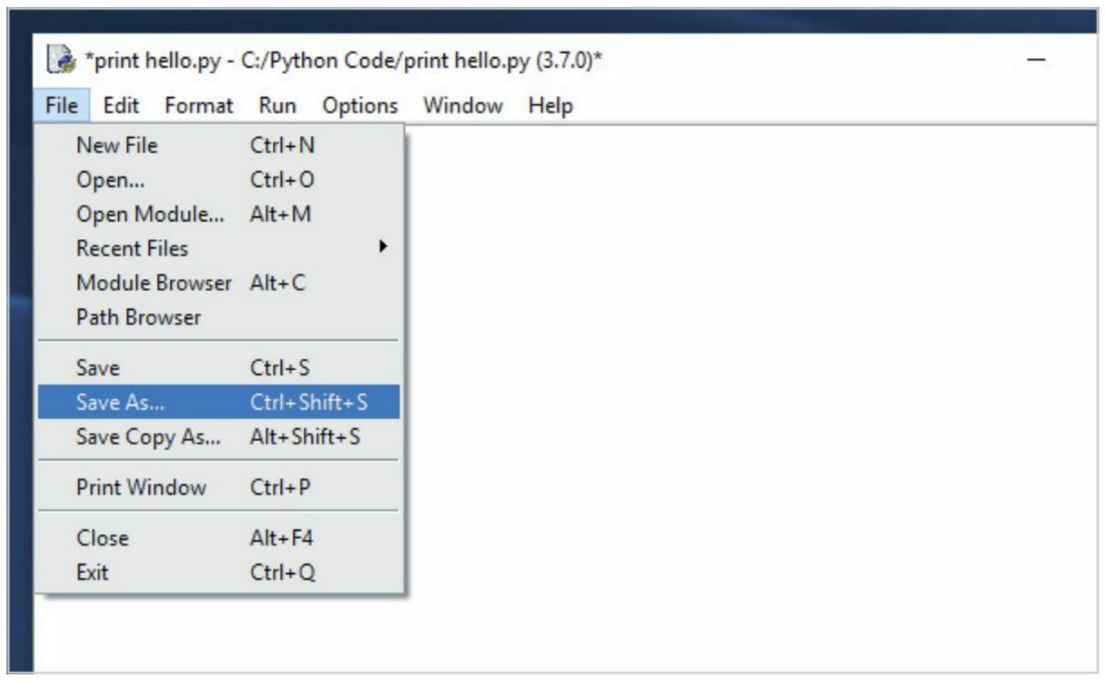
STEP 8 Let's extend the code and enter a few examples from the previous tutorial:

```
a=2
b=2
name="David"
surname="Hayward"
print(name, surname)
print (a+b)
```

If you press **F5** now, you'll be asked to save the file again, as it's been modified from before.



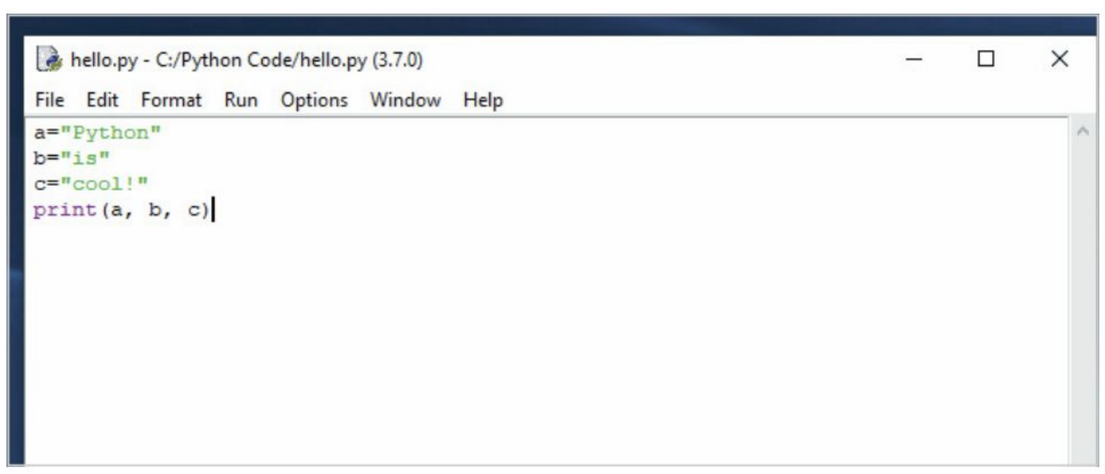
STEP 9 If you click the **OK** button the file will be overwritten with the new code entries, and executed; with the output in the Shell. It's not a problem with just these few lines, but if you were to edit a larger file overwriting can become an issue. Instead, use **File > Save As** from within the Editor to create a backup.



STEP 10 Now create a new file. Close the Editor, and open a new instance (File > New File from the Shell). Enter the following, and save it as **hello.py**:

```
a="Python"
b="is"
c="cool!"
print(a, b, c)
```

We will use this code in the next tutorial.



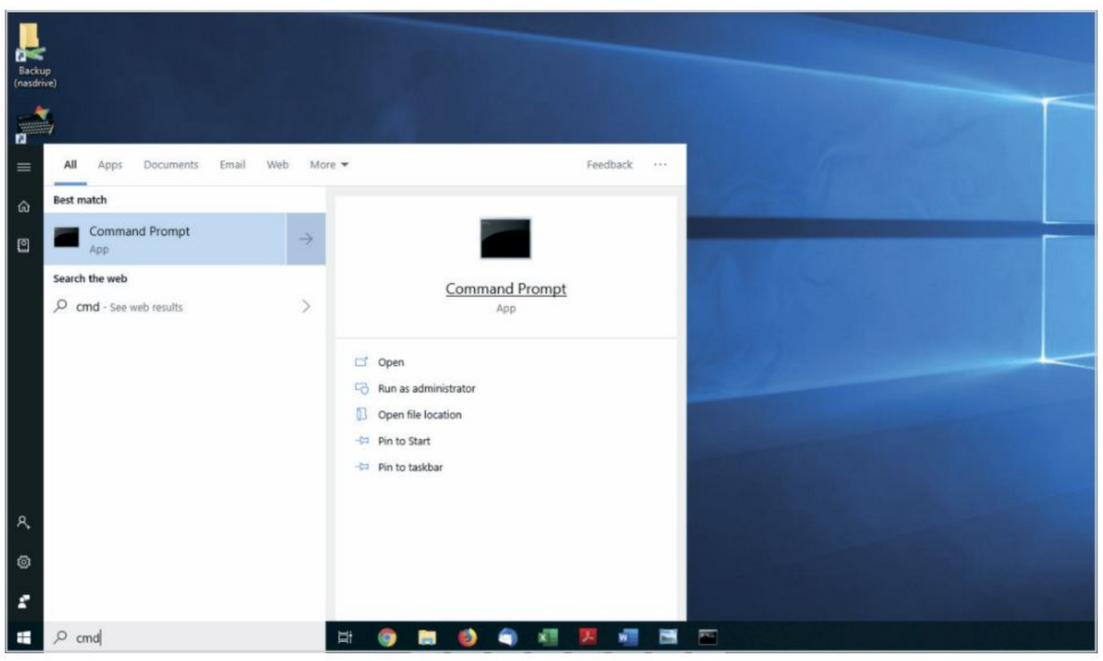
Executing Code from the Command Line

While we're going to be working from the GUI IDLE, it's worth taking a moment to look at Python's command line handling. Sometimes, depending on the code you write, executing via the command line is a better solution over the IDLE.

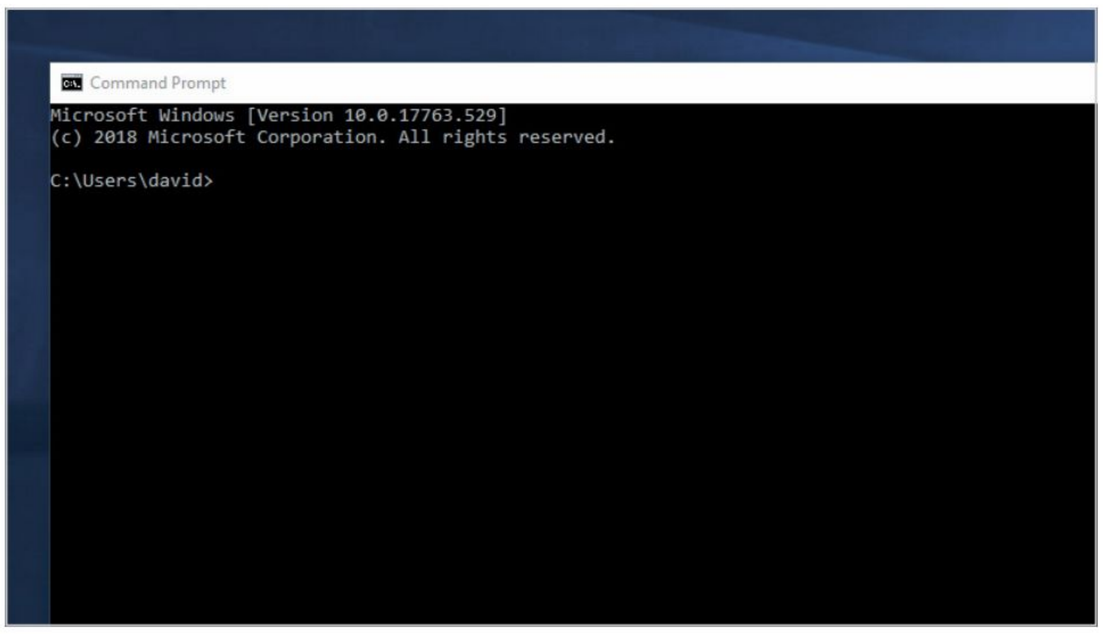
COMMAND THE CODE

Using the code we created in the previous tutorial, the one we named hello.py, let's see how we can run code that was made in the GUI at the command line level.

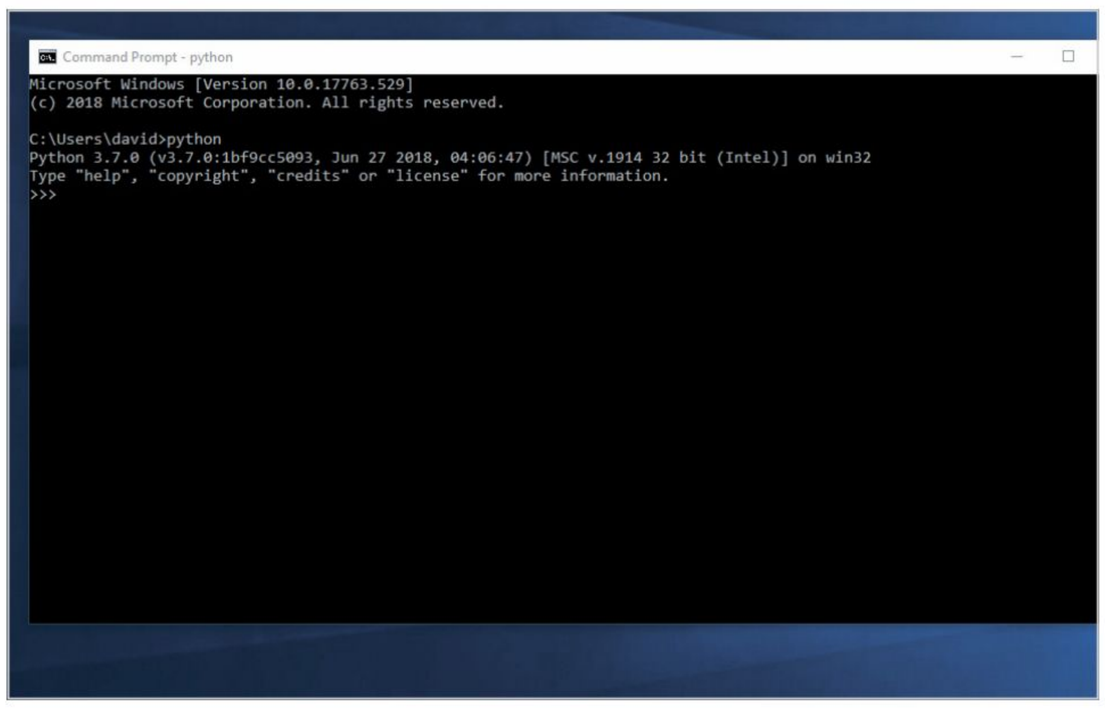
STEP 1 When you first installed Python, the installation routine automatically included all the necessary components to allow the execution of code outside of the GUI IDLE; in other words, the command line. To begin with, click on the Windows Start Button, and type: `cmd`.



STEP 2 As you did when launching the Python IDLE, click on the returned result from the search, the Command Prompt App. This will launch a new window, with a black background and white text. This is the command line, also called a Terminal in macOS, Linux, and Raspberry Pi operating systems.



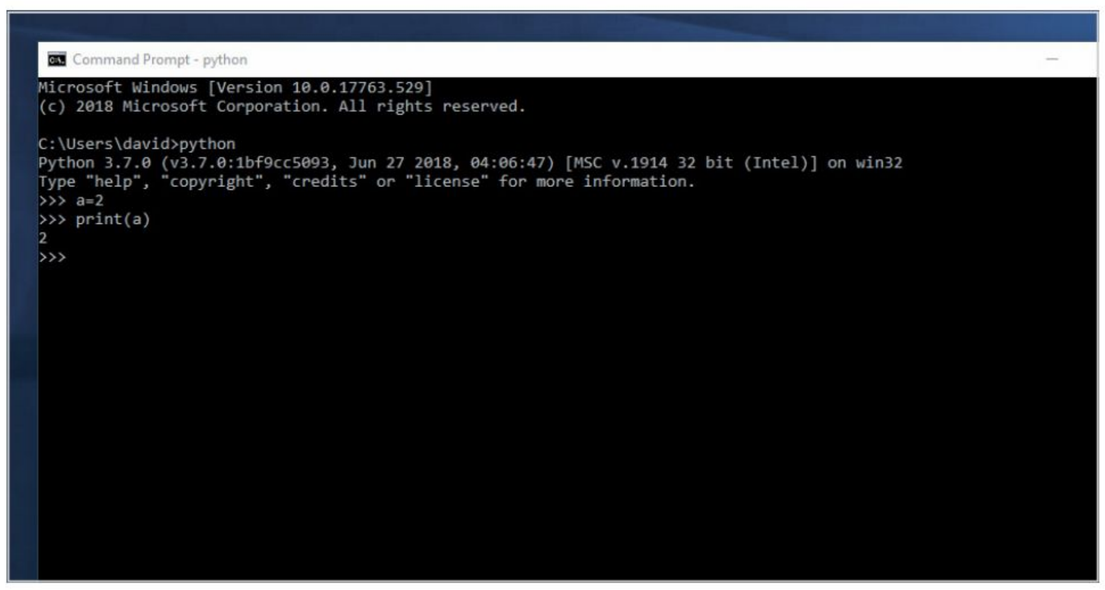
STEP 3 Now you're at the command line, we can start Python using the command `python` and pressing the Enter key. This will put you into the command line version of the Shell, with the familiar, three right-facing arrows as the cursor (>>>).



STEP 4 From here you're able to enter the code you've looked at previously, such as:

```
a=2
print(a)
```

As you can see, it works exactly the same.



STEP 5 Now enter `exit()` to leave the command line Python session, and return back to the command prompt. Enter the folder where you saved the code from the previous tutorial, and list the available files within; you should see the **hello.py** file.

```
Command Prompt
Microsoft Windows [Version 10.0.17763.529]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\david>python
Python 3.7.0 (v3.7.0:1bf9cc5093, Jun 27 2018, 04:06:47) [MSC v.1914 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> a=2
>>> print(a)
2
>>> exit()

C:\Users\david>cd\

C:\>cd "Python Code"

C:\Python Code>dir/w
 Volume in drive C has no label.
 Volume Serial Number is 8E47-ABFF

 Directory of C:\Python Code

[.]             [..]            hello.py         print hello.py
               2 File(s)             73 bytes
               2 Dir(s)  76,514,889,728 bytes free

C:\Python Code>
```

STEP 6 From within the same folder as the code you're going to run, enter the following into the command line:

```
python hello.py
```

This will execute the code we created, which to remind you is:

```
a="Python"
b="is"
c="cool!"
print(a, b, c)
```

```
Command Prompt

C:\Python Code>python hello.py
Python is cool!

C:\Python Code>
```

DIFFERENT VERSIONS OF PYTHON

If you've previously used Python 3 on a Mac or Linux, and subsequently the Raspberry Pi, you may be a little confused as to why the Windows version of Python uses the command line: **python**, instead of **python3**.

The reason behind this is that UNIX-like systems, such as macOS and Linux, already have Python libraries pre-installed. These older libraries are present because some of the macOS and Linux system utilities rely on Python 2, and therefore installing a newer version of Python, and thus altering the executable name, could have dire consequences to the system.

As a result, developers decided that the best approach for macOS and Linux systems would be to leave the command line **'python'** as exclusive Python 2 use, and newer versions of user-installed Python would be **'python3'**.

This isn't an issue with Windows, as it doesn't use any Python libraries other than the ones installed by the user themselves when actually installing Python. When a Windows user installs Python, the installation wizard will auto-include the command line instance to the core Windows PATH variable, which you can view by entering: `path` into the command line. This points to the python.exe file required to execute Python code from the command line.

We don't recommend you install both Python 2 and Python 3 within Windows 10; naturally, you can if you want, but realistically, although Python 2 still has a foothold in the coding world, Python 3 is the newest version. However, if you do, then you will need to rename one of the Python versions names; as they will be installed in different folders and both use python.exe as the command line executable. It's a little long-winded, so unless there's a dire need to have both versions of Python installed, it's best to stick to Python 3.

```
Command Prompt
Microsoft Windows [Version 10.0.17763.529]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\david>path
PATH=C:\ProgramData\Oracle\Java\javapath;C:\Program Files (x86)\Intel\iCLS Client\;C:\Program Files\Intel\iCLS Client\;C
:\Windows\system32;C:\Windows;C:\Windows\System32\Wbem;C:\Windows\System32\WindowsPowerShell\v1.0\;C:\Program Files (x86
)\Intel\Intel(R) Management Engine Components\DAL;C:\Program Files\Intel\Intel(R) Management Engine Components\DAL;C:\Pr
ogram Files (x86)\Intel\Intel(R) Management Engine Components\IPT;C:\Program Files\Intel\Intel(R) Management Engine Comp
onents\IPT;C:\Program Files (x86)\NVIDIA Corporation\PhysX\Common;C:\WINDOWS\system32;C:\WINDOWS;C:\WINDOWS\System32\Wbe
m;C:\WINDOWS\System32\WindowsPowerShell\v1.0\;C:\Program Files (x86)\Windows Live\Shared;C:\Program Files\PuTTY\;C:\WIND
OWS\System32\OpenSSH\;C:\Program Files\NVIDIA Corporation\NVIDIA NvDLISR;C:\Users\david\AppData\Local\Programs\Python\Py
thon37-32\Scripts\;C:\Users\david\AppData\Local\Programs\Python\Python37-32\;"C:\Users\david\AppData\Local\Microsoft\Win
dowsApps; C:\Users\david\AppData\Local\Programs\Python\Python36-32";;C:\Users\david\AppData\Local\Microsoft\WindowsApps

C:\Users\david>
```

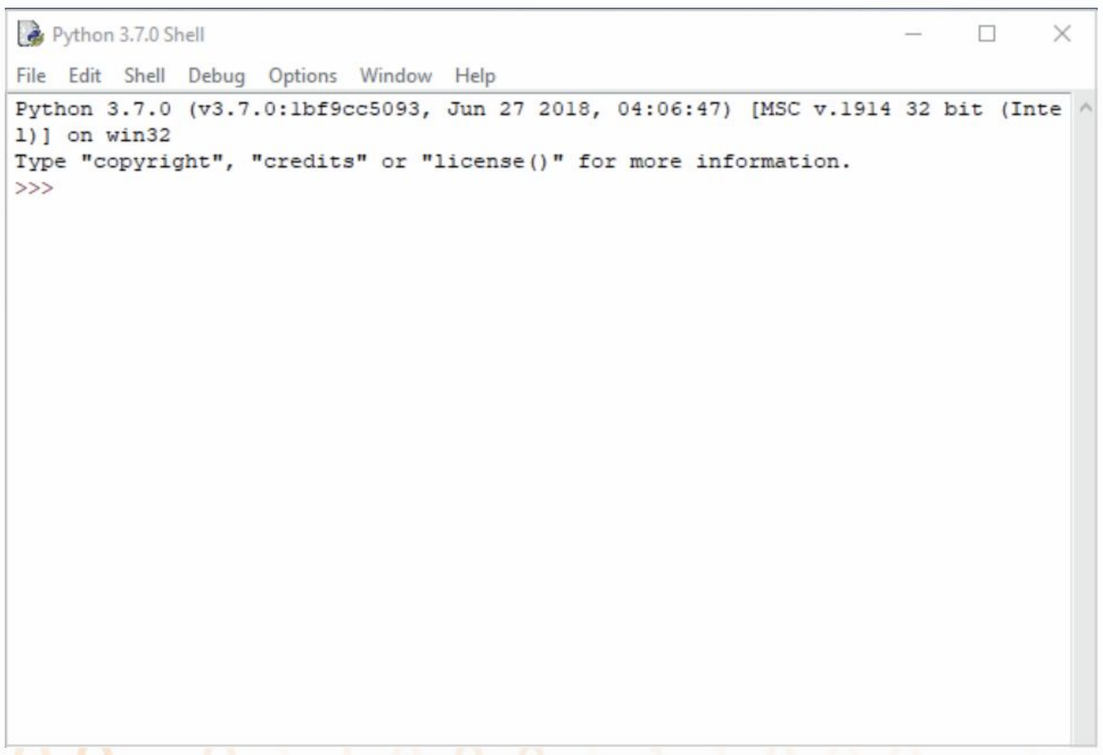
Numbers and Expressions

We've seen some basic mathematical expressions with Python, simple addition and the like. Now let's expand on that, and see just how powerful Python is as a calculator. You can work within the IDLE Shell, or in the Editor, whichever you like.

IT'S ALL MATHS, MAN

You can get some really impressive results from the mathematical powers of Python, as maths is the driving force behind the code with most, if not all, programming languages.

STEP 1 Open up the GUI version of Python 3, as mentioned you can use either the Shell or the Editor. For the time being, we're going to use the Shell. If you've opted to use a third-party text editor, note that you need to get to the IDLE Shell for this part of the tutorial.



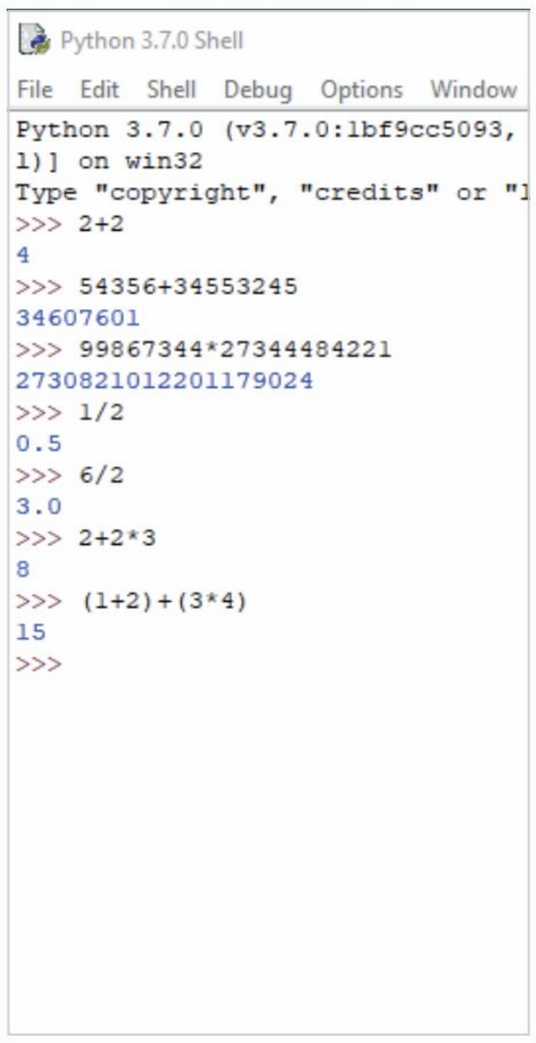
STEP 2 In the Shell enter the following:

```
2+2
54356+34553245
99867344*27344484221
```

As you can see, Python can handle some quite large numbers.

STEP 3 You can use all the customary Mathematical operations: divide, multiply, brackets and so on. Practise with a few, for example:

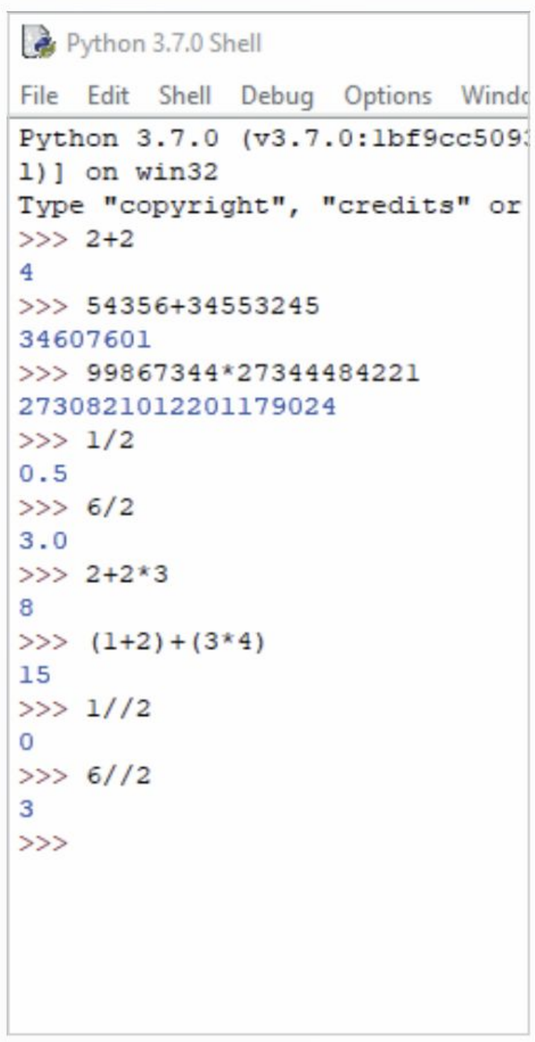
```
1/2
6/2
2+2*3
(1+2)+(3*4)
```



STEP 4 As you've no doubt noticed, division produces a decimal number. In Python, these are called floats, or floating point arithmetic. If however, you need an integer as opposed to a decimal answer, then you can use a double slash:

```
1//2
6//2
```

and so on.



STEP 5

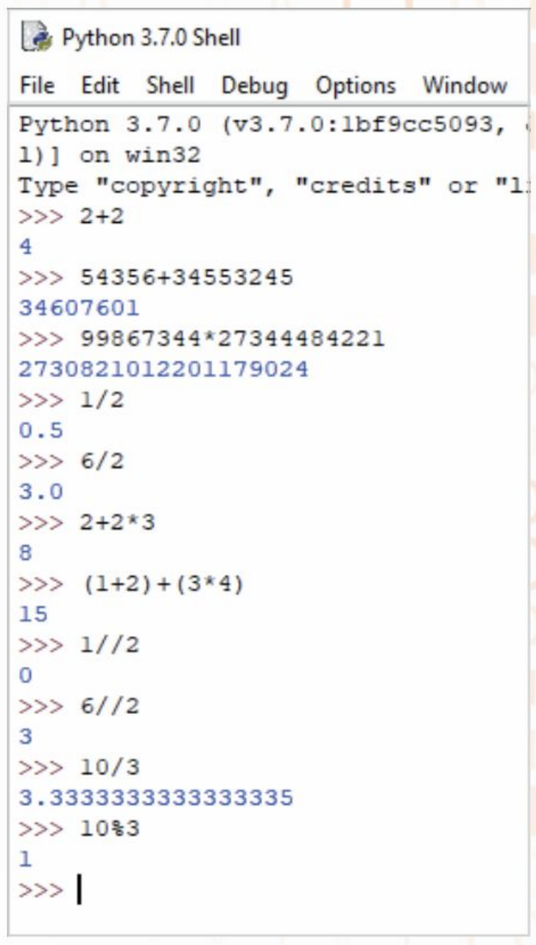
You can also use an operation to see the remainder left over from division. For example:

```
10/3
```

will display 3.333333333, which is, of course, 3.3-recurring. If you now enter:

```
10%3
```

This will display 1, which is the remainder left over from dividing 10 by 3.

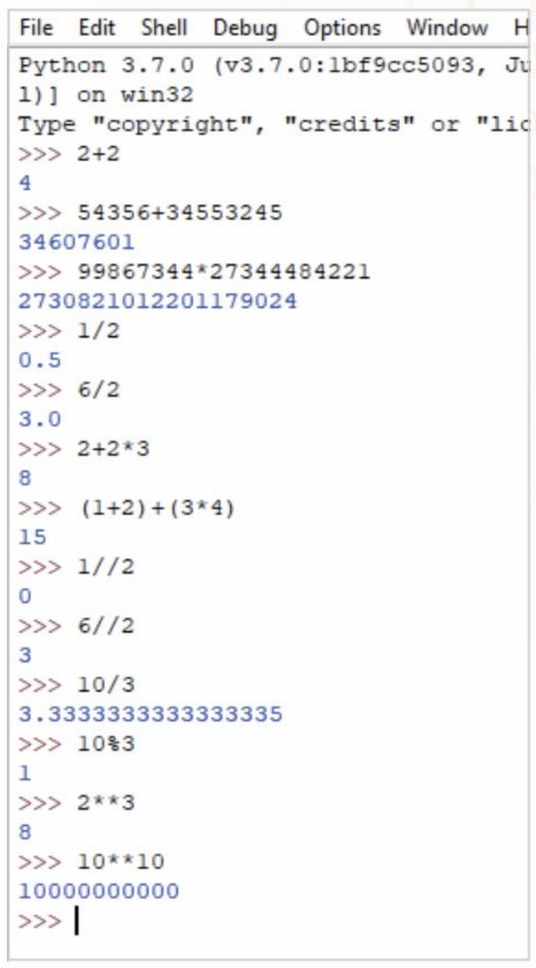


STEP 6

Next up we have the power operator, or exponentiation if you want to be technical. To work out the power of something you can use a double multiplication symbol, or double-star on the keyboard:

```
2**3
10**10
```

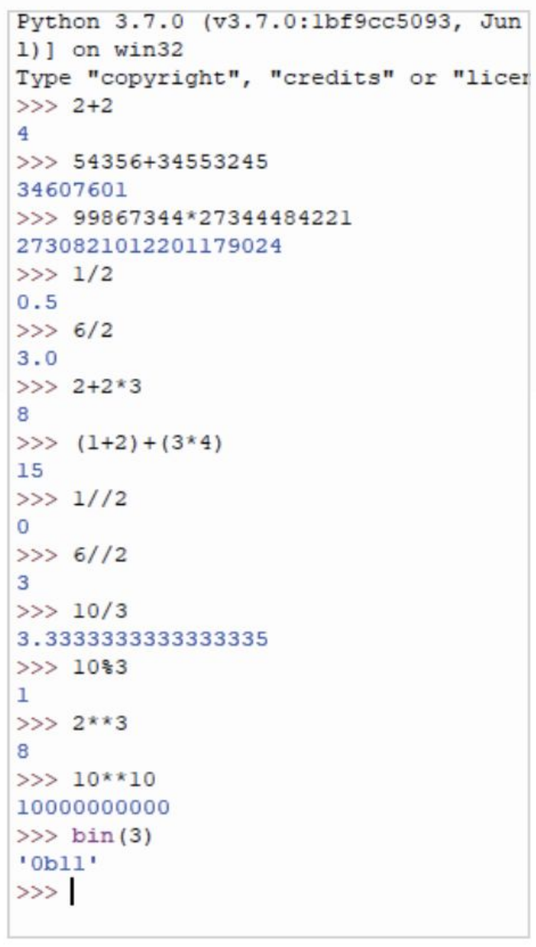
Essentially, it's 2x2x2, but we're sure you already know the basics behind maths operators. This is how you would work it out in Python.



STEP 7

Numbers and expressions don't stop there. Python has numerous built-in functions to work out sets of numbers, absolute values, complex numbers, and a host of Mathematical expressions and Pythogarian tongue-twisters. For example, to convert a number to binary, use:

```
bin(3)
```

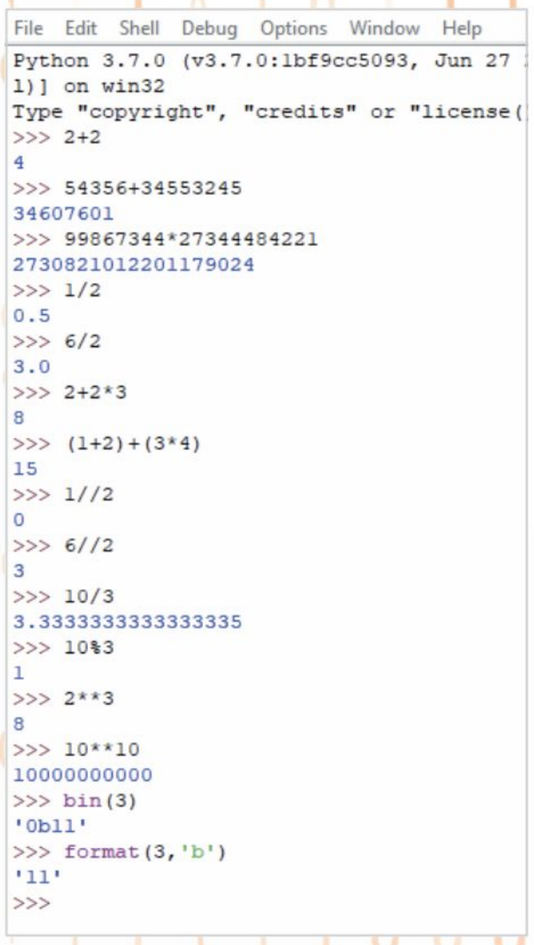


STEP 8

This will be displayed as '0b11', converting the integer into binary, and adding the prefix 0b to the front. If you want to remove the 0b prefix, then you can use:

```
format(3, 'b')
```

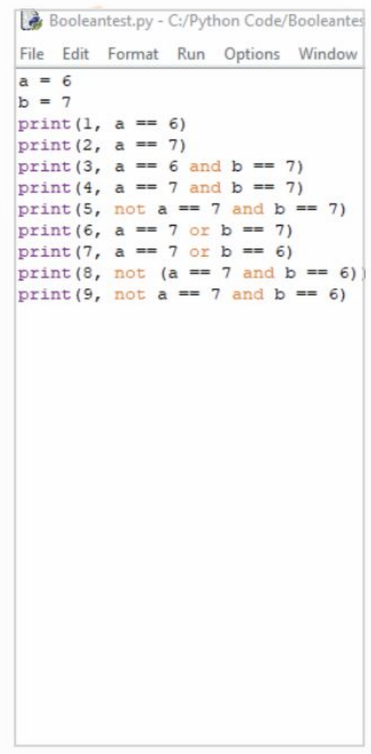
The Format command converts a value, the number 3, to a formatted representation as controlled by the format specification, the 'b' part.



STEP 9

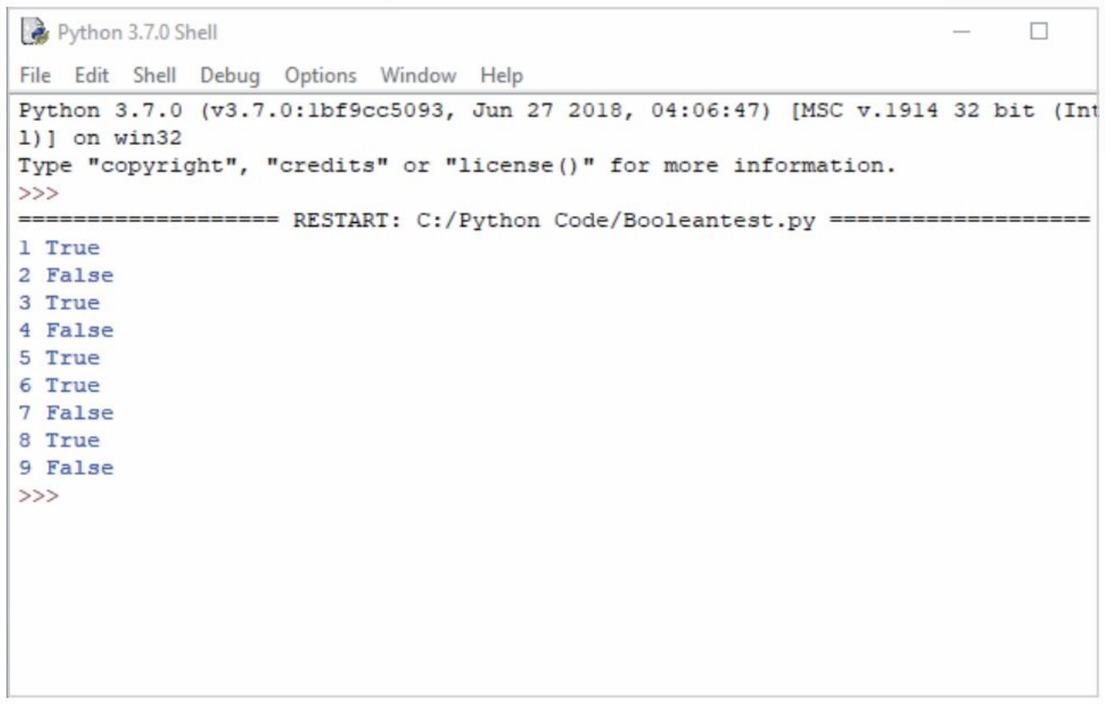
A Boolean Expression is a logical statement that will either be true or false. We can use these to compare data, and test to see if it's equal to, less than, or greater than. Try this in a New File:

```
a = 6
b = 7
print(1, a == 6)
print(2, a == 7)
print(3, a == 6 and b == 7)
print(4, a == 7 and b == 7)
print(5, not a == 7 and b == 7)
print(6, a == 7 or b == 7)
print(7, a == 7 or b == 6)
print(8, not (a == 7 and b == 6))
print(9, not a == 7 and b == 6)
```



STEP 10

Execute the code from Step 9, and you'll see a series of True or False statements depending on the result of the two defining values: 6 and 7. It's an extension of what we've looked at, and an important part of programming.



Using Comments

When writing your code, the flow, what each variable does, how the overall program will operate and so on, is all inside your head. Another programmer could follow the code line by line, but when the code starts to hit thousands of lines, things get a little difficult to read.

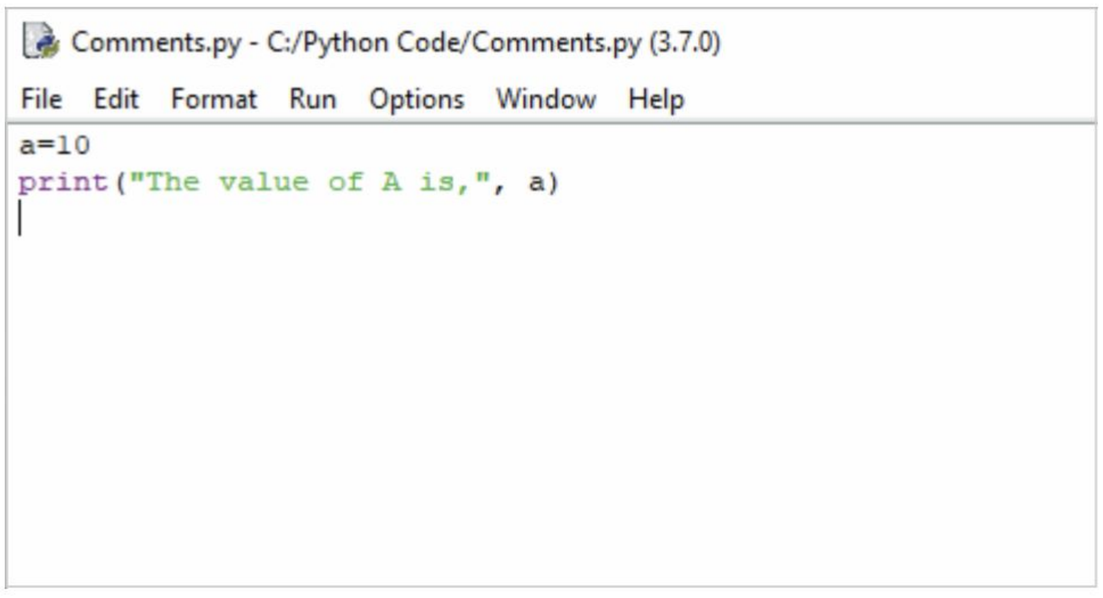
#COMMENTS!

A method used by most programmers for keeping their code readable, is by commenting on certain sections. For example, if a variable is used, the programmer comments on what it's supposed to do. It's just good practise.

STEP 1 We'll start by creating a new instance of the IDLE Editor (**File > New File**), and then create a simple variable and print command:

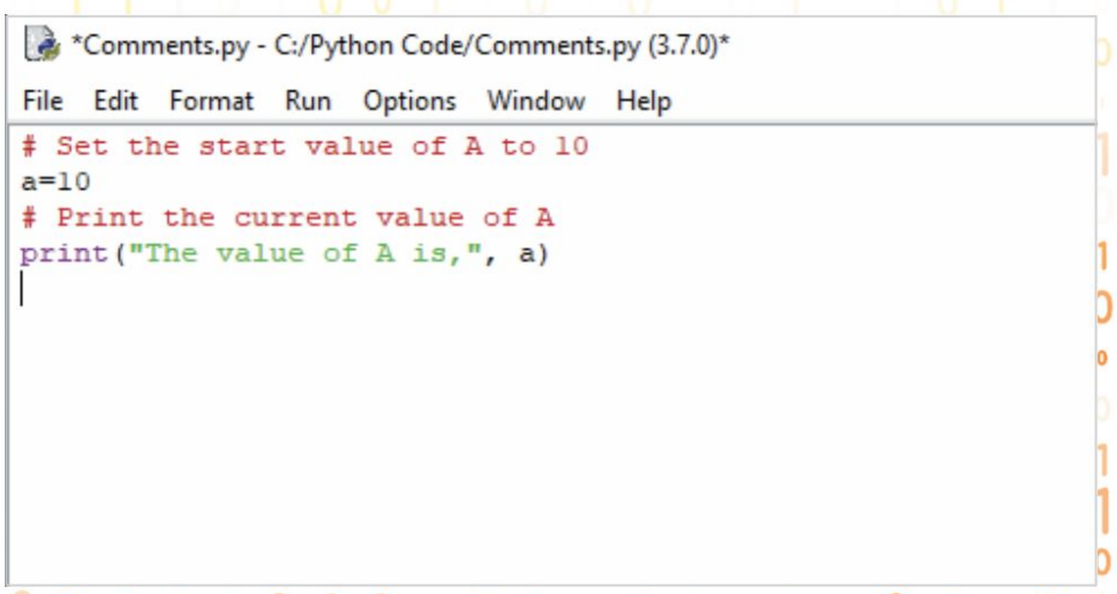
```
a=10
print("The value of A is,", a)
```

Save the file, and execute the code.



STEP 2 Running the code will return the line: **The value of A is, 10** into the IDLE Shell window – which is what we expected. Now let's add some of the types of comments you'd normally see within code:

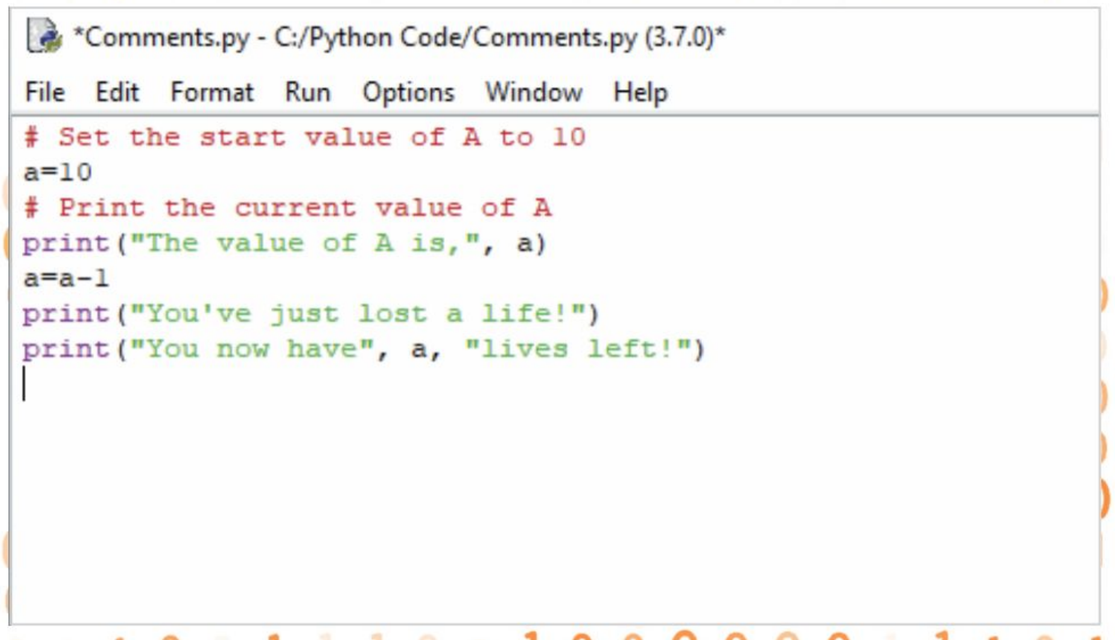
```
# Set the start value of A to 10
a=10
# Print the current value of A
print("The value of A is,", a)
```



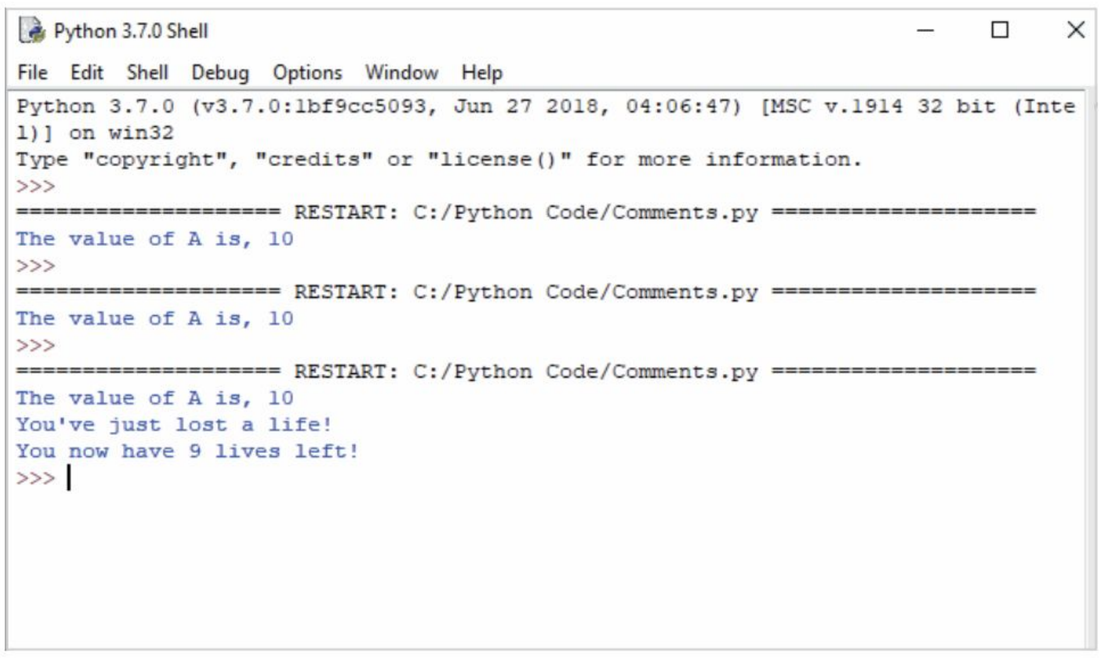
STEP 3 Re-save the code and execute it. You'll see that the output in the IDLE Shell is still the same as before, despite the extra lines being added. Simply put, the hash symbol (#) denotes a line of text the programmer can insert, to inform them and others of what's going on, without the user being aware.

STEP 4 Let's assume that the variable A we've created is the number of lives in a game. Every time the player dies, the value decreases by 1. The programmer could insert a routine along the lines of:

```
a=a-1
print("You've just lost a life!")
print("You now have", a, "lives left!")
```

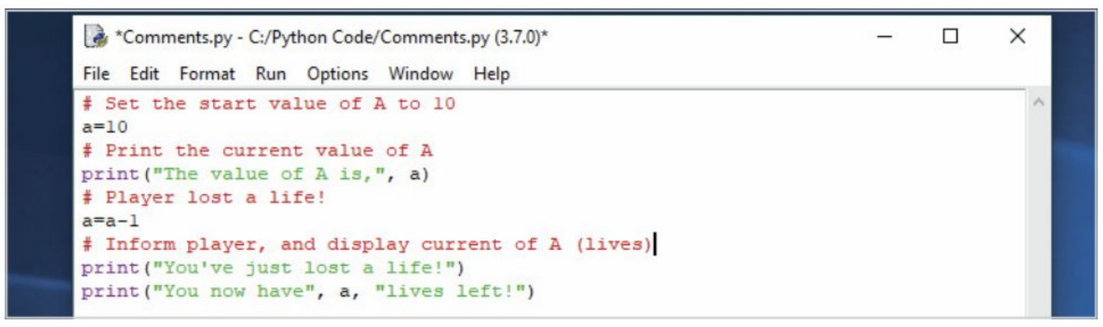


STEP 5 While we know that the variable A denotes number of lives and the player has just lost one, a casual viewer, or someone checking the code, may not know. Imagine for a moment that the code is twenty thousand lines long, instead of just our seven. You can see how handy comments are.



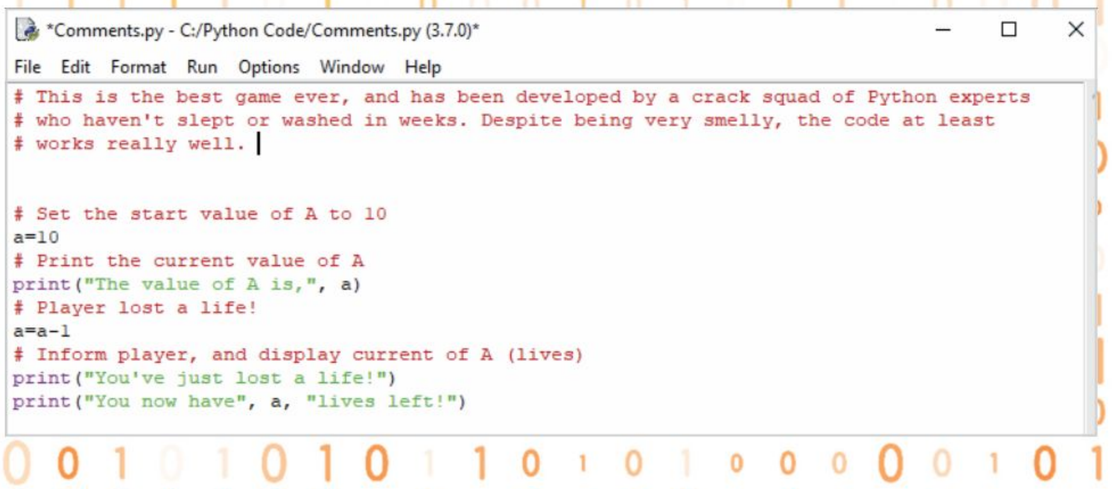
STEP 6 Essentially, the new code together with comments could look like:

```
# Set the start value of A to 10
a=10
# Print the current value of A
print(“The value of A is,”, a)
# Player lost a life!
a=a-1
# Inform player, and display current value of A (lives)
print(“You’ve just lost a life!”)
print(“You now have”, a, “lives left!”)
```



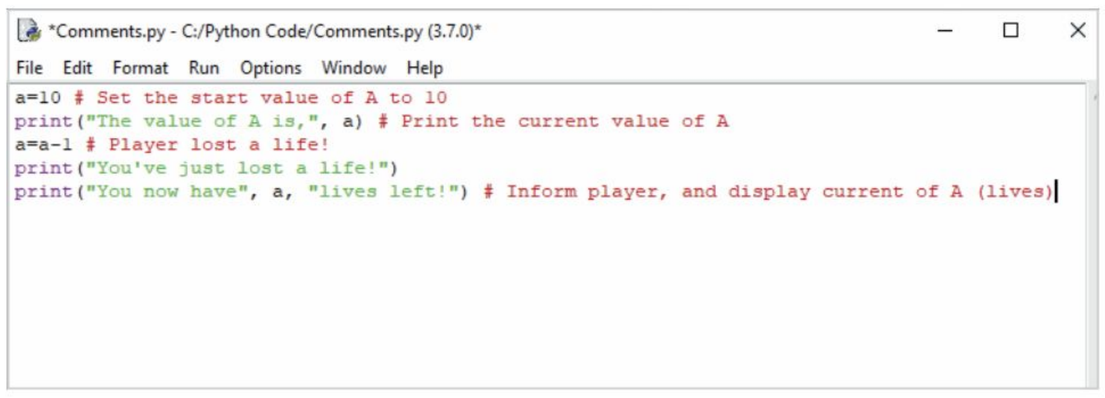
STEP 7 You can use comments in different ways. For example, Block Comments are a large section of text that details what’s going on in the code, such as telling the code reader which variables you’re planning on using:

```
# This is the best game ever, and has been
developed by a crack squad of Python experts
# who haven’t slept or washed in weeks. Despite
being very smelly, the code at least
# works really well.
```



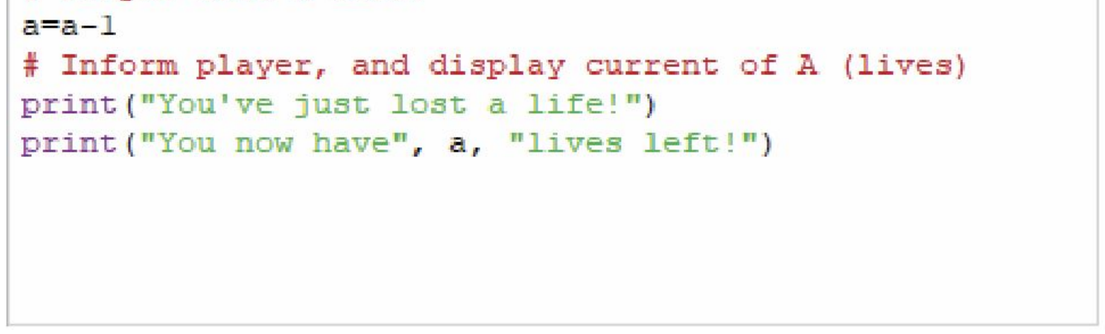
STEP 8 Inline Comments are comments that follow a section of code. Take our examples from above, instead of inserting the code on a separate line, we could use:

```
a=10 # Set the start value of A to 10
print(“The value of A is,”, a) # Print the current
value of A
a=a-1 # Player lost a life!
print(“You’ve just lost a life!”)
print(“You now have”, a, “lives left!”) # Inform
player, and display current value of A (lives)
```



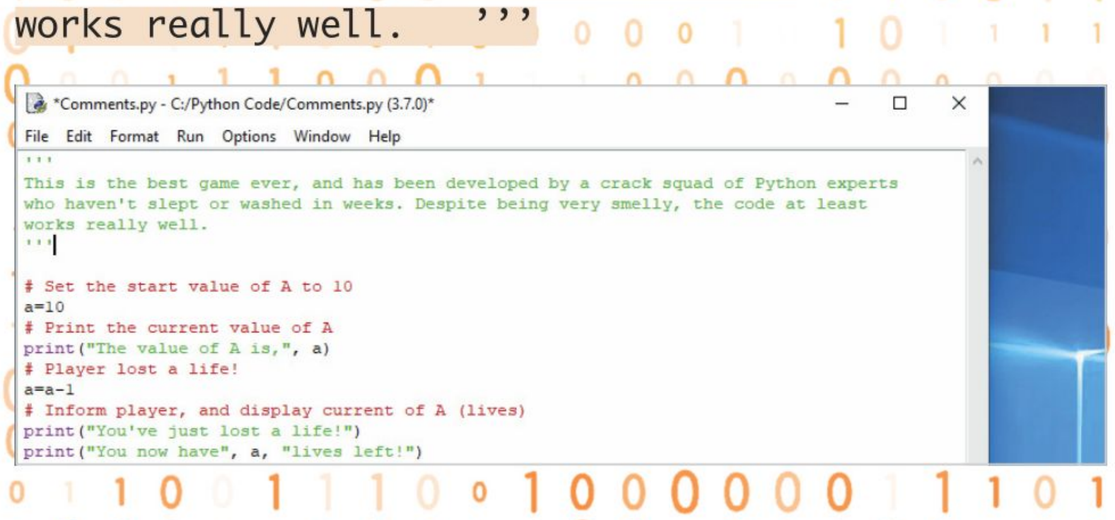
STEP 9 The comment, the hash symbol, can also be used to comment out sections of code you don’t want to be executed in your program. For instance, if you wanted to remove the first print statement, you would use:

```
# print(“The value of A is,”, a)
```



STEP 10 You also use three single quotes to comment out a Block Comment, or multi-line section of comments. For them to work, place them before and after the areas you want to comment:

```
‘’’
This is the best game ever, and has been developed
by a crack squad of Python experts
who haven’t slept or washed in weeks. Despite
being very smelly, the code at least
works really well.  ’’’
```



Working with Variables

We've seen some examples of variables in our Python code already, but it's always worth going through the way they operate, and how Python creates and assigns certain values to a variable.

VARIOUS VARIABLES

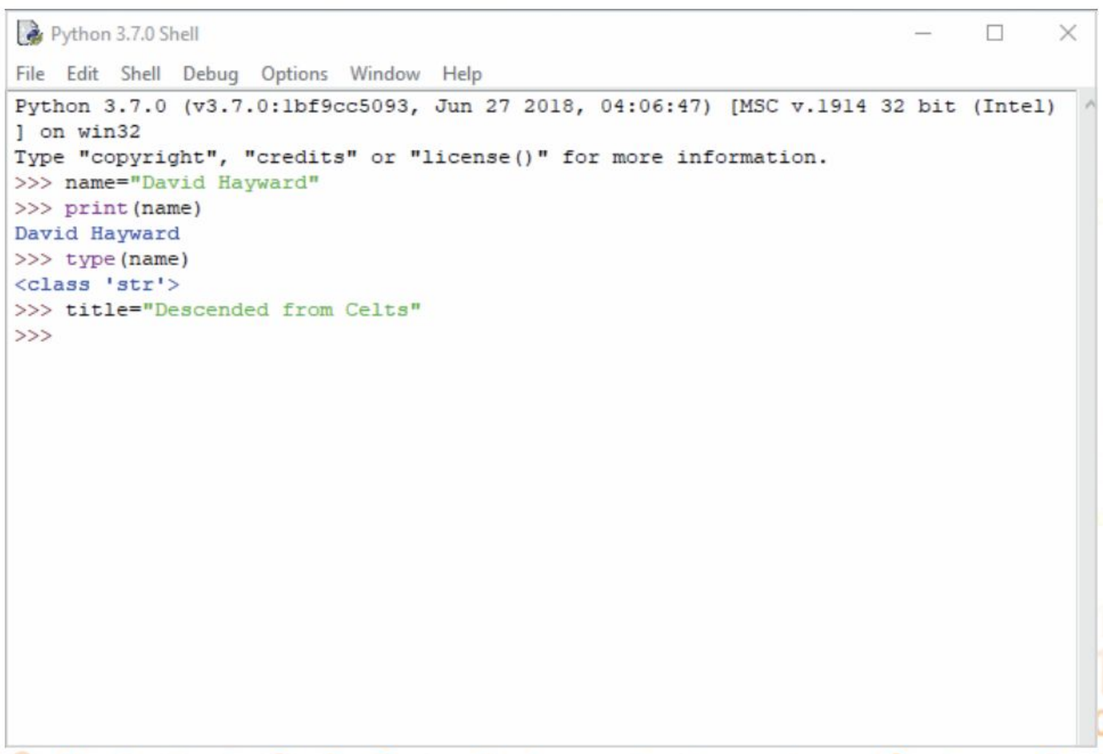
We'll be working with the Python 3 IDLE Shell in this tutorial. If you haven't already, open Python 3 or close down the previous IDLE Shell to clear up any old code.

STEP 1

In some programming languages, you're required to use a dollar sign to denote a string, which is a variable made up of multiple characters, such as a name of a person. In Python this isn't necessary, so, for example, in the Shell enter: `name="David Hayward"` (use your own name, unless you're also called David Hayward).

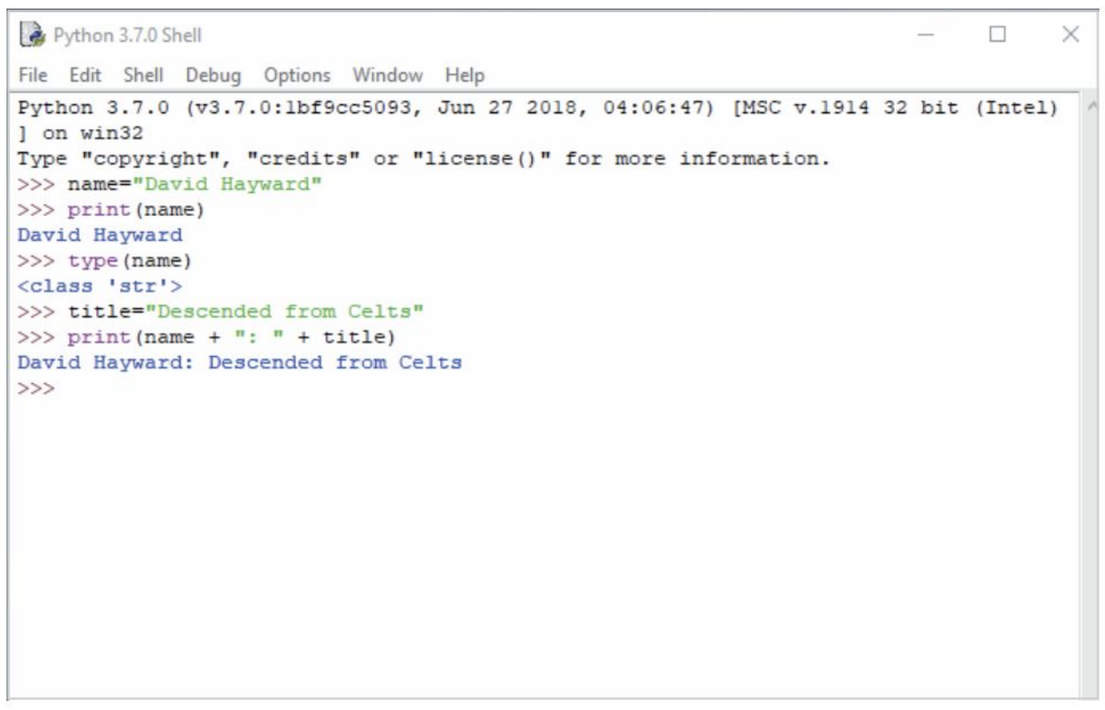
STEP 2

You can check the type of variable in use by issuing the `type ()` command, placing the name of the variable inside the brackets. In our example, this would be: `type (name)`. Add a new string variable: `title="Descended from Celts"`.



STEP 3

As we've seen previously, variables can be concatenated using the plus symbol between the variable names. In our example, we can use: `print (name + ": " + title)`. The middle part, between the quotations, allows us to add a colon and a space. As variables are connected without spaces, we need to add them manually.



STEP 4

We can also combine variables within another variable. For example, to combine both name and title variables into a new variable, we use:

```
character=name + ": " + title
```

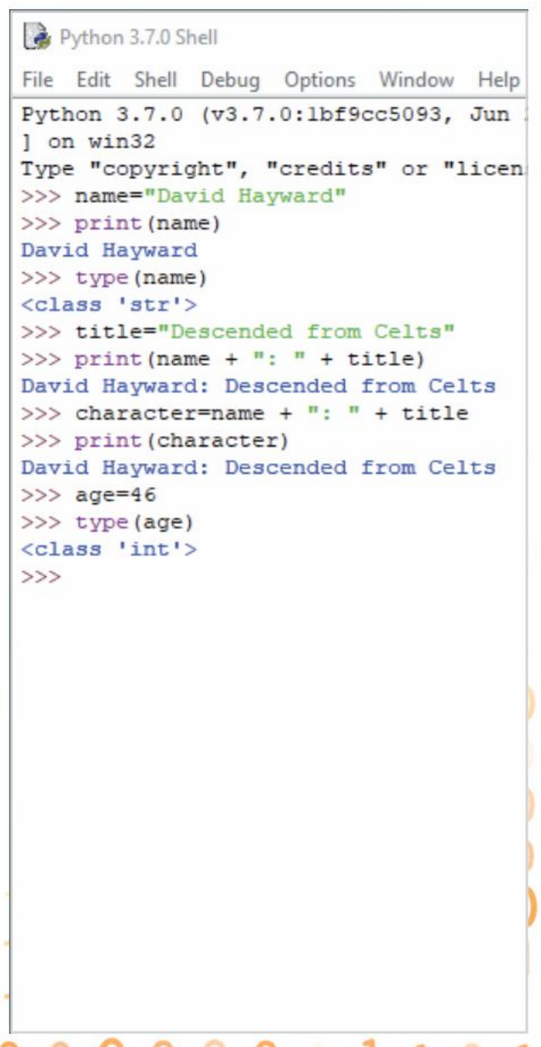
Then output the content of the new variable as:

```
print (character)
```

Numbers are stored as different variables:

```
age=44
Type (age)
```

Which, as we know, are integers.



STEP 5 However, you can't combine both strings and integer type variables in the same command as you would a set of similar variables. You'll need to turn one into the other, or vice versa. When you do try to combine both, you'll get an error message:

```
print (name + age)
```

```
] on win32
Type "copyright", "credits" or "license()" for more information.
>>> name="David Hayward"
>>> print(name)
David Hayward
>>> type(name)
<class 'str'>
>>> title="Descended from Celts"
>>> print(name + ": " + title)
David Hayward: Descended from Celts
>>> character=name + ": " + title
>>> print(character)
David Hayward: Descended from Celts
>>> age=46
>>> type(age)
<class 'int'>
>>> print (name+age)
Traceback (most recent call last):
  File "<pyshell#9>", line 1, in <module>
    print (name+age)
TypeError: can only concatenate str (not "int") to str
>>>
```

STEP 6 This is a process known as TypeCasting. The Python code is:

```
print (character + " is " + str(age) + " years old.")
```

Alternatively, you can use:

```
print (character, "is", age, "years old.")
```

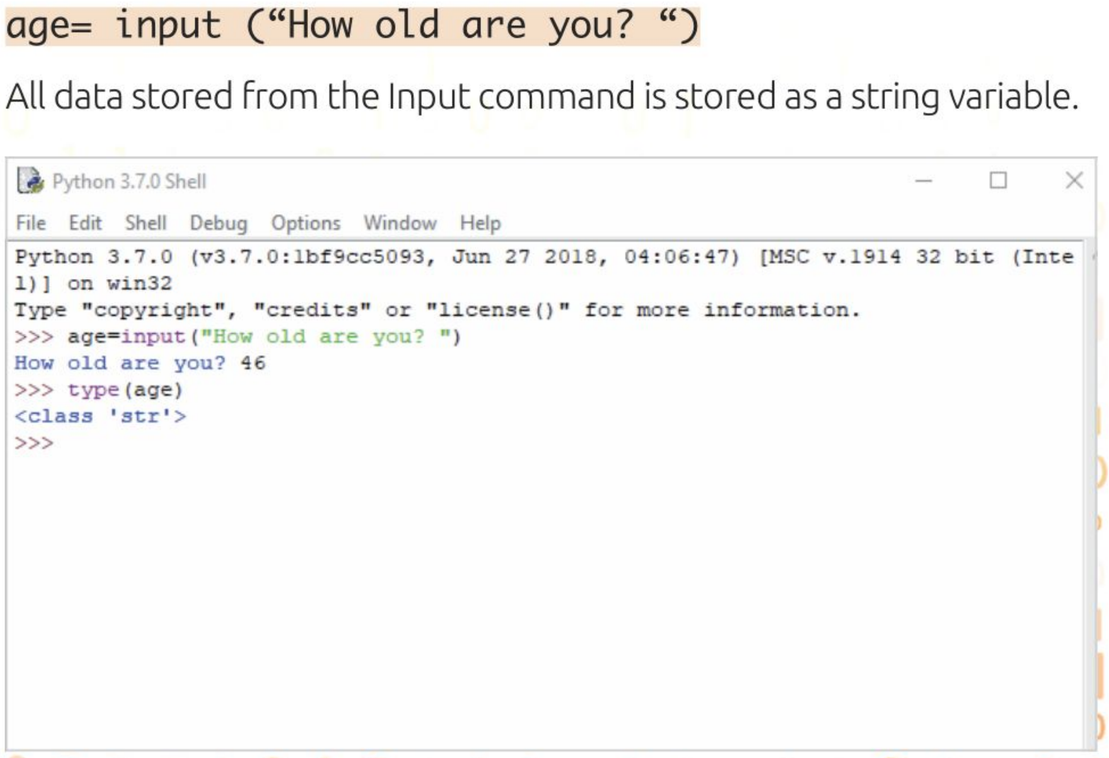
Notice again that in the last example, you don't need the spaces between the words in quotes, as the commas treat each argument to print separately.

```
David Hayward: Descended from Celts
>>> age=46
>>> type(age)
<class 'int'>
>>> print (name+age)
Traceback (most recent call last):
  File "<pyshell#9>", line 1, in <module>
    print (name+age)
TypeError: can only concatenate str (not "int") to str
>>> print (character + " is " + str(age) + " years old.")
David Hayward: Descended from Celts is 46 years old.
>>> print (character, "is", age, "years old.")
David Hayward: Descended from Celts is 46 years old.
>>>
```

STEP 7 Another example of TypeCasting is when you ask for input from the user, such as a number. for example, enter:

```
age= input ("How old are you? ")
```

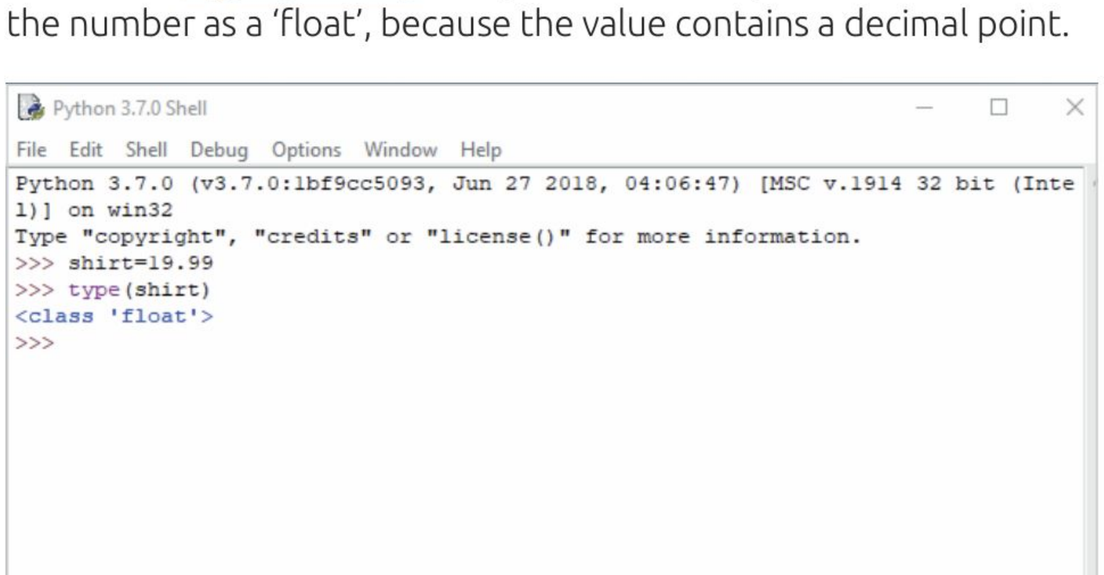
All data stored from the Input command is stored as a string variable.



STEP 8 This presents a bit of a problem when you want to work with a number that's been inputted by the user, for example, as age + 10 is both a string variable and an integer, it won't work. Instead, you need to enter:

```
int(age) + 10
```

This will TypeCast the age string into an integer that can be worked with.

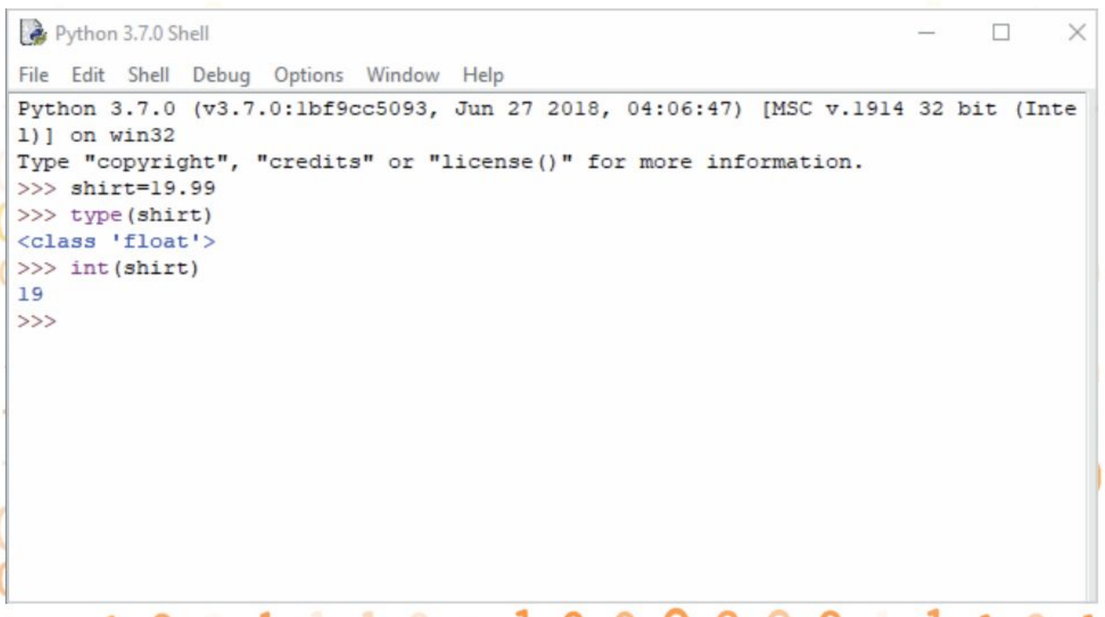


STEP 9 The use of TypeCasting is also important when dealing with floating point arithmetic; remember: numbers that have a decimal point in them. For example, enter:

```
shirt=19.99
```

Now enter `type(shirt)` and you'll see that Python has allocated the number as a 'float', because the value contains a decimal point.

STEP 10 When combining integers and floats Python usually converts the integer to a float, but should the reverse ever be applied, it's worth remembering that Python doesn't return the exact value. When converting a float to an integer, Python will always round down to the nearest integer, called truncating; in our case instead of 19.99, it becomes 19.



User Input

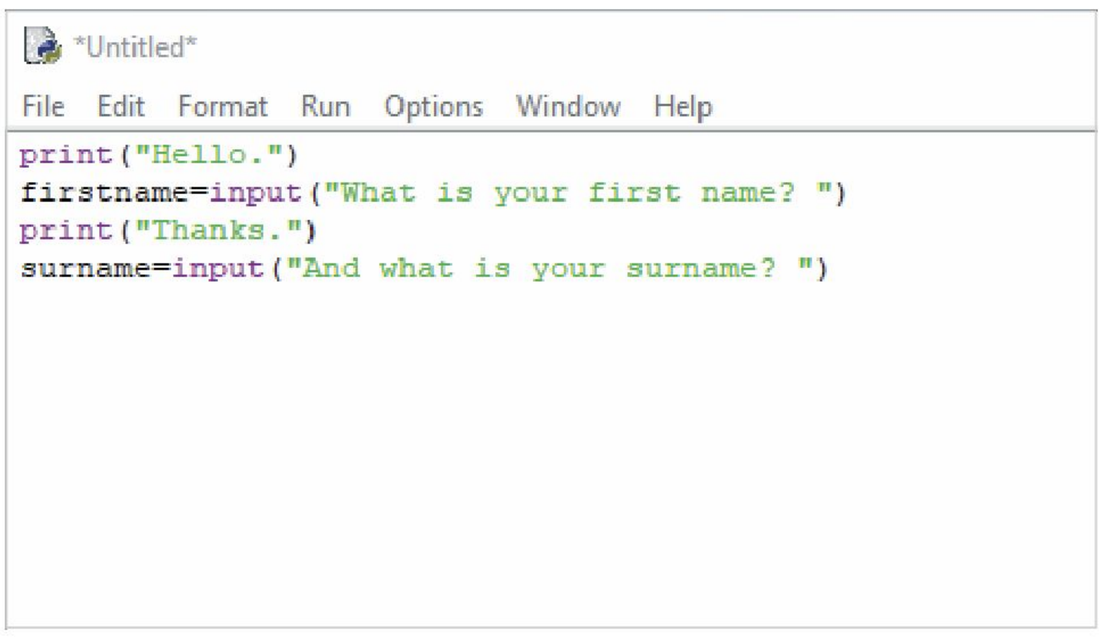
We've seen some basic user interaction with the code from a few of the examples earlier, so now would be a good time to focus solely on how you get information from the user, then store and present it.

USER FRIENDLY

The type of input you want from the user will depend greatly on the type of program you're coding. A game, for example, may ask for a character's name, whereas a database can ask for personal details.

STEP 1 If it's not already, open the Python 3 IDLE Shell, and start a New File in the Editor. Let's begin with something really simple, enter:

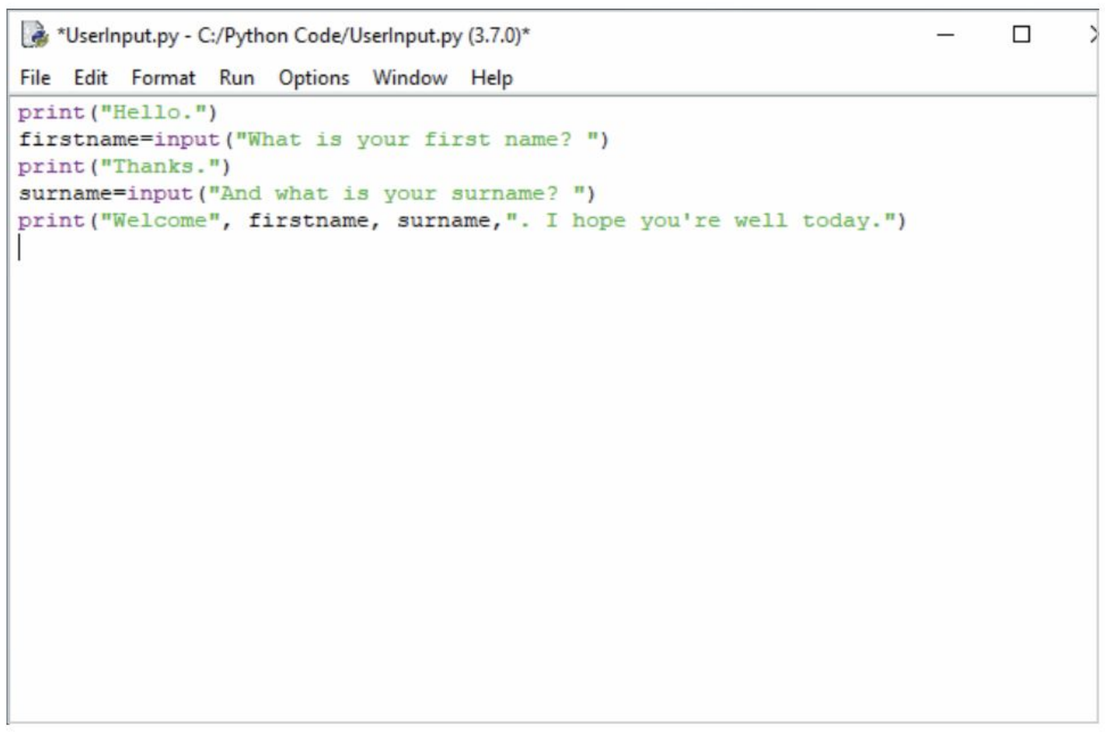
```
print("Hello")
firstname=input("What is your first name? ")
print("Thanks.")
surname=input("And what is your surname? ")
```



STEP 2 Save and execute the code, and, as you no doubt suspected, in the IDLE Shell the program will ask for your first name, storing it as the variable **firstname**, followed by your surname; also stored in its own variable **(surname)**.

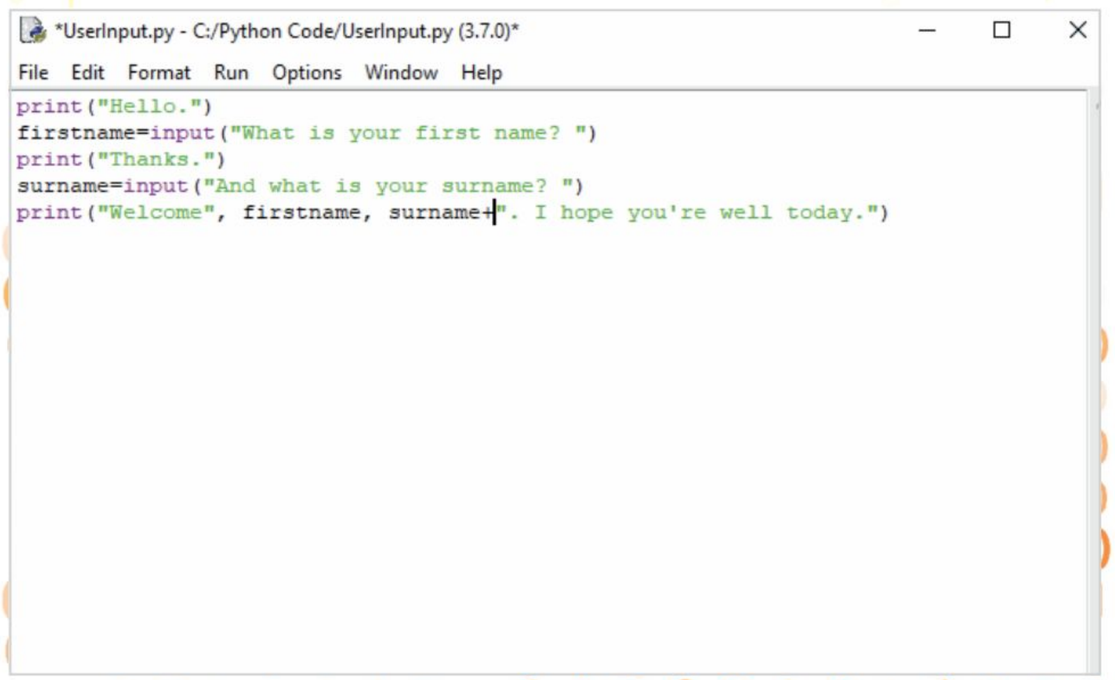
STEP 3 Now that we have the user's name stored in a couple of variables, we can call them up whenever we want:

```
print("Welcome", firstname, surname, ". I hope you're well today.")
```



STEP 4 Run the code and you'll notice a slight issue, the full stop after the surname follows a blank space. To eliminate that, we can add a plus sign instead of the comma in the code:

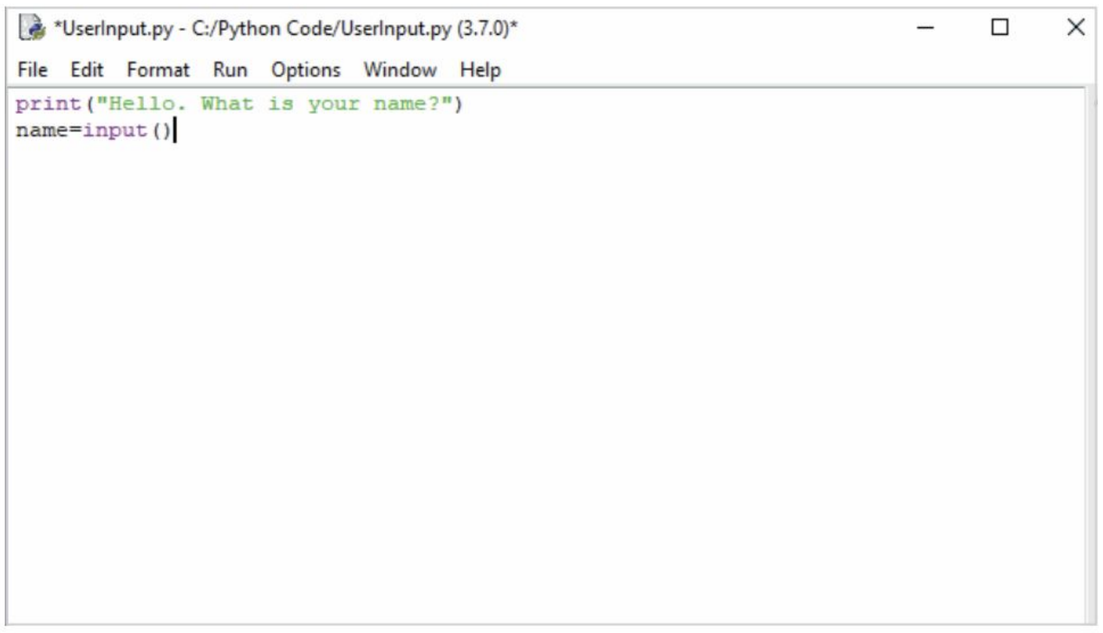
```
print("Welcome", firstname, surname+". I hope you're well today.")
```



STEP 5

You don't always have to include quoted text within the input command. For example, you can ask the user their name, and have the input in the line below:

```
print("Hello. What's your name?")
name=input()
```



STEP 6

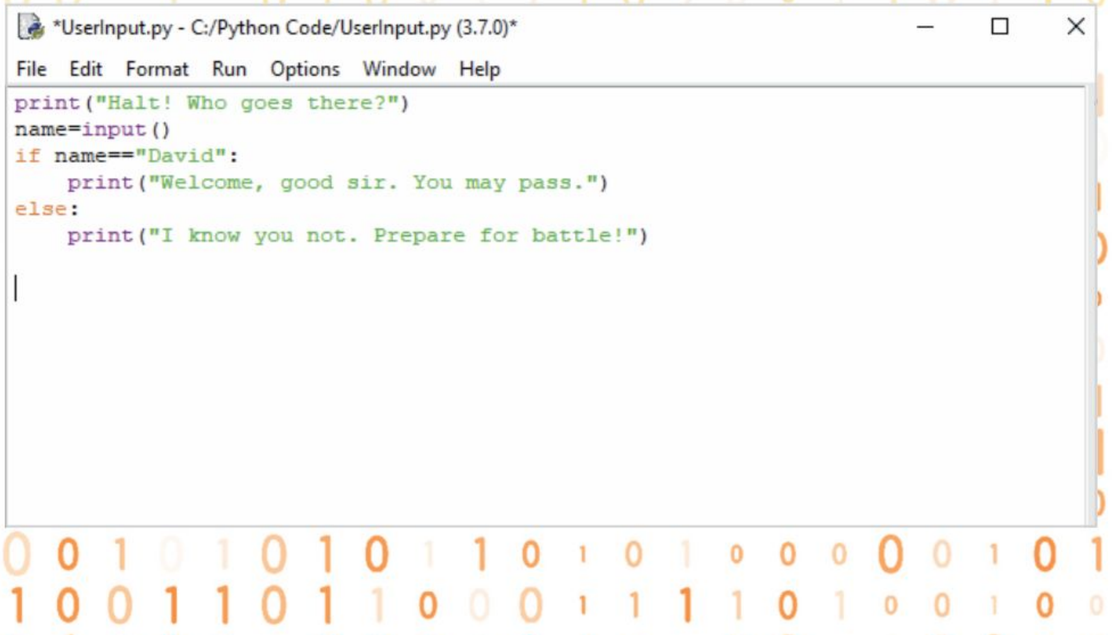
The code from the previous step is often regarded as being a little neater than having a lengthy amount of text in the input command, but it's not a rule that's set in stone, so do as you like in these situations. Expanding on the code, try this:

```
print("Halt! Who goes there?")
name=input()
```

STEP 7

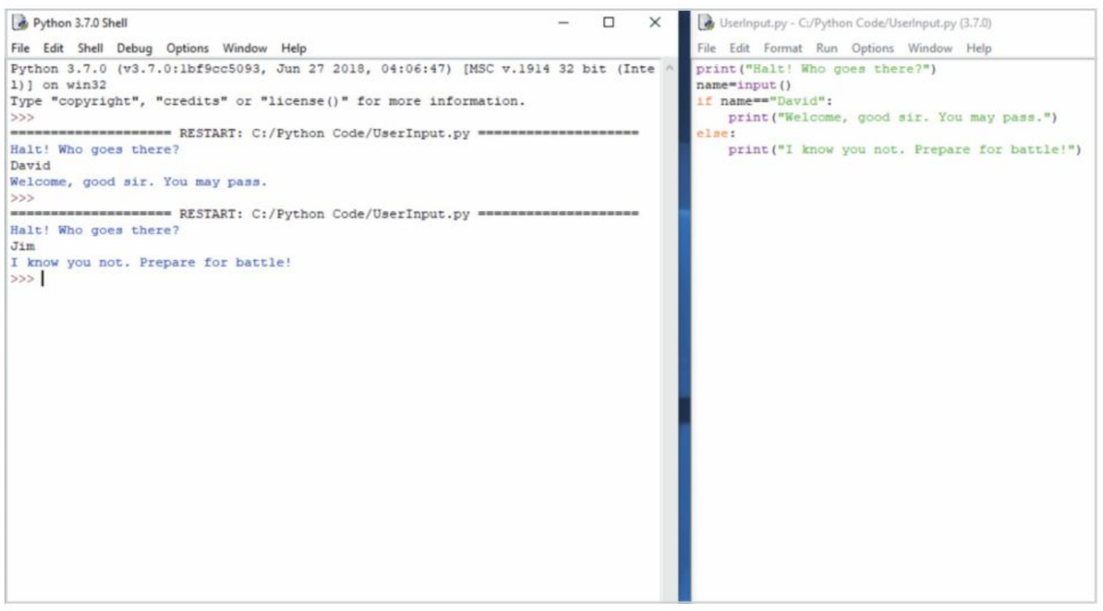
It's a good start to a text adventure game, perhaps? Now we can expand on it, and use the raw input from the user to flesh out the game a little:

```
if name=="David":
  print("Welcome, good sir. You may pass.")
else:
  print("I know you not. Prepare for battle!")
```



STEP 8

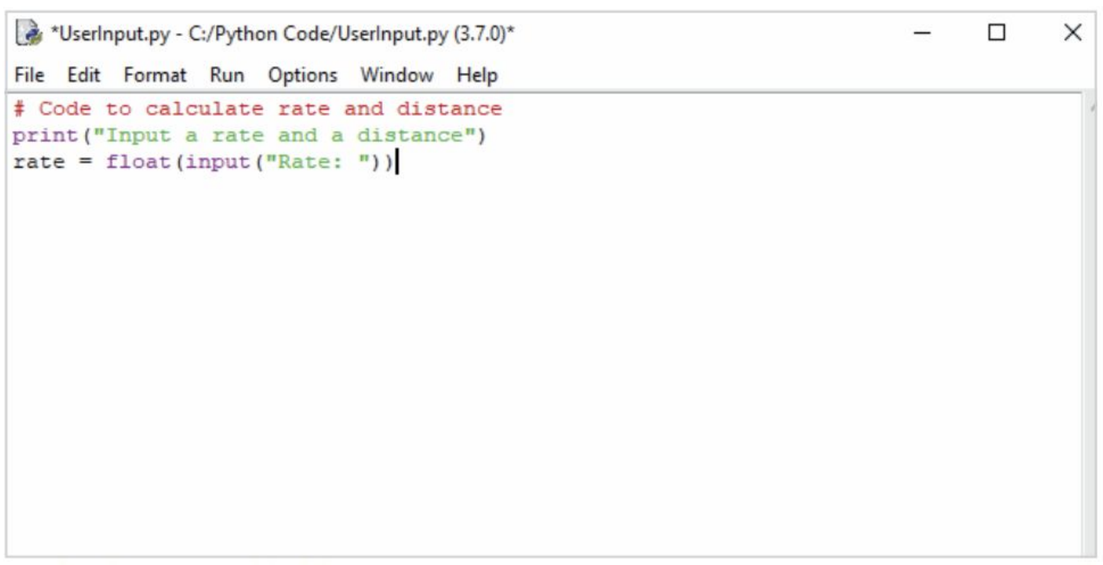
What you've created here is a condition, based on the user's input. In short, we're using the input from the user and measuring it against a condition. Therefore, if the user enters David as their name, the guard will allow them to pass unhindered. If, however, they enter a name other than David, the guard challenges them to a fight.



STEP 9

As you learned previously, any input from a user is automatically a string, so you'll need to apply a TypeCast in order to turn it into something else. This creates some interesting additions to the input command. For example:

```
# Code to calculate rate and distance
print("Input a rate and a distance")
rate = float(input("Rate: "))
```

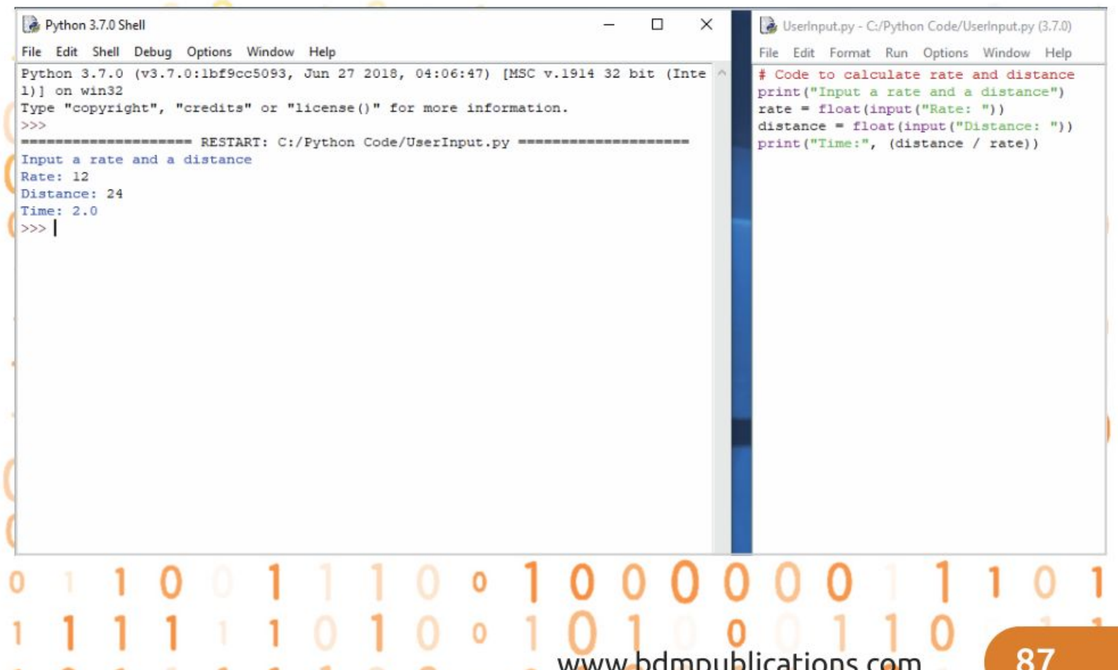


STEP 10

And to finalise the rate and distance code, we can add:

```
distance = float(input("Distance: "))
print("Time:", (distance / rate))
```

Save and execute the code, and enter some numbers. Using the **float(input** element, we've told Python that anything entered is a floating point number rather than a string.



Creating Functions

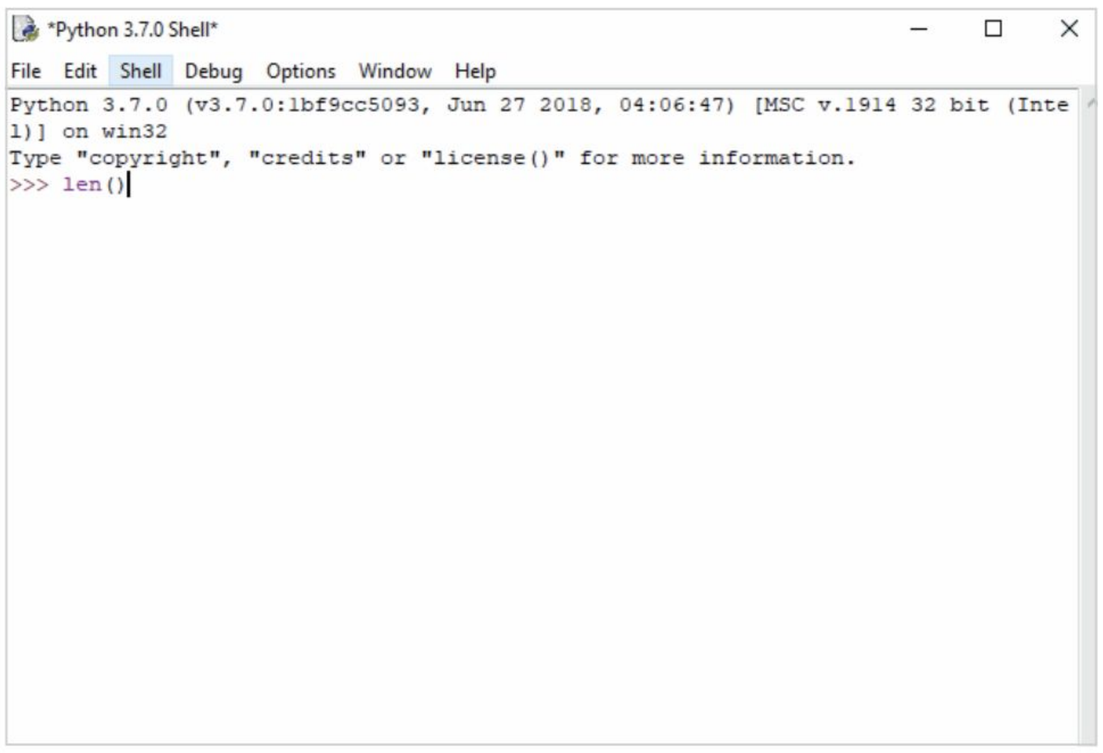
Now that you've mastered the use of variables and user input, the next step is to tackle functions. You've already used a few functions, such as the print command, but Python enables you to define your own function.

FUNKY FUNCTIONS

A function is a command that you enter into Python in order to do something. It's a little piece of self-contained code that takes data, works on it, and then returns the result.

STEP 1

It's not only data that a function works on. Functions can do all manner of useful things in Python, such as sort data, change items from one format to another, and check the length or type of items. Basically, a function is a short word followed by brackets. For example, **len()**, **list()**, or **type()**.



STEP 2

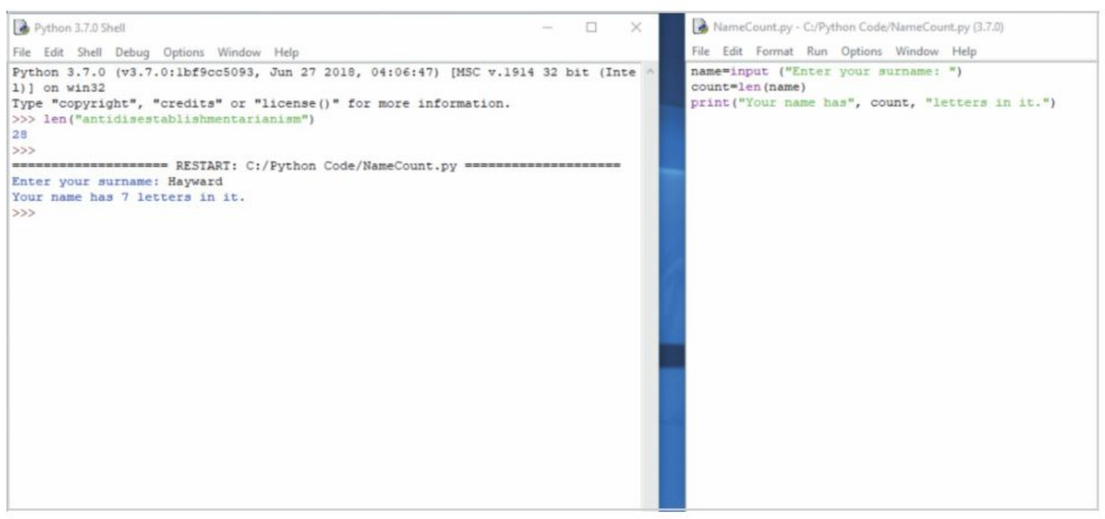
A function takes data, usually a variable, works on it depending on what the function is programmed to do, and returns the end value. The data being worked on goes inside the brackets, so if you wanted to know how many letters are in the word antidisestablishmentarianism, then you'd enter: `len("antidisestablishmentarianism")`, and the number 28 would return.

STEP 3

You can pass variables through functions in much the same manner. Let's assume you want the number of letters in a person's surname, you could use the following code (enter the text editor for this example):

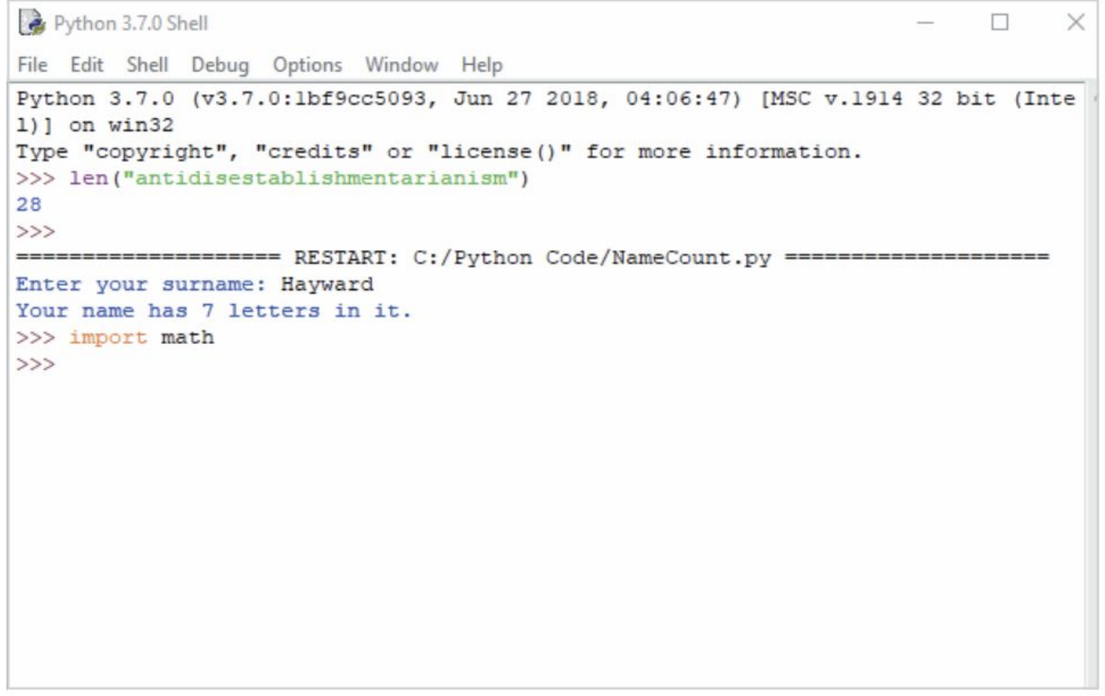
```
name=input ("Enter your surname: ")
count=len(name)
print ("Your surname has", count, "letters in
it.")
```

Press **F5** and save the code to execute it.



STEP 4

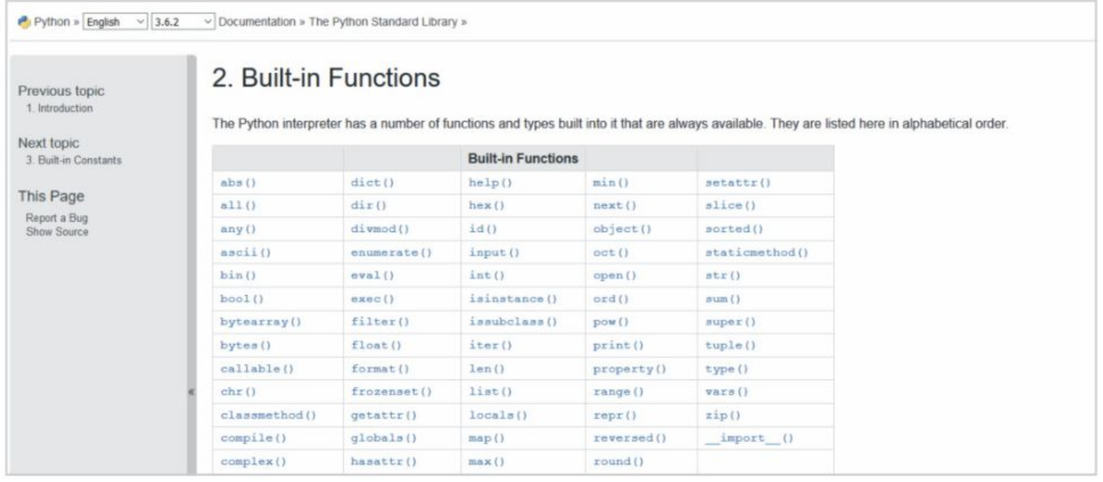
Python has tens of functions built into it, far too many to get into in the limited space available here. However, to view the list of built-in functions available to Python 3, navigate to **https://docs.python.org/3/library/functions.html**. These are the pre-defined functions, but since users have created many more, they're not the only ones available.



STEP 5 Additional functions can be added to Python through modules. Python has a vast range of modules available that can cover numerous programming duties. They add functions and can be imported as and when required. For example, to use advanced Mathematics functions enter:

```
import math
```

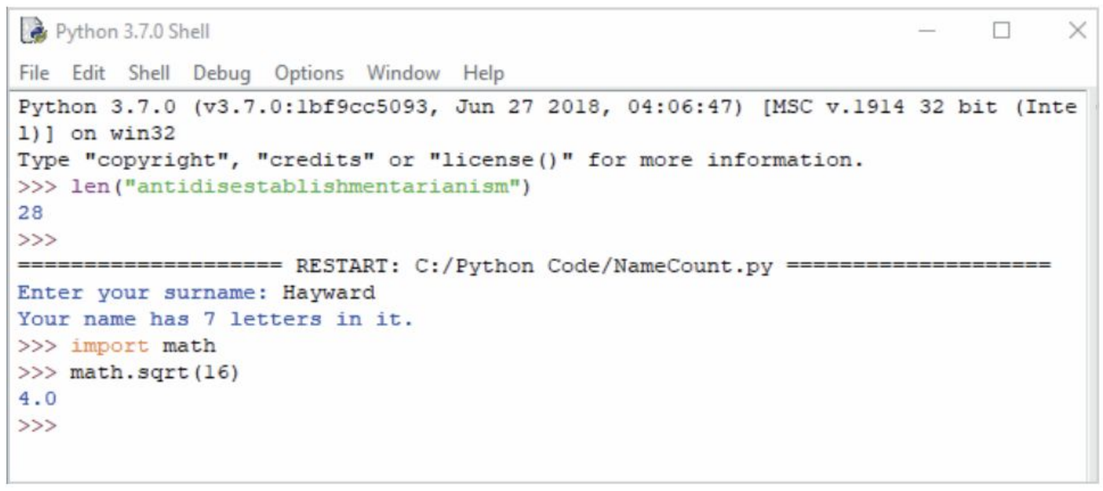
Once entered, you'll have access to all the Math module functions.



STEP 6 To use a function from a module, enter the name of the module, followed by a full stop, then the name of the function. For instance, using the math module, since we've just imported it into Python, we can utilise the square root function. To do so, enter:

```
math.sqrt(16)
```

As you can see, the code is presented as **module.function(data)**.



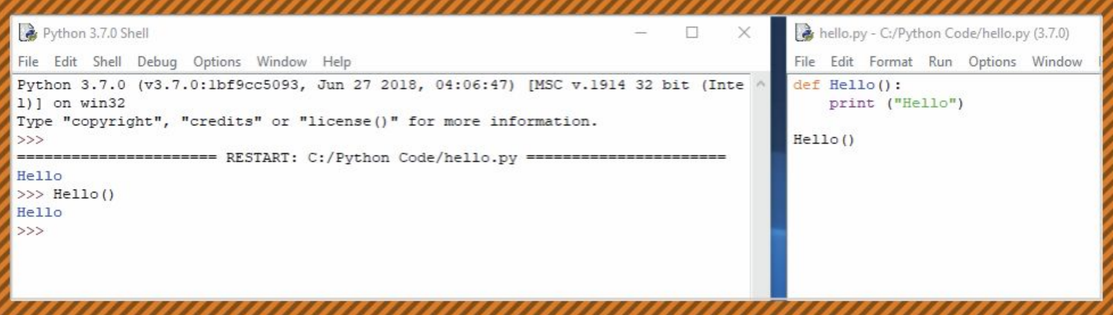
FORGING FUNCTIONS

There are many different functions, created by other Python programmers, which you can import and you'll undoubtedly come across some excellent examples in the future. However, you can also create your own with the def command.

STEP 1 Choose **File > New File** to enter the editor, let's create a function called Hello that will greet a user. Enter:

```
def Hello():
    print ("Hello")

Hello()
```

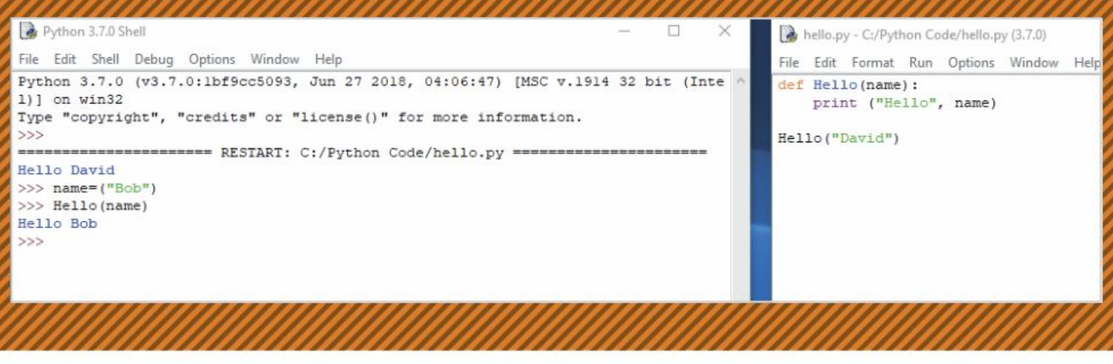
Press **F5** to save and run the script. You'll see Hello in the Shell, type in **Hello()** and it'll return the new function.



STEP 2 Let's now expand the function to accept a variable, the user's name for example. Edit your script to read:

```
def Hello(name):
    print ("Hello", name)

Hello("David")
```

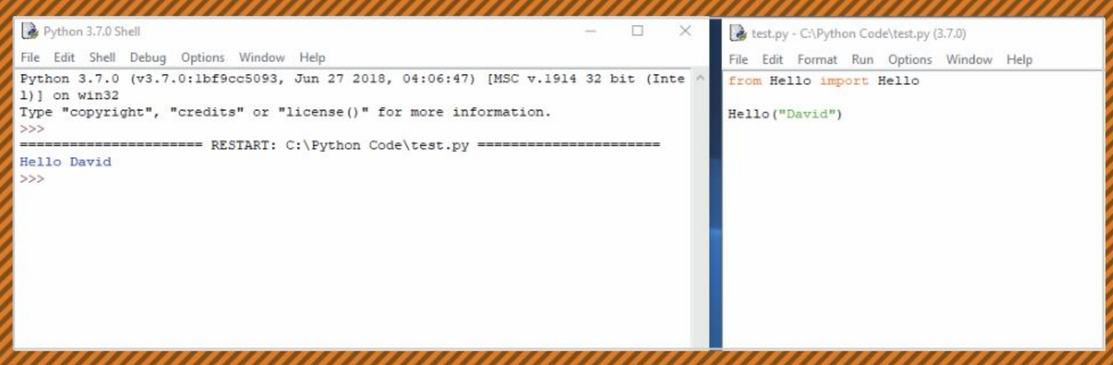
This will now accept the variable name, otherwise it will print Hello David. In the Shell, enter: **name=("Bob")**, then, **Hello(name)**. Your function can now pass variables through it.



STEP 3 To modify it further, delete the **Hello("David")** line, the last line in the script, and press Ctrl+S to save the new script. Close the Editor and create a new file (**File > New File**). Enter the following:

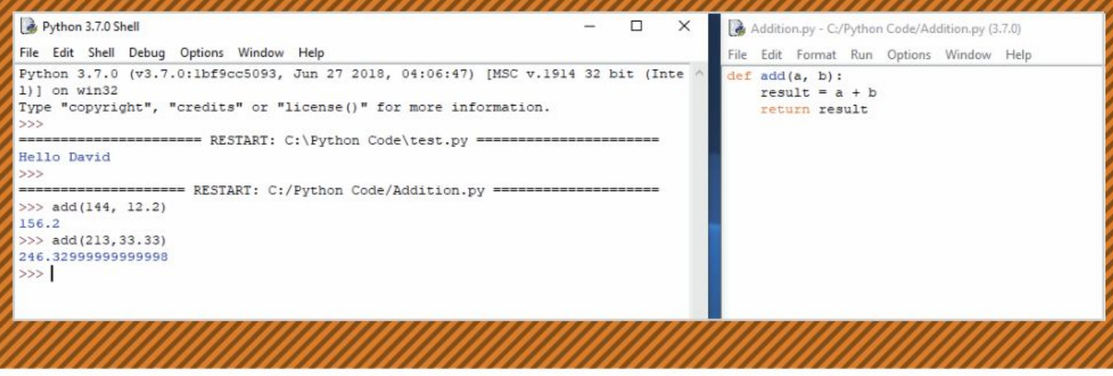
```
from Hello import Hello

Hello("David")
```

Press **F5** to save and execute the code.



STEP 4 What you've just done is import the Hello function from the saved Hello.py program, and then used it to say hello to David. This is how modules and functions work, you import the module then use the function. Try this one, and modify it for extra credit:

```
def add(a, b):
    result = a + b
    return result
```



Conditions and Loops

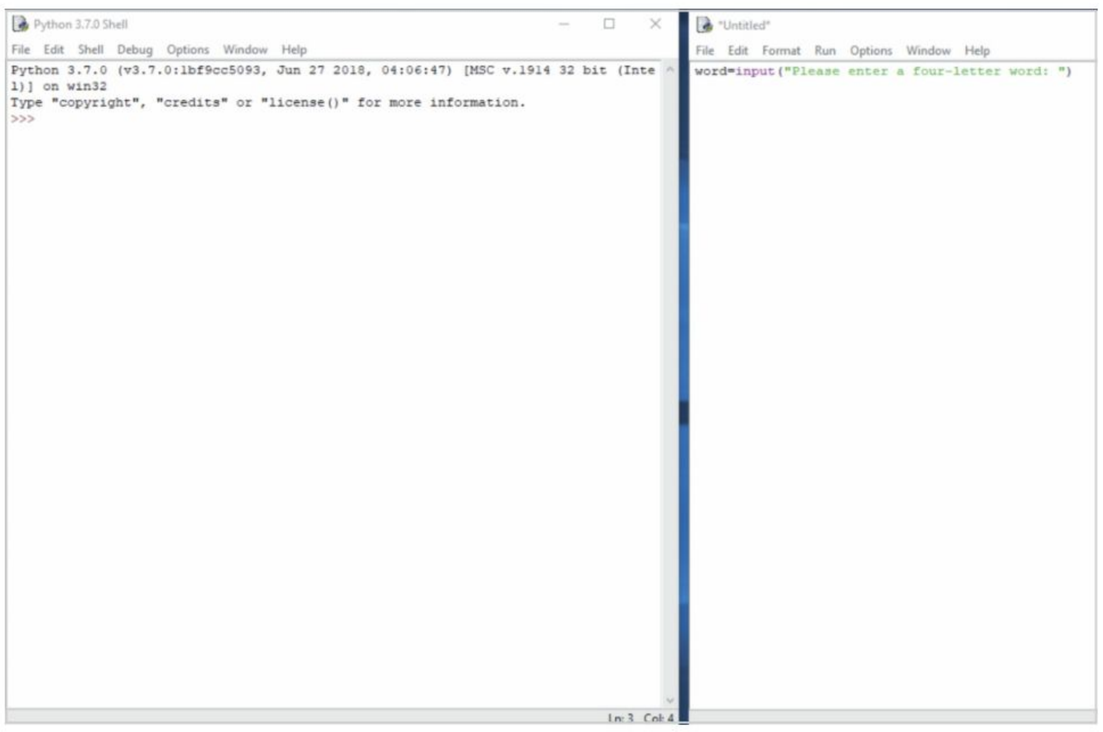
Conditions and loops are what make a program interesting, they can be simple or rather complex. How you use them depends greatly on what the program is trying to achieve, they could be the number of lives left in a game, or just displaying a countdown.

TRUE CONDITIONS

Keeping conditions simple, to begin with, makes learning to program a more enjoyable experience. Let's start then by checking if something is TRUE, then doing something else if it isn't.

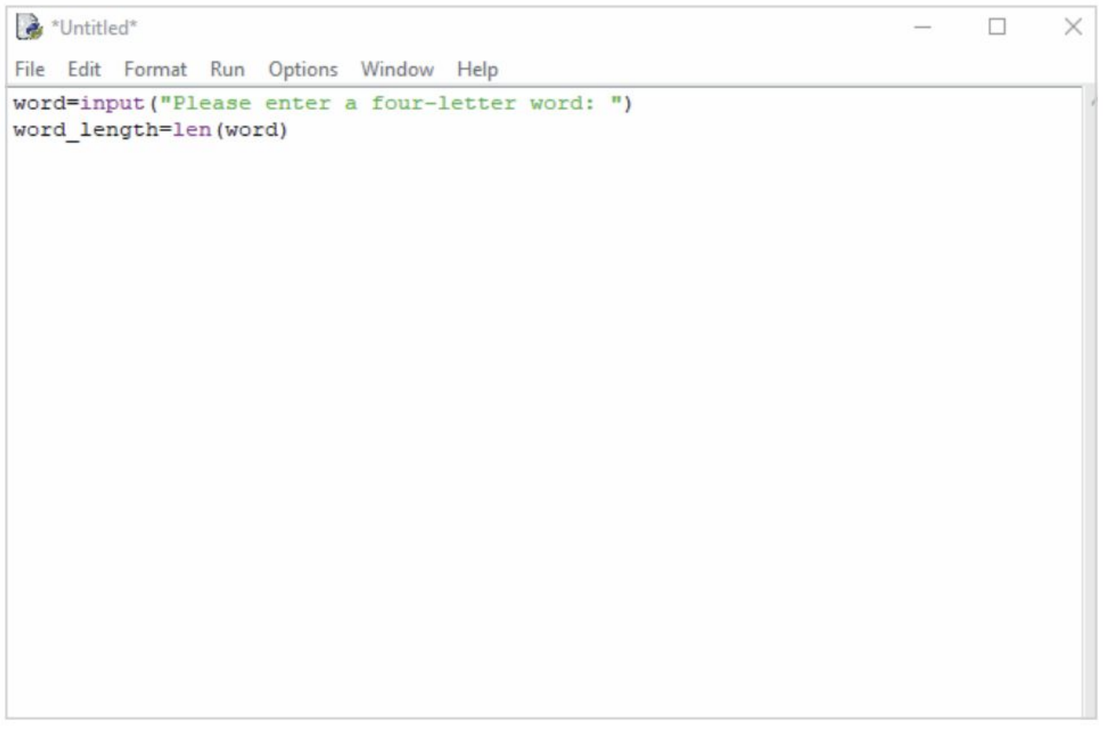
STEP 1 Let's create a new Python program that will ask the user to input a word, then check it to see if it's a four-letter word or not. Start with **File > New File**, and begin with the input variable:

```
word=input("Please enter a four-letter word: ")
```



STEP 2 Now we can create a new variable, then use the len function and pass the word variable through it to get the total number of letters the user has just entered:

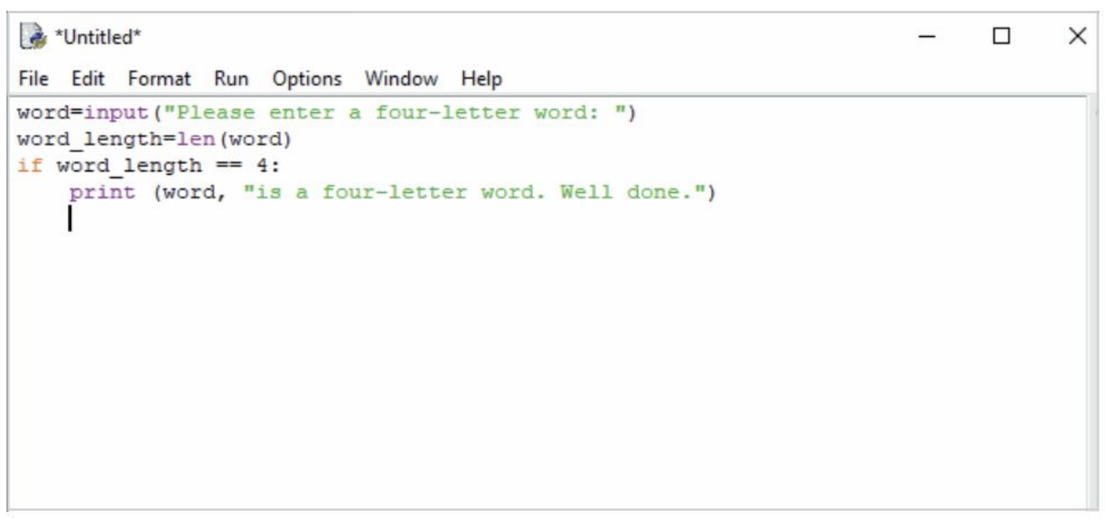
```
word=input("Please enter a four-letter word: ")
word_length=len(word)
```



STEP 3 Now we'll use an if statement to check if the word_length variable is equal to four, and print a friendly conformation if it applies to the rule:

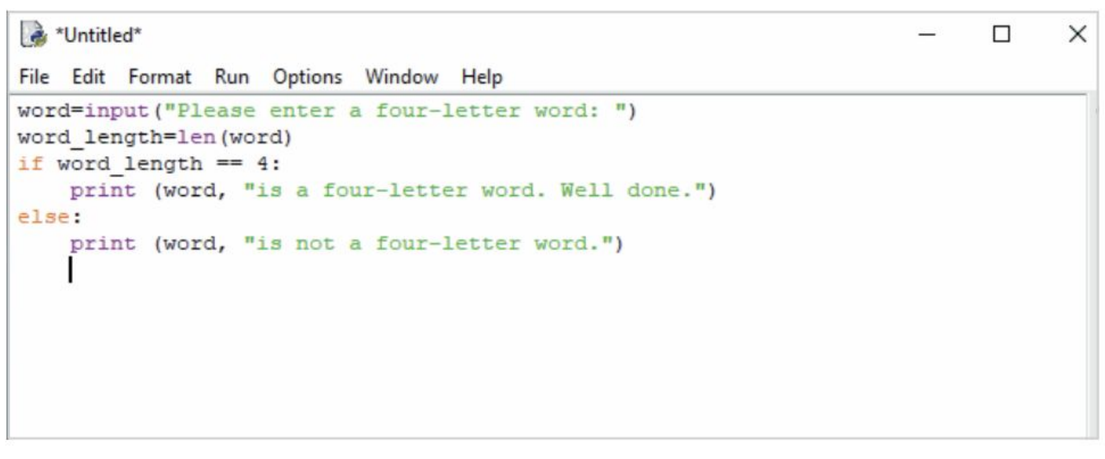
```
word=input("Please enter a four-letter word: ")
word_length=len(word)
if word_length == 4:
   print (word, "is a four-letter word. Well done.")
```

The double equal sign (==) check if something is equal to something else.

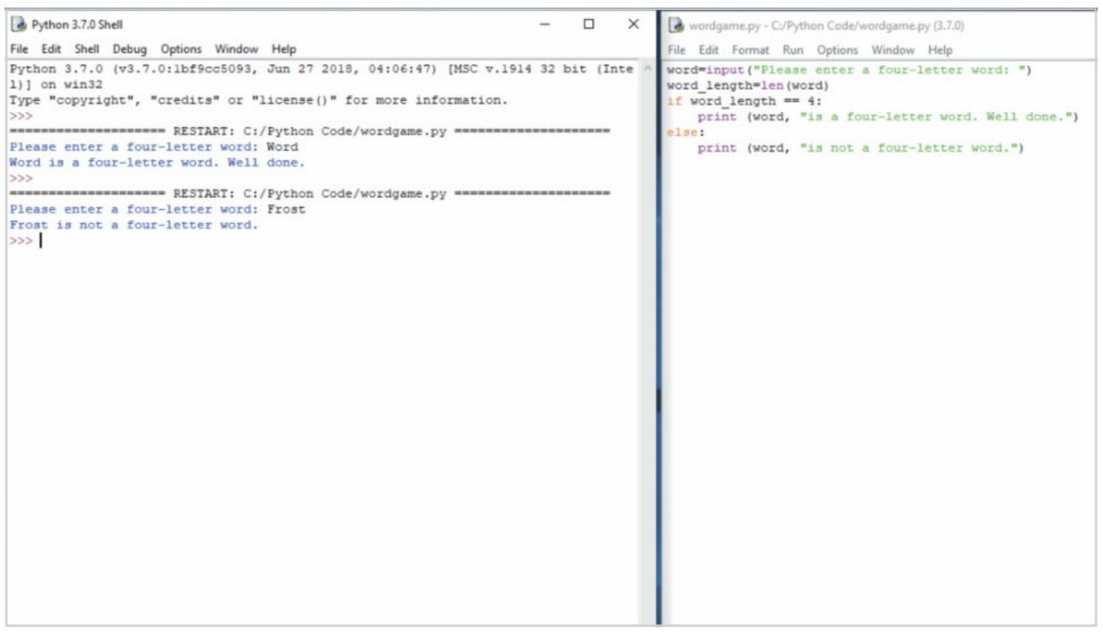


STEP 4 The colon at the end of if tells Python that if this statement is true, do everything after the colon that's indented. Next, move the cursor back to the beginning of the Editor:

```
word=input("Please enter a four-letter word: ")
word_length=len(word)
if word_length == 4:
   print (word, "is a four-letter word. Well done.")
else:
   print (word, "is not a four-letter word.")
```

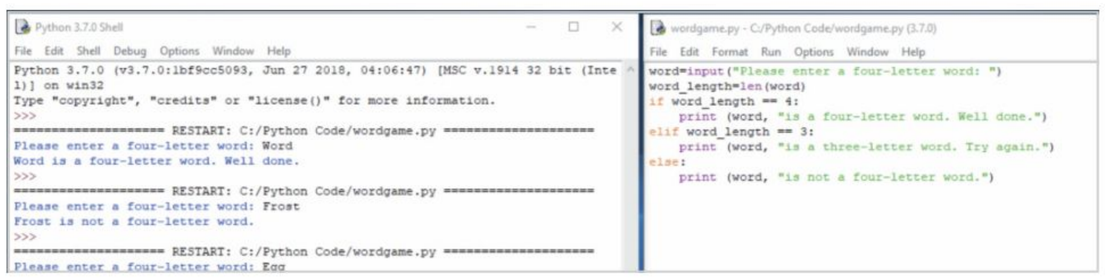


STEP 5 Press **F5** and save the code to execute it. Enter a four-letter word in the Shell to begin with, you should have the returned message that the word is four letters. Now press **F5** again, and re-run the program, but this time, enter a five-letter word. The Shell will display that it's not a four-letter word.



STEP 6 Now expand the code to include other conditions. Eventually, it could become quite complex. We've added a condition for three-letter words:

```
word=input("Please enter a four-letter word: ")
word_length=len(word)
if word_length == 4:
   print (word, "is a four-letter word. Well
done.")
elif word_length == 3:
   print (word, "is a three-letter word. Try again.")
else:
   print (word, "is not a four-letter word.")
```



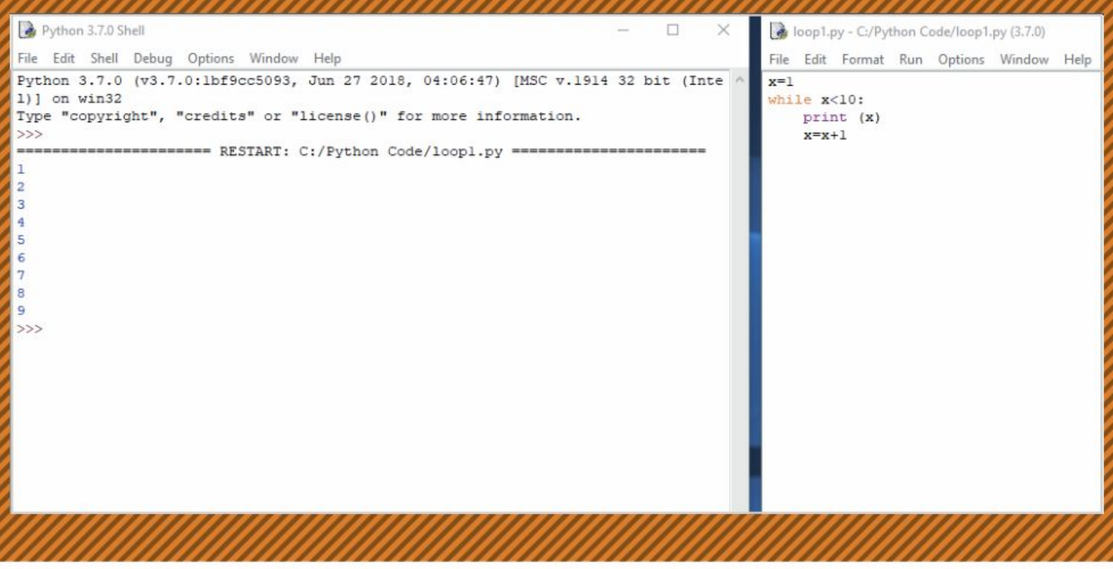
LOOPS

Although a loop looks quite similar to a condition, they are somewhat different in their operation. A loop will run through the same block of code a number of times, usually with the support of a condition.

STEP 1 Let's start with a simple **while** statement. Like **if**, this will check to see if something is TRUE, then run the indented code:

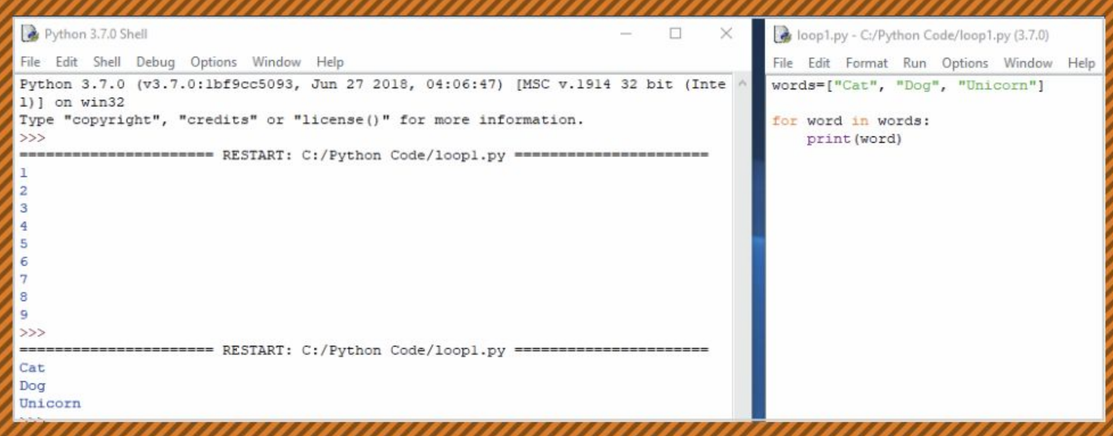
```
x = 1
while x < 10:
   print (x)
   x = x + 1
```

STEP 2 The difference between **if** and **while** is that when **while** gets to the end of the indented code, it goes back and checks the statement is still true. In our example x is less than 10. With each loop, it prints the current value of x, then adds one to that value. When x does eventually equal 10 it'll stop.



STEP 3 The **for** loop, is another example. **For** is used to loop over a range of data, usually a list stored as variables inside square brackets. For example:

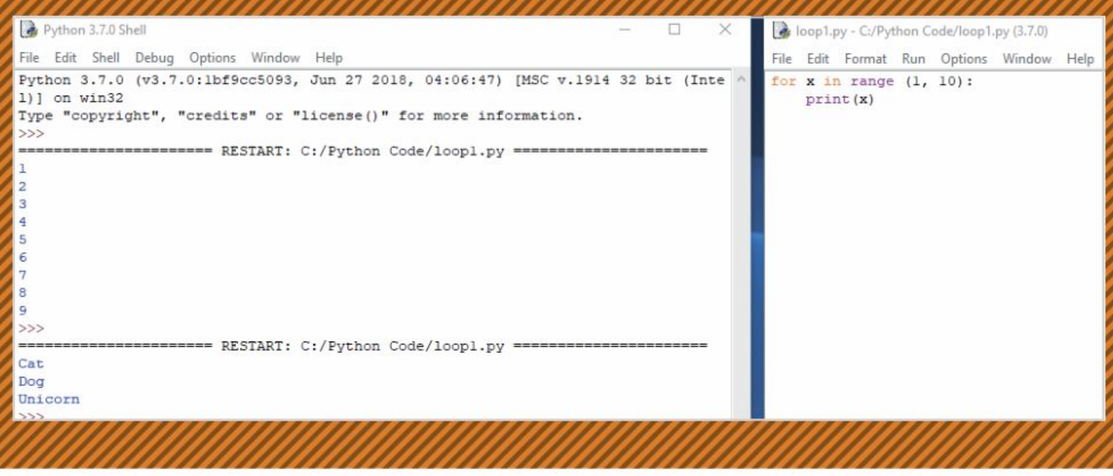
```
words=["Cat", "Dog", "Unicorn"]

for word in words:
   print (word)
```



STEP 4 The **for** loop can also be used in the countdown example by using the **range** function:

```
for x in range (1, 10):
   print (x)
```

The x=x+1 part isn't needed here, because the **range** function creates a list between the first and last numbers used.



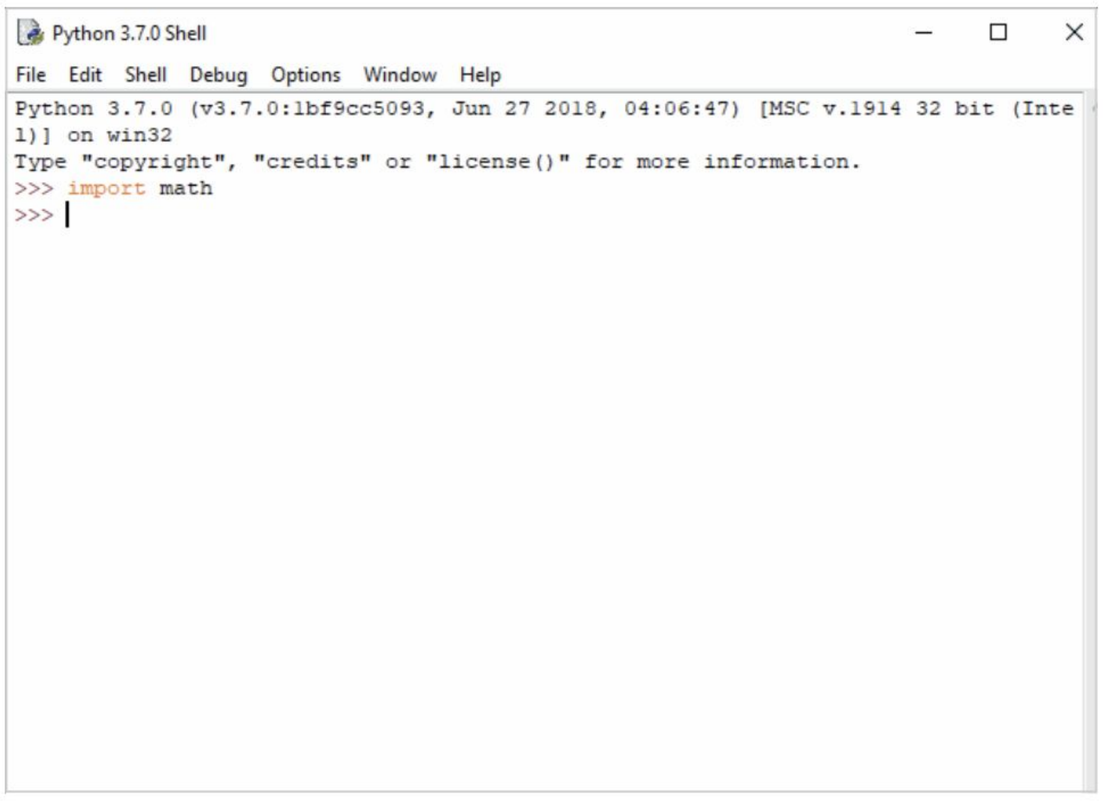
Python Modules

We've mentioned modules previously, using the Math module as an example, but since using modules is such a large part of getting the most from Python it's worth dedicating a little more time to them.

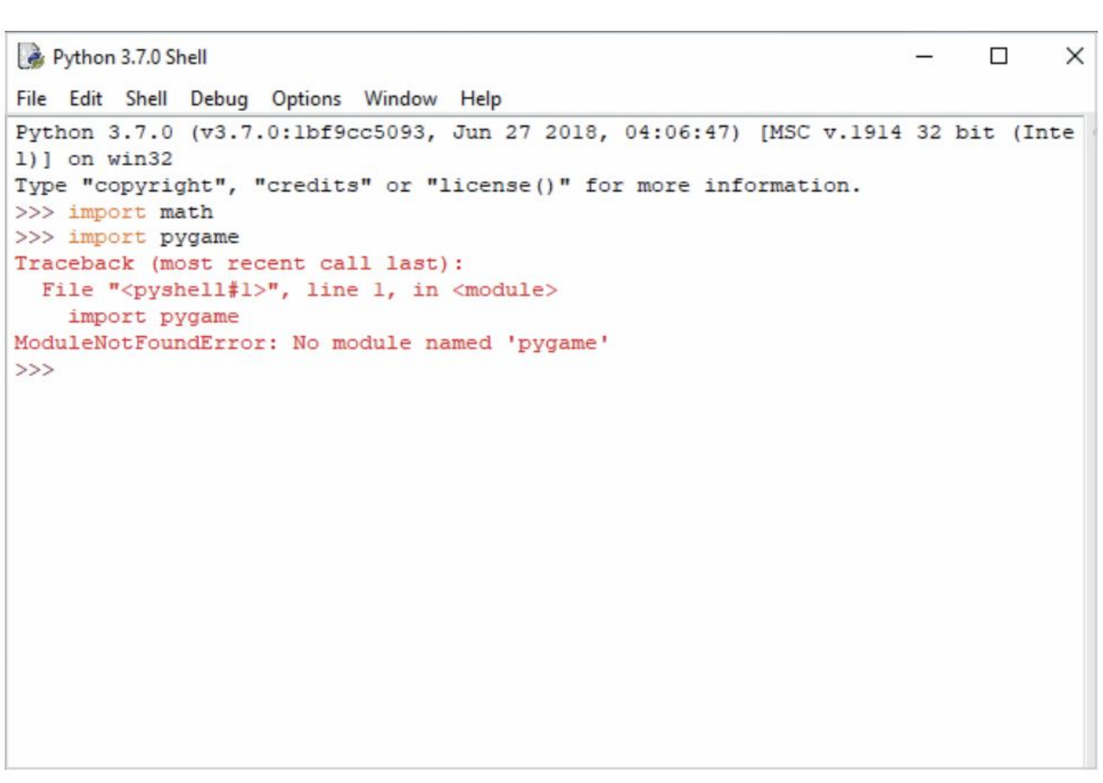
MASTERING MODULES

Think of modules as an extension that's imported into your Python code to enhance and extend its capabilities. There are countless modules available, and as we've seen, you can even make your own.

STEP 1 Although good, the built-in functions within Python are limited. The use of modules, however, allows us to make more sophisticated programs. As you are aware, modules are Python scripts that are imported, such as import math.

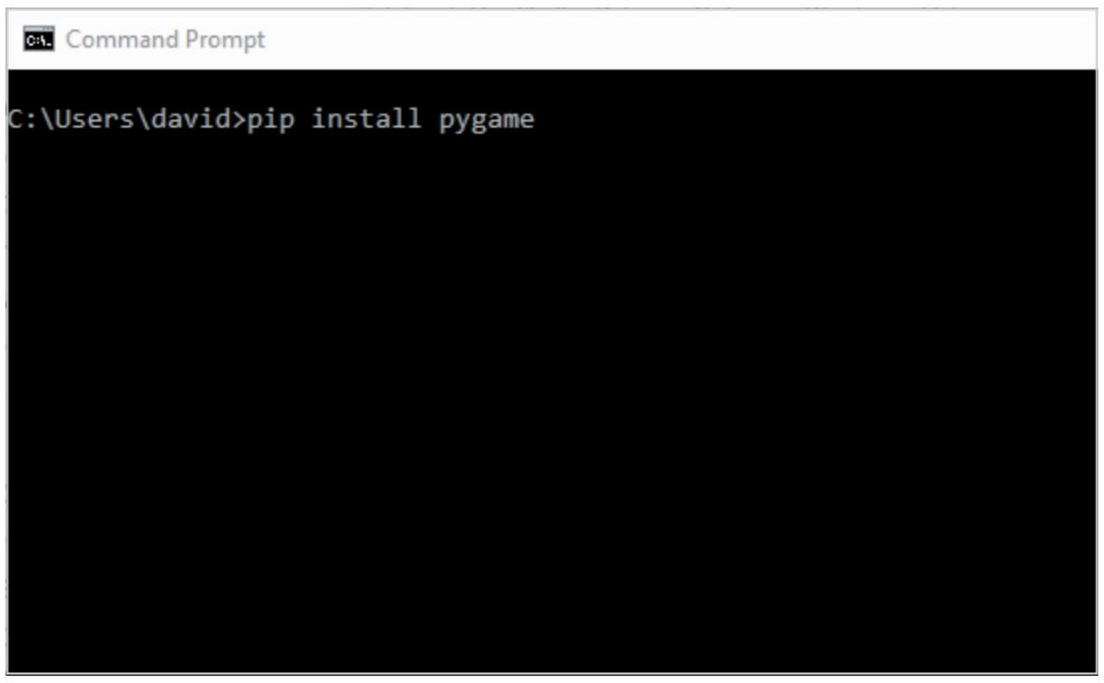


STEP 2 Some modules, especially on the Raspberry Pi, are included by default; the Math module is a prime example. Sadly, other modules aren't always available. A good example on non-Pi platforms is the Pygame module, which contains many functions to help create games. Try: **import pygame**.

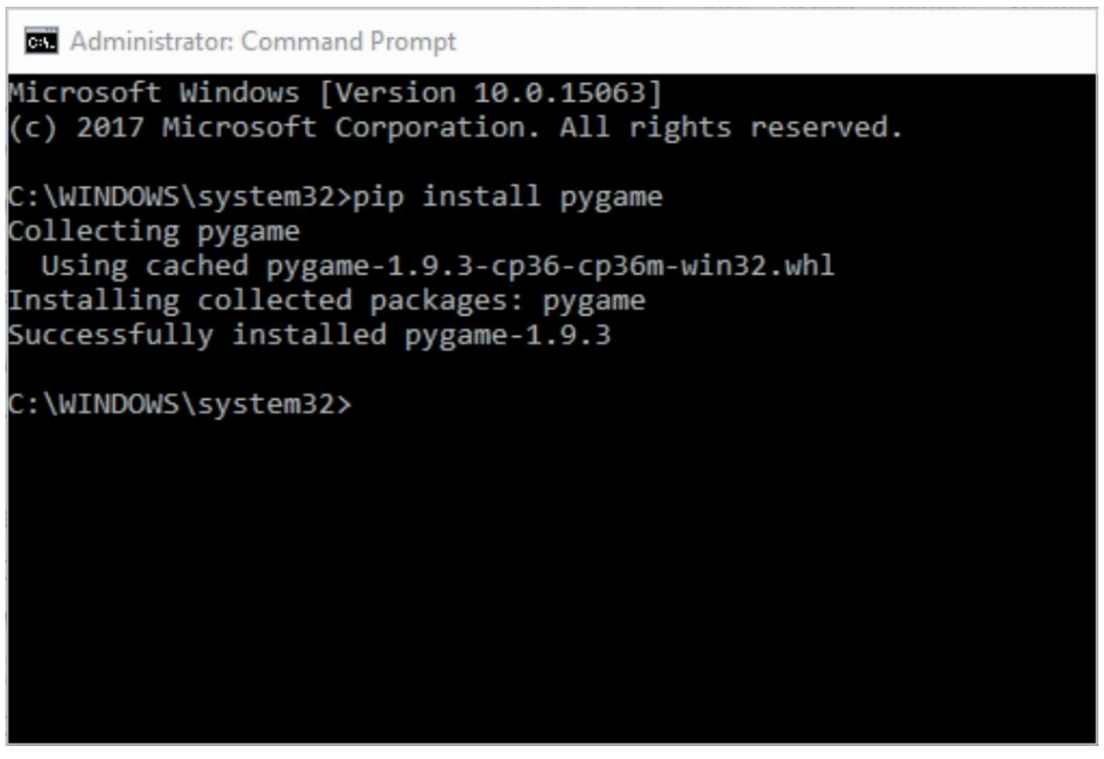


STEP 3 The result is an error in the IDLE Shell, as the Pygame module isn't recognised or installed in Python. To install a module we can use PIP (Pip Installs Packages). Close down the IDLE Shell and drop into a command prompt or Terminal session. At an elevated admin command prompt, enter:

```
pip install pygame
```



STEP 4 The PIP installation requires an elevated status due to it installing components at different locations. Start with a search for **CMD**, via the Start button, right-click the result, and then click **Run as Administrator**. Linux and Mac users can use the Sudo command, with **sudo pip install package**.



STEP 5 Close the command prompt or Terminal, and re-launch the IDLE Shell. When you now enter `import pygame`, the module will be imported into the code without any problems. You'll find that most code downloaded, or copied, from the Internet will contain a module, mainstream or unique, and their absence is commonly the source of errors in execution.

STEP 6 The modules contain the extra code needed to achieve a certain result within your own code, with which we've previously experimented. For example:

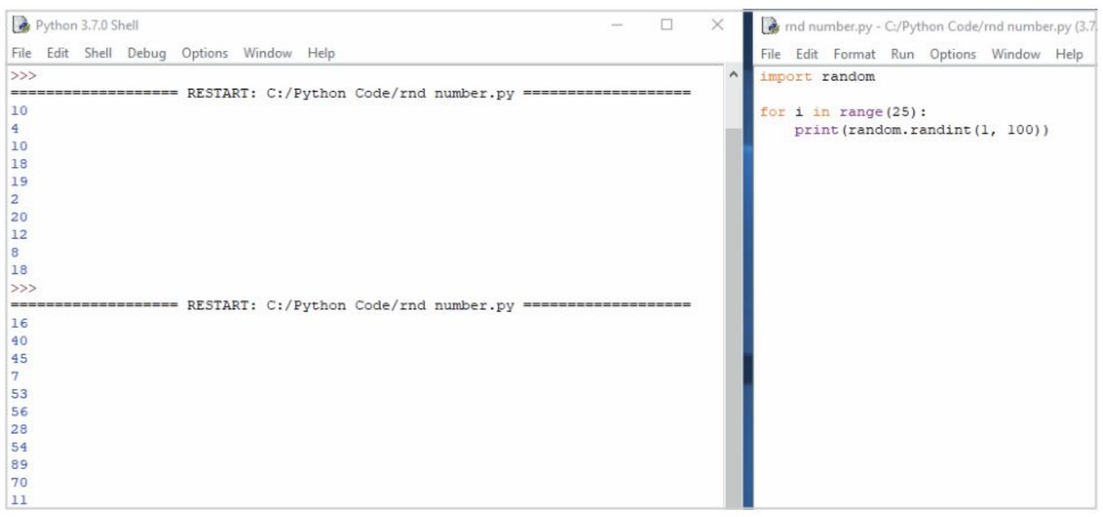
```
import random
```

Brings in the code from the Random number generator module. We can then use this module to create something like:

```
for i in range(10):
  print(random.randint(1, 25))
```

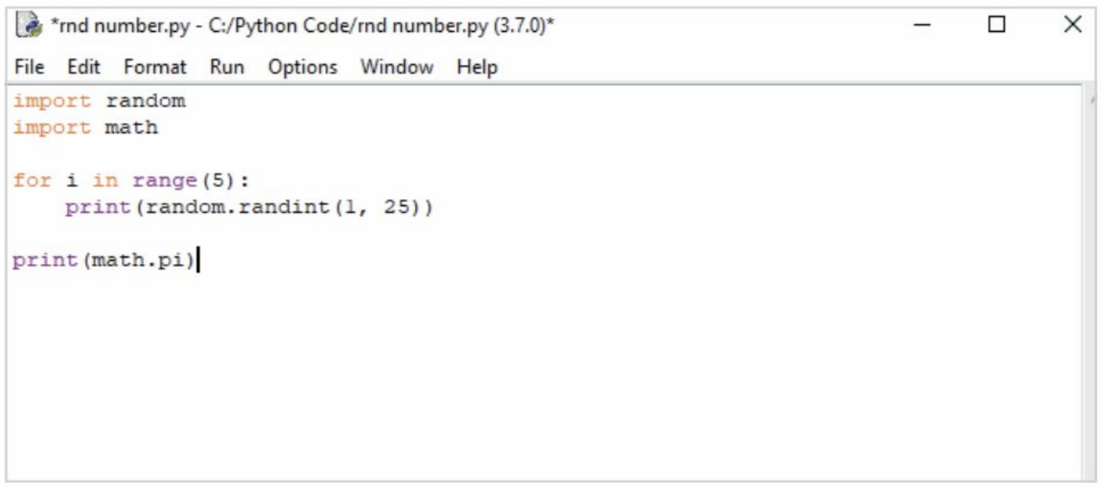
STEP 7 This code, when saved and executed, will display ten random numbers from 1 to 25. You can play around with the code to display more or less, and from a greater or lesser range. For example:

```
import random

for i in range(25):
  print(random.randint(1, 100))
```



STEP 8 Multiple modules can be imported within your code. To extend our example, use:

```
import random
import math

for I in range(5):
  print(random.randint(1, 25))

print(math.pi)
```



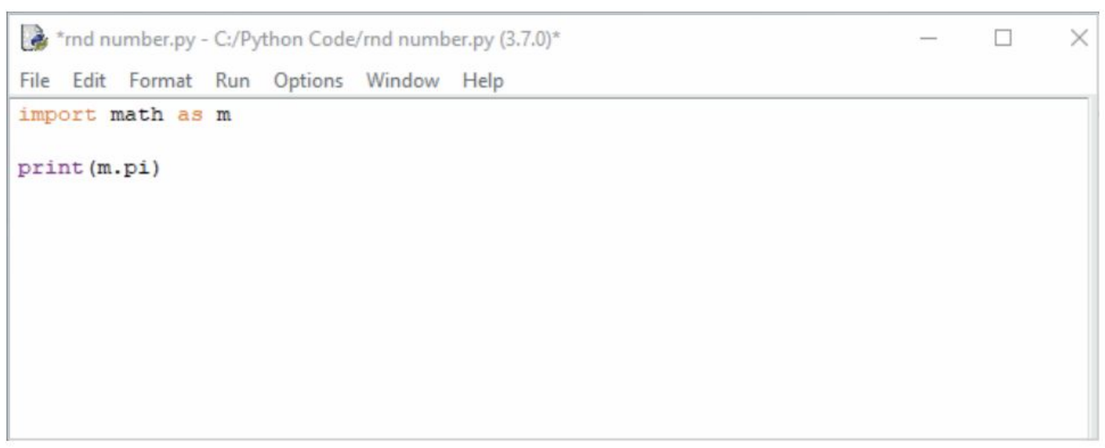
STEP 9 The result is a string of random numbers followed by the value of Pi, as pulled from the math module using the **print(math.pi)** function. You can also pull in certain functions from a module by using the **from** and **import** commands, such as:

```
from random import randint

for i in range(5):
  print(randint(1, 25))
```

STEP 10 This helps create a more streamlined approach to programming. You can also use: **import module***, which will import everything defined within the named module. However, it's often regarded as a waste of resources, but it works nonetheless. Finally, modules can be imported as aliases:

```
import math as m

print(m.pi)
```

Of course, adding comments helps to tell others what's going on.



Did you know that Windows has its own built-in scripting language? Batch files have been around since the early days of Windows, and while they are overshadowed by the might of Windows' modern graphical user interface and PowerShell, they are still there and still just as capable as they were thirty years ago.

Batch file programming is a skill that system administrators still use, so it's worth spending a bit of time learning how they work, and what you can do with them. This section introduces batch files, and covers user interactions, variables, loops and even a batch file quiz game to inject an element of fun.

96 What is a Batch File?

98 Getting Started with Batch Files

100 Getting an Output

102 Playing with Variables

104 Batch File Programming

106 Loops and Repetition

108 Creating a Batch File Game

"Measuring programming progress by lines of code is like measuring aircraft building progress by weight."

– Bill Gates
(Co-founder of Microsoft)

Coding with Windows 10 Batch Files

What is a Batch File?

The Windows batch file has been around since the early days of DOS, and was once a critical element of actually being able to boot into a working system. There's a lot you can do with a batch file but let's just take a moment to see what one is.

.BAT MAN

A Windows batch file is simply a script file that runs a series of commands, one line at a time, much in the same fashion as a Linux script. The series of commands are executed by the command line interpreter and stored in a plain text file with the .BAT extension; this signifies to Windows that it's an executable file, in this case, a script.

Batch files have been around since the earliest versions of Microsoft DOS. Although not exclusively a Microsoft scripting file, batch files are mainly associated with Microsoft's operating systems. In the early days, when a PC booted into a version of DOS (which produced a simple command prompt when powered up), the batch file was used in the form of a system file called Autoexec.bat. Autoexec.bat was a script that automatically executed (hence Autoexec) commands once the operating system had finished dealing with the Config.sys file.

When a user powered up their DOS-based computer, and once the BIOS had finished checking the system memory and so on, DOS would look to the Config.sys file to load any specific display requirements and hardware drivers, allocate them a slot in the available memory, assign any memory managers and tell the system where the Command.com file, which is the command line interpreter for DOS, was. Once it had done that, then the Autoexec.bat file took over and ran through each line in turn, loading programs that would activate the mouse or optical drive into the memory areas assigned by the Config.sys file.

The DOS user of the day could opt to create different Autoexec.bat files depending on what they wanted to do. For example, if they wanted to play a game and have as much memory available as possible, they'd create a Config.sys and Autoexec.bat set of files that loaded the bare minimum of drivers and so on. If they needed access to the network, an Autoexec.bat file could be created to

The Autoexec.bat file was a PC user's first experience with a batch file.

Batch files are plain text and often created using Notepad.

Batch files were often used as utility programs, to help users with complex tasks.

load the network card driver and automatically gain access to the network. Each of these unique setups would be loaded on to a floppy disk and booted as and when required by the user.

The Autoexec.bat was the first such file many users came across in their PC-based computing lives; since many had come from a 16-bit or even 8-bit background; remember, this was the late eighties and early nineties. The batch file was the user's primary tool for automating tasks, creating shortcuts and adventure games and translating complex processes into something far simpler.

Nowadays however, a batch file isn't just for loading in drivers and such when the PC boots. You can use a batch file in the same way as any other scripting language file, in that you can program it to ask for user input and display the results on the screen; or save to a file and even send it to a locally or network attached printer. You can create scripts to back up your files to various locations, compare date stamps and only back up the most recently changed content as well as program the script to do all this automatically. Batch files are remarkably powerful and despite them not being as commonly used as they were during the older days of DOS, they are still there and can be utilised even in the latest version of Windows 10; and can be as complex or simple as you want them to be.

So what do you need to start batch file programming in Windows? Well, as long as you have Windows 10, or any older version of Windows for that matter, you can start batch file programming immediately. All you need is to be able to open Notepad and get to the command prompt of Windows. We show you how it all works, so read on.

BATCH FILE POWER

Just like any other programming interface that can directly interrogate and manipulate the system, batch files require a certain amount of care when programming. It's hard to damage your system with a batch file, as the more important elements of the modern Windows system are protected by the User Account Control (UAC) security; UAC works by only allowing elevated privileges access to important system files. Therefore if you create a batch file that somehow deletes a system file, the UAC activates and stop the process.

However, if you're working in the command prompt with elevated privileges to begin with, as the Administrator, then the UAC won't question the batch file and continue regardless of what files are being deleted.

That said, you're not likely to create a batch file that intentionally wipes out your operating system. There are system controls in place to help prevent that; but it's worth mentioning as there are batch files available on the Internet that contain malicious code designed to create problems. Much like a virus, a rogue batch file (when executed with Administrator privileges) can cause much mayhem and system damage. In short, don't randomly execute any batch file downloaded from the Internet as an Administrator, without first reviewing what it does.

You can learn more about batch files in the coming pages, so don't worry too much about destroying your system with one. All this just demonstrates how powerful the humble batch file can be.

You can create complex batch files or simple ones that display ASCII images on screen.

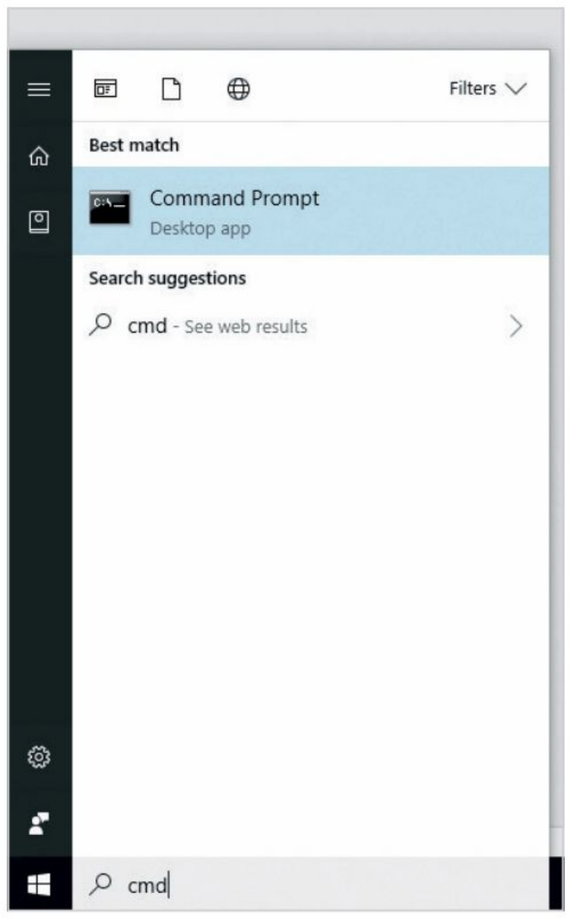
Getting Started with Batch Files

Before you begin to program with batch files, there are a few things you need to know. A batch file can only be executed once it has the .bat extension and editing one with Notepad isn't always straightforward.

A NEW BATCH

Throughout this section on batch files we're going to be working with Notepad, the command prompt and within a folder called 'Batch Files'. To begin with, let's see how you get to the Windows command prompt.

STEP 1 The Windows command prompt may look a little daunting to the newcomer but it's simply another interface (or Shell) used to access the filesystem. You can go anywhere you like in the command prompt, as you would with the graphical interface. To begin, click on the Windows Start button and enter CMD into the search box.



STEP 2 Click on the search result labelled Command Prompt (Desktop App) and a new window pops up. The Command Prompt window isn't much to look at to begin with but you can see the Microsoft Windows version number and copyright information followed by the prompt itself. The prompt details the current directory or folder you're in, together with your username.

STEP 3 While at the command prompt window, enter: `dir/w.` This lists all the files and directories from where you are at the moment in the system. In this case, that's your Home directory that Windows assigns every user that logs in. You can navigate by using the CD command (Change Directory). Try:

```
cd Documents
```

Then press Return.

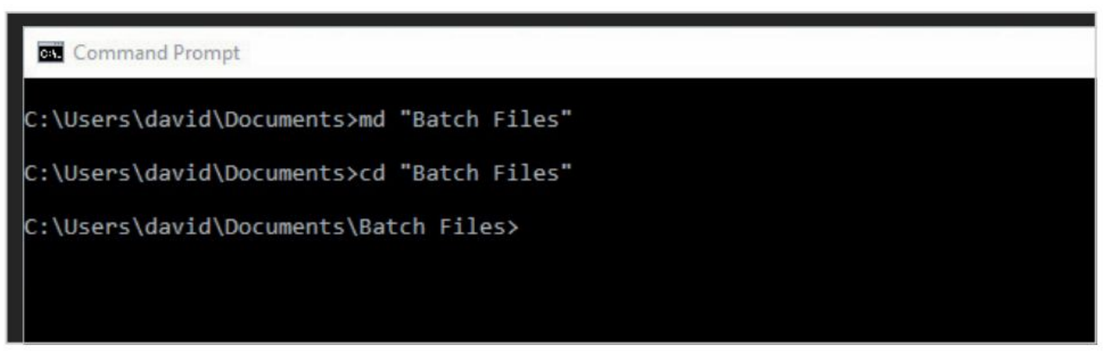
STEP 4 The prompt should change and display `\Documents>;` this means you're in the Documents directory. Now, create a new directory call Batch Files. Enter:

```
md "Batch Files"
```

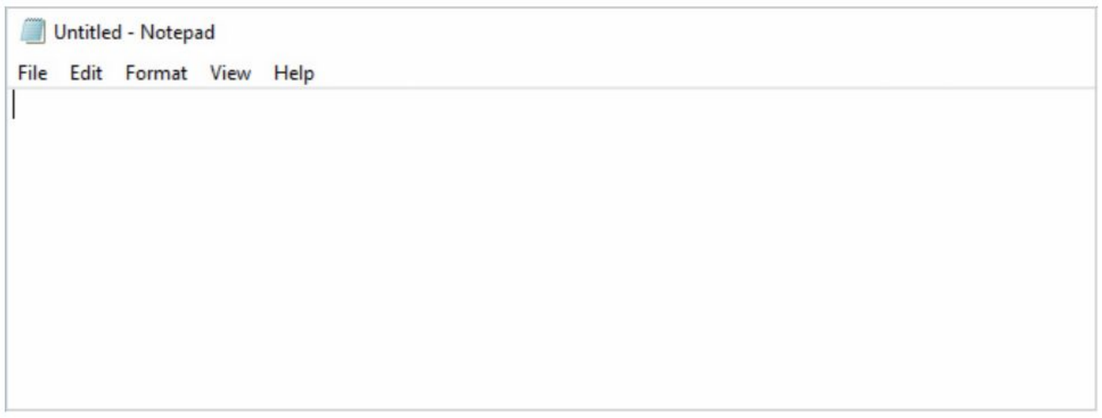
You need the quotations because without them, Windows creates two directories: Batch and Files. Now change directory into the newly created Batch Files.

```
cd Batch Files
```

You won't need the quotes to change directories.



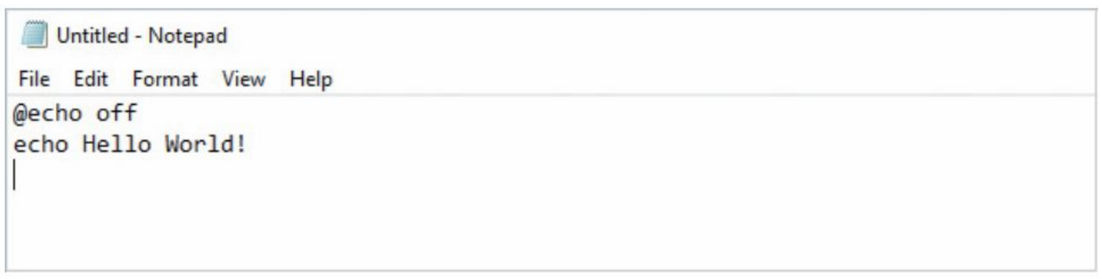
STEP 5 Now that you have the directory set up, where you store your batch files, here is how you can create one. Leave the command prompt window open and click on the Windows Start button again. This time enter Notepad and click on the search result to open the Notepad program. Notepad is a simple text editor but ideal for creating batch scripts with.



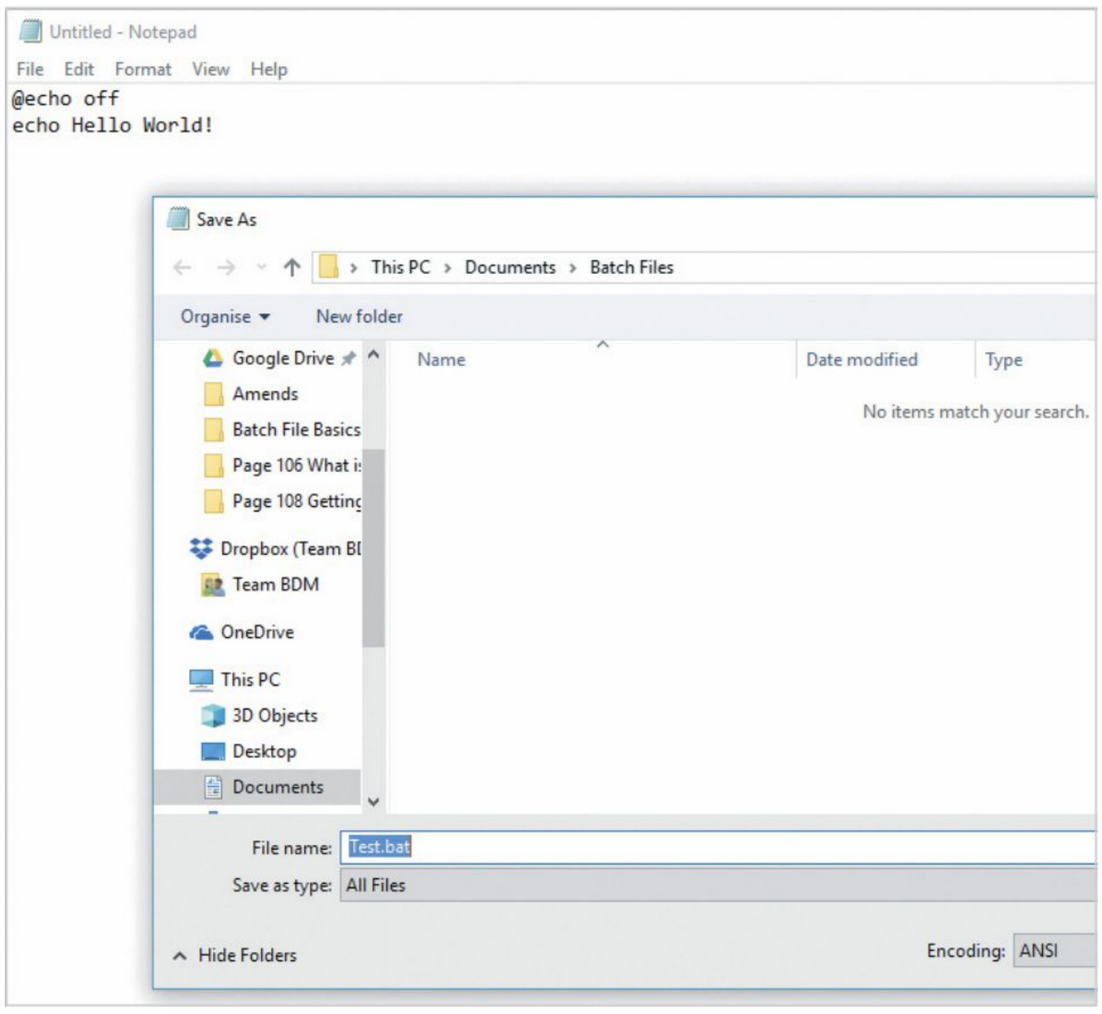
STEP 6 To create your first batch file, enter the following into Notepad:

```
@echo off
echo Hello World!
```

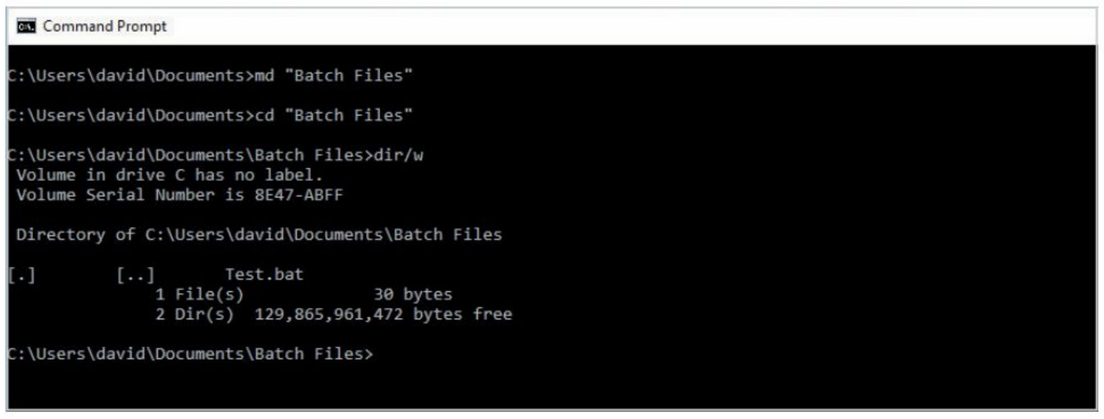
By default, a batch file displays all the commands that it runs through, line by line. What the @echo off command does is turn that feature off for the whole script; with the '@' (at) sign to apply that command to itself.



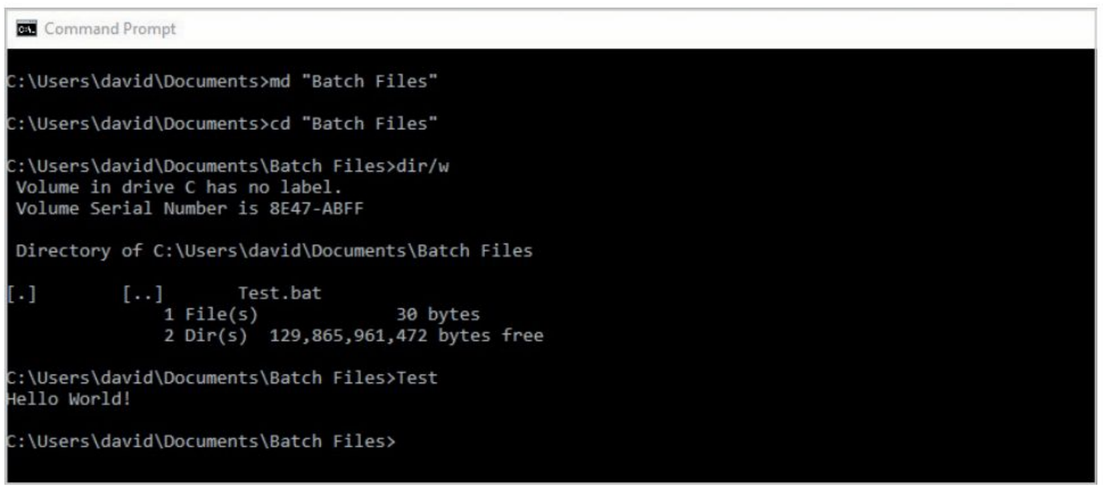
STEP 7 When saving anything in Notepad the default extension is .txt, to denote a text file. However, you want the extension to be .bat. Click on File > Save As and navigate to the newly created Batch Files directory in Documents. Click the drop-down menu Save as Type, and select All Files from the menu. In File Name, call the file **Test.bat**.



STEP 8 Back at the command prompt window, enter: `dir/w` again to list the newly created Test.bat file. By the way, the /w part of dir/w means the files are listed across the screen as opposed to straight down. Enter `dir` if you want (although you need more files to view) but it's considered easier to read with the /w flag.



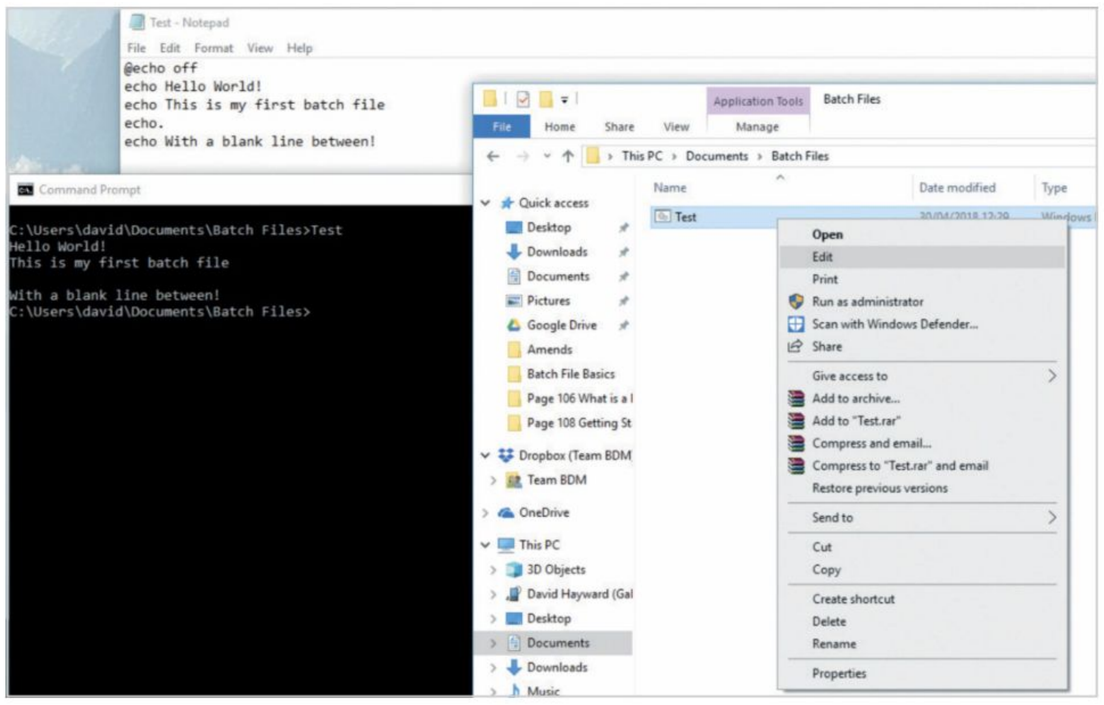
STEP 9 To execute the batch file you've just created, simply enter its name, Test, in the command prompt window. You don't need to add the .bat part, as Windows recognises it as an executable file, and the only one with that particular name in the current directory. Press return and see how you're greeted with Hello World! in the command prompt.



STEP 10 The echo command displays whatever is after it to the screen. Right-click the Test.bat file from Windows Explorer and select Edit to add more echo commands if you like. Try this:

```
@echo off
echo Hello World!
echo This is my first batch file
echo.
echo With a blank line between!
```

Remember to save each new change to the batch file.



Getting an Output

While it's great having the command prompt window display what you're putting after the echo command in the batch file, it's not very useful at the moment, or interactive for that matter. Let's change up a gear and get some output.

INPUT, OUTPUT

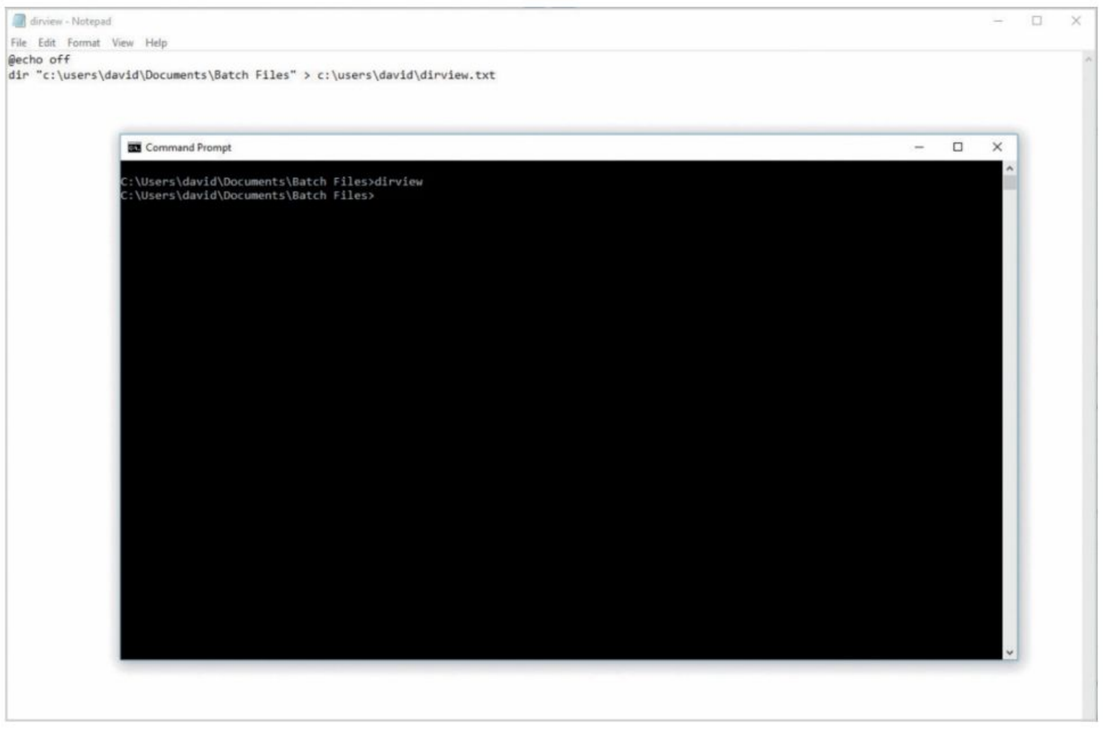
Batch files are capable of taking a normal Windows command and executing it, while also adding extra options and flags in to the equation.

STEP 1 Let's keep things simple to begin with. Create a new batch file called 'dirview.bat', short for Directory View. Start with the @echo off command and under that add:

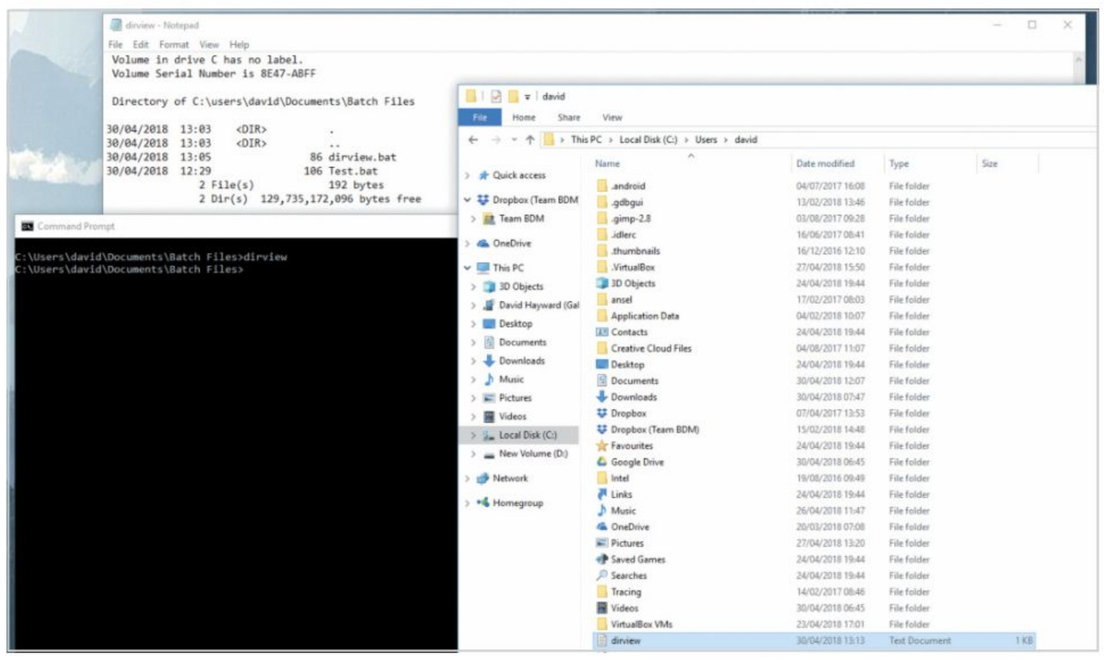
```
dir "c:\users\YOURNAME\Documents\Batch Files" > c:\users\YOURNAME\dirview.txt
```

Substitute YOURNAME with your Windows username.

STEP 2 The new line uses the dir command to list the contents of the directory Batch Files, in your Home directory, dumping the output to a text file called `dirview.txt` in the root of your Home directory. This is done, so that the Windows UAC doesn't require elevated permissions, as everything is in your own Home area. Save and run the batch file.



STEP 3 You have no doubt noticed that there is no indication that the batch file worked as there's no meaningful output on the screen. However, if you now open Explorer and browse to `c:\Users\YOURNAME`, remembering to substitute `YOURNAME` with your Windows username, and double-click the `dirview.txt` file, you can see the batch file's output.



STEP 4 If you want to automate the task of opening the text file that contains the output, add the following line to the batch file:

```
notepad.exe c:\users\YOURNAME\dirview.txt
```

Save the file and once again run from the command prompt. This time, it creates the output and automatically opens Notepad with the output contents.

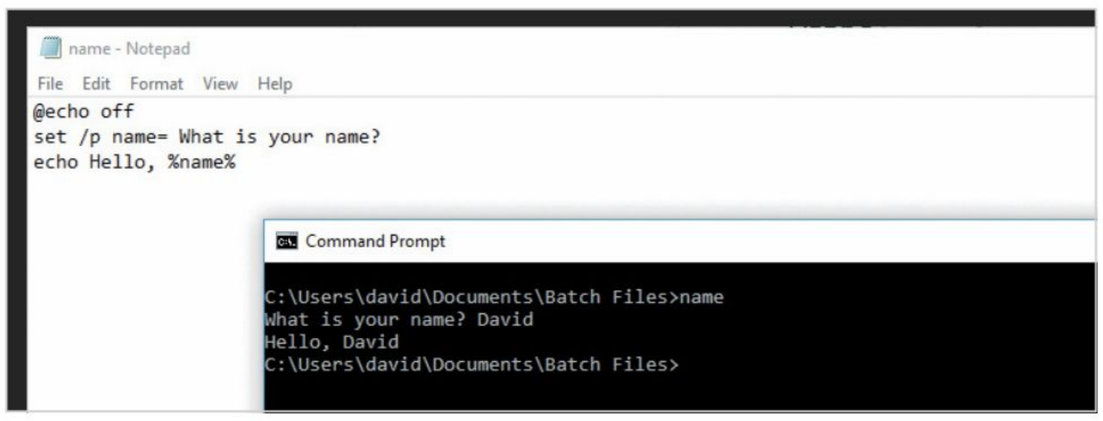
OUTPUT WITH VARIABLES

Variables offer a more interesting way of outputting something to the screen and create a higher level of interaction between the user and the batch file. Try this example below.

STEP 1 Create a new batch file and call it **name.bat**. Start with the `@echo off` command, then add the following lines:

```
set /p name= What is your name?
echo Hello, %name%
```

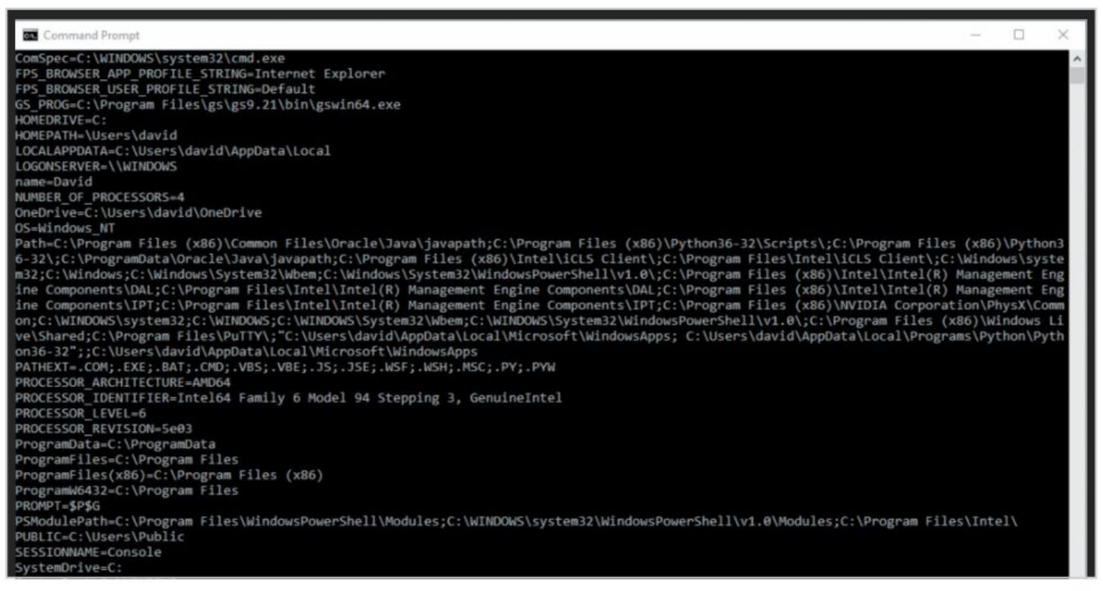
Note: there's a space after the question mark. This is to make it look neater on the screen. Save it and run the batch file.



STEP 2 The set **/p** name creates a variable called name, with the **/p** part indicating that an '**=prompt string**' is to follow. The Set command displays, sets or removes system and environmental variables. For example, while in the command prompt window enter:

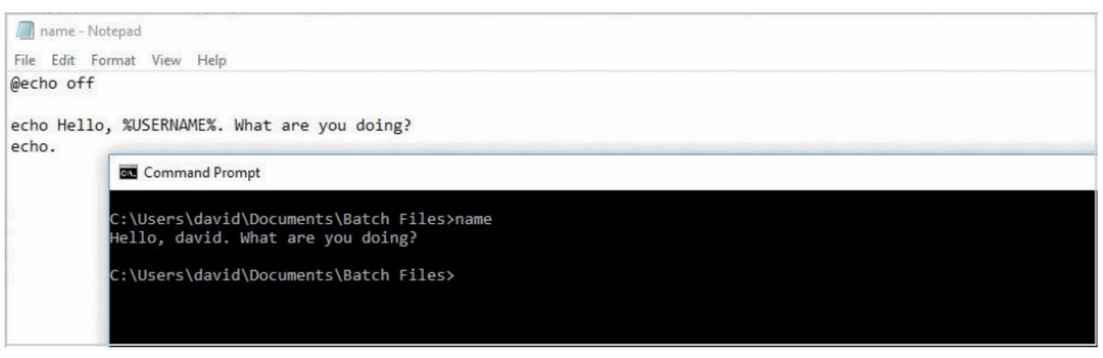
```
set
```

To view the current system variables. Note the name= variable we just created.



STEP 3 Variables stored with Set can be called with the **%VARIABLENAME% syntax**. In the batch file, we used the newly created %name% syntax to call upon the contents of the variable called name. Your username, for example, is stored as a variable. Try this in a batch file:

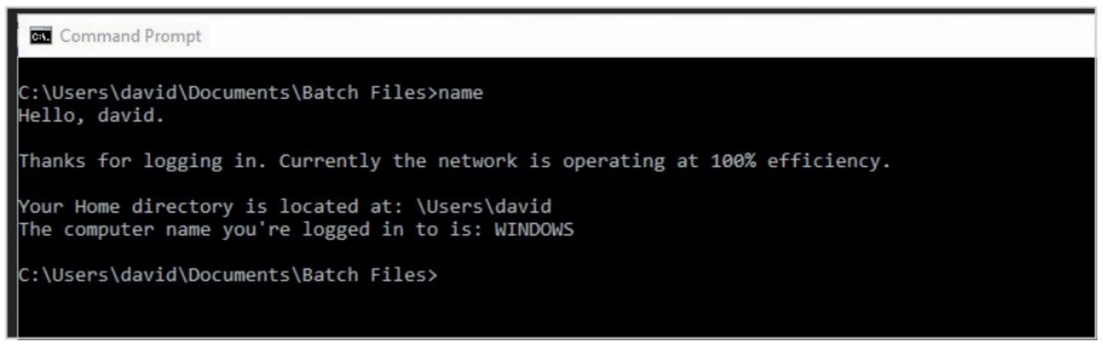
```
echo Hello, %USERNAME%. What are you doing?
```



STEP 4 This is extremely useful if you want to create a unique, personal batch file that automatically runs when a user logs into Windows. Using the default systems variables that Windows itself creates, you can make a batch file that greets each user:

```
@echo off
echo Hello, %USERNAME%.
echo.
echo Thanks for logging in. Currently the network is operating at 100%% efficiency.
echo.
echo Your Home directory is located at: %HOMEPATH%
echo The computer name you're logged in to is: %COMPUTERNAME%
echo.
```

STEP 5 Save and execute the batch file changes; you can overwrite and still use name.bat if you want. The batch file takes the current system variables and reports them accordingly, depending on the user's login name and the name of the computer. Note: the double percent symbol means the percent sign will be displayed, and is not a variable.



STEP 6 Alternatively, you can run the batch file and display it on the user's desktop as a text file:

```
@echo off
echo Hello, %USERNAME%. > c:%HOMEPATH%\user.txt
echo. >> c:%HOMEPATH%\user.txt
echo Thanks for logging in. Currently the network is operating at 100%% efficiency. >> c:%HOMEPATH%\user.txt
echo. >> c:%HOMEPATH%\user.txt
echo Your Home directory is located at: %HOMEPATH% >> c:%HOMEPATH%\user.txt
echo The computer name you're logged in to is: %COMPUTERNAME% >> c:%HOMEPATH%\user.txt
echo. >> c:%HOMEPATH%\user.txt

notepad c:%HOMEPATH%\user.txt
```

The > outputs to a new file called user.txt, while the >> adds the lines within the file.

Playing with Variables

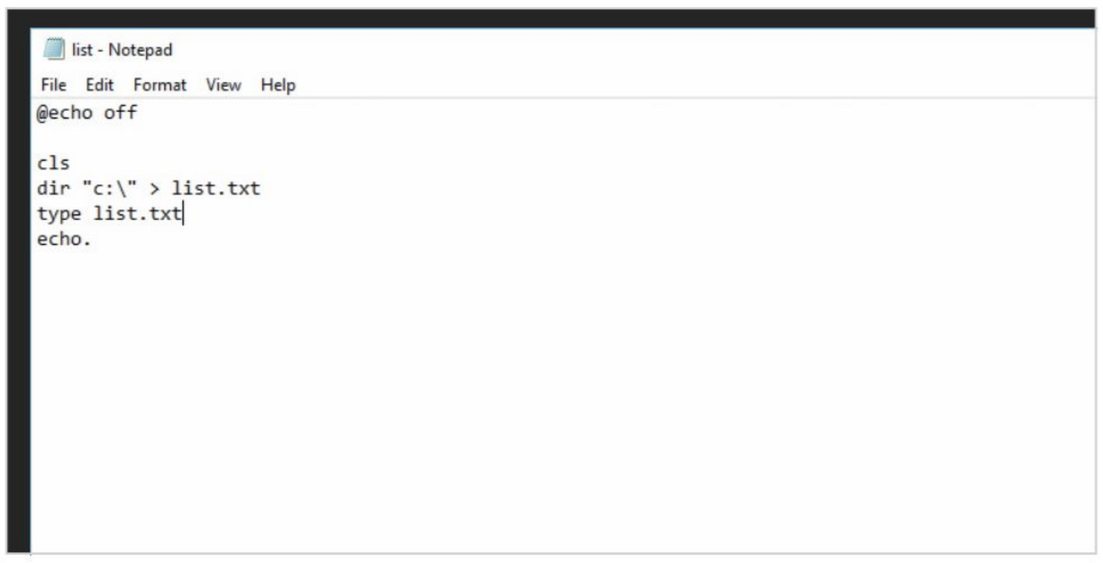
There's a lot you can accomplish with both the system and environmental variables, alongside your own. Mixing the two can make for a powerful and extremely useful batch file and when combined with other commands, the effect is really impressive.

USING MORE VARIABLES

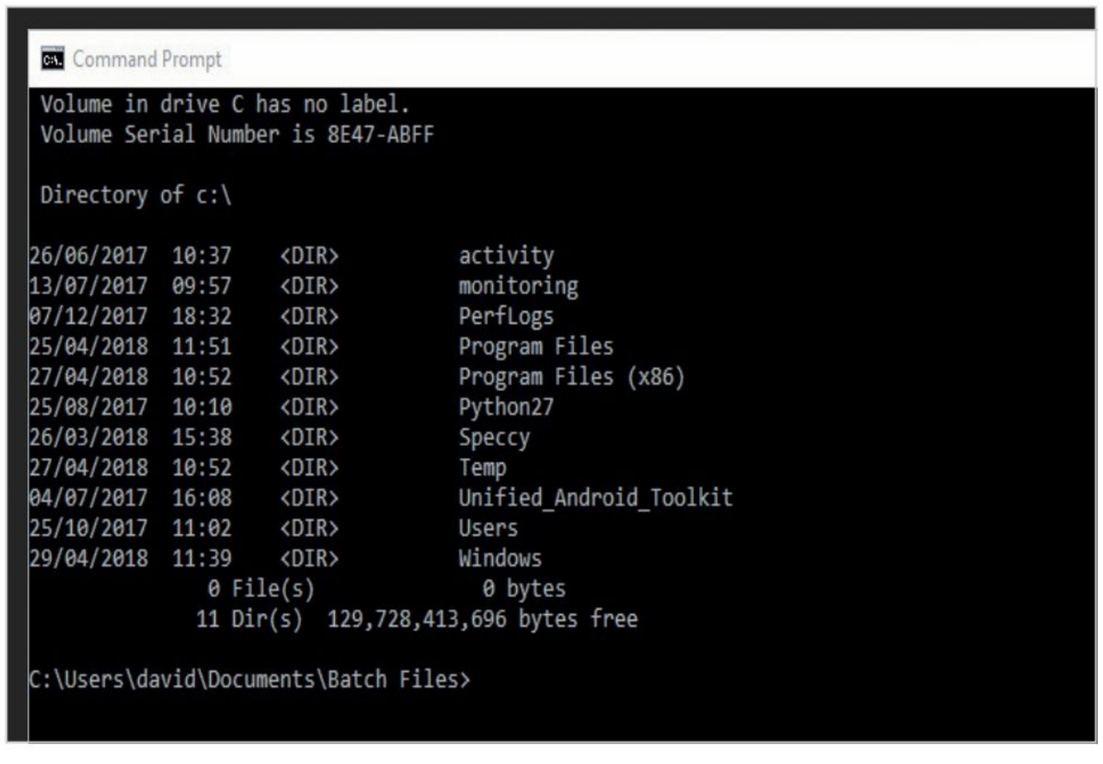
Here's a good example of mixing system and environmental variables with some of your own creation, along with a number of external Windows commands.

STEP 1 Create a new batch file called list.bat and start it off with the `@echo off` command. Begin by clearing the command prompt screen and displaying a list of the current directories on the computer:

```
cls
dir "c:\" > list.txt
type list.txt
echo.
```



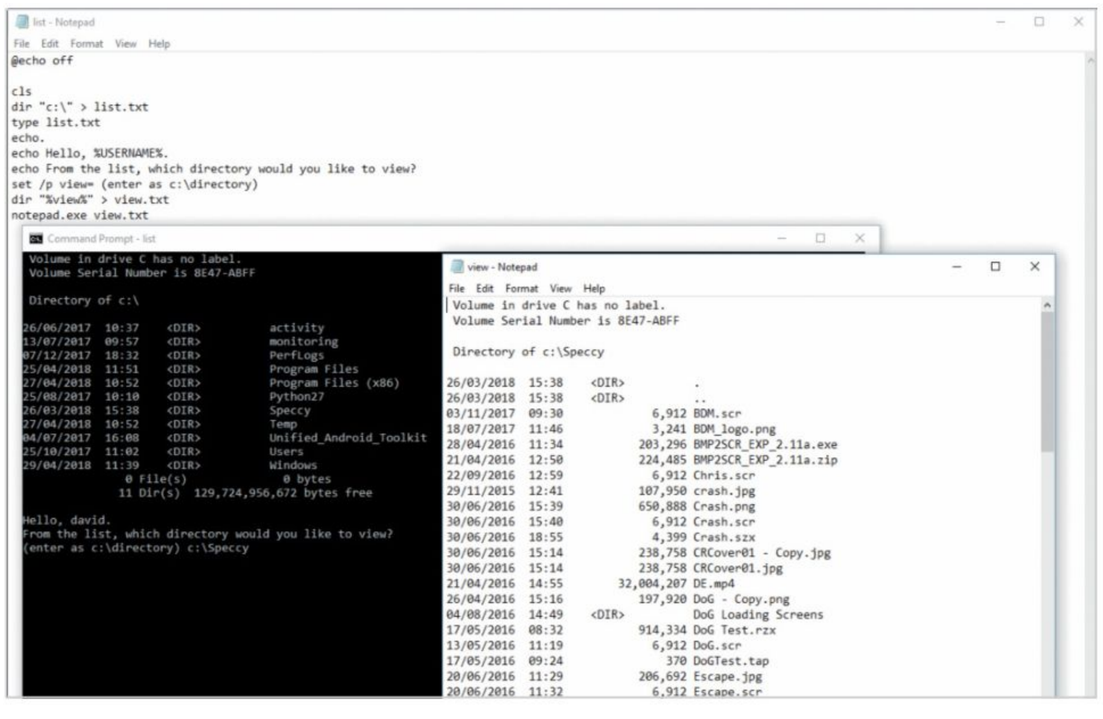
STEP 2 Save and execute the batch file. Within the command prompt you can see the contents of all the files and directories from the root of the C:\ drive; and as any user under Windows has permission to see this, there's no UAC elevated privileges required.



STEP 3 Now, create a batch file that displays the contents of any directory and post it as a text file to the user's screen. Add the following to the list.bat batch file:

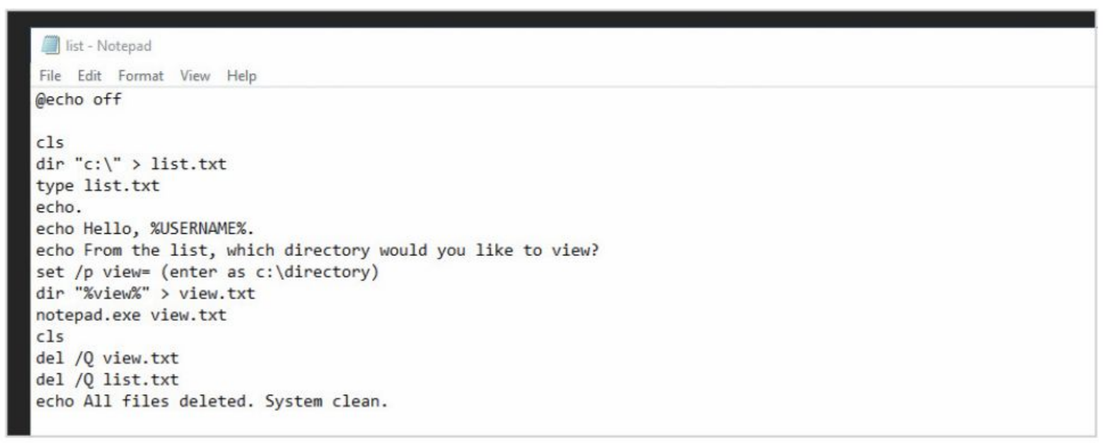
```
echo Hello, %USERNAME%.
echo From the list, which folder would you like to
view?
set /p view= (enter as c:\folder)
dir "%view%" > view.txt
notepad.exe view.txt
```

STEP 4 What's happening here is the batch file asks the user to enter any of the directories displayed in the list it generated, in the form of '**c:\directory**'. Providing the user enters a valid directory, its contents are displayed as a text file. We created the view variable here along with %HOMEPATH%, to store the input and the text file.

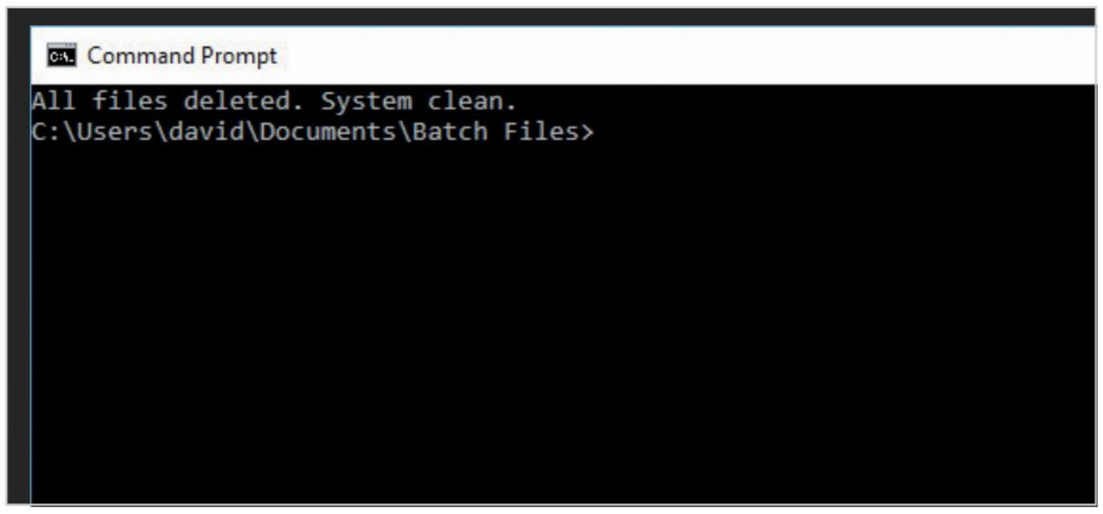


STEP 5 It's always a good idea, when creating text files for the user to temporarily view, to clean up after yourself. There's nothing worse than having countless, random text files cluttering up the file system. That being the case, let's clear up with:

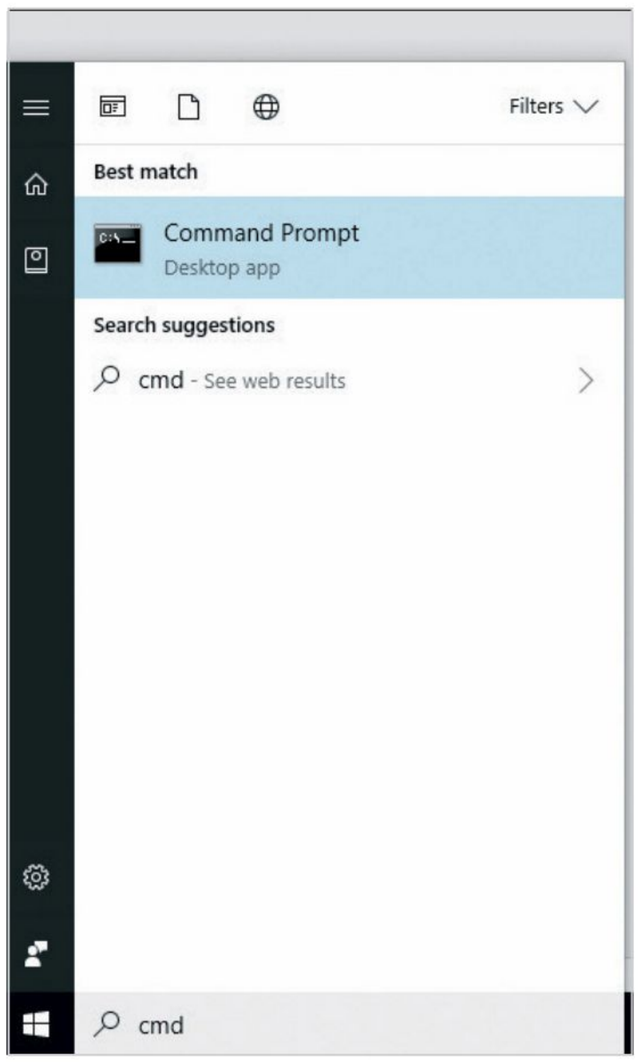
```
cls
del /Q view.txt
del /Q list.txt
echo All files deleted. System clean.
```



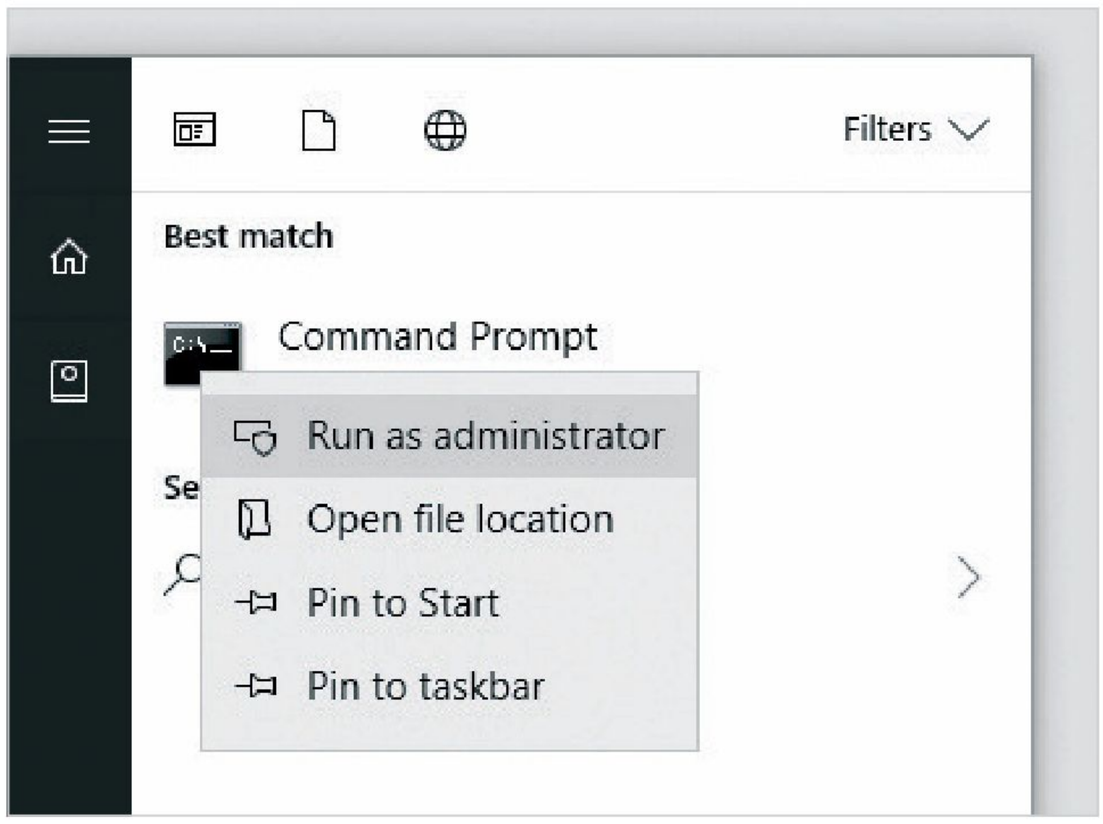
STEP 6 The additions to the batch file simply clear the command prompt window (using the cls command) and delete both the view.txt and list.txt files that were created by the batch file. The /Q flag in the del command means it deletes the files without any user input or notification. The final message informs the user that the files are removed.



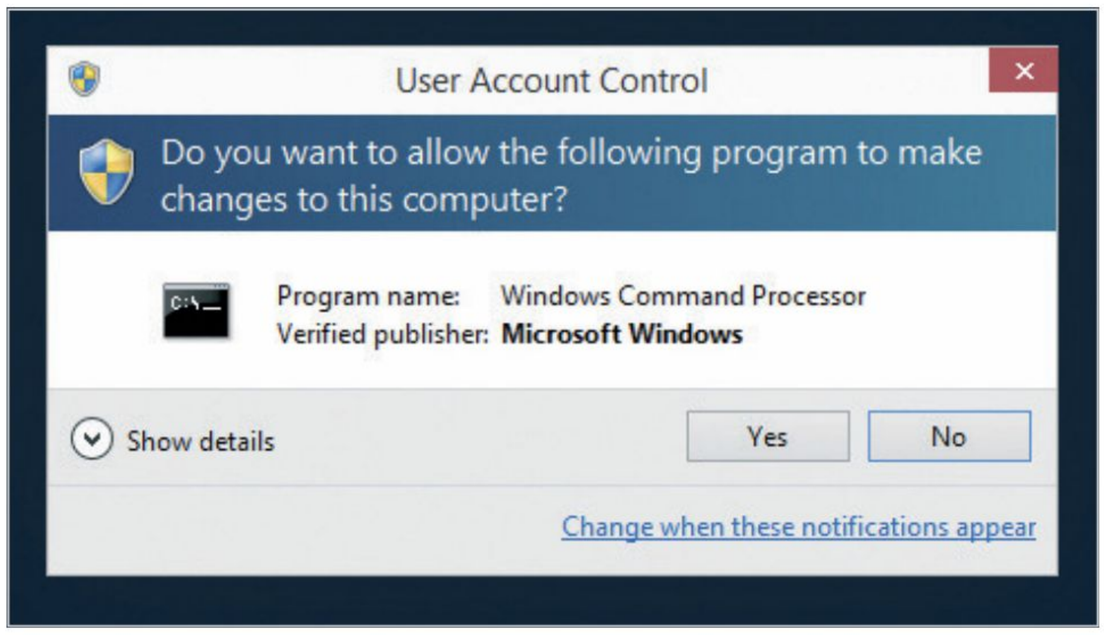
STEP 7 Depending on how your system is configured, you may not get any directory information at all or a message stating Access Denied. This is because the UAC is blocking access to protected areas of the system, like c:\Windows or C:\Program Files. Therefore, you need to run the batch file as an Administrator. Click the Windows Start button and enter **CMD** again.



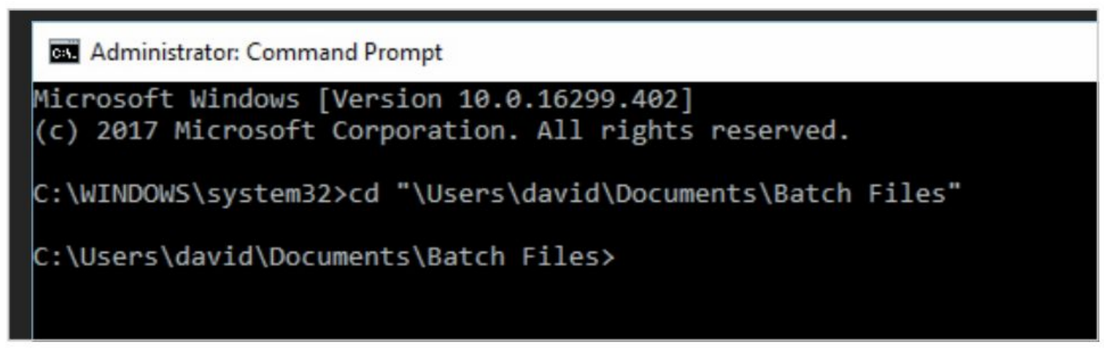
STEP 8 Instead of left clicking on the Command Prompt result, as you did the first time you opened it, right-click it and from the menu choose Run as Administrator. There is a risk that you could damage system files as the Administrator but as long as you're careful and don't do anything beyond viewing directories, you will be okay.



STEP 9 This action triggers the UAC warning message, asking you if you're sure you want to run the Windows command prompt with the elevated Administrator privileges. Most of the time we wouldn't recommend this course of action: the UAC is there to protect your system. In this case, however, click Yes.



STEP 10 With the UAC active, the command prompt looks a little different. For starters, it's now defaulting to the C:\WINDOWS\system32 folder and the top of the windows is labelled Administrator. To run the batch file, you need to navigate to the Batch Files directory with: **cd \Users\USERNAME\Documents\Batch Files**. To help, press the Tab key to auto-complete the directory names.



Batch File Programming

It's the little additions we can make to a batch file that help it stand out and ultimately become more useful. While the Windows graphical interface is still king, the command line can do just as much, and this is where batch files come into their own.

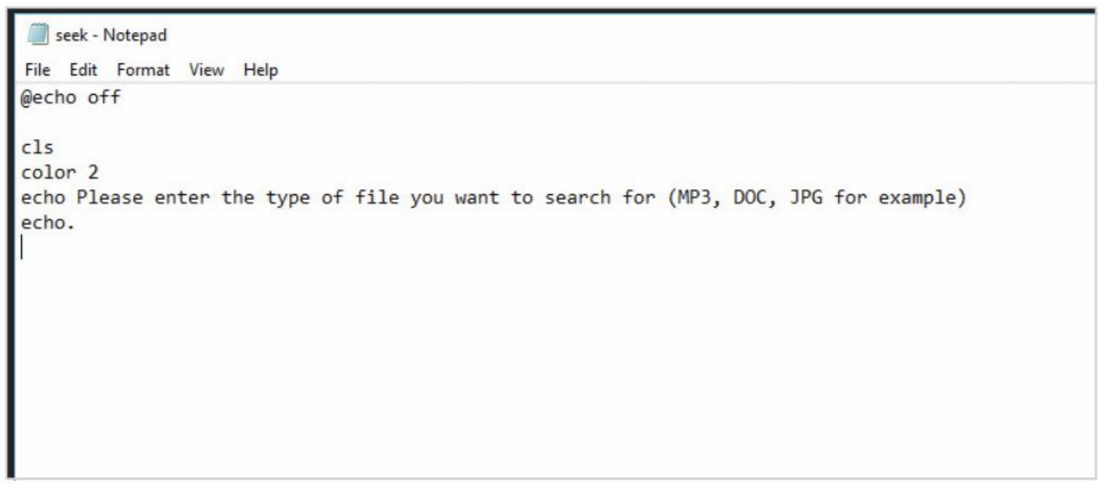
SEARCHING FOR FILES

Here's an interesting little batch file that you can easily extend for your own use. It asks the user for a file type to search for and displays the results.

STEP 1

We are introducing a couple of new commands into the mix here but we think they're really useful. Create a new batch file called seek.bat and in it put:

```
@echo off
cls
color 2
echo Please enter the type of file you want to
search for (MP3, DOC, JPG for example)
echo.
```



STEP 2

The new command in this instance is color (Americanised spelling). Color, as you already assume, changes the colour of the command prompt display. The color attributes are specified by two hex digits, the first corresponds to the background colour of the Command console and the second to the foreground, and can be any of the following values:

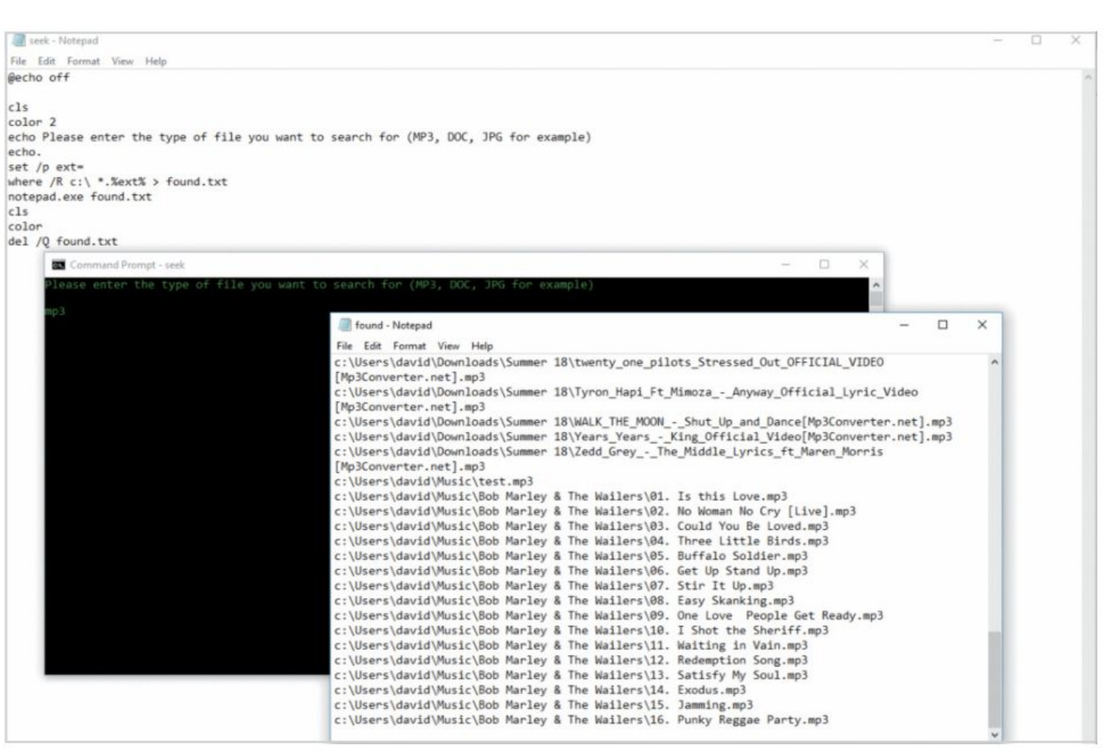
STEP 3

Now let's extend the seek.bat batch file:

```
@echo off
cls
color 2
echo Please enter the type of file you want to
search for (MP3, DOC, JPG for example)
echo.
set /p ext=
where /R c:\ *.%ext% > found.txt
notepad.exe found.txt
cls
color
del /Q found.txt
```

STEP 4

Another new command, Where, looks for a specific file or directory based on the user's requirements. In this case, we have created a blank variable called ext that the user can enter the file type in, which then searches using Where and dumps the results in a text file called found.txt. Save and run the batch file.



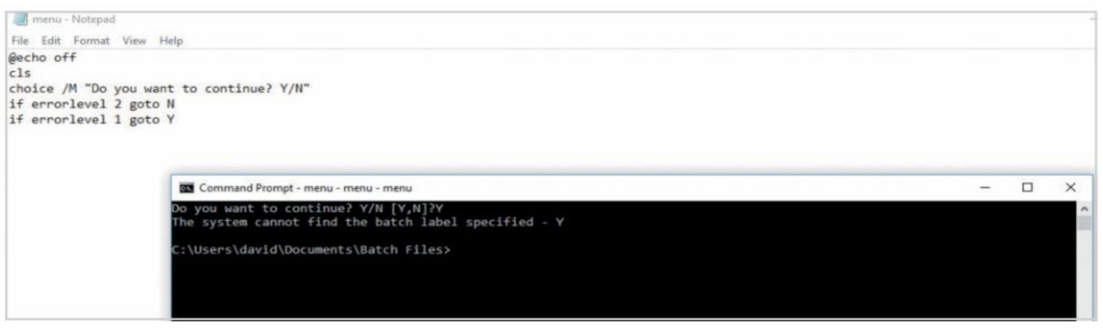
CHOICE MENUS

Creating a menu of choices is a classic batch file use and a good example to help expand your batch file programming skills. Here's some code to help you understand how it all works.

STEP 1

Rather than using a variable to process a user's response, batch files can instead use the Choice command in conjunction with an ErrorLevel parameter to make a menu. Create a new file called menu.bat and enter the following:

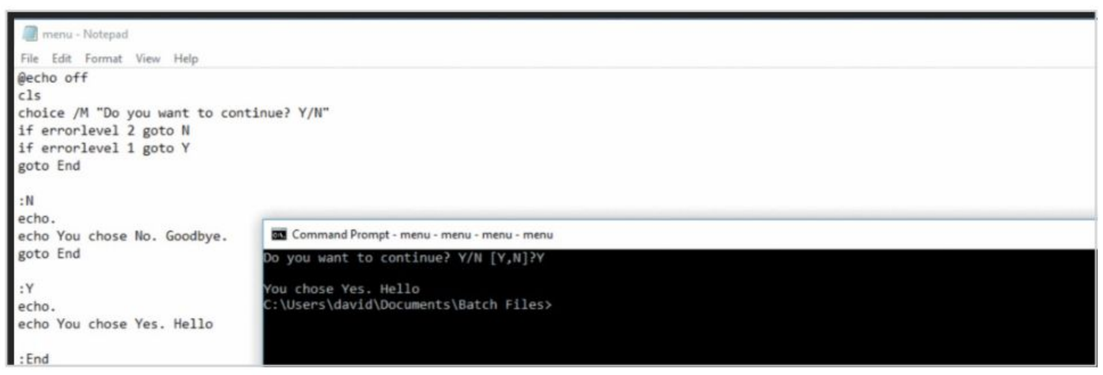
```
@echo off
cls
choice /M "Do you want to continue? Y/N"
if errorlevel 2 goto N
if errorlevel 1 goto Y
goto End:
```



STEP 2

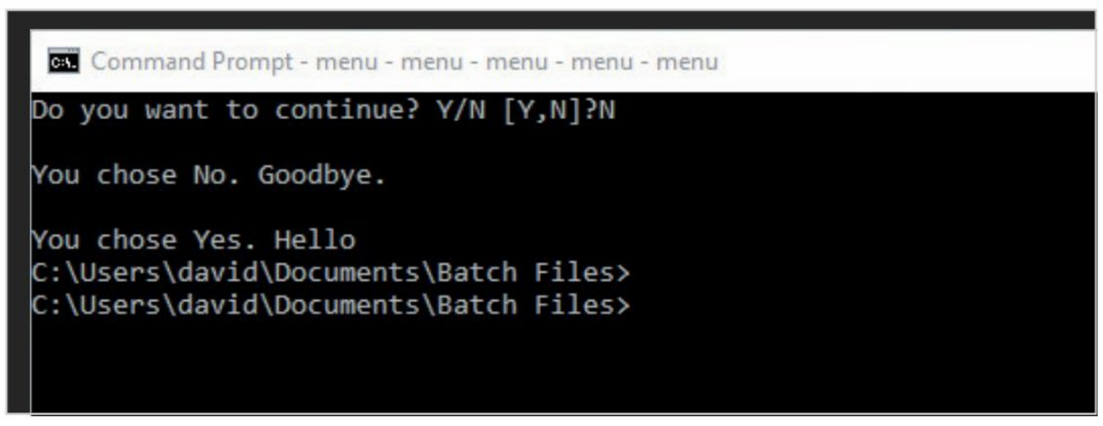
Running the code produces an error as we've called a Goto command without any reference to it in the file. Goto does exactly that, goes to a specific line in the batch file. Finish the file with the following and run it again:

```
:N
echo.
echo You chose No. Goodbye.
goto End

:Y
echo.
echo You chose Yes. Hello

:End
```



STEP 3

The output from your choice is different depending on whether you pick Y or N. The :End part simply signifies the end of the file (also known as EOF). Without it the batch file runs through each line and display the Y response even if you enter N; so it's important to remember to follow your Goto commands.



STEP 4

ErrorLevels are essentially variables and the /M switch of Choice allows a descriptive message string to be displayed. Extend this menu with something new:

```
@echo off
cls
echo.
echo ----------------------------------------
echo.
echo Please choose a directory.
echo.
echo Press 1 for c:\Music
echo.
echo Press 2 for c:\Documents
echo.
echo Press 3 for c:\Pictures
echo.
echo Press 4 for c:\Videos
echo.
echo ----------------------------------------
choice /C 1234
if errorlevel 4 goto Videos
if errorlevel 3 goto Pictures
if errorlevel 2 goto Documents
if errorlevel 1 goto Music
```

STEP 5

Now add the Goto sections:

```
:Videos
cls
CD %HOMEPATH%\Videos
echo You are now in the Videos directory.
goto End

:Pictures
cls
CD %HOMEPATH%\Pictures
echo You are now in the Pictures directory.
goto End

:Documents
cls
CD %HOMEPATH%\Documents
echo You are now in the Documents directory.
goto End

:Music
cls
CD %HOMEPATH%\Music
echo you are now in the Music directory.
goto End

:End
```

STEP 6

When executed, the batch file displays a menu and with each choice the code changes directory to the one the user entered. The %HOMEPATH% system variable will enter the currently logged in user's Music, Pictures and so directories, and not anyone else's.

Loops and Repetition

Looping and repeating commands are the staple diet of every programming language, including batch file programming. For example, you can create a simple countdown or even make numbered files or directories in the system.

COUNTERS

Creating code that counts in increasing or decreasing number sets is great for demonstrating loops. With that in mind, let's look at the If statement a little more, alongside more variables, and introduce the Else, Timeout and eof (End of File) commands.

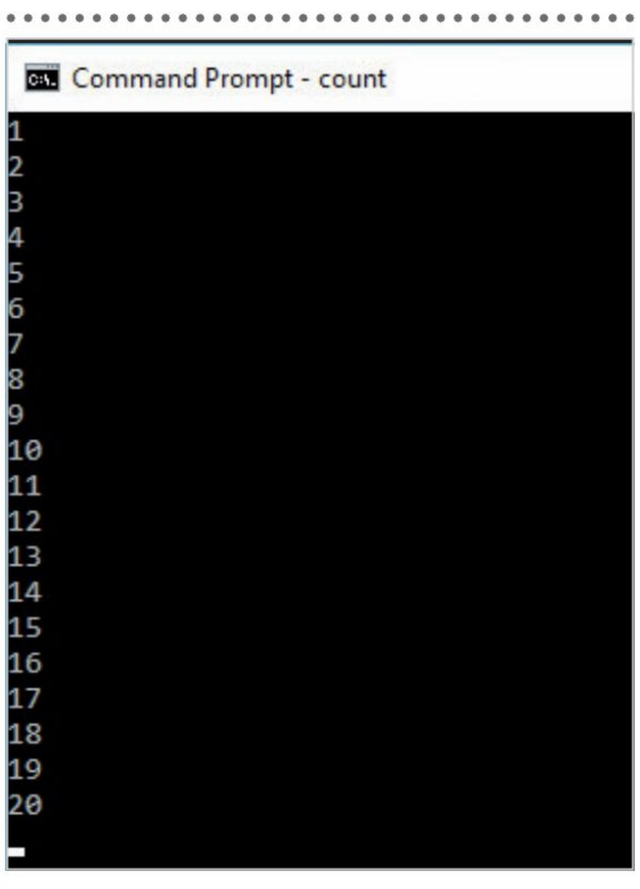
STEP 1

Start by creating a new batch file called count.bat. Enter the following, save it and run:

```
@echo off
cls
set /a counter=0

:numbers
set /a counter=%counter%+1
if %counter% ==100 (goto :eof) else (echo
%counter%)
timeout /T 1 /nobreak > nul
goto :numbers
```

STEP 2

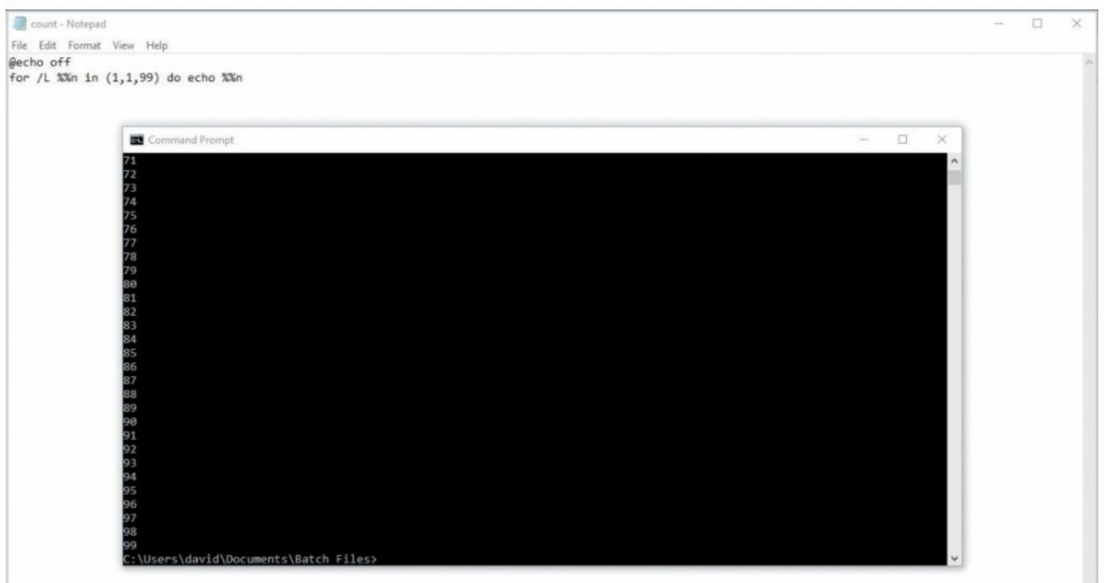
The count.bat code starts at number one and counts, scrolling down the screen, until it reaches 100. The Timeout command leaves a one second gap between numbers and the Else statement continues until the counter variable equals 100 before going to the eof (End Of File), thus closing the loop.



STEP 3

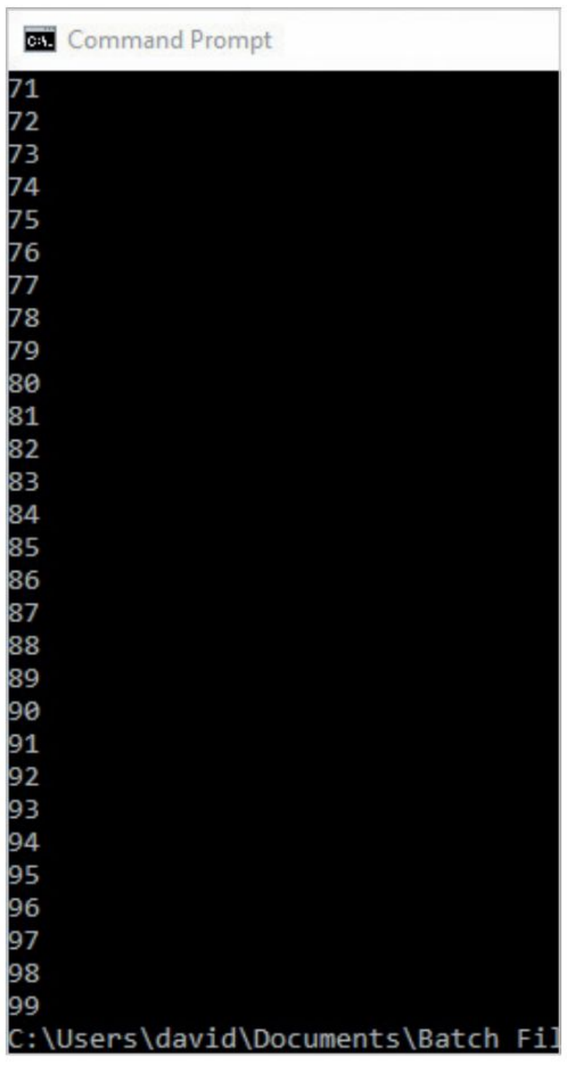
The count.bat is a rough way of demonstrating a loop; a better approach would be to use a for loop. Try this example instead:

```
@echo off
for /L %%n in (1,1,99) do echo %%n
```



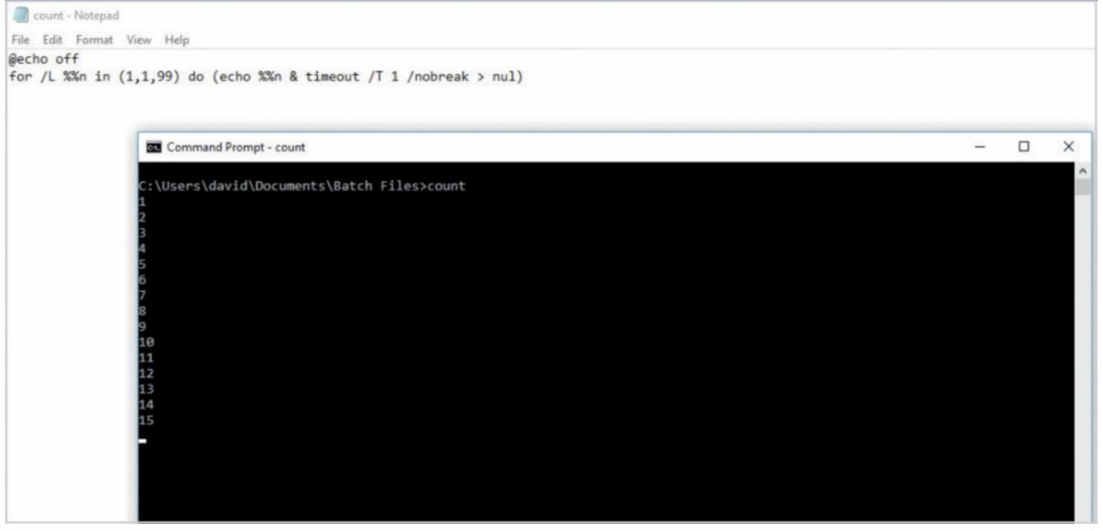
STEP 4

Breaking it down, there's For, then the /L switch, which handles a range of numbers. Then the parameter labelled as %%n to denote a number. Then the in (1,1,99) part, which tells the statement how to count, as in 1 (start number), 1 (steps to take), 99 (the end number). The next part is do, meaning DO whatever command is after.



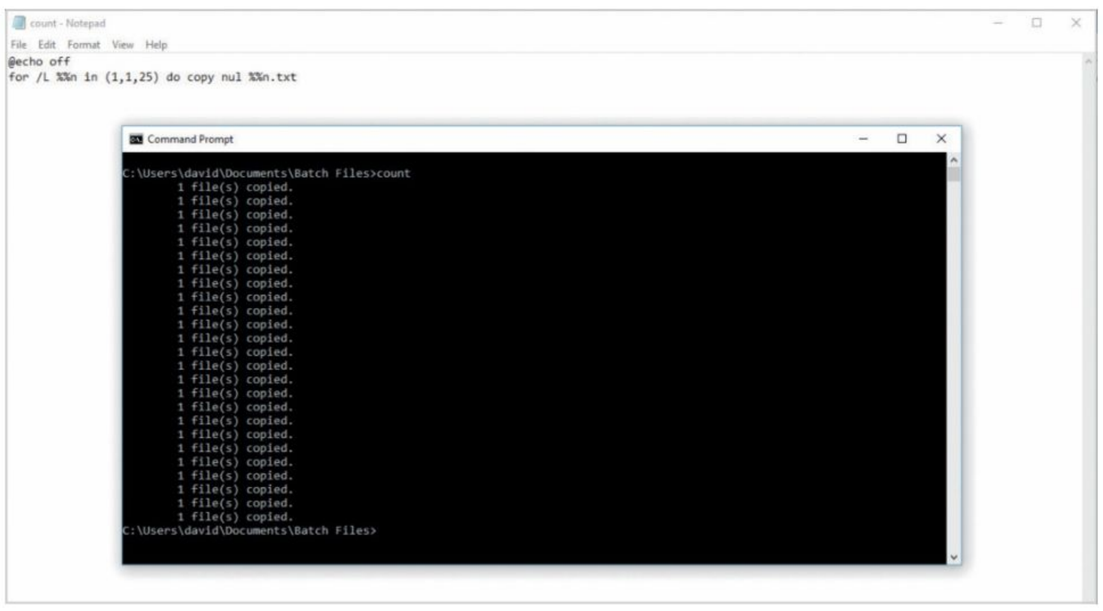
STEP 5 You can include the pause between the numbers easily enough within the far simpler For loop by adding multiple commands after the Do For loop. The brackets and ampersand (&) separate the different commands. Try this:

```
@echo off
for /L %%n in (1,1,99) do (echo %%n & timeout /T 1
/nobreak > nul)
```



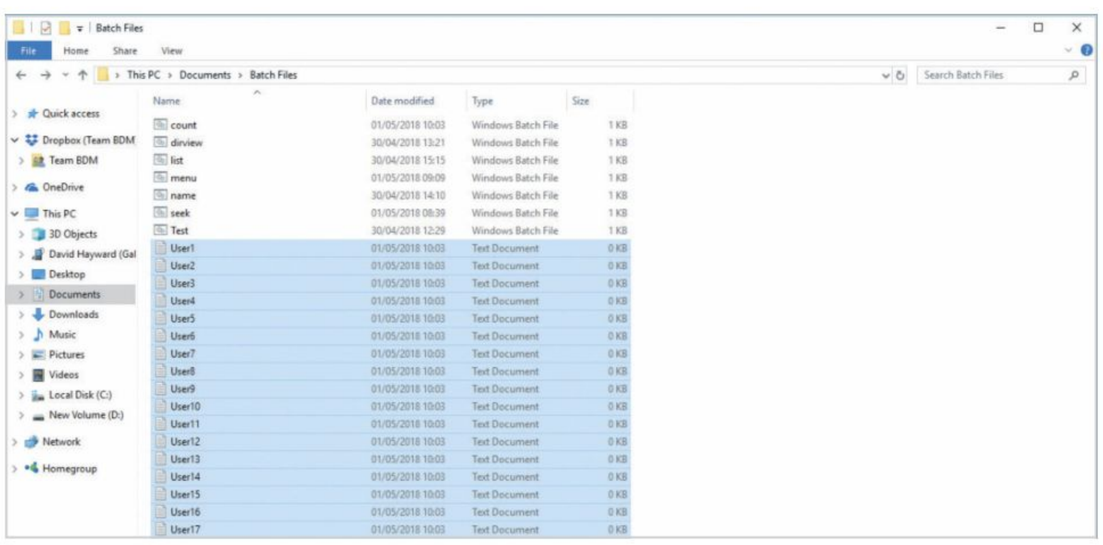
STEP 6 One of the great time saving uses of batch files is to create multiple, numbered files. Assume that you want twenty five text files within a directory, all numbered from 1 to 25. A For loop much like the previous example does the trick:

```
@echo off
for /L %%n in (1,1,25) do copy nul %%n.txt
```



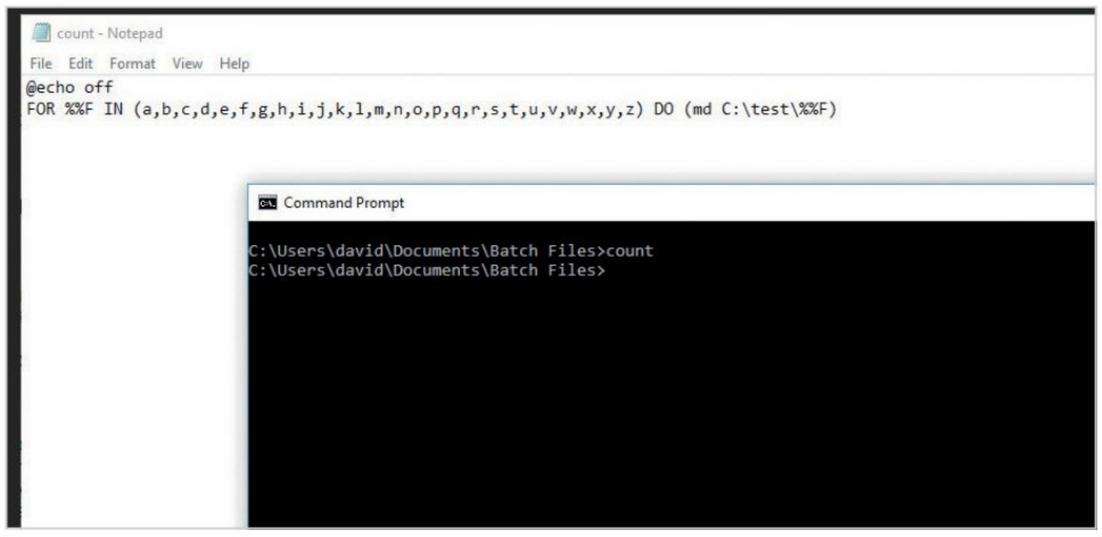
STEP 7 If you open Windows Explorer, and navigate to the Batch Files directory where you're working from, you can now see 25 text files all neatly numbered. Of course, you can append the file name with something like user1.txt and so on by altering the code to read:

```
@echo off
for /L %%n in (1,1,25) do copy nul User%%n.txt
```

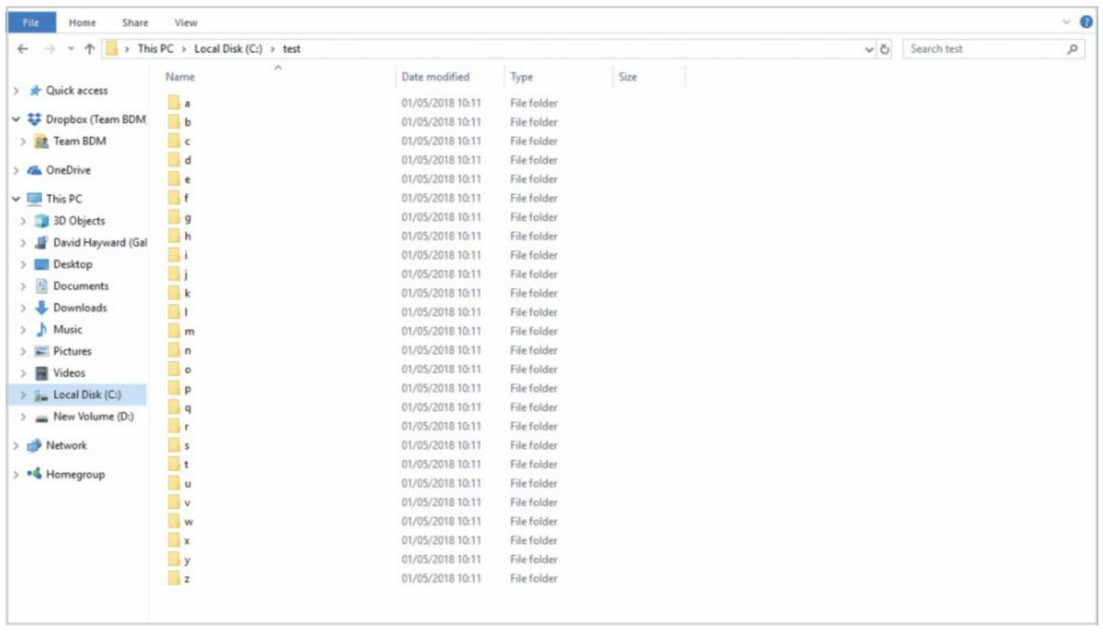


STEP 8 There are different ways of using the For loop. In this example, the code creates 26 directories, one for each letter of the alphabet, within the directory c:\test which the batch file makes using the MD command:

```
@echo off
FOR %%F IN (a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,
s,t,u,v,w,x,y,z) DO (md C:\test\%%F)
```

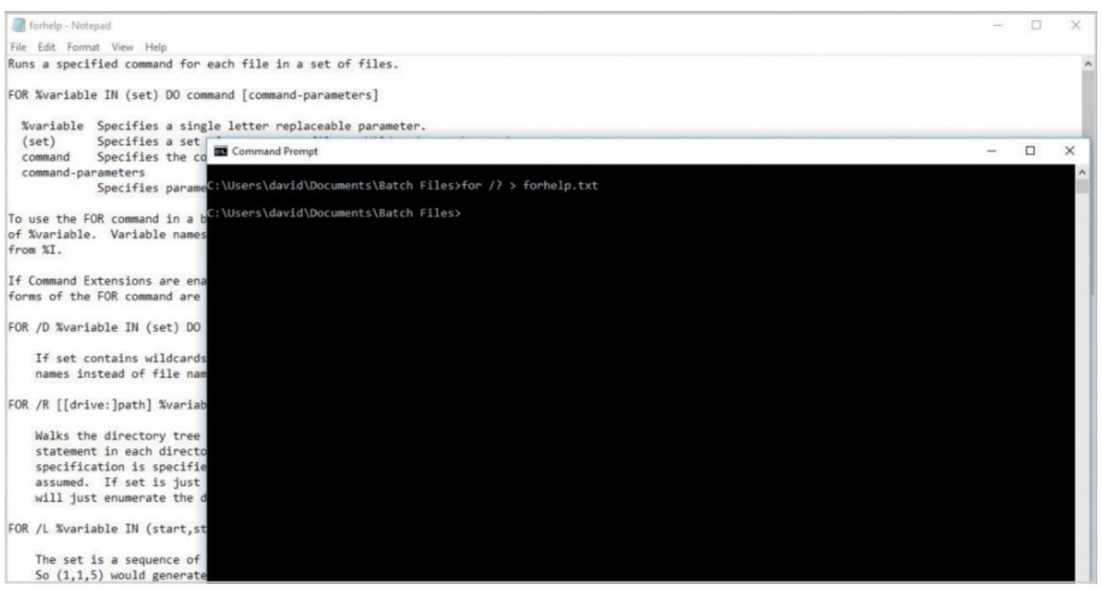


STEP 9 Loops can be powerful and extremely useful elements in a batch file. While creating 26 directories may not sound too helpful, imagine having to create 1,000 users on a network and assign each one their own set of unique directories. This is where a batch file saves an immense amount of time.



STEP 10 Should you ever get stuck when using the various commands within a batch file, drop into the command prompt and enter the command followed by a question switch. For example, for /? or if /?. You get an on-screen help file detailing the commands' use. For easier reading, pipe it to a text file:

```
For /? > forhelp.txt
```

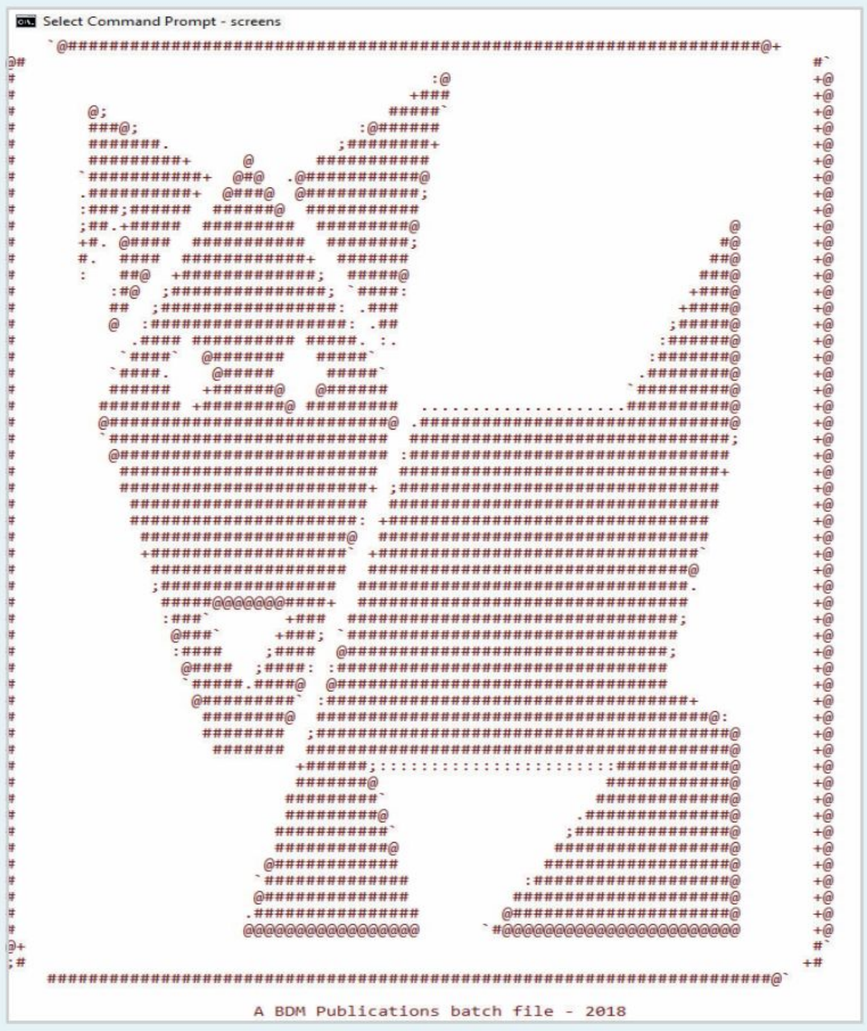


Creating a Batch File Game

Based on what you've looked at so far with batch files, you can probably come up with your own simple text adventure or multiple-choice game. Here's one that we created, that you're free to fiddle with and make your own.

Make up your own questions but how about also including an introductory or loading screen? Make your loading screen in a separate batch file and save it as screens.bat (for example). Then, from the main game batch file, you can load it at the beginning of the file with the 'call' command followed by colour to reset the game's colours:

```
@echo off
Cls
Call screens.bat
color
:start
set /a score=0
set /a question=0
cls
set /p name= What is your name?
```




```
@echo off
Cls
:start
set /a score=0
set /a question=0
cls
set /p name= What is your name?

:menu
cls
echo.
echo ************************************************
  **
echo.
echo Welcome %name% to the super-cool trivia game.
echo.
echo Press 1 to get started
echo.
echo Press 2 for instructions
echo.
echo Press Q to quit
echo.
echo ************************************************
  **
choice /C 12Q
if errorlevel 3 goto :eof
if errorlevel 2 goto Instructions
if errorlevel 1 goto Game

:Instructions
cls
echo.
echo ************************************
echo.
echo The instructions are simple. Answer the
  questions correctly.
echo.
echo ************************************
pause
cls
goto menu

:Game
set /a question=%question%+1
cls
if %question% ==5 (goto end) else (echo you are on
  question %question%)
echo.
echo get ready for the question...
echo.
timeout /T 5 /nobreak > nul
if %question% ==5 (goto end) else (goto %question%)

:1
cls
echo.
echo ******************************
echo.
```

```
echo Your current score is %score%
echo.
echo ******************************
echo.
echo.
echo Question %question%.
echo.
echo Which of the following version of Windows is the
  best?
echo.
echo A. Windows 10
echo.
echo B. Windows ME
echo.
echo C. Windows Vista
echo.
choice /C abc
if errorlevel 3 goto wrong
if errorlevel 2 goto wrong
if errorlevel 1 goto correct

:2
cls
echo.
echo ******************************
echo.
echo Your current score is %score%
echo.
echo ******************************
echo.
echo.
echo Question %question%.
echo.
echo Which of the following version of Windows is the
  most stable?
echo.
echo A. Windows 10
echo.
echo B. Windows 95
echo.
echo C. Windows ME
echo.
choice /C abc
if errorlevel 3 goto wrong
if errorlevel 2 goto wrong
if errorlevel 1 goto correct

:3
cls
echo.
echo ******************************
echo.
echo Your current score is %score%
echo.
echo ******************************
echo.
echo.
echo Question %question%.
echo.
echo Which of the following Windows version is the
  latest?
echo.
echo A. Windows 10
echo.
echo B. Windows 98
echo.
echo C. Windows 7
echo.
choice /C abc
if errorlevel 3 goto wrong
if errorlevel 2 goto wrong
if errorlevel 1 goto correct

:4
cls
echo.
echo ******************************
echo.
echo Your current score is %score%
echo.
echo ******************************
echo.
echo.
echo Question %question%.
echo.
echo Which of the following Windows uses DirectX 12?
echo.
echo A. Windows 10
echo.
echo B. Windows 3.11
echo.
echo C. Windows XP
echo.
choice /C abc
if errorlevel 3 goto wrong
if errorlevel 2 goto wrong
if errorlevel 1 goto correct

:Wrong
cls
echo ******************
echo.
echo WRONG!!!!
echo.
echo ******************
set /a score=%score%-1
pause
goto :game

:correct
cls
echo ******************
echo.
echo CORRECT. YIPEE!!!
echo.
echo ******************
set /a score=%score%+1
pause
goto :game

:end
cls
echo ******************************
echo.
echo Well done, %name%, you have answered all the
  questions
echo.
echo And your final score is....
echo.
echo %score%
echo.
echo ******************************
choice /M "play again? Y/N"
if errorlevel 2 goto :eof
if errorlevel 1 goto start
```

Linux is such a versatile operating system, it's both malleable and powerful, while offering the programmer a perfect foundation on which to build their skills. Linux scripting in particular is a highly prized skill at the moment by employers, and learning how to master it, and the operating system, will certainly enhance your future job prospects.

Scripting is an amazing interface to the Linux system, so we've crafted this section to help you get to grips with how everything fits together, and how to make some amazing Linux scripts.

112 Why Linux?
114 The Best Linux Distributions
116 Equipment You Will Need
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120 Installing Linux on a PC
122 Installing a Virtual Environment
124 Installing Linux in a Virtual Environment
126 Getting Ready to Code in Linux
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138 Command Line Quick Reference
140 Common Coding Mistakes
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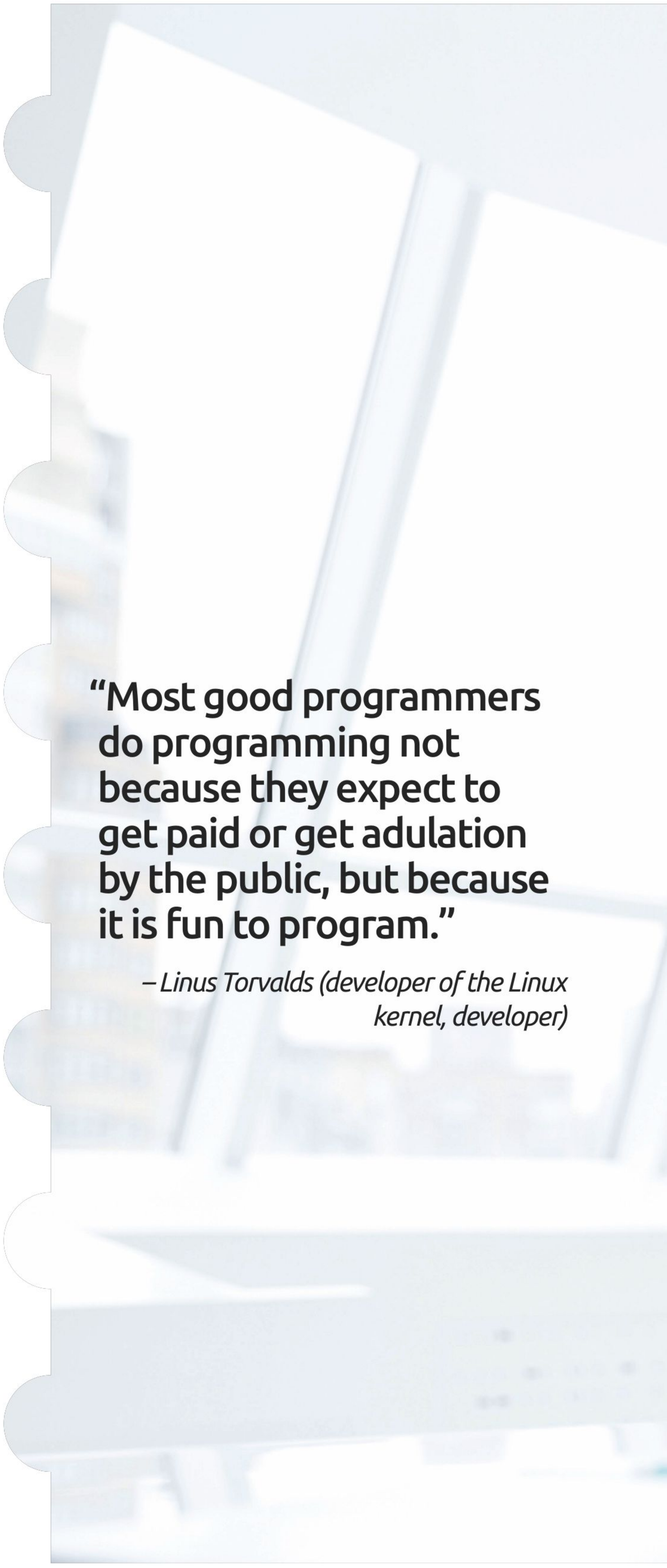
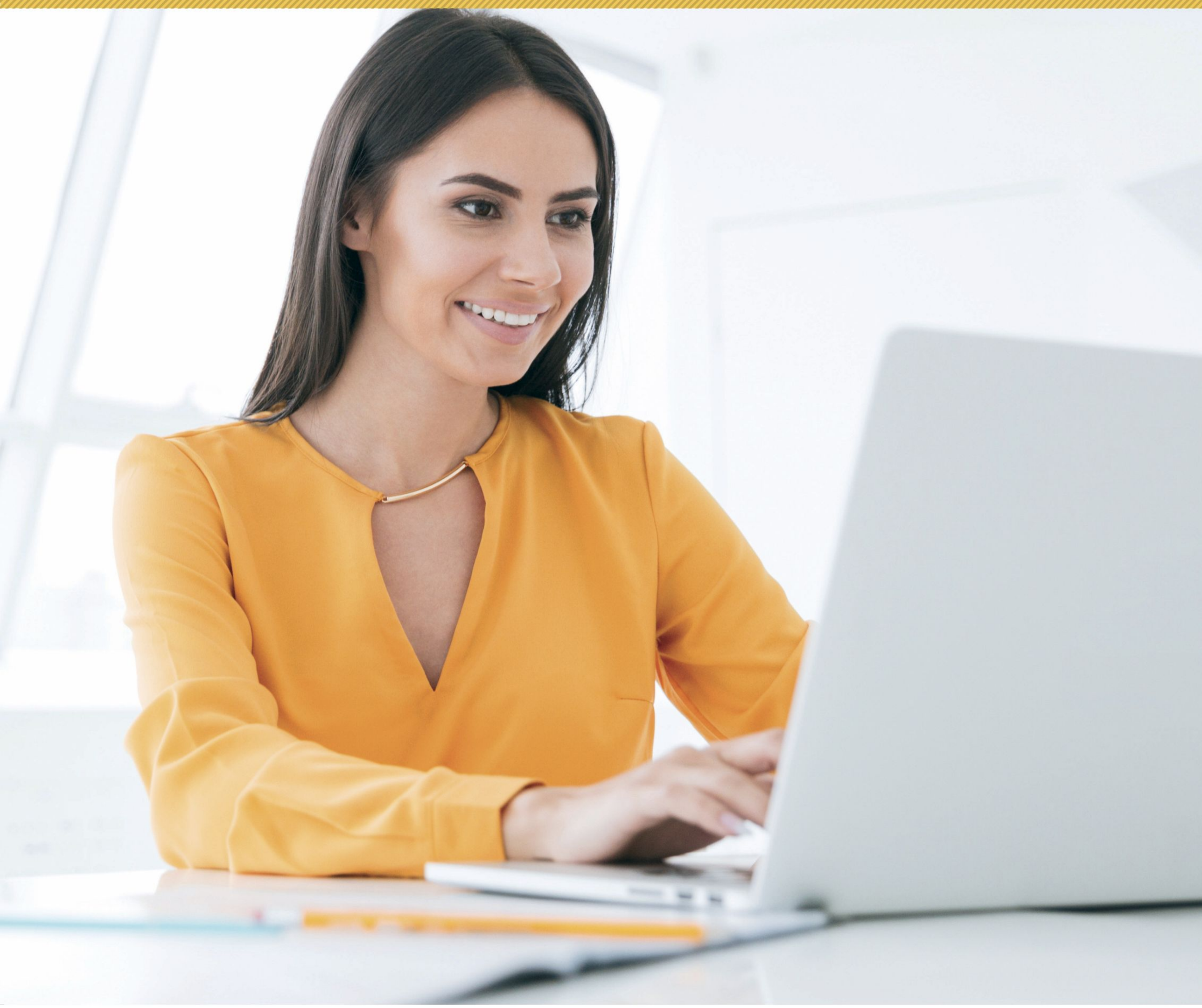
144 C++ Beginner's Mistakes



"Most good programmers do programming not because they expect to get paid or get adulation by the public, but because it is fun to program."

– Linus Torvalds (developer of the Linux kernel, developer)

Coding on Linux



Why Linux?

For many of its users, Linux means freedom. Freedom from the walled-gardened approach of other operating systems, freedom to change and use the OS as you please and freedom from any form of licensing or payment. There's a lot more to Linux than you may think.

FREE AND OPEN

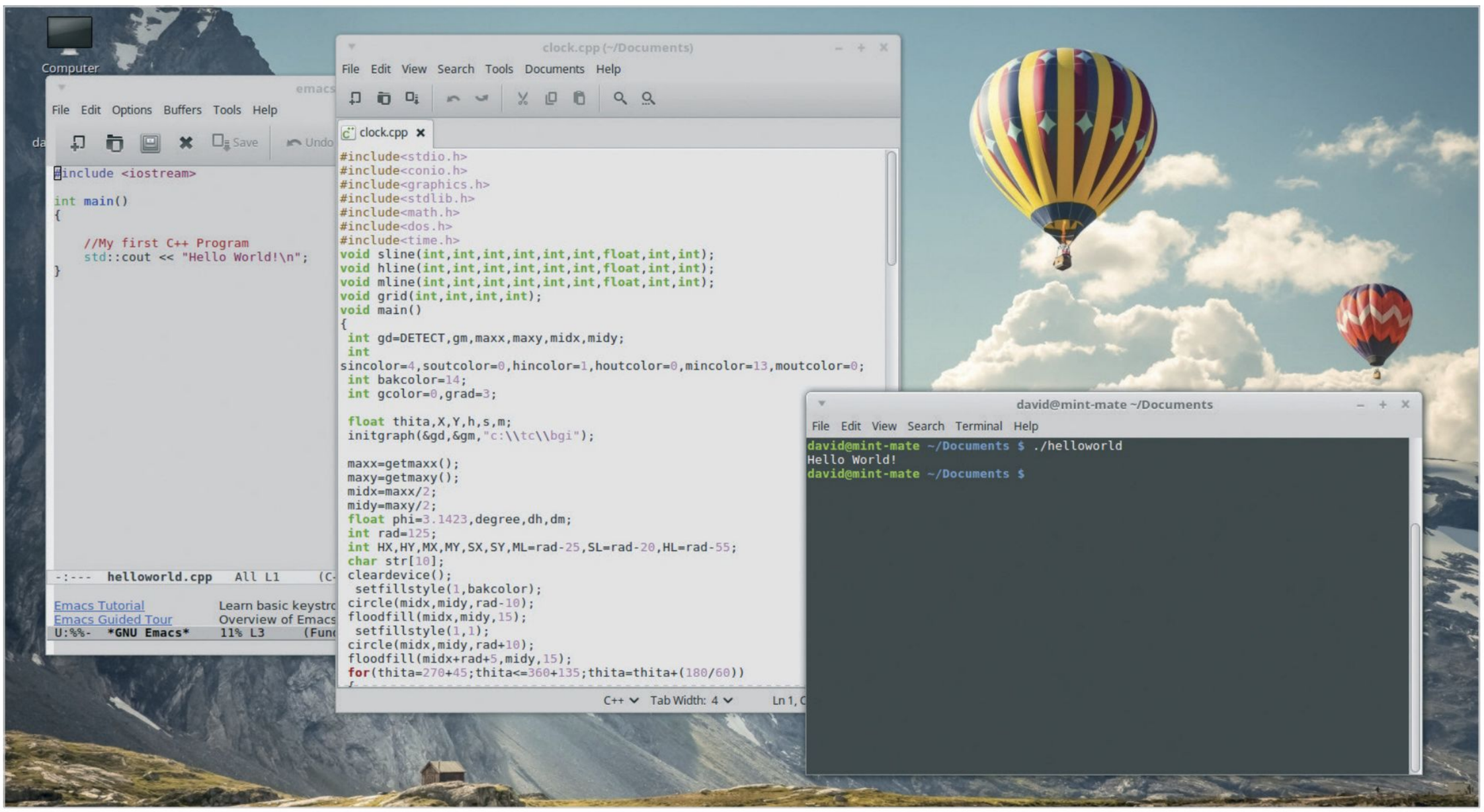
Linux is a fantastic fit for those who want something different; the efficiency of the system, the availability of applications and its stability, are just a few reasons why.

The first thing we need to address is that there is no basic operating system called Linux. Fundamentally, Linux is the operating system kernel, the core component of an OS. When talking about Linux we are, in fact, referring to one of the many distributions, or distros, that use the Linux kernel. No doubt you've heard of at least one of the current popular distros: Ubuntu, Linux Mint, Fedora, openSUSE, Debian, Raspbian… the list goes on. Each one of these distros offers the user something a little different. While each has the Linux kernel at its core, they offer a different looking desktop environment, different pre-loaded applications, different ways in which to update the system and get more apps installed and a slightly different look and feel throughout the entire system. However, at the centre lies Linux, which is why we say, Linux.

Linux works very differently to Windows or macOS. For a start, it's free to download, free to install on as many computers as you like, free to use for an unlimited amount of time and free to upgrade and extend with equally free programs and applications. This free to use element is one of the biggest draws for the developer. While a Windows license can cost up to £100 and a Mac considerably more, a user, be they a developer, gamer, or someone who wants to put an older computer to use, can quickly download a distro and get to work in a matter of minutes.

Alongside the free to use aspect comes a level of freedom to customise and mould the system to your own uses. Each of the distros available on the Internet have a certain 'spin', some offer increased security, a fancy-

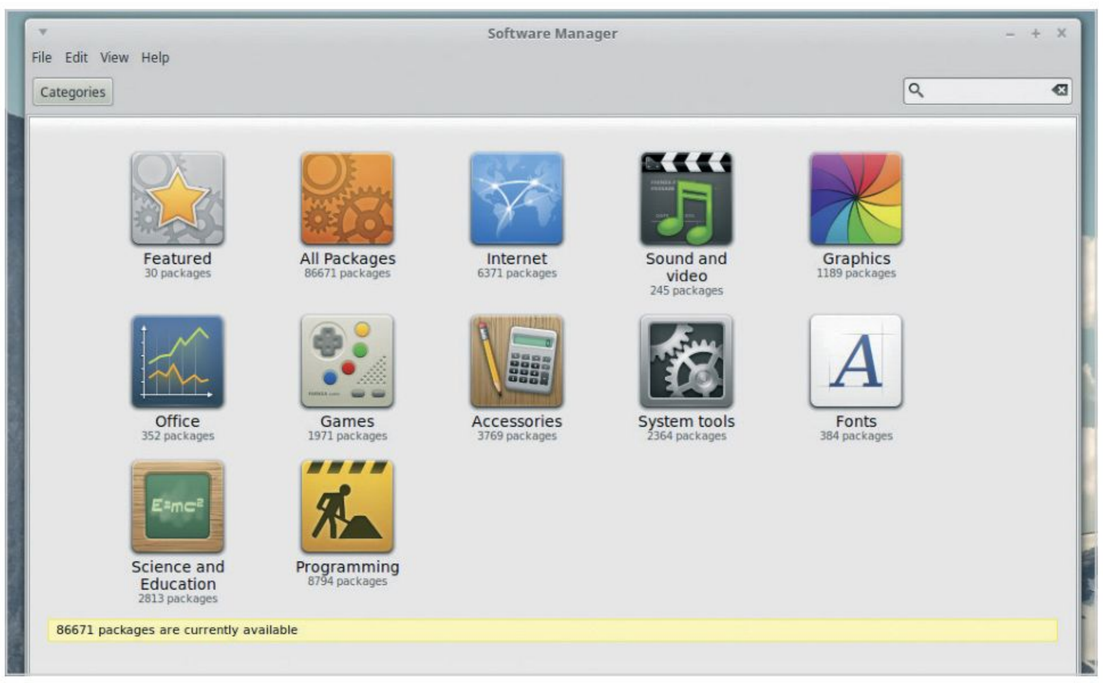
Linux is a great operating system in which to start coding.



looking desktop, a gaming specific spin, or something directed toward students. This extensibility makes Linux a more desirable platform to use, as you can quickly mould the system into a development base, including many different kinds of IDEs for use with Python, web development, C++, Java and so on, or even a base for online anonymity, perhaps as a Minecraft server, media centre and much more.

Another remarkable advantage for those looking to learn how to code is that Linux comes with most of the popular coding environments built-in. Both Python and C++ are pre-installed in a high percentage of Linux distros, which means you can start to program almost as soon as you install the system and boot it up for the first time.

Generally speaking, Linux doesn't take up as many system resources as Windows or macOS, (by system resources, we mean memory, hard drive space and CPU load), as the Linux code has been streamlined and is free from third-party 'bloatware', which hogs those systems resources. A more efficient system, means more available resources for the coding and testing environment and the programs you will eventually create. Less resource use also means you can use Linux on older hardware that would normally struggle, or even refuse to run, the latest versions of Windows or macOS.



There are thousands of free packages available for programmers under Linux.

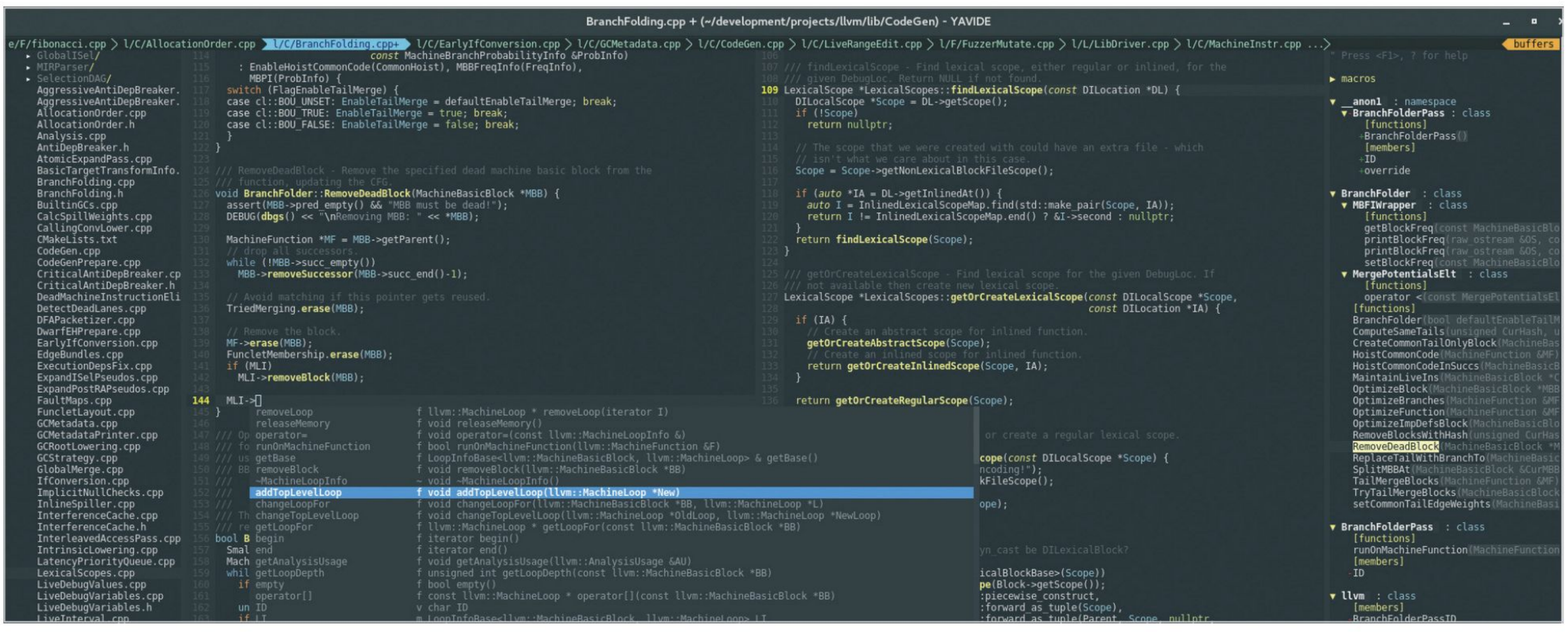
Each distro offers something unique to the user but all have Linux at the core.

So rather than throwing away an old computer, it can be reused with a Linux distro.

However, it's not all about C++, Python, or any of the other more popular programming languages. Using the command line of Linux (also called the Terminal), you're able to create Shell scripts, which are programs made up of scripting languages and designed to run from the command line. They are used mainly to automate tasks, or offer the user some form of input and output for a certain operation.

There are many more advantages we could list, for example, there are thousands and thousands of free programs and apps available that cover practically every aspect of computing. Known as packages, there are (at the time of writing) over 8,700 specific programming applications on Linux Mint alone and an incredible 62,000+ overall packages, catering from Amateur Radio to WWW tools.

In conclusion, Linux is a great resource and environment in which to program. It's perfectly suited for developers, while continually improving and evolving. If you're serious about getting into coding, or you just want to explore something new, then give Linux a try and see how it works for you.



A Linux programming environment can be as simple or as complex as you need it to be.

The Best Linux Distributions

There are numerous versions of Linux available, known as “Distributions”. Each has a different ethos and approach. Here are five great distributions to try and where you can get them.

LINUX MINT – LINUXMINT.COM

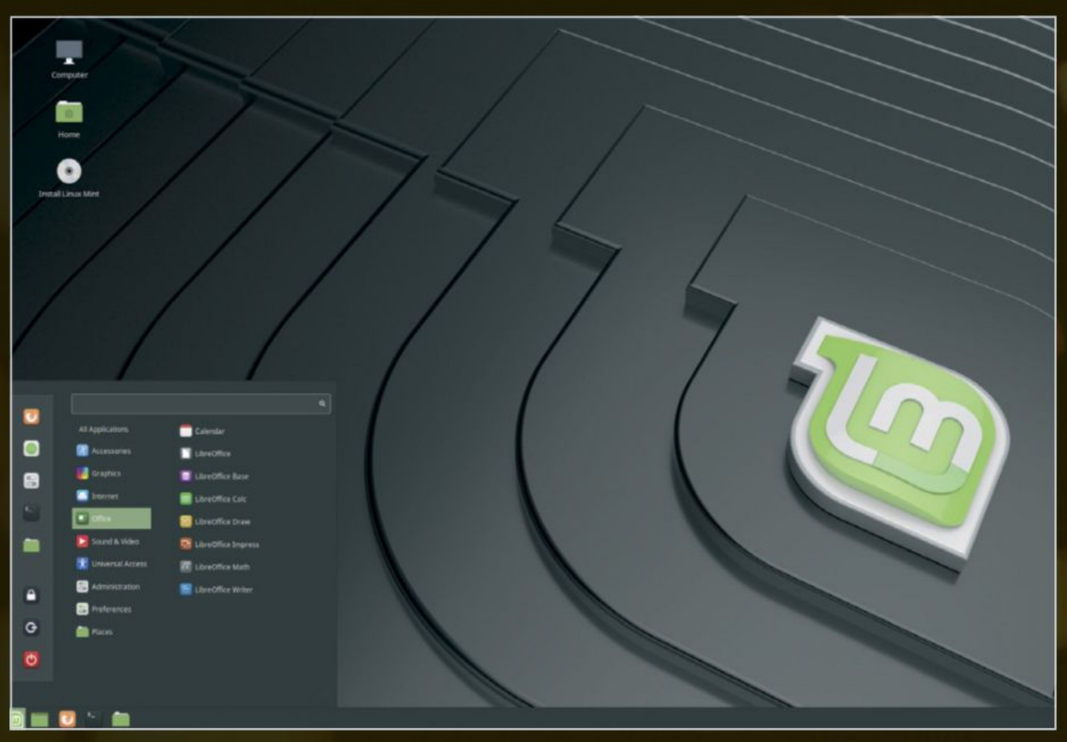
By far the most popular Linux distro (distribution) is Linux Mint. Mint began life back in 2006, as an alternative to the then, most popular distro, Ubuntu. Although based on Ubuntu’s Long Term Support build, Linux Mint took a different direction to offer the user a better overall experience.

Linux Mint has three main desktop versions available with each new version of the core OS it releases. This may sound confusing at first, but it’s quite simple. Currently, Linux Mint uses the Cinnamon Desktop Environment as its flagship model, although MATE and Xfce models are also available.

Cinnamon is a graphically rich desktop environment, while MATE uses less fancy graphics but is more stable on a wider variety of desktop systems and finally Xfce is an extremely streamlined desktop environment that is built for speed and ultimate stability.

Throughout this title, we’ll be using the Cinnamon version, however, you can try out any of the other desktop environments.

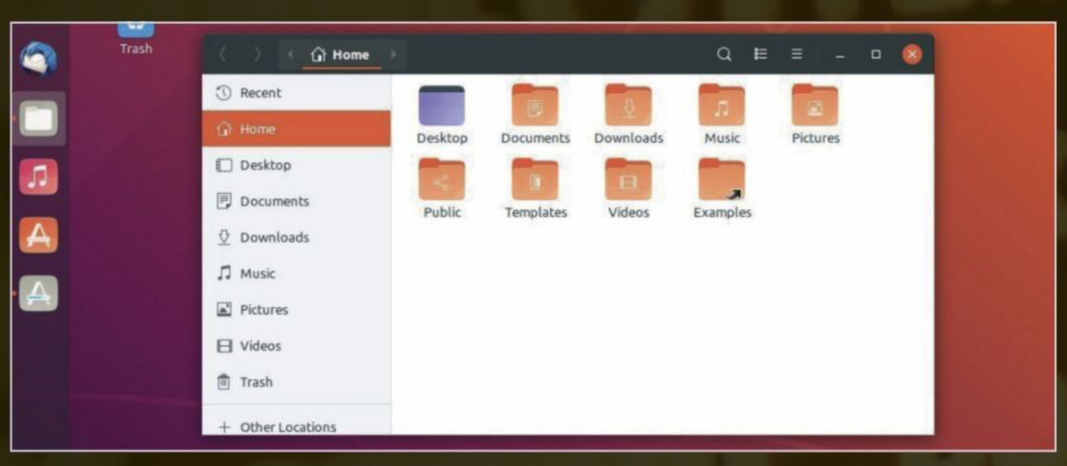
In fact, it’s recommended that you spend at least some time trying different environments and even different distros, to see which suits you and your computer best.



UBUNTU – UBUNTU.COM

The second most popular distro available is Ubuntu: an ancient African word meaning ‘humanity to others’. Ubuntu’s popularity has fluctuated over its fourteen-year life. At one time, it was easily the most used, Linux-based operating system in the world, sadly, some wrong choices along the way with regards to its presentation, along with some unfavourable and controversial elements involving privacy, saw it topple from the number one spot.

That said; Ubuntu has since made amends and is slowing crawling its way back up the Linux leader board. The latest versions of the OS use the GNOME 3 desktop environment, it’s impressive although it can be a little confusing for former Windows users



and it’s a little heavy on system resources (especially if you plan to install it on an older computer).

Ubuntu, for all its faults, is a good Linux distro to start experimenting with. It’s a clean interface, easy to use and install and offers the user the complete Linux experience.

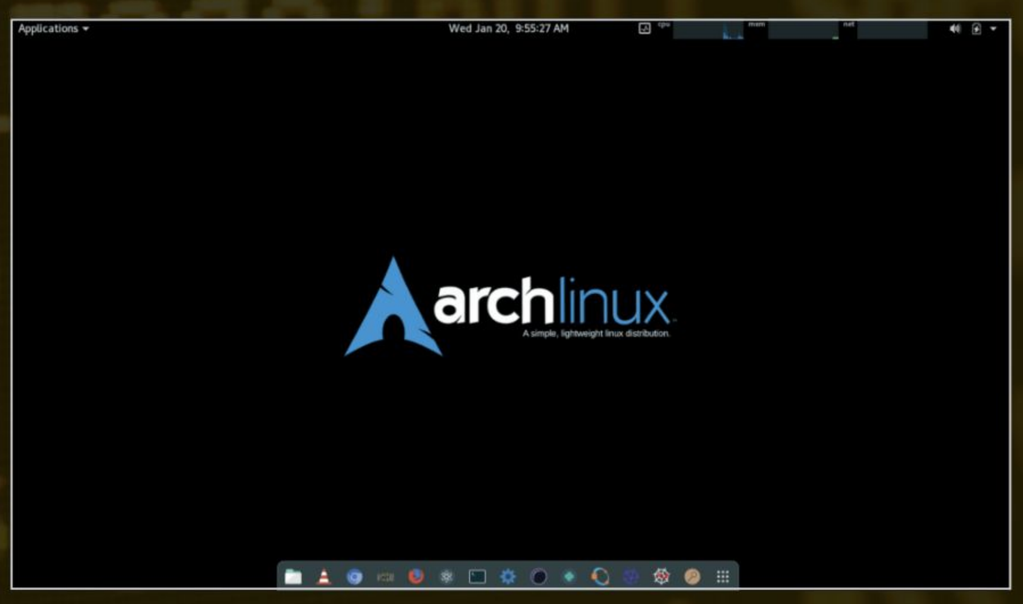
ARCH – ARCHLINUX.ORG

Arch is one of the longest running Linux distributions and forms the basis of many other versions of Linux. So why install Mint, or Ubuntu when you can install Arch? Many users do exactly that, but it's not ideal for beginners. Ubuntu and Mint both offer an easier installation path and come with software packages that will help you get started.

Arch, on the other hand, is a more 'bare bones' affair. It is committed to free software and its repositories contain over 50,000 apps to install. You can also install multiple Desktop environments and use them as you would with any other distro.

Arch is a distro for when you're more experienced with Linux. You start with nothing more than the command line and from there: you manually partition your hard drive, set where the installation files will go, create a user, set the OS locale and install a desktop environment, along with the apps you want.

The advantage, for all this hard work, is a distro that you've created. This means your Arch distro won't come with all the unnecessary files and apps that other distros have pre-installed; it's custom made for you, by you.



OPENSUSE – OPENSUSE.ORG

Most Linux distributions fall into two camps: those with the latest features and technology like Ubuntu and Mint and those with fewer new features, but rock-solid reliability, like Debian.

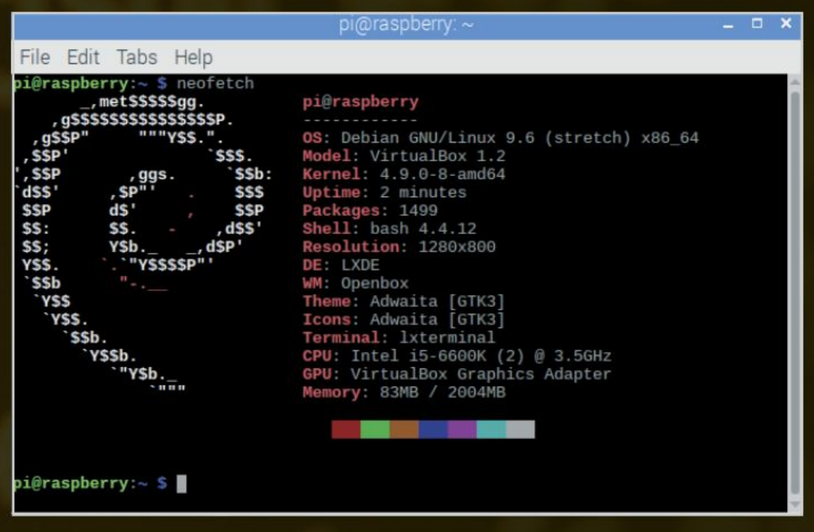
Meanwhile, openSUSE attempts to cover both bases. OpenSUSE Leap is a rock-solid system. It's developed openly by a community, along with SUSE employees. They develop an enterprise-level operating system: SUSE, which powers the London Stock Exchange, amongst other things. It is designed for mission critical environments where 'there is no scope for instability'. If you find all that too sensible, openSUSE Tumbleweed is a rolling release with all the latest features and the occasional crash.

openSUSE is a highly respected Linux distribution and many of its core contributors work on the Linux Kernel, LibreOffice, Gnome and other key Linux areas. In short: openSUSE is where you'll find the pros hanging out.

RASPBERRY PI DESKTOP – RASPBERRYPI.ORG/DOWNLOADS/RASPBERRY-PI-DESKTOP

No doubt you've heard of the Raspberry Pi? It's hard not to have, as this remarkable, tiny computer has taken the technology world by storm since it was introduced six years ago.

There are several aspects to the Raspberry Pi that make it such a sought-after piece of the computing world. For one, it's cheap, costing around £25 for, what is essentially, a fully working computer. It's small, measuring not much bigger than a credit card. You can employ it to build electronics, using a fully programmable interface and it comes with Raspbian, its own custom-made, Debian-based operating system that includes an office suite alongside many different programming languages and educational resources.



Originally, Raspbian was exclusive to the Pi hardware, as the Raspberry Pi uses an ARM processor to power it. However, the Raspberry Pi Foundation has since released a PC version of Raspbian: Raspberry Pi Desktop.

As with the Pi version, Raspberry Pi Desktop comes with the all the coding, educational and other apps you will ever need. It's quick, stable and works superbly. If you're interested in stretching your Linux experience, then this is definitely one of the top distros to consider.

18+

WHAT IS AVAXHOME?

AVAXHOME-

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Equipment You Will Need

The system requirements for successfully installing Linux Mint on to a PC are surprisingly low, so even a computer that's several years old will happily run this distro. However, it's worth checking you have everything in place before proceeding.

MINTY INGREDIENTS

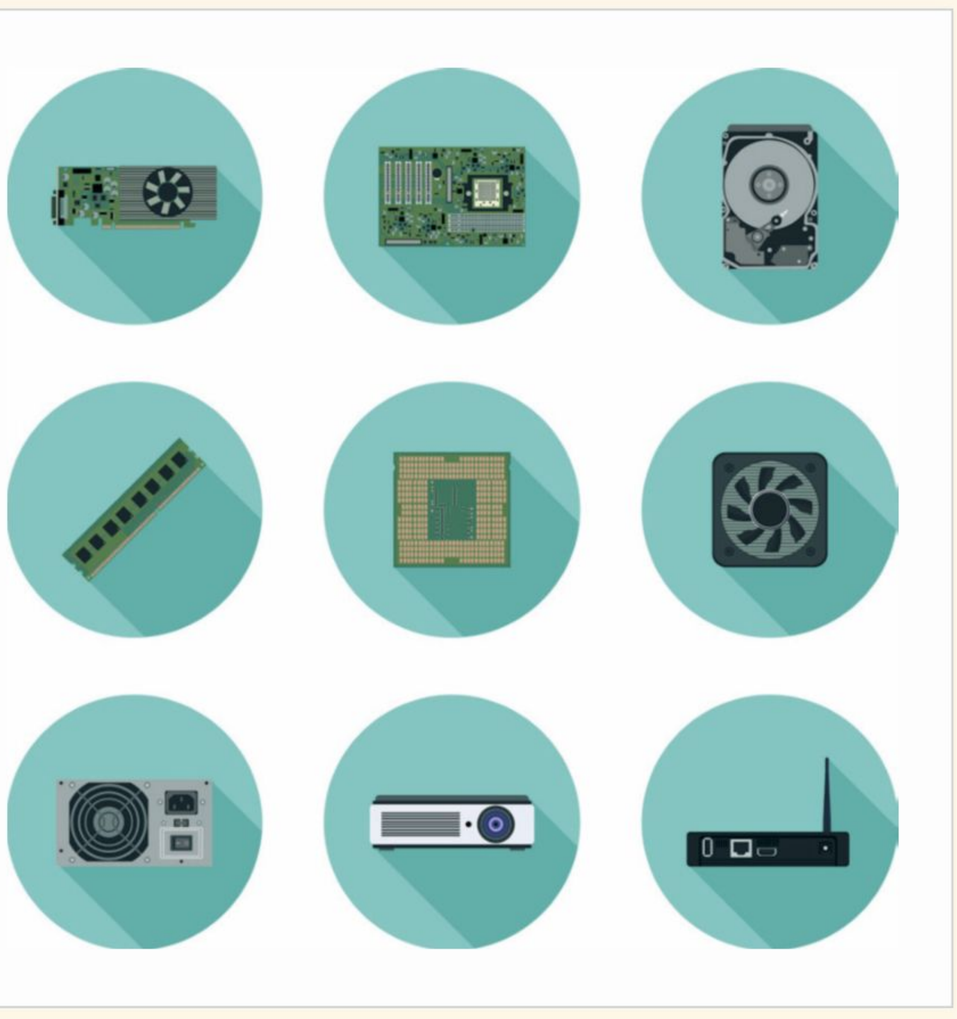
Here's what you'll need to install and run Linux Mint as we work through this book. You have several choices available, so take your time and see which works best for you.

SYSTEM REQUIREMENTS

The minimum system requirements for Linux Mint are as follows:

CPU	700MHz
RAM	512MB
Hard Drive Space	9GB (20GB recommended)
Monitor	1024 x 768 resolution

Obviously the better the system you have, the better and quicker the experience will be.

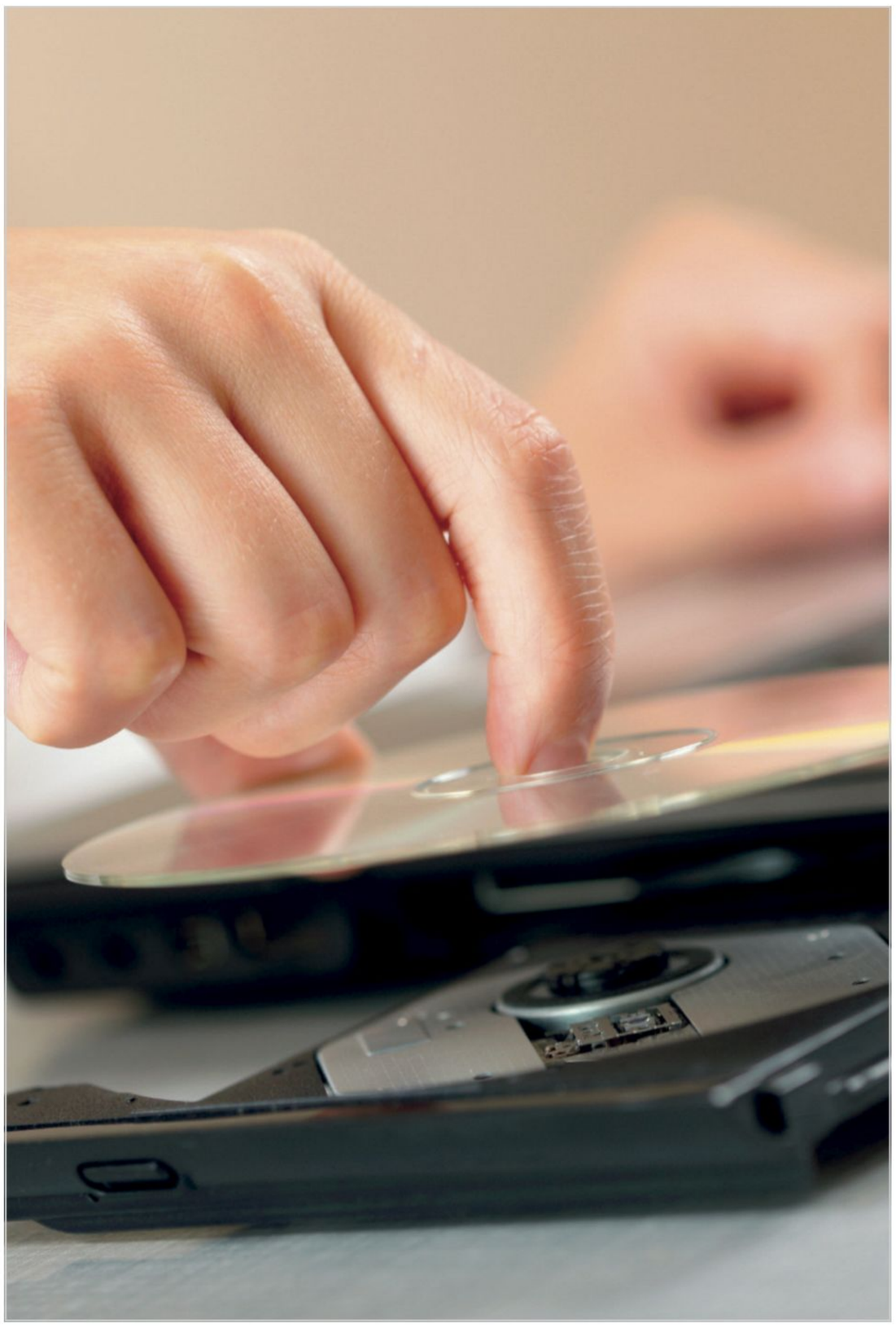


USB INSTALLATION

You can install Linux Mint onto your computer via USB or DVD. We'll look into each a little later on, but if you're already familiar with the process (or you're thinking of USB and just gathering the hardware you'll need), then you're going to need a minimum 4GB USB flash drive/stick to contain the Linux Mint ISO.

DVD INSTALLATION

DVD installation of Linux Mint simply requires a blank DVD-R disc. Of course, you'll also need an optical drive (a DVD Writer drive) before you're able to transfer, or burn, the ISO image to the disc.



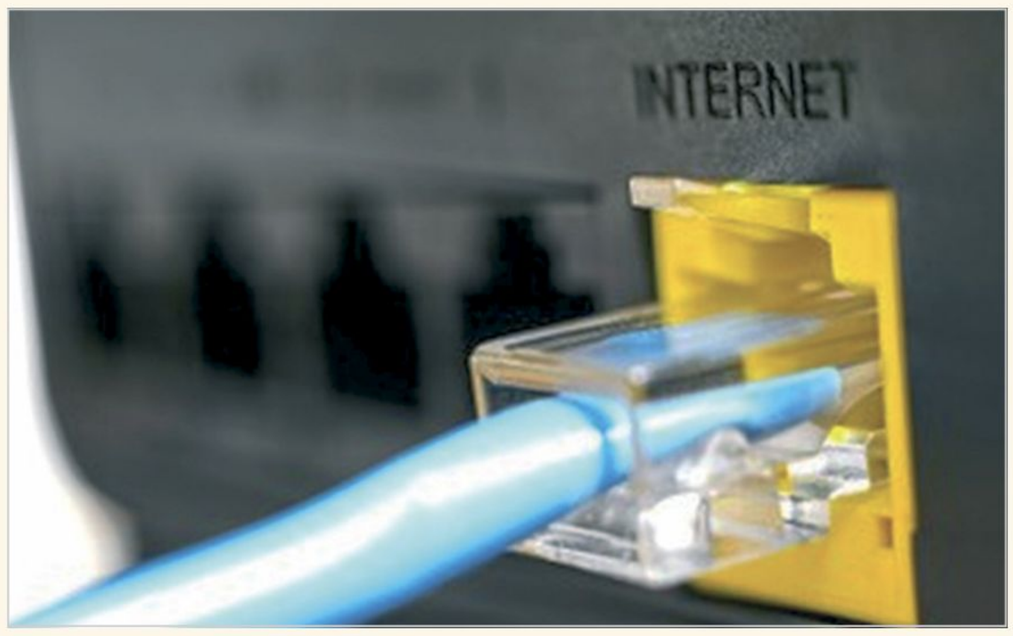
VIRTUAL ENVIRONMENT

Installation to a virtual environment is a favourite method of testing and using Linux distros. Linux Mint works exceedingly well when used in a virtual environment, more on that later. There are many different virtual environment apps available, however VirtualBox, from Oracle, is one of the easiest. You can get the latest version from **www.virtualbox.org**.

VirtualBox

INTERNET CONNECTION

It goes without saying, that an Internet connection is vital for making sure that Linux Mint is resourced with the latest updates and patches, as well as the installation of further software. Although you don't need an Internet connection to use Linux Mint, you'll miss out on a world of free software available for the distro.



MAC HARDWARE

Although Linux Mint can be installed onto a Mac, there's a school of thought that recommends Mac owners use a virtual environment, such as VirtualBox or Parallels; and why not, macOS is already a splendid operating system. If you're looking to breathe new life into an older Mac, make sure it's an Intel CPU model and not the Power-PC models. However, be aware, it's not as pain-free as installing on to a PC.

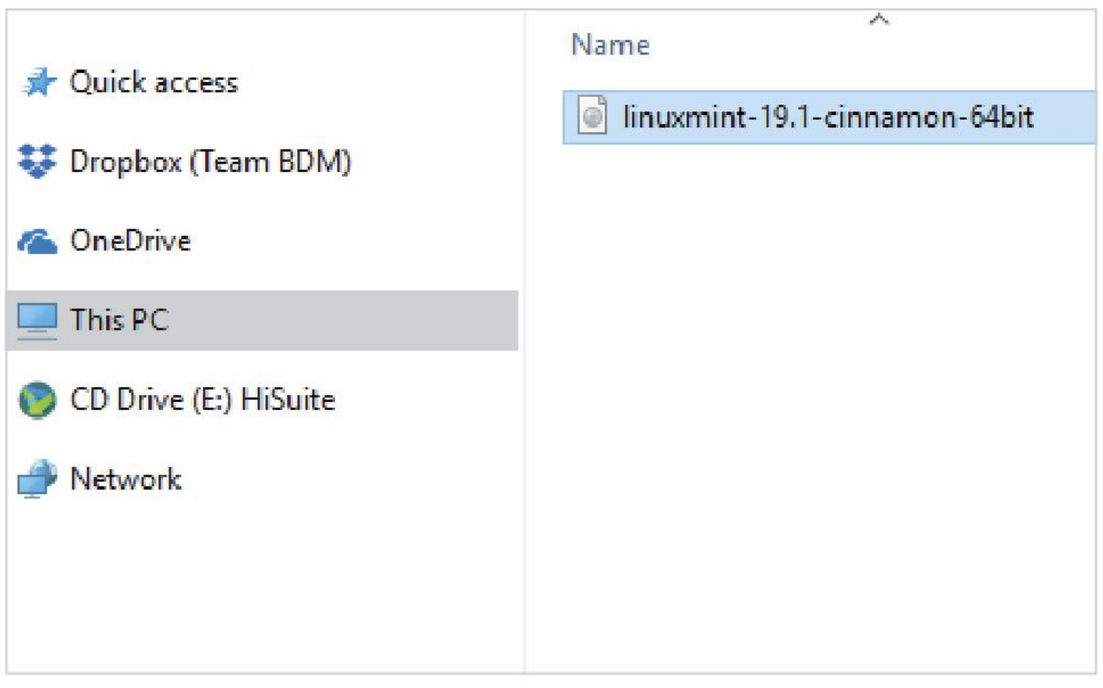
Creating a Linux Installer on Windows

You need to transfer the downloaded Linux ISO to either a DVD or a USB key before you can install it to a computer. This will be a live environment, which will allow you to test the OS prior to installation, but first you need to create the bootable media.

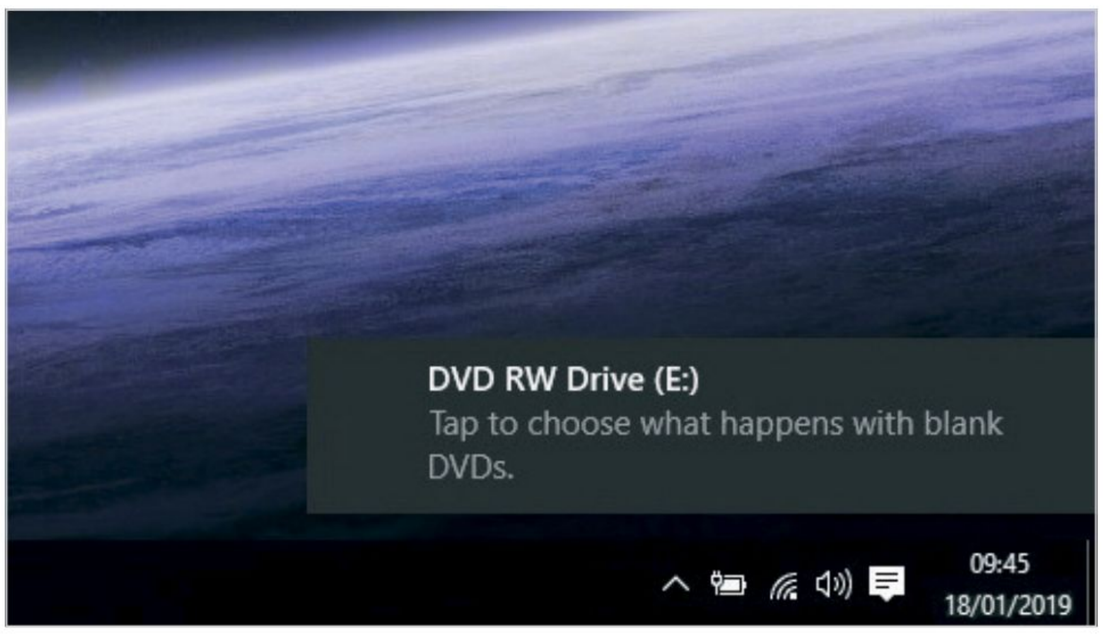
DVD BOOTABLE MEDIA

We're using a Windows 10 PC here to transfer the ISO to a DVD. As long as you're using a version of Windows from 7 onward, the process is extremely easy.

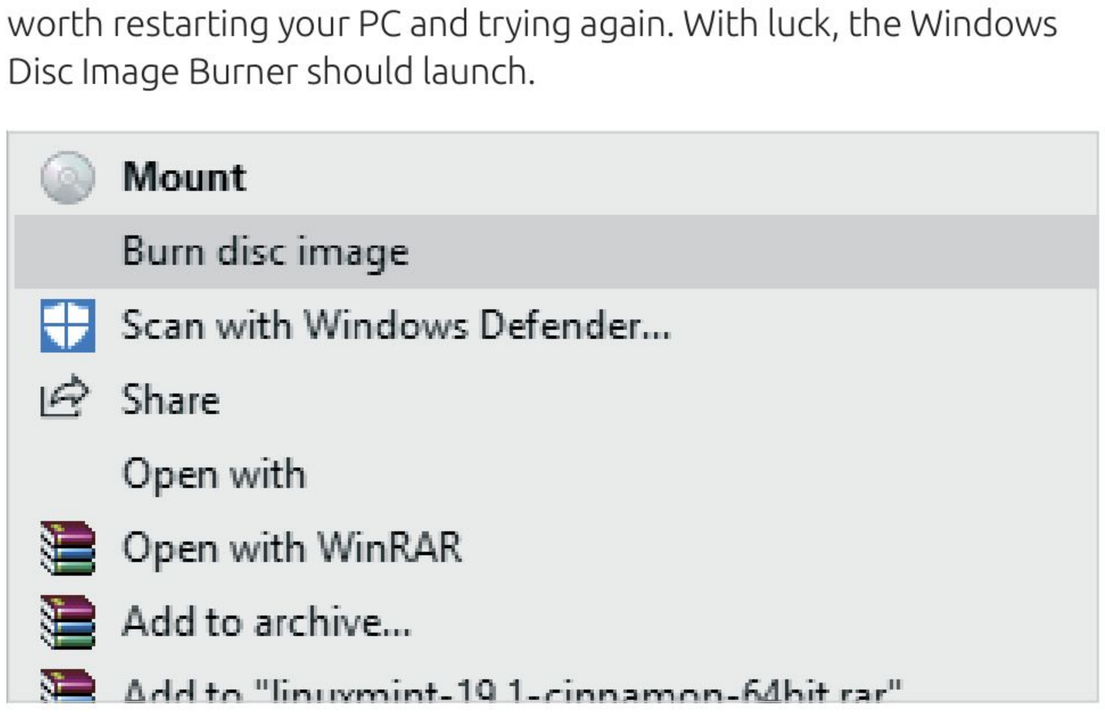
STEP 1 First locate the ISO image of Linux you've already downloaded. In Windows 7, 8.1 and 10 computers, you'll usually find this in the Downloads folder unless, when saving it, you've specified a different location.



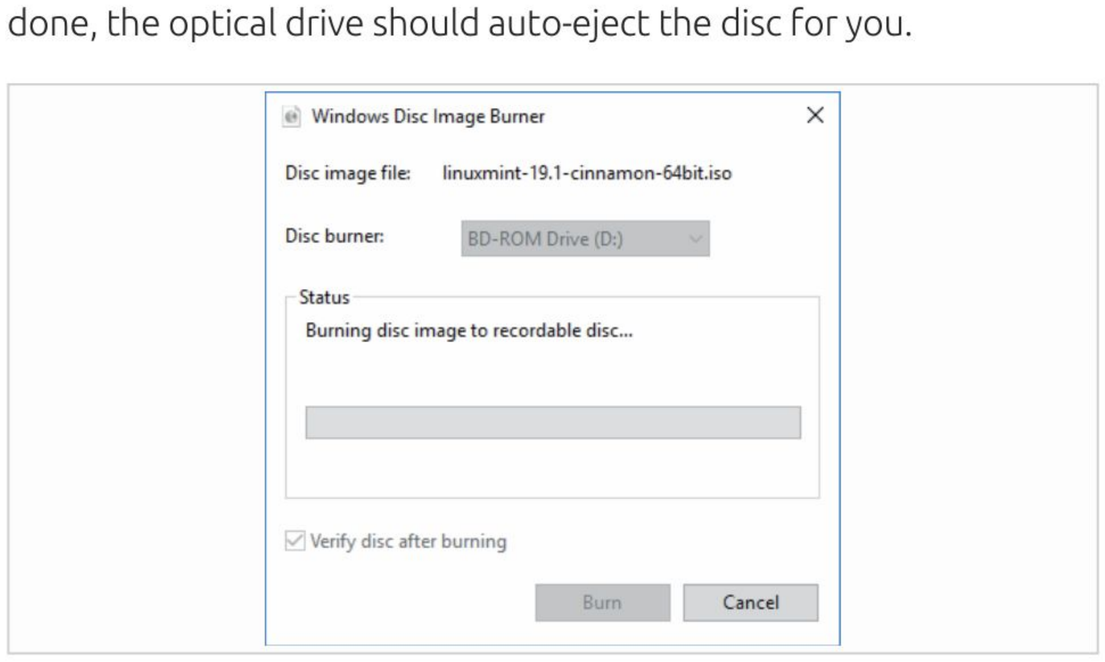
STEP 2 Next, insert a recordable DVD disc into your computer's optical drive. After a few seconds, while the disc is read, Windows will display a pop-up message asking you what to do with the newly inserted disc, ignore this as we're going to use the built-in image burning function.



STEP 3 Right-click the Linux ISO and from the menu select Burn Disc Image. Depending on the speed of the PC, it may take a few seconds before anything happens. Don't worry too much, unless it takes more than a minute, in which case it might be worth restarting your PC and trying again. With luck, the Windows Disc Image Burner should launch.



STEP 4 With the Windows Disc Image Burner dialogue box open, click on the 'Verify disc after burning' tick box, followed by the **Burn** button. The process should take a few minutes, depending on the speed of your PC's optical drive. Once it's complete, it will run through the verification stage and when done, the optical drive should auto-eject the disc for you.

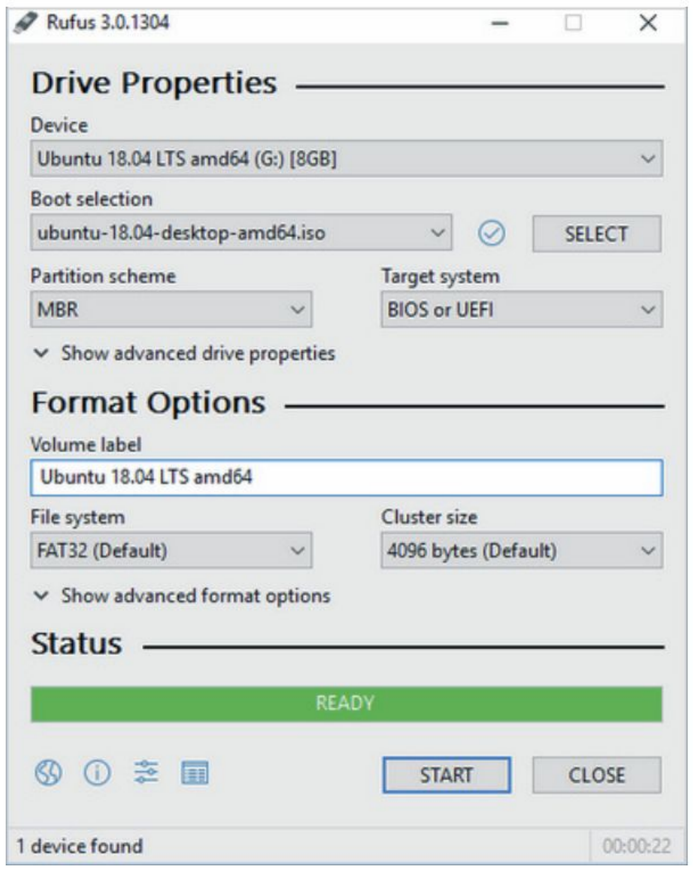


USB BOOTABLE MEDIA

USB media is faster than a DVD and it's often more convenient as most modern PCs don't have an optical drive installed. The process of transferring the image is easy, but you'll need a third-party app first and a USB flash drive of 4GB or more.

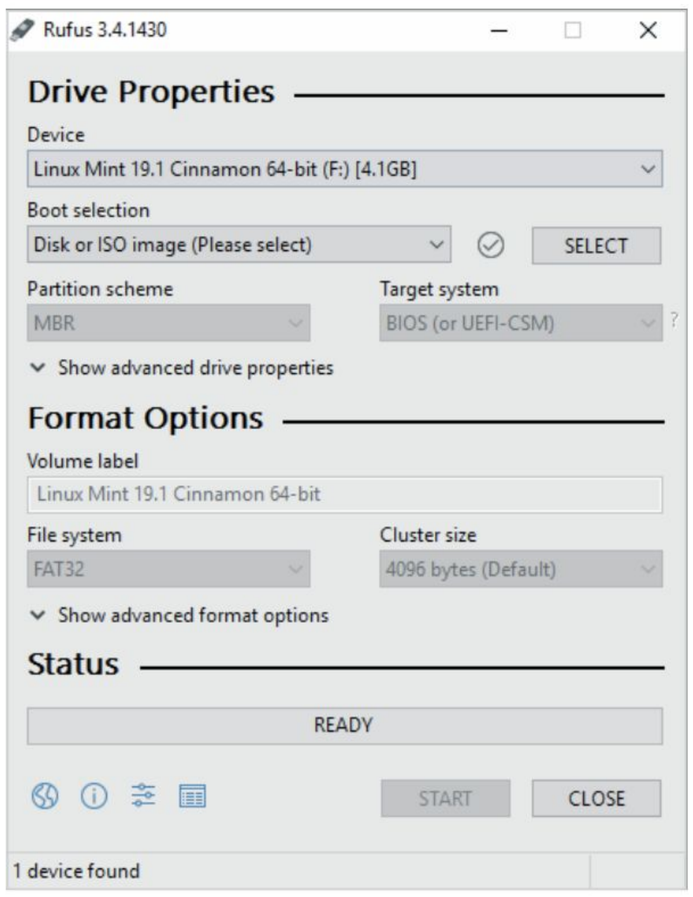
STEP 1

First, open up a web browser and go to **https://rufus.akeo.ie/**. Scroll down the page a little and you'll come to a Download heading, under which you'll see the latest version of Rufus. Left-click on the link to start the download.



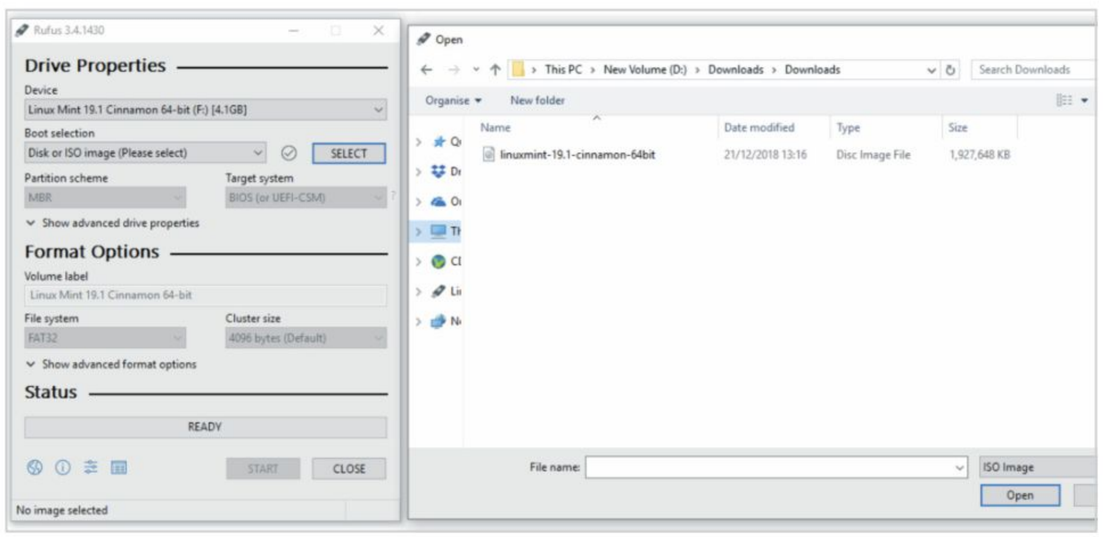
STEP 2

Double-click the downloaded Rufus executable; you can click 'Yes' to the Windows security question and 'Yes' to checking for updates. With Rufus launched, it should have already identified your inserted USB flash drive (if not, just remove and reinsert).



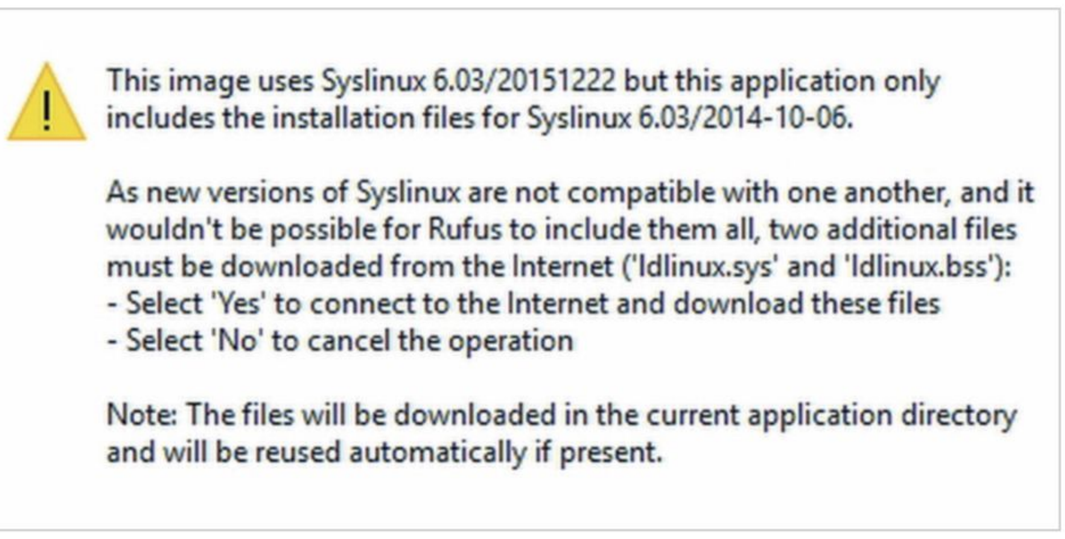
STEP 3

At first glance the Rufus interface can look a little confusing, don't worry though, it's really quite simple. To begin with, click on the SELECT button next to the 'Disk or ISO Image (Please select)' pull-down menu. This will launch a Windows Explorer window from where you can locate and select the Linux ISO.



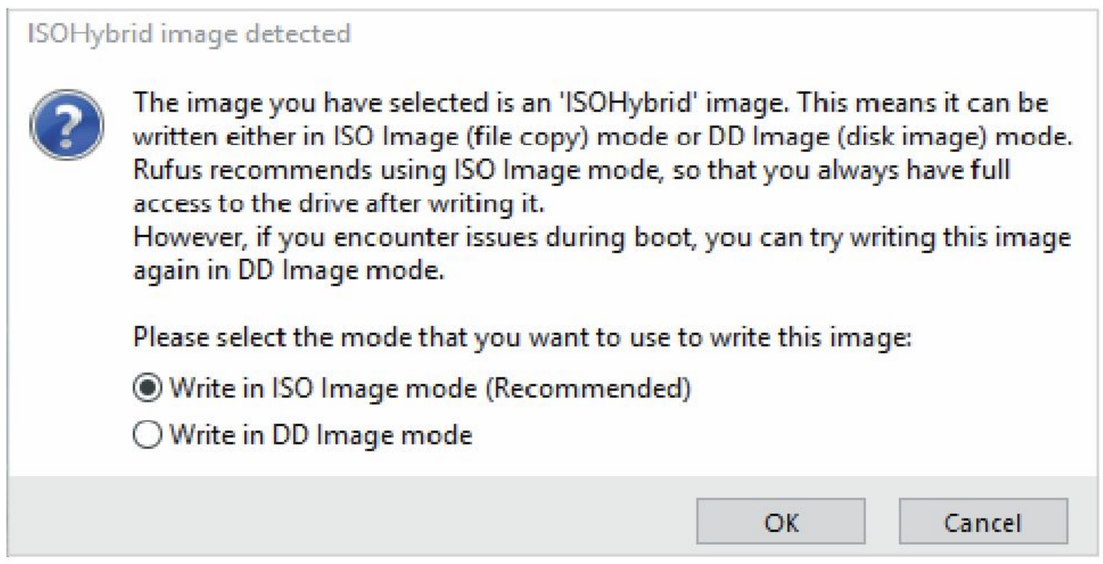
STEP 4

When you're ready, click on the Start button at the bottom of the Rufus app. This may open up another dialogue box asking you to download and use a new version of SysLinux. SysLinux is a selection of boot loaders used to allow a modern PC to access and boot from a USB flash drive. It is necessary, so if asked, click on 'Yes' to continue.



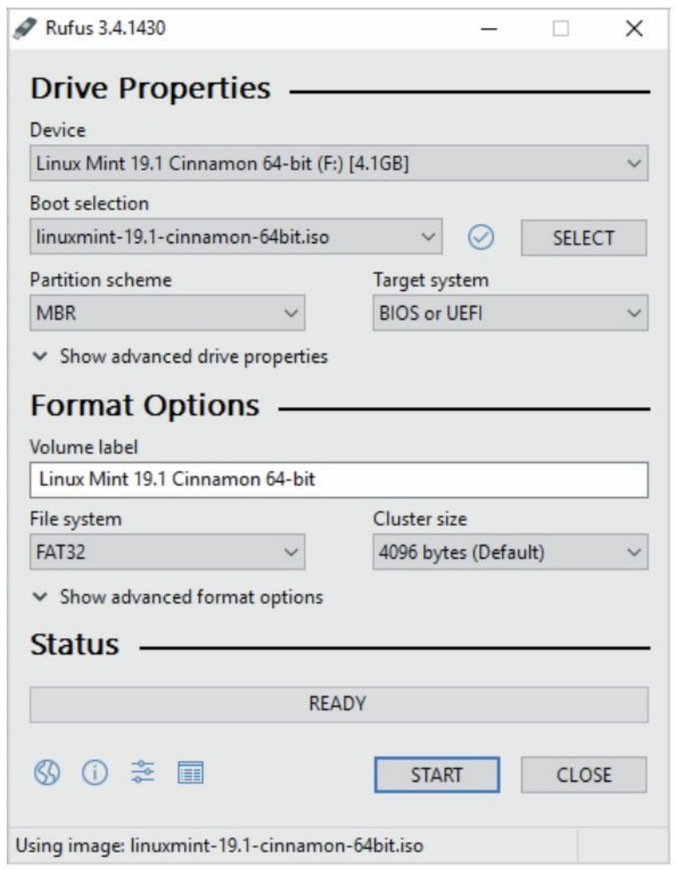
STEP 5

The next step asks in which image mode do you want the Linux ISO to be written to the USB flash drive. Both methods work for different situations, but generally, the recommended ISO Image Mode is the more popular. Make sure this mode is pre-selected and click 'OK' to continue, followed by 'OK' again to confirm the action.



STEP 6

The Linux ISO is now being transferred to the USB flash drive. The process shouldn't take too long, depending on the speed of the USB device and the PC. During the process, you may find Rufus will auto-open the USB drive in Windows Explorer, don't worry you can minimise or close it if you want. Click on the Close button once the process is complete.



Installing Linux on a PC

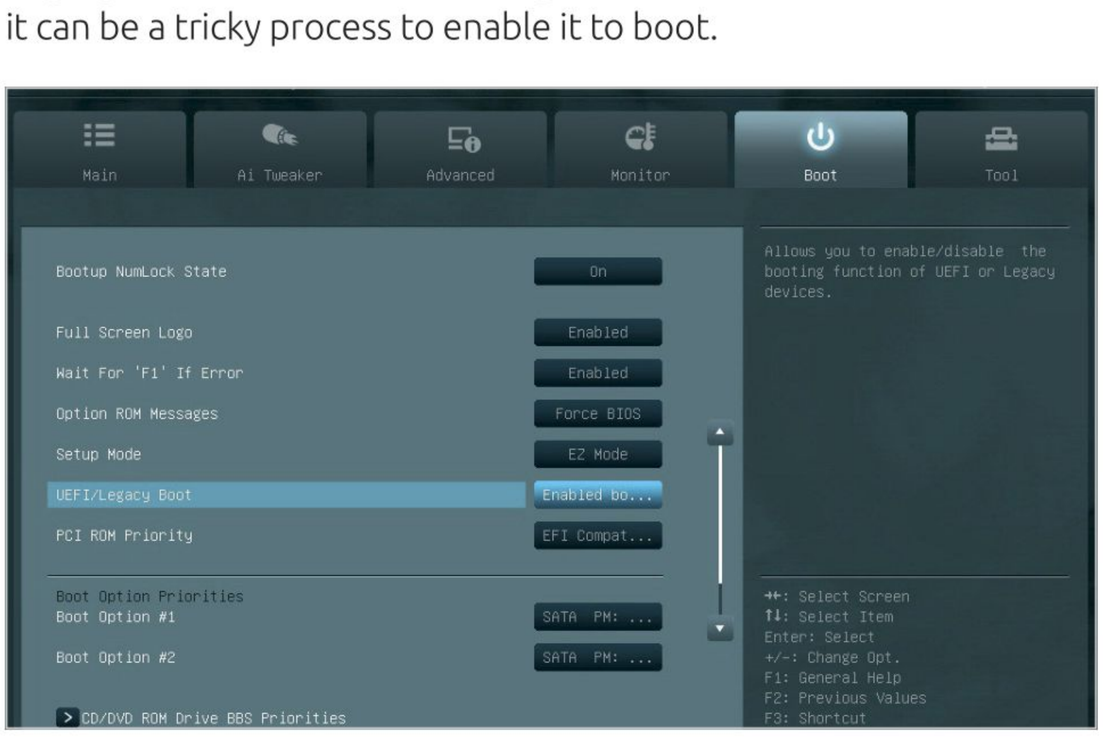
Most Linux distros come as a Live Environment. This means you can boot into an actual, fully working distro straight from the DVD or USB you've just created. Let's see how that works and how you go about installing Linux from there.

UEFI BIOS

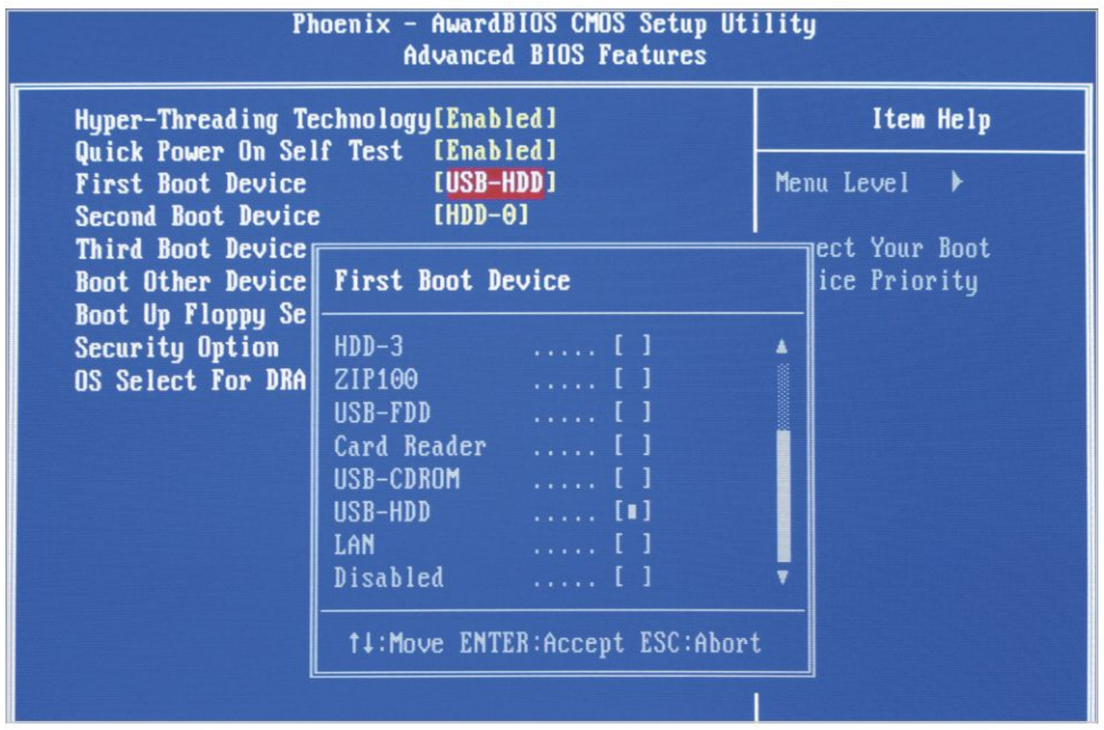
The Unified Extensible Firmware Interface (UEFI) is used to identify hardware and protect a PC during its boot-up process. It replaces the traditional BIOS, but can cause issues when installing Linux.

STEP 1 Insert your DVD or USB flash drive into your PC and, if you haven't already, shutdown Windows. In this instance, we're using the USB boot media but the process is virtually identical. Start the PC and when prompted press the appropriate keys to enter the BIOS or SETUP; these could be, for example, **F2**, **Del** or even **F12**.

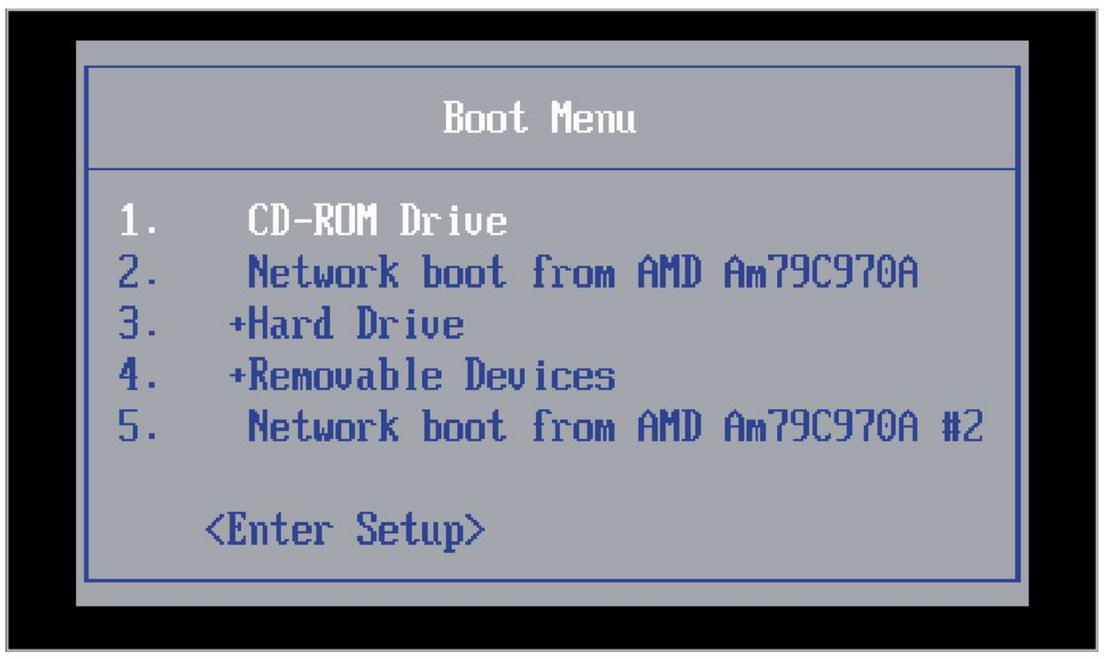
STEP 2 There are different versions of a UEFI BIOS, so covering them all would be impossible. What you're looking for is a section that details the **Boot Sequence** or **Boot Mode**. Here you'll have the option to turn off UEFI and choose **Legacy**, or disable **Secure Booting**. Most distros work with UEFI but it can be a tricky process to enable it to boot.



STEP 3 With UEFI turned to Legacy mode, there are now two ways of booting into the Live Environment. The first is via the BIOS you're already in. Locate the **Boot Sequence** and change the first boot device from its original setting, usually Internal HDD or similar, to: **USB Storage Device** for the USB media option; or **DVD Drive**, for the DVD media option.



STEP 4 Alternatively use the Boot Option Menu. With this option, you can press **F12** (or something similar) to display a list of boot media options; from there, you can choose the appropriate boot media. Either way, you can now Save and Exit the BIOS by navigating to the Save & Exit option and choosing **Save Changes and Exit**.

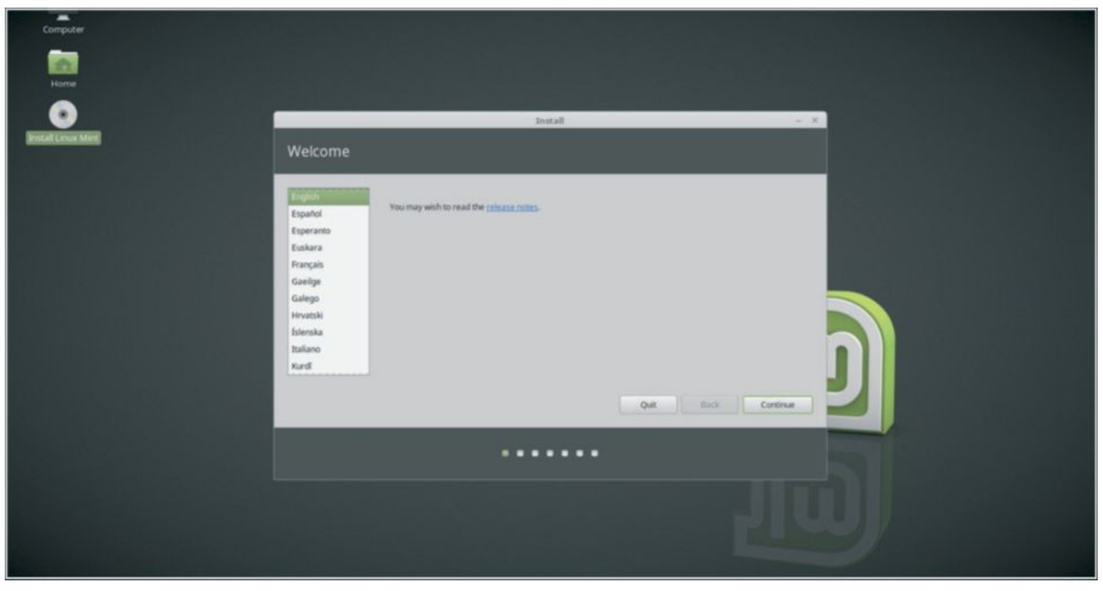


INSTALLING LINUX

Once the Live Environment has booted, you will see the option to install the distro to your computer. Have a look around and when you're ready, look for the Install option on the desktop.

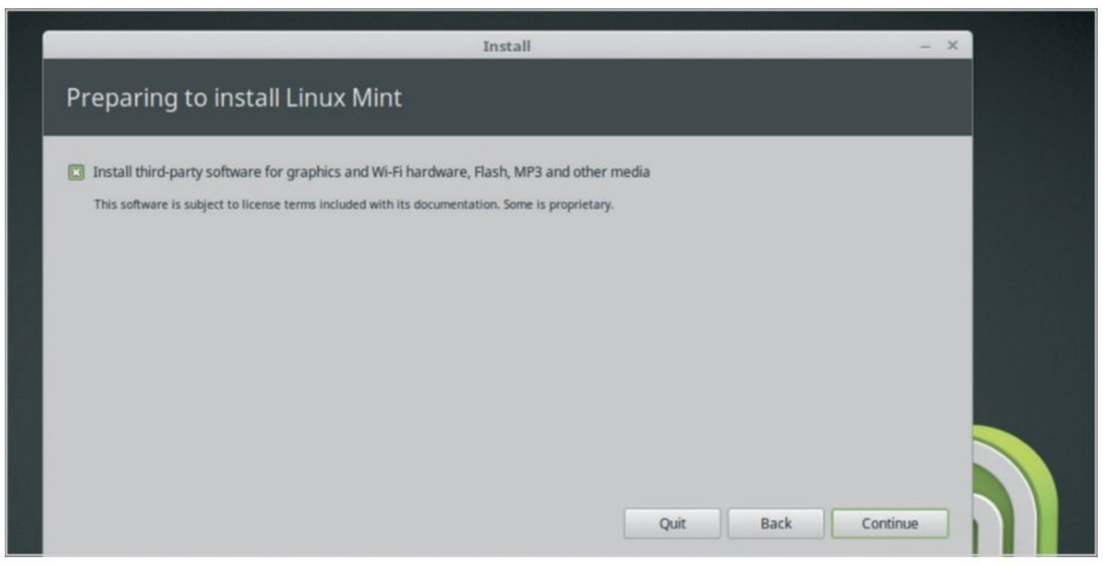
STEP 1

Providing you're connected to the Internet (if not, then do so now) and you're in the Live Environment, start the installation process by double-clicking on the **Install Linux Mint** icon on the desktop. Other distros will display their own name, of course, but the process is the same. Click **Continue** when you're ready.



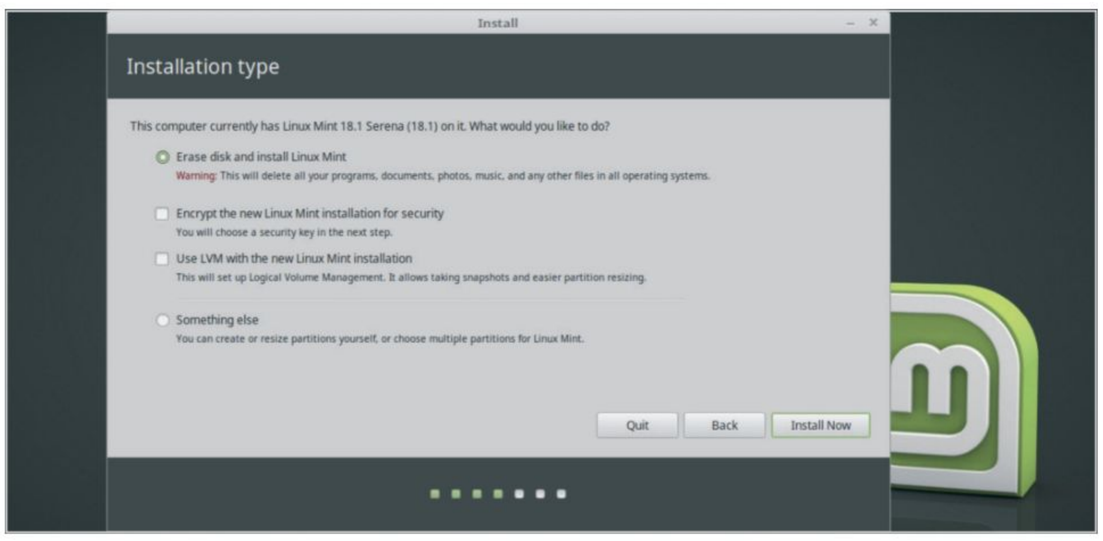
STEP 2

While the installation process is very similar across most Linux distros, some offer different questions during the installation. Generally, the questions aren't too difficult, or technical, but some such as 'Installing third-party software…' can be confusing. In this case, you can click **Continue**, but if you're unsure, have an Internet-connected device available to ask any questions.



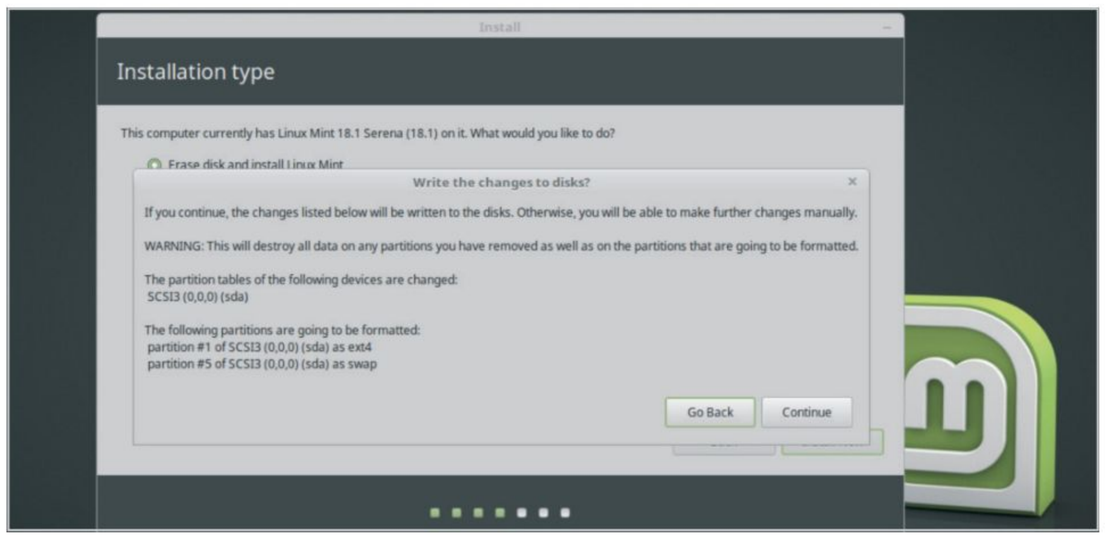
STEP 3

When installing a new operating system it's recommended that you wipe the old OS, replacing it with the new. When you reach this stage of the installation process, ensure the 'Erase disk and install Linux…' option is selected. NOTE: **This will completely wipe Windows 10 from your computer; make sure you have backups of all your personal files and data.**



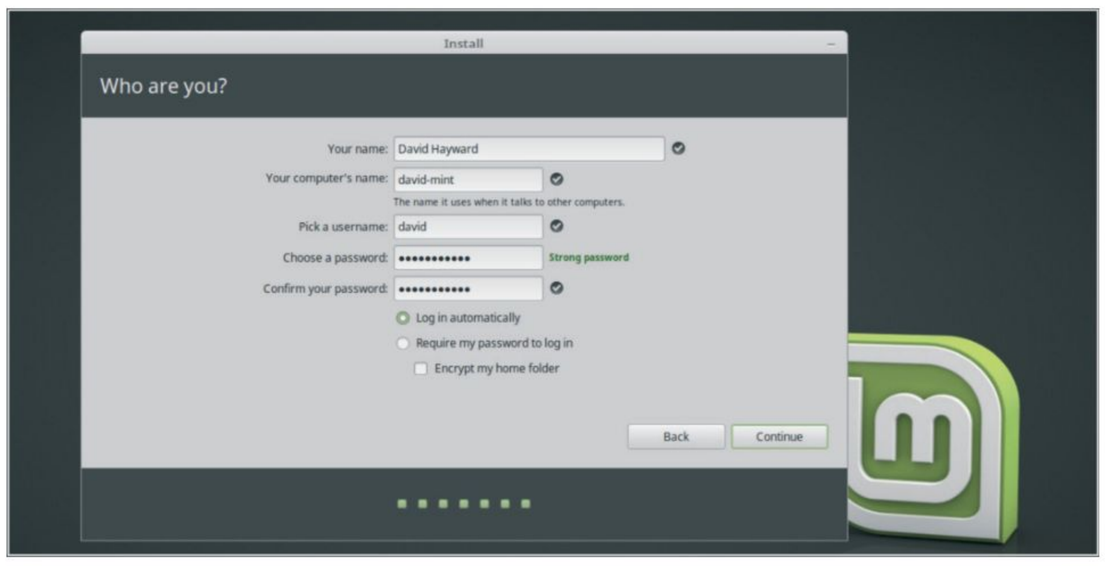
STEP 4

Before the installation process begins, you're asked if the choice you made regarding the erasure of the hard drive is correct. This is your last chance to back out. If you're certain you don't mind wiping everything and starting again with Linux Mint, click **Continue**. If you need to back up your files remove the Linux disc/USB, reboot, back up and start again.



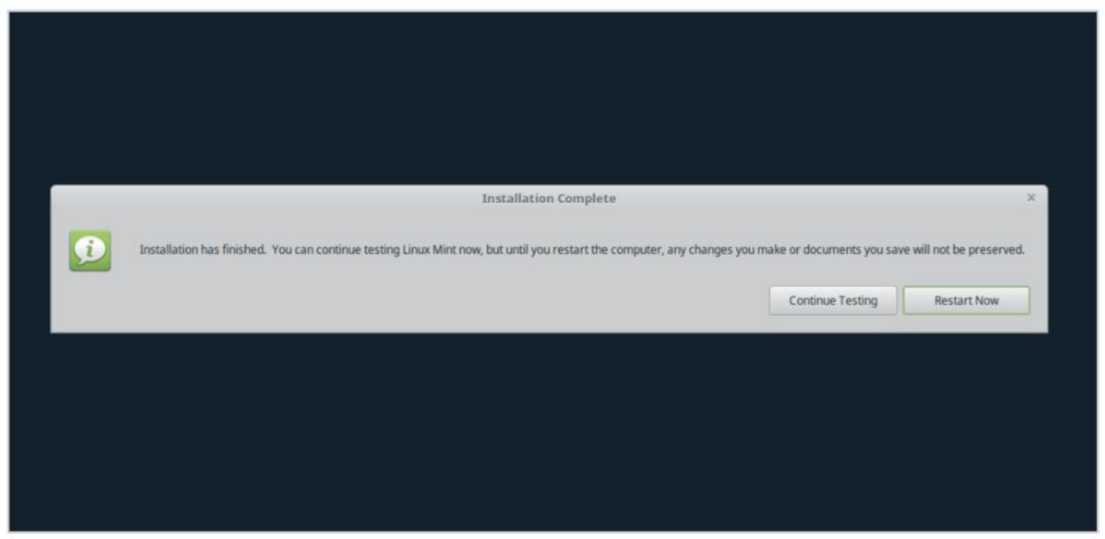
STEP 5

Eventually you will be asked to set up your Linux username and password. Enter your Name to begin with, then **Computer Name** – which is the name used to identify it on the network. Next, choose a **Username**, followed by a good Password. You can tick the **Login Automatically** option, but leave the Encrypt Home Folder option for now.



STEP 6

The installation process can be quick and there may be more questions to answer, or it may simply start installing Linux based on your previous answers. Either way, you will end up being asked to Continue Testing the Live Environment, or Restarting to use the newly installed OS. If you're ready to use Linux, then click **Restart Now**.



Installing a Virtual Environment

A Virtual Environment is a simulated computer system. Using a Virtual Machine, you can mimic a standard PC and install an entire operating system on it without affecting the one installed on your computer. It's a great way to test and use Linux, while still having Windows 10 as your main OS.

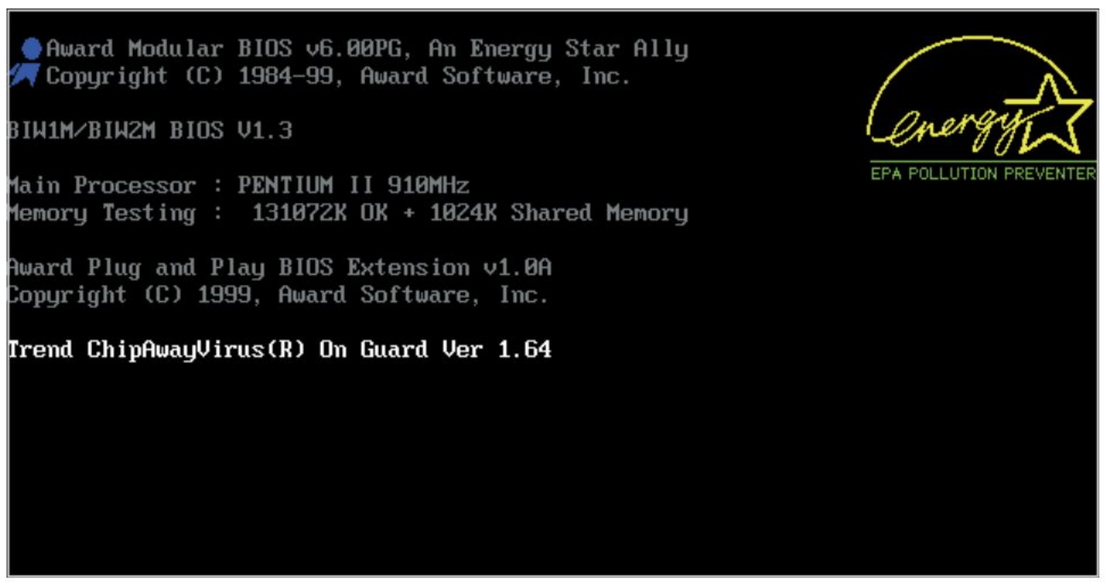
GOING VIRTUAL

Using a Virtual Machine (VM) will take resources from your computer: memory, hard drive space, processor usage and so on. So make sure you've got enough of each before commencing.

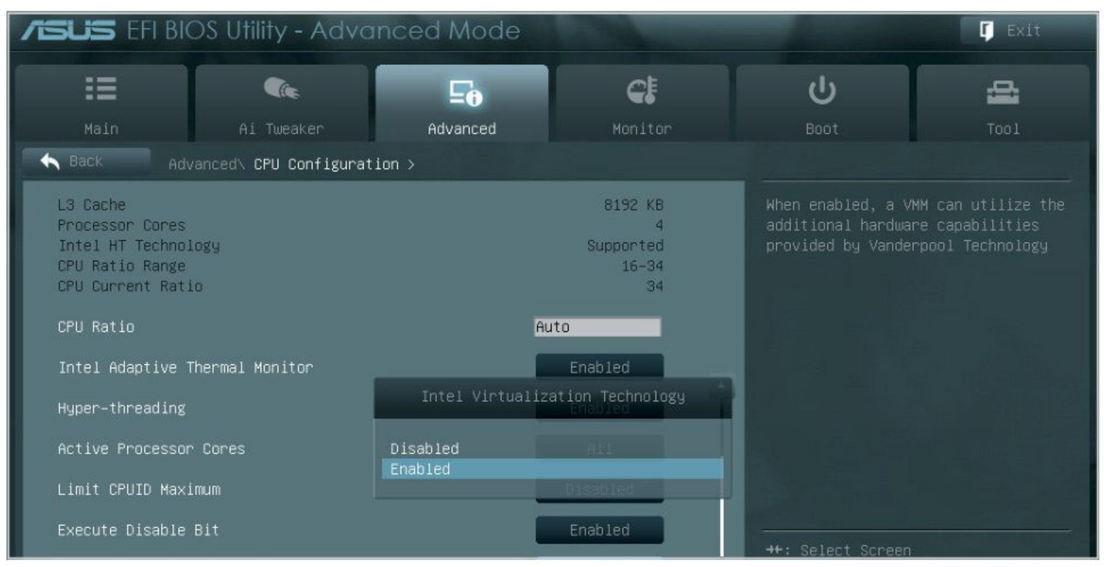
STEP 1 We're using VirtualBox in this instance, as it's one of the easiest virtual environments to get to grips with. Enter **www.virtualbox.org** and click on **'Download VirtualBox'**. This will take you to the main download page. Locate the correct host for your system: Windows or Mac – the Host is the current installed operating system and click the link to begin the download.

STEP 2 Next, while still at the VirtualBox download page, locate the VirtualBox Extension Pack link. The Extension Pack supports USB devices, as well as numerous other extras that can help make the VM environment a more accurate emulation of a 'real' computer.

STEP 3 With the correct packages downloaded, before we install anything, we need to make sure that the computer you're using is able to host a VM. To do this, reboot the computer and enter the BIOS. As the computer starts up, press the **Del**, **F2**, or whichever key is necessary to **Enter Setup**.

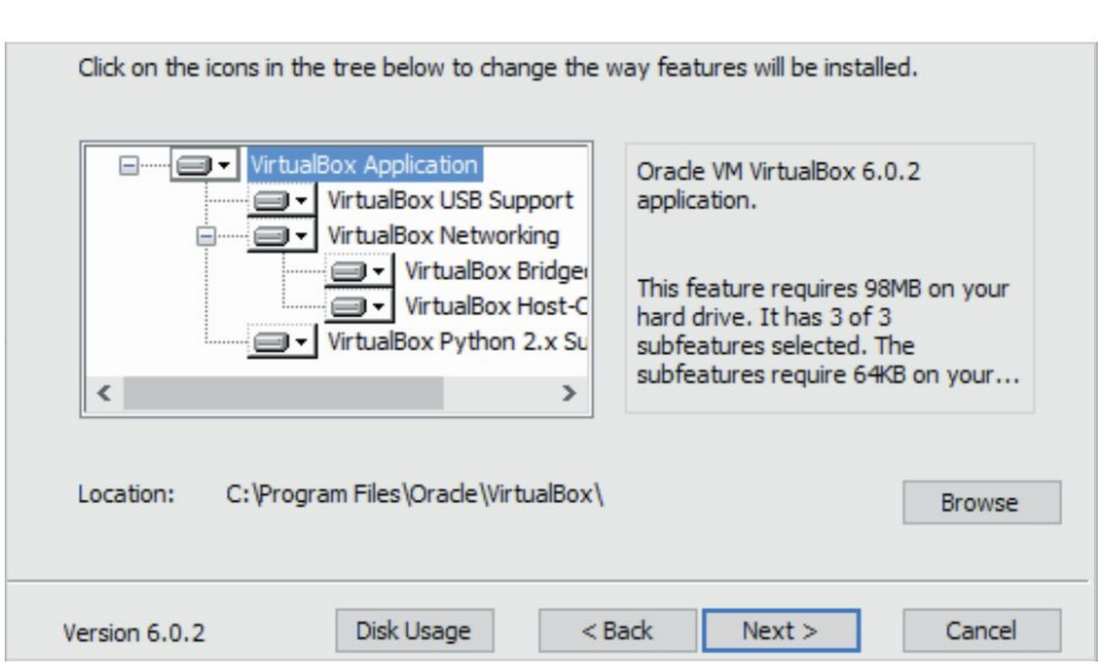


STEP 4 As each BIOS is laid out differently, it's very difficult to assess where to look in each personal example. However, as a general rule of thumb, you're looking for Intel Virtualisation Technology, or simply Virtualisation, usually within the Advanced section of the BIOS. When you've located it, Enable it, save the settings, exit the BIOS and reboot the computer.

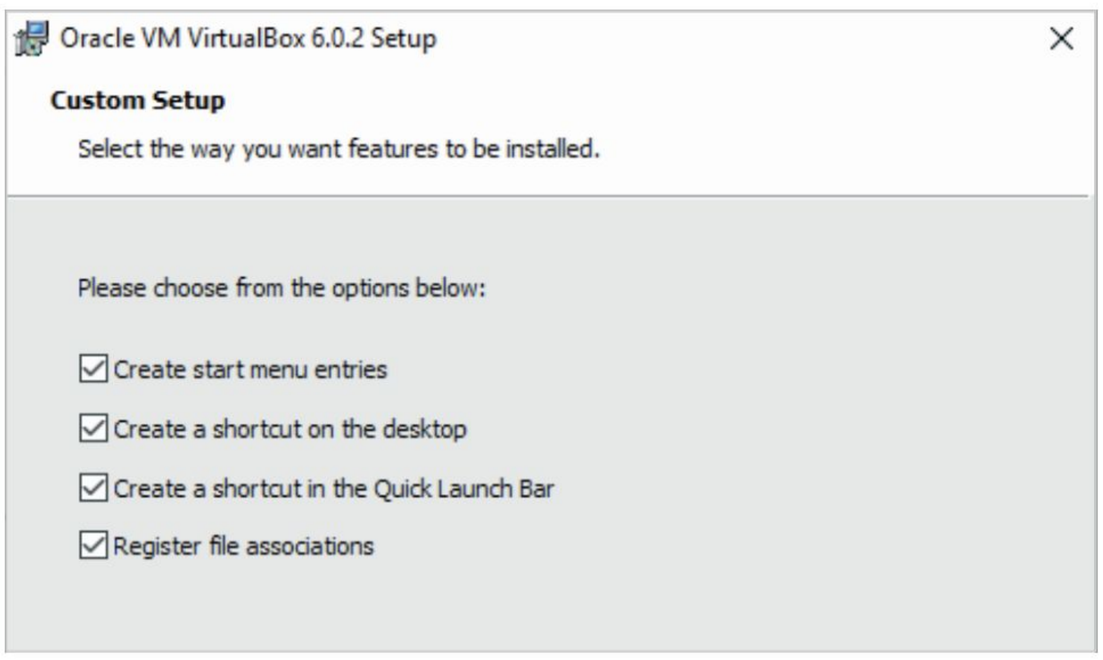


STEP 5 With the computer back up and running, locate the downloaded main VirtualBox application and double-click to begin the installation process. Click Next to continue, when you're ready.

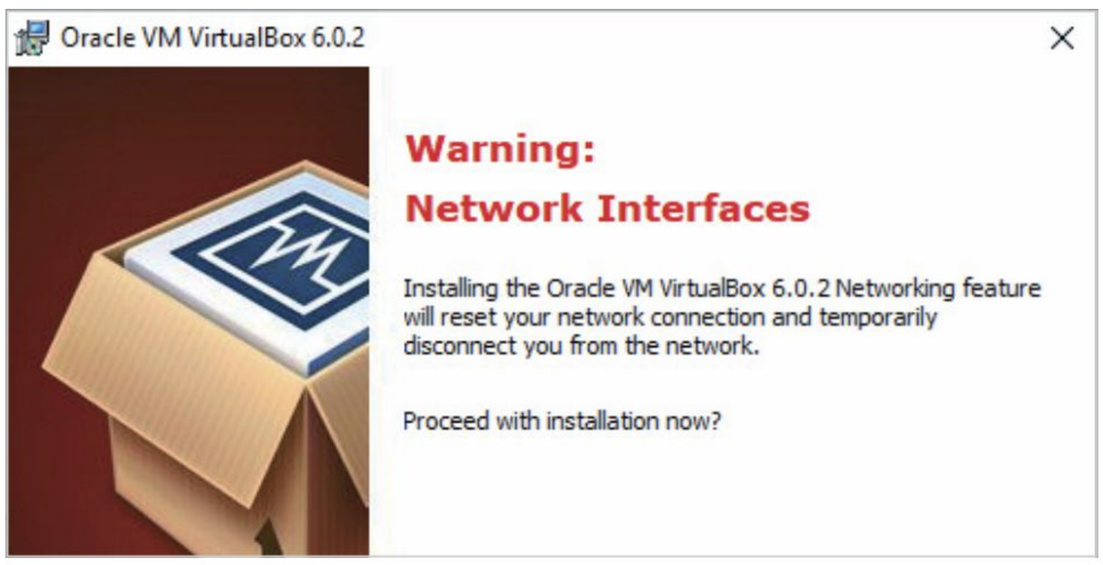
STEP 6 The default installation location of VirtualBox should satisfy most users, but if you have any special location requirements, click on the 'Browse' button and change the install folder. Also, make sure that all the icons in the VirtualBox feature tree are selected and none of them have a red X next to them. Click Next to move on.



STEP 7 This section can be left to the defaults, should you wish. It simply makes life a little easier when dealing with VMs, especially when dealing with downloaded VMs, as you may encounter in the future. Again, clicking Next will move you on to the next stage.

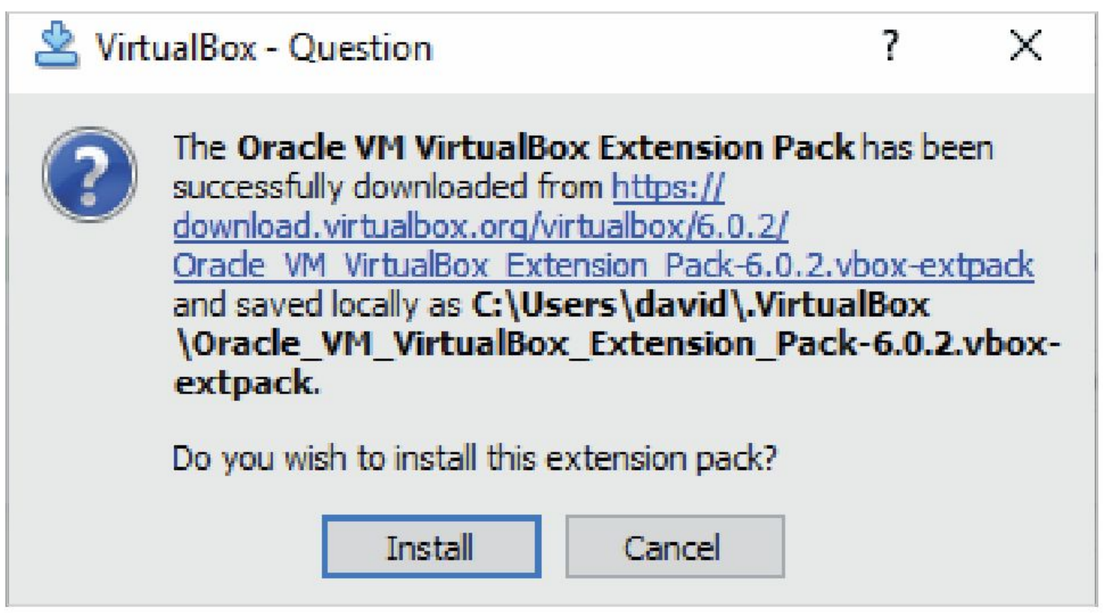


STEP 8 When installing VirtualBox, your network connection will be disabled for a very brief period. This is due to VirtualBox creating a linked, virtual network connection so that any VM installed will be able to access the Internet and your home network resources, via the computer's, already established, network connection. Click Yes, then, Install to begin the installation.



STEP 9 You'll probably be asked by Windows to accept a security notification, click Yes for this and next you may encounter a dialogue box asking you to trust the installation from Oracle, again, click yes and accept the installation of the VirtualBox application. When it's complete, click finish to start VirtualBox.

STEP 10 With VirtualBox up and running, you can now install the VirtualBox Extension Pack. Locate the downloaded add-on and double-click. There may be a short pause while VirtualBox analyses the pack, but you'll eventually receive a message to install it; click Install to begin the process, scroll down the next screen to accept the agreement and click 'I Agree'.



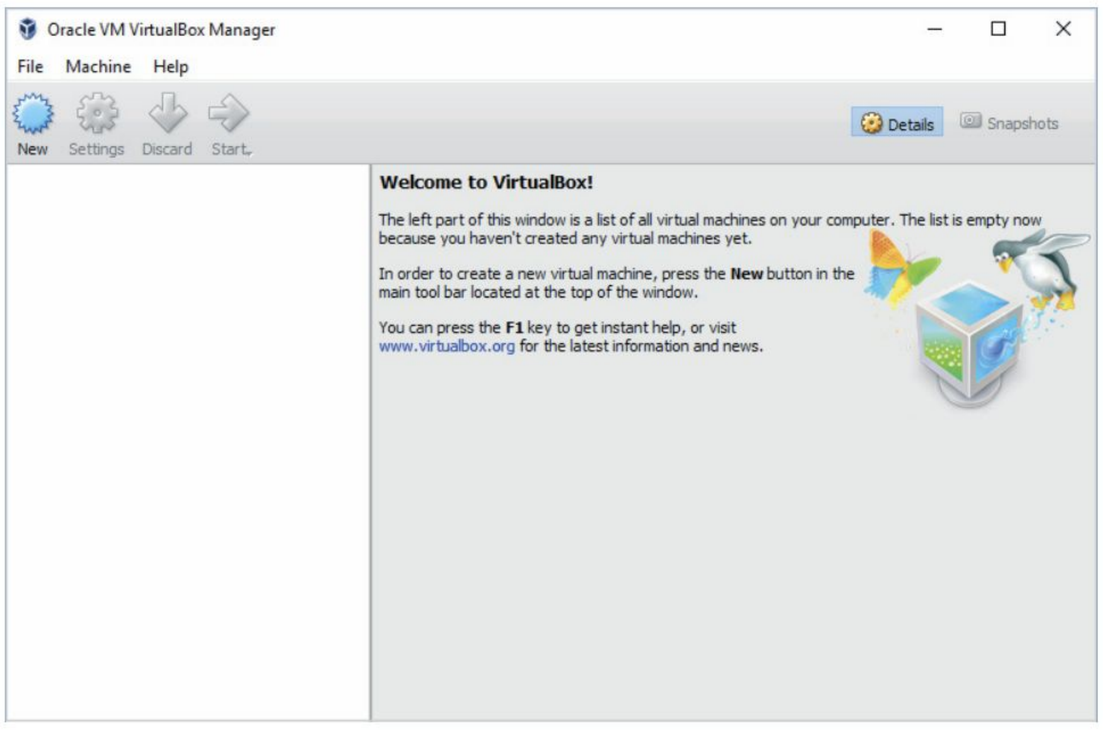
Installing Linux in a Virtual Environment

With Oracle's VirtualBox now up and running, the next task is to create the Virtual Machine (VM) environment into which you will install Linux. This process won't affect your currently installed operating system, which is why a VM is a great choice.

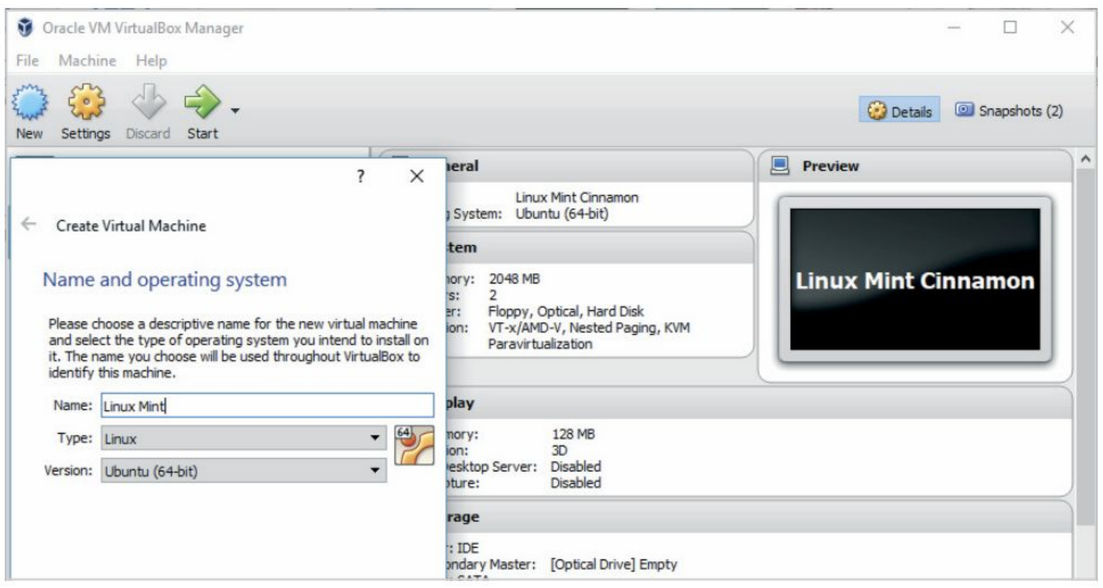
CREATING THE VM

There are plenty of options to choose from when creating a VM. For now though, we'll set up a VM adequate to run Mint Cinnamon and perform well.

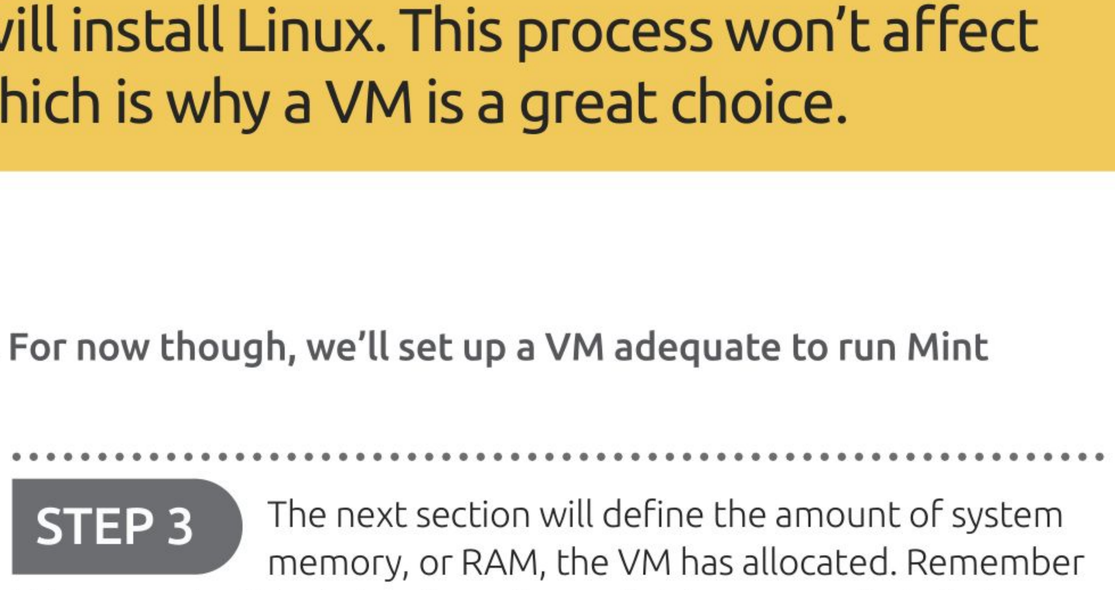
STEP 1 With VirtualBox open, click on the **New** icon in the upper right of the app. This will open the new VM Wizard.



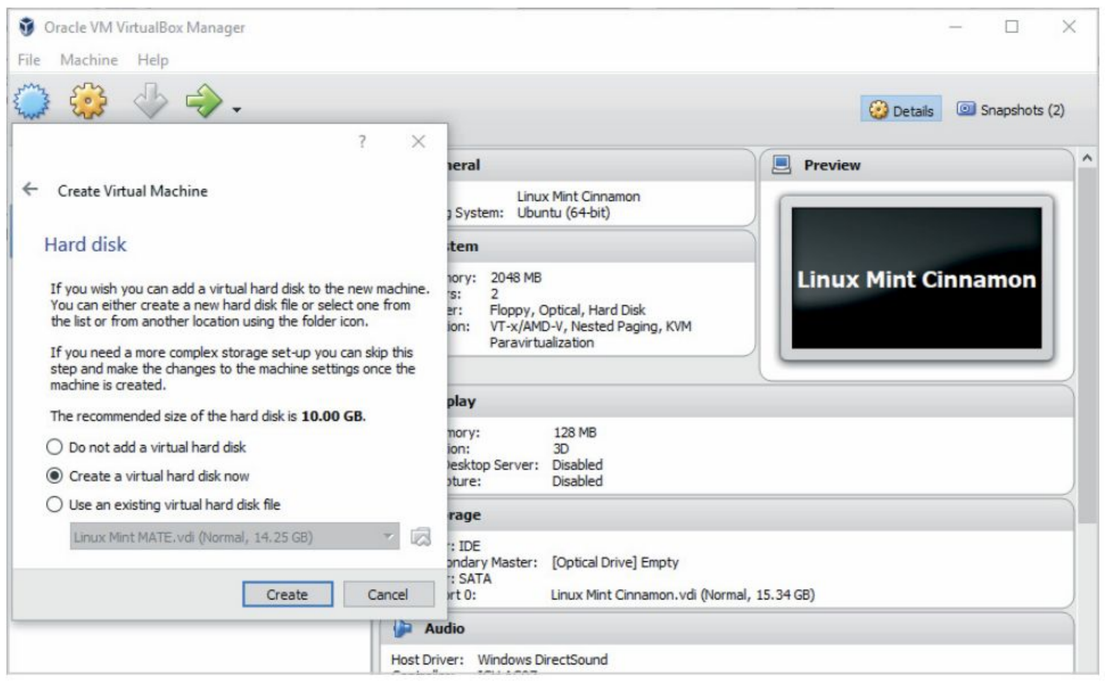
STEP 2 In the box next to Name, type **Linux Mint** and VirtualBox should automatically choose Linux as the Type and Ubuntu (64-bit) as the Version, if not then use the drop-down boxes to select the correct settings (remember Mint mainstream is based on Ubuntu). Click **Next** when you're ready to proceed.



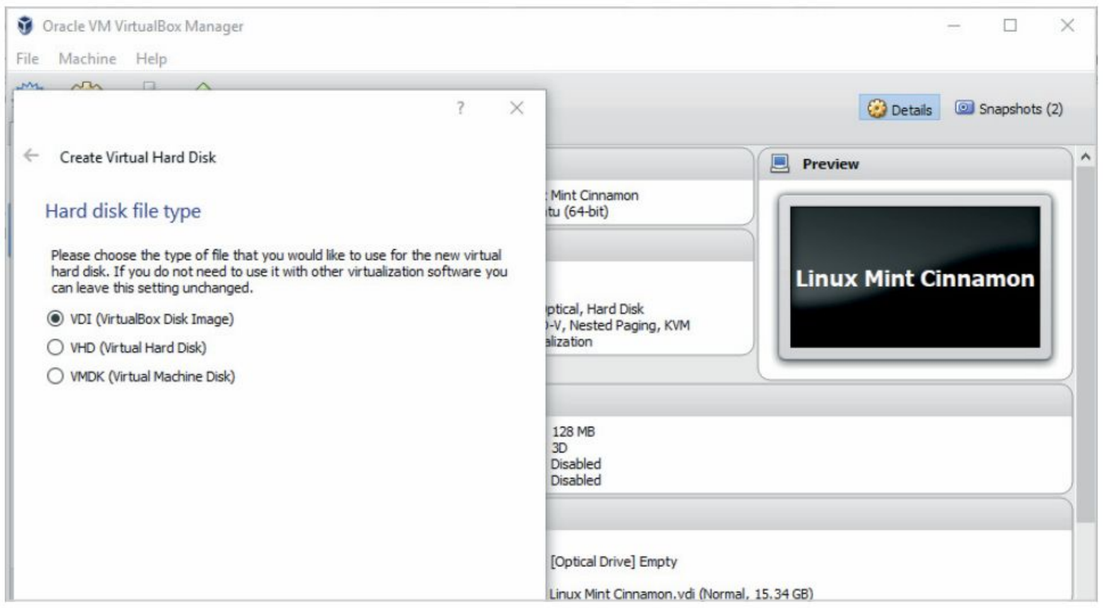
STEP 3 The next section will define the amount of system memory, or RAM, the VM has allocated. Remember this amount will be taken from the available memory installed on your computer, so don't give the VM too much. For example, we have 8GB of memory installed and we're giving 2GB (2048MB) to the VM. When you're ready, click **Next** to continue.



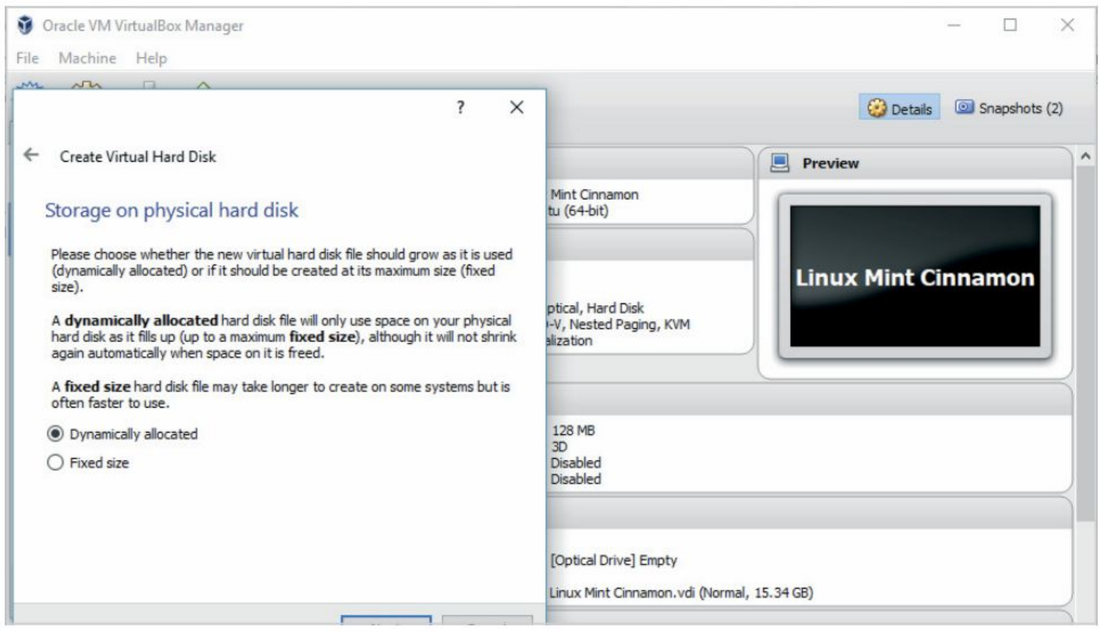
STEP 4 This section is where you'll start to create the virtual hard disk on which the VM will install Mint. The default option, 'Create a virtual hard disk now', is the one we're using. Click **Create** to move on.



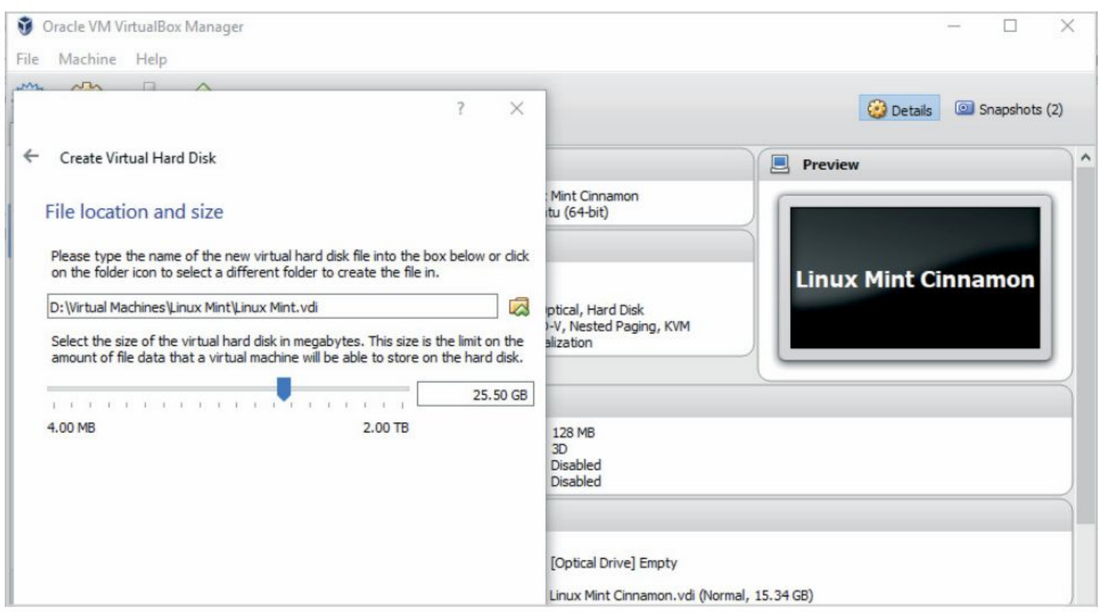
STEP 5 After clicking Create, the pop-up window that appears asks you what type of virtual hard disk you want to create. We're going to use the default VDI (VirtualBox Disk Image) in this case, as the others are more often used to move VMs from one VM application to the next. Make sure VDI is selected and click **Next**.



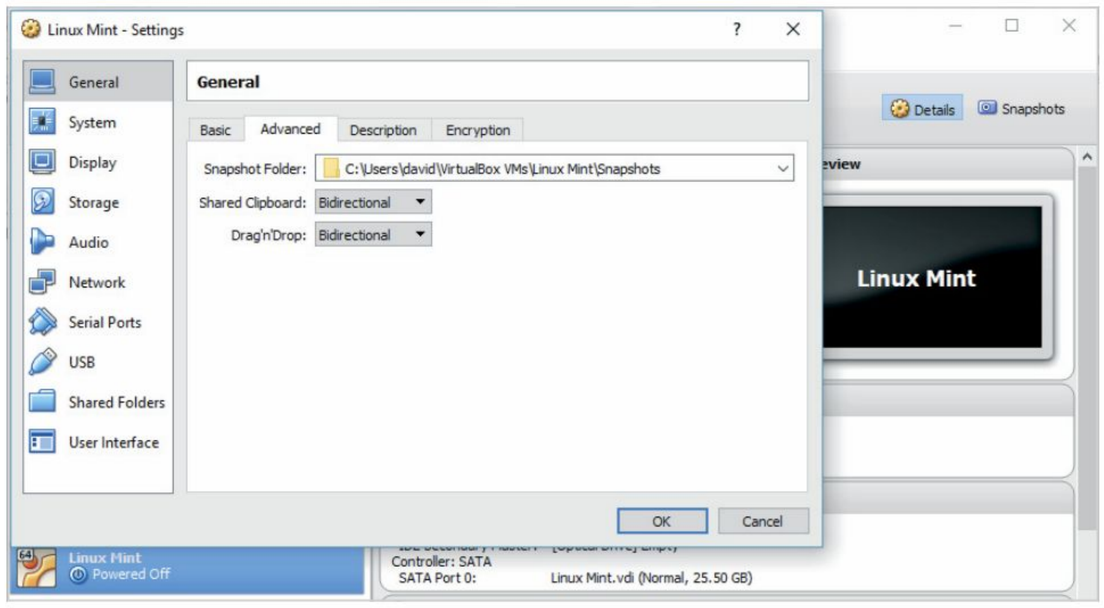
STEP 6 The question of whether to opt for Dynamically or Fixed-sized virtual hard disks may come across as somewhat confusing to the newcomer. Basically, a Dynamically Allocated virtual hard disk is a more flexible storage management option. It won't take up much space within your physical hard disk either. Ensure **Dynamically Allocated** is selected and click **Next**.



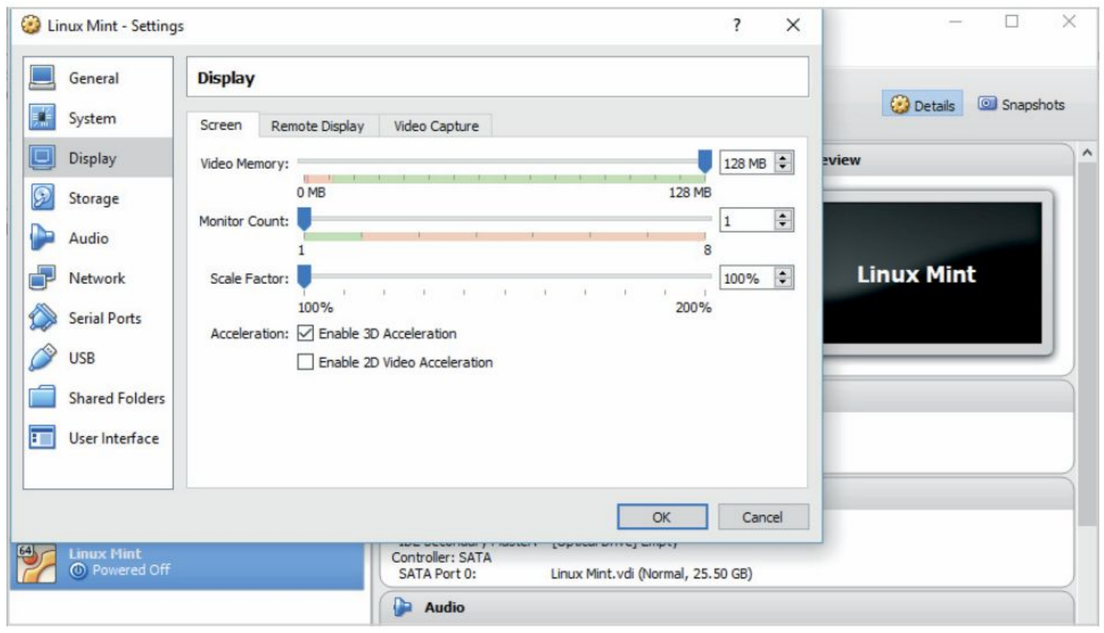
STEP 7 The virtual hard disk will be a single folder, up to the size you state in this section. On your computer, ensure the location of the virtual hard disk has enough free space available. For example, we've used a bigger storage option on our D:\ drive, named it Linux Mint and allocated 25.50GB of space to the virtual hard disk.



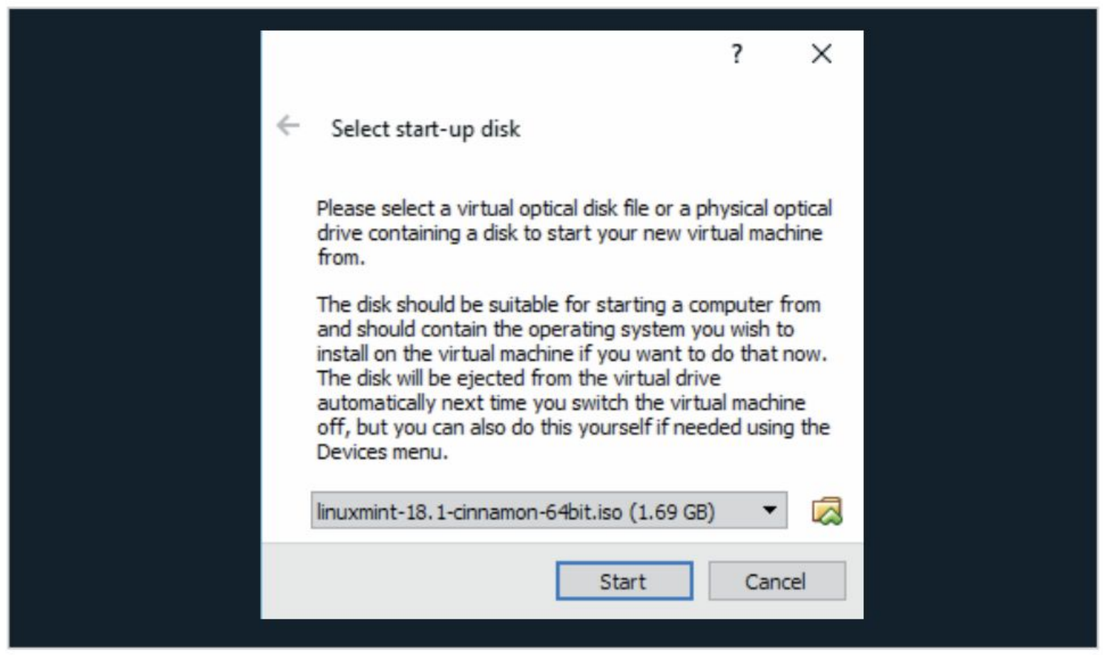
STEP 8 After clicking Create, the initial setup of the VM is complete; you should now be looking at the newly created VM within the VirtualBox application. Before you begin though, click the **Settings** button and then from within the General section, click the **Advanced** tab. Now using the pull-down menus, choose 'Bidirectional' for both Shared Clipboard and Drag'n'Drop.



STEP 9 Follow that by clicking on the **System** section, then the **Processor** tab. Depending on your CPU allocate as many cores as you can without detriment to your host system; we've opted for two CPUs. Now click on the **Display** section, slide the **Video Memory** up to the maximum and tick 'Enable 3D Acceleration'. Click **OK** to commit the new settings.



STEP 10 Click on the **Start** button and use the Explorer button (a folder with a green arrow) in the 'Select Start-up Disk' window to locate the downloaded ISO of Mint. Click **Start** to boot the VM with the Linux Mint Live Environment. You can now install Linux as per the standard PC installation requirements.



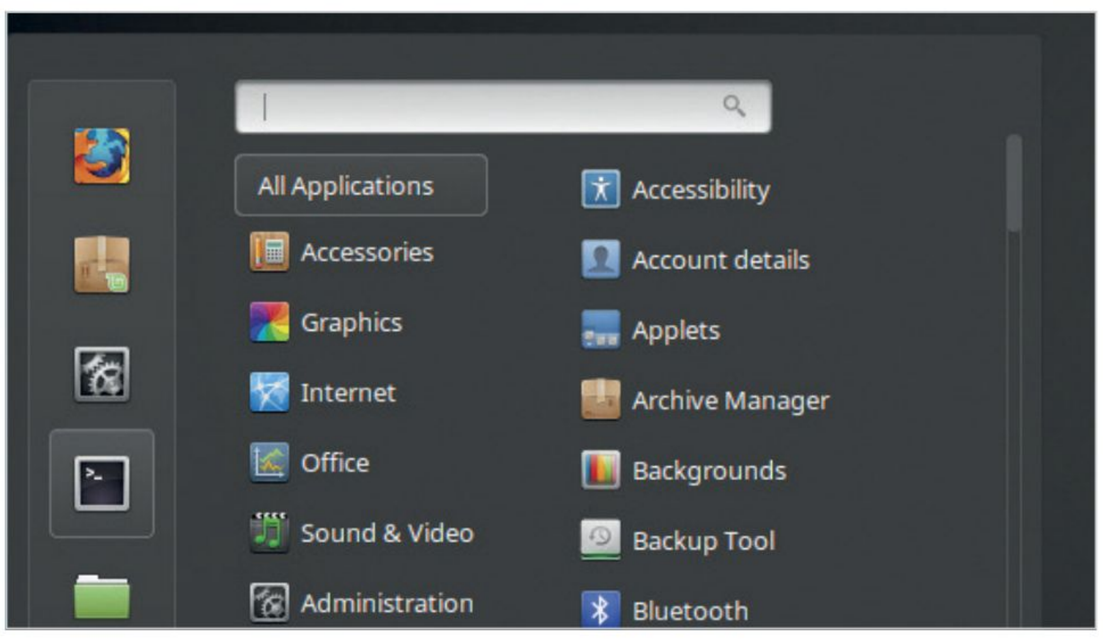
Getting Ready to Code in Linux

Coding in Linux mostly happens in the Terminal or the Command Line. While it can be a scary looking place to begin with, the Terminal is an extremely powerful environment. Before you can start to code, it's best to master the Terminal.

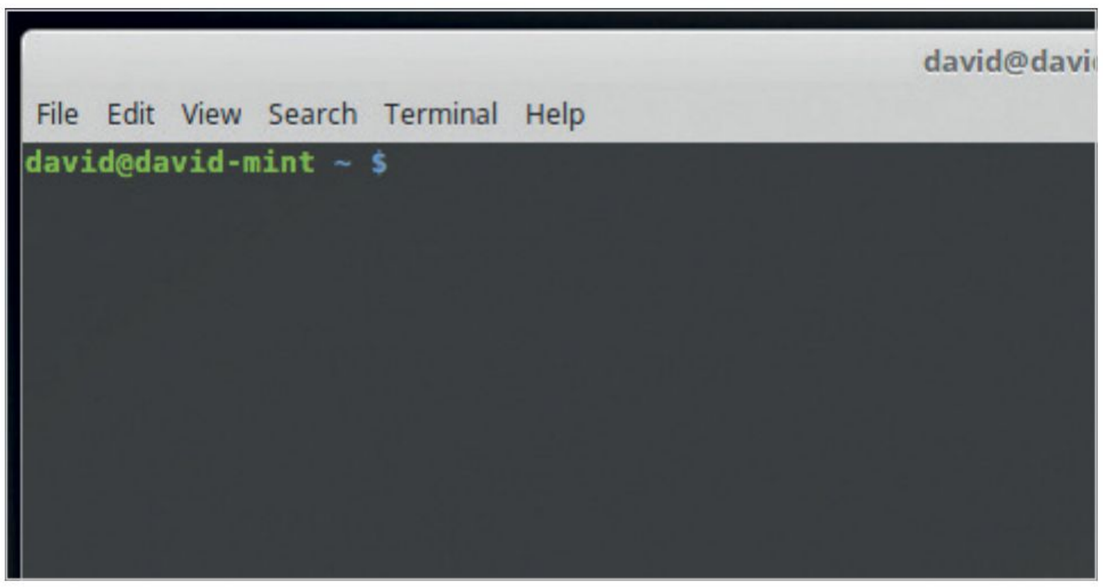
TAKING COMMAND

The command line is at the core of Linux and when you program with it, this is called scripting. These are self-contained programs designed to be run in the Terminal.

STEP 1 The Terminal is where you begin your journey with Linux, through the command line and thus any scripting from. In Linux Mint, it can be accessed by clicking on the Menu followed by the Terminal icon in the panel, or entering 'Terminal' into the search bar.

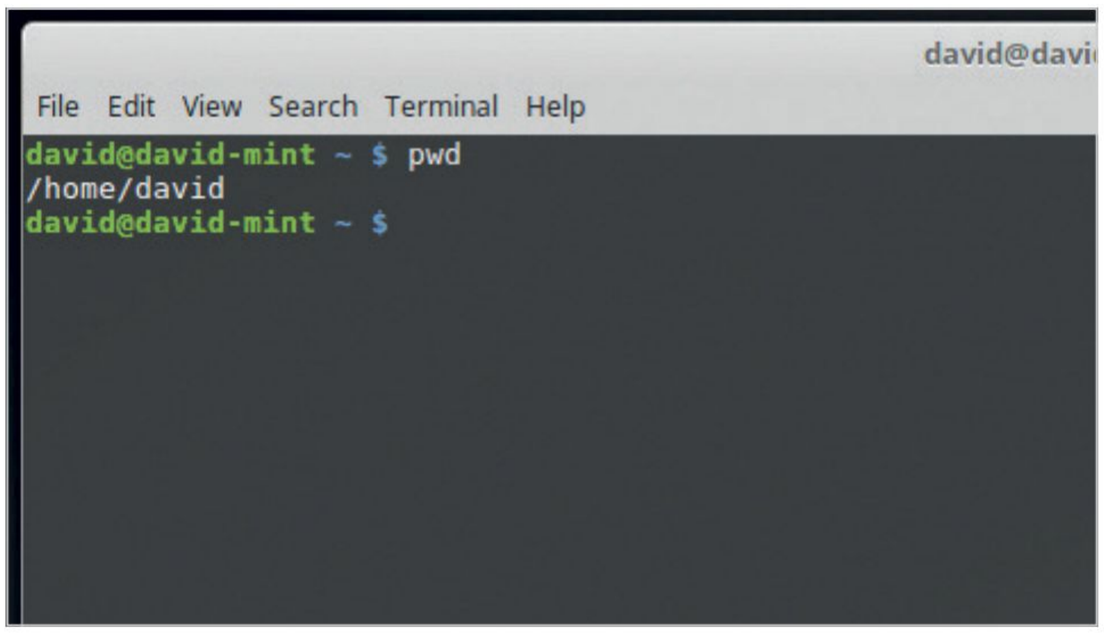


STEP 2 The Terminal will give you access to the Linux Mint Shell, called BASH; this gives you access to the underlying operating system, which is why scripting is such a powerful language to learn and use. Everything in Mint, and Linux as a whole, including the desktop and GUI, is a module running from the command line.



STEP 3 What you currently see in the Terminal is your login name followed by the name of the computer, as you named it when you first installed the OS on to the computer. The line then ends with the current folder name; at first this is just a tilde (~), which means your Home folder.

STEP 4 The flashing cursor at the very end of the line is where your text-based commands will be entered. You can begin to experiment with a simple command, Print Working Directory (pwd), which will output to the screen the current folder you're in. Type: pwd and press Enter.



STEP 5 All the commands you enter will work in the same manner. You enter the command, include any parameters to extend the use of the command and press Enter to execute the command line you've entered. Now type: `uname -a` and press Enter. This will display information regarding Linux Mint. In scripting, you can use all the Linux command-line commands within your own scripts.

```
File  Edit  View  Search  Terminal  Help
david@david-mint ~ $ pwd
/home/david
david@david-mint ~ $ uname -a
Linux david-mint 4.4.0-53-generic #74-Ubuntu SMP
david@david-mint ~ $
```

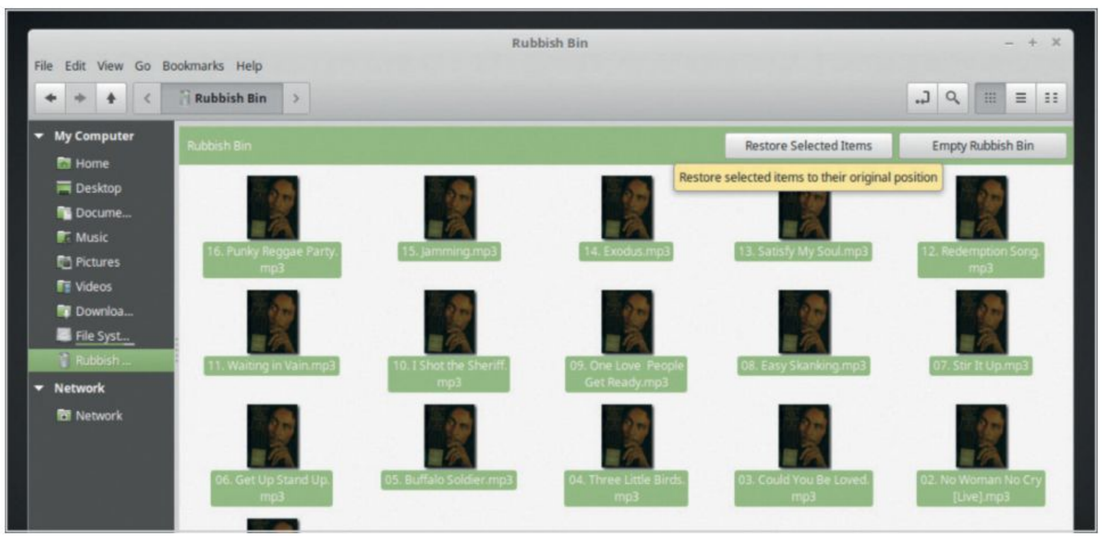
STEP 6 The list of available Linux commands is vast, with some simply returning the current working directory, while others are capable of deleting the entire system in an instant. Getting to know the commands is part of learning how to script. By using the wrong command, you could end up wiping your computer. Type `compgen -c` to view the available commands.

```
david@david-mint ~
File  Edit  View  Search  Terminal  Help
david@david-mint ~ $ compgen -c
alert
cls
egrep
fgrep
grep
l
la
ll
ls
```

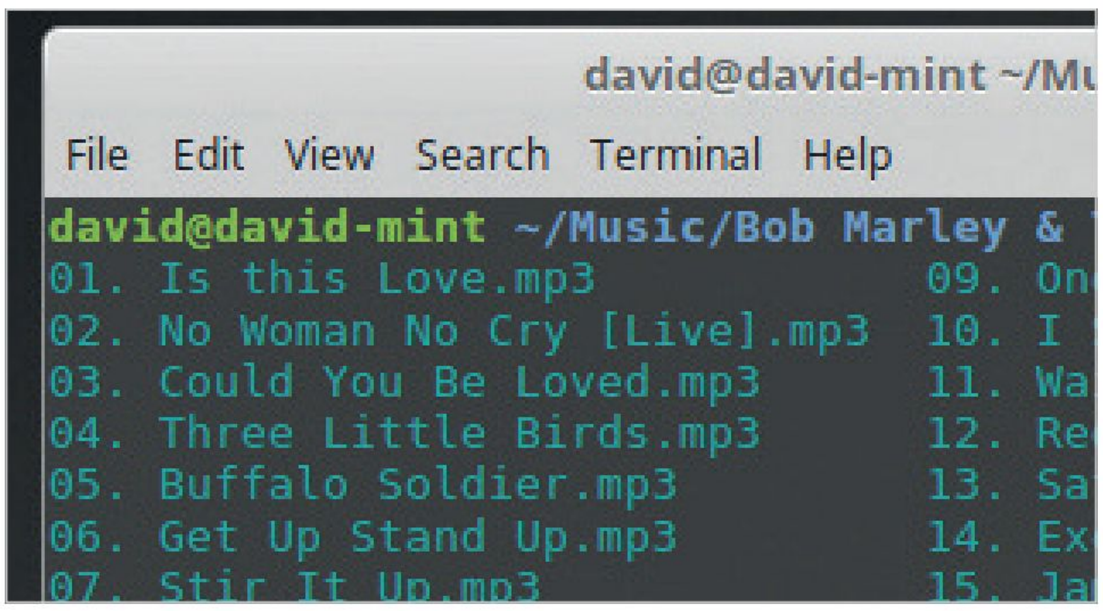
HERE BE DRAGONS!

There's an urban myth on the Internet that an employee at Disney Pixar nearly ruined the animated movie Toy Story by inadvertently entering the wrong Linux command and deleting the entire system the film was stored on.

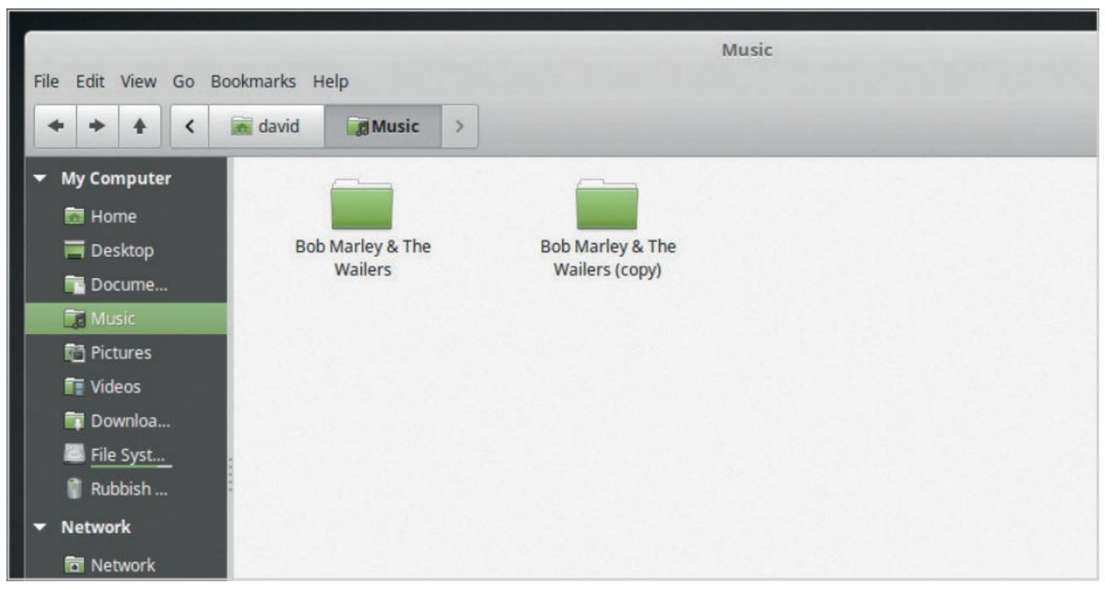
STEP 1 Having access to the Terminal means you're bypassing the GUI desktop method of working with the system. The Terminal is a far more powerful environment than the desktop, which has several safeguards in place in case you accidentally delete all your work, such as Rubbish Bin to recover deleted files.



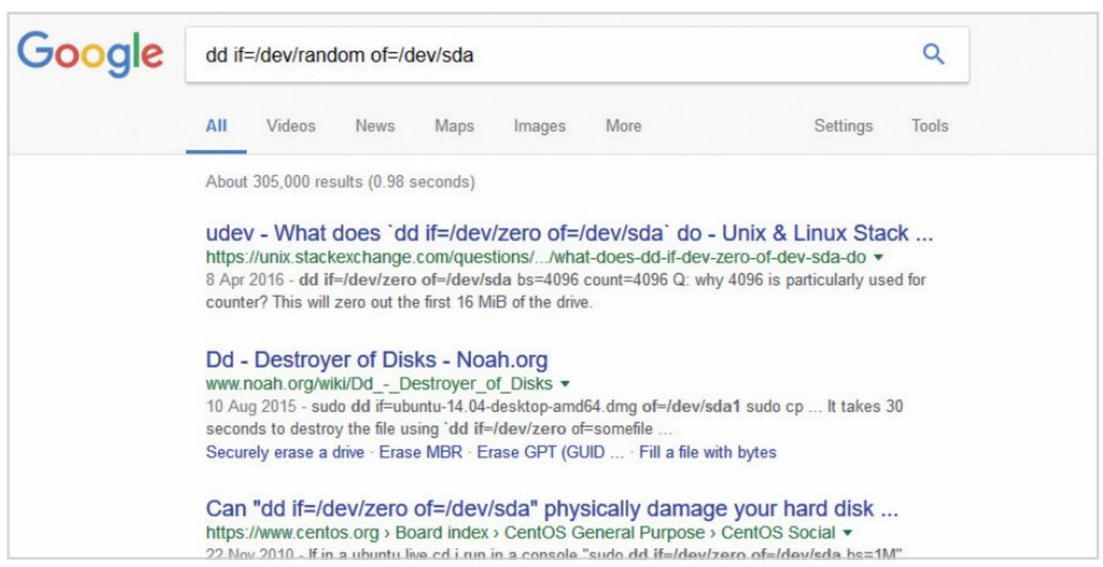
STEP 2 However, the Terminal doesn't offer that luxury. If you were to access a folder with files within via the Terminal and then enter the command: `rm *.*`, all the files in that folder would be instantly deleted. They won't appear in the Rubbish Bin either, they're gone for good.



STEP 3 Therefore it's always a good idea to work in the Terminal using a two-pronged approach. First, use the desktop to make regular backups of the folders you're working in when in the Terminal. This way, should anything go wrong, there's a quick and handy backup waiting for you.



STEP 4 Second, research before blindly entering a command you've seen on the Internet. If you see the command: `sudo dd if=/dev/random of=/dev/sda` and use it in a script, you'll soon come to regret the action as the command will wipe the entire hard drive and fill it with random data. Take a moment to Google the command and see what it does.



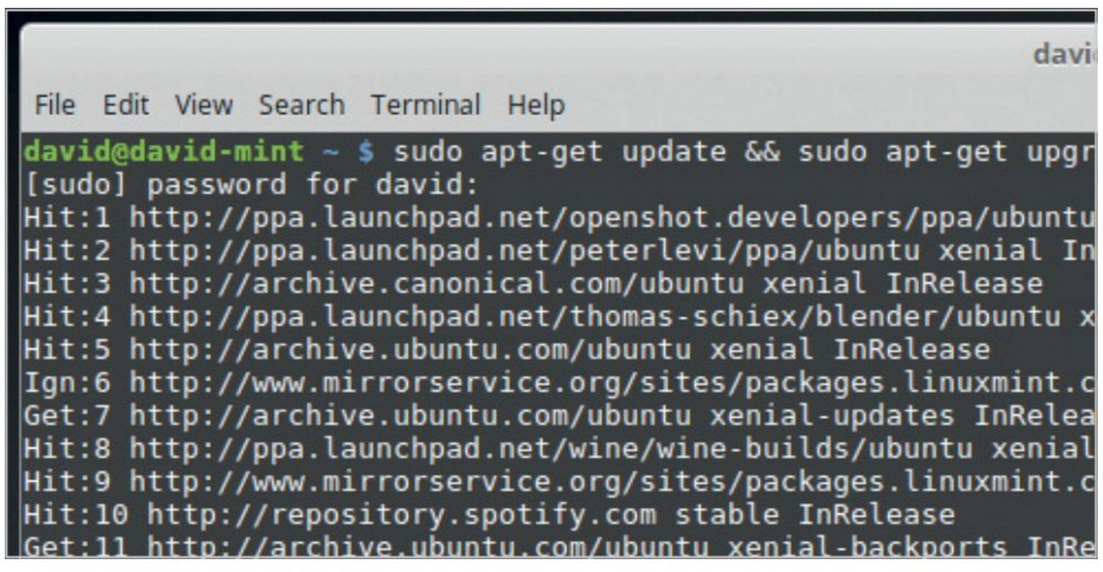
Creating Bash Scripts – Part 1

Eventually, as you advance with Linux Mint, you'll want to start creating your own automated tasks and programs. These are essentially scripts, Bash Shell scripts to be exact, and they work in the same way as a DOS Batch file does, or any other programming language.

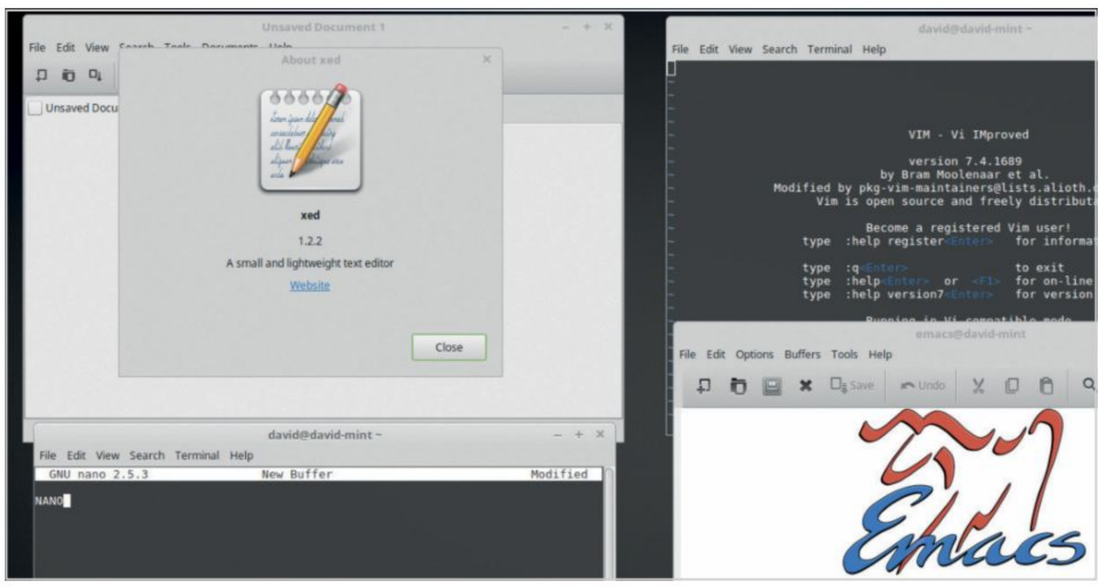
GET SCRIPTING

A Bash script is simply a series of commands that Mint will run through to complete a certain task. They can be simple or remarkably complex, it all depends on the situation.

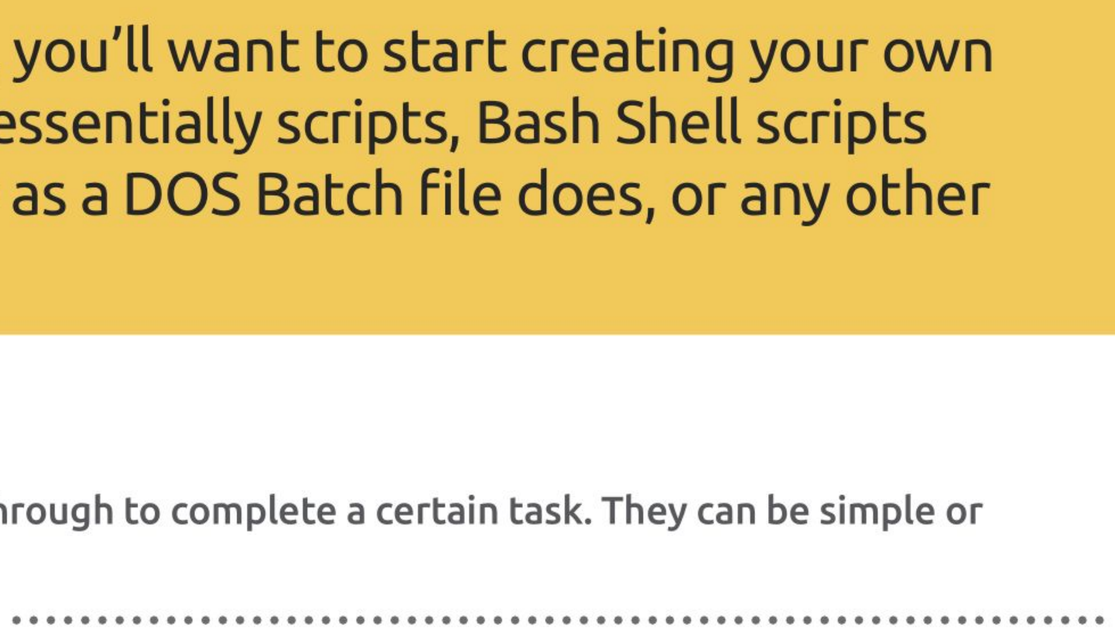
STEP 1 You'll be working within the Terminal and with a text editor throughout the coming pages. There are alternatives to the text editor, which we'll look at in a moment but for the sake of ease, we'll be doing our examples in Xed. Before you begin, however, run through the customary update check: `sudo apt-get update && sudo apt-get upgrade`.



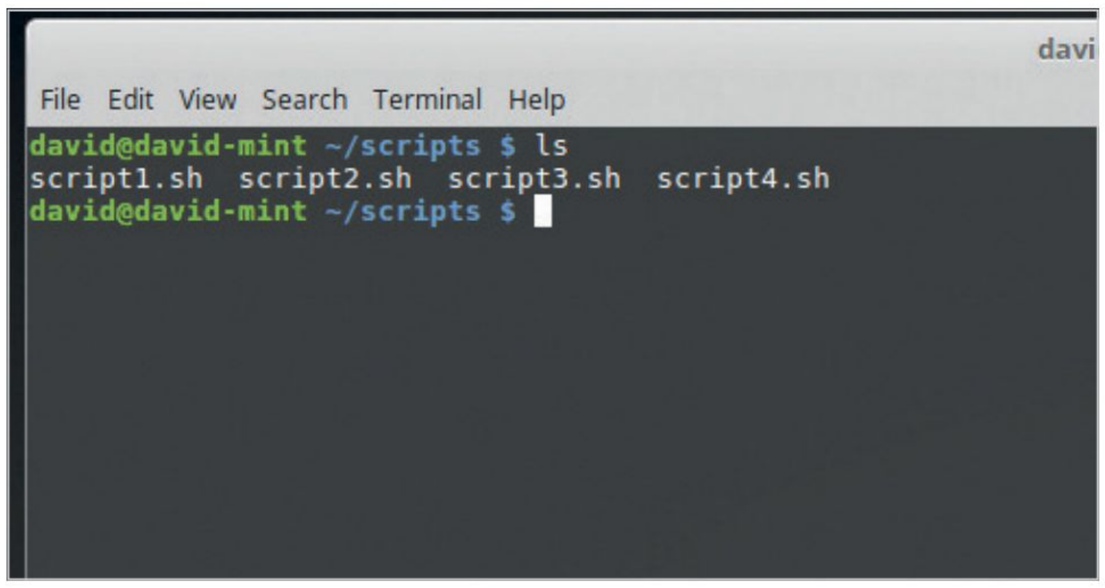
STEP 2 There are several text editors we can use to create a Bash script: Xed, Vi, Nano, Vim, GNU Emacs and so on. In the end it all comes down to personal preference. Our use of Xed is purely due to making it easier to read the script in the screenshots you see below.



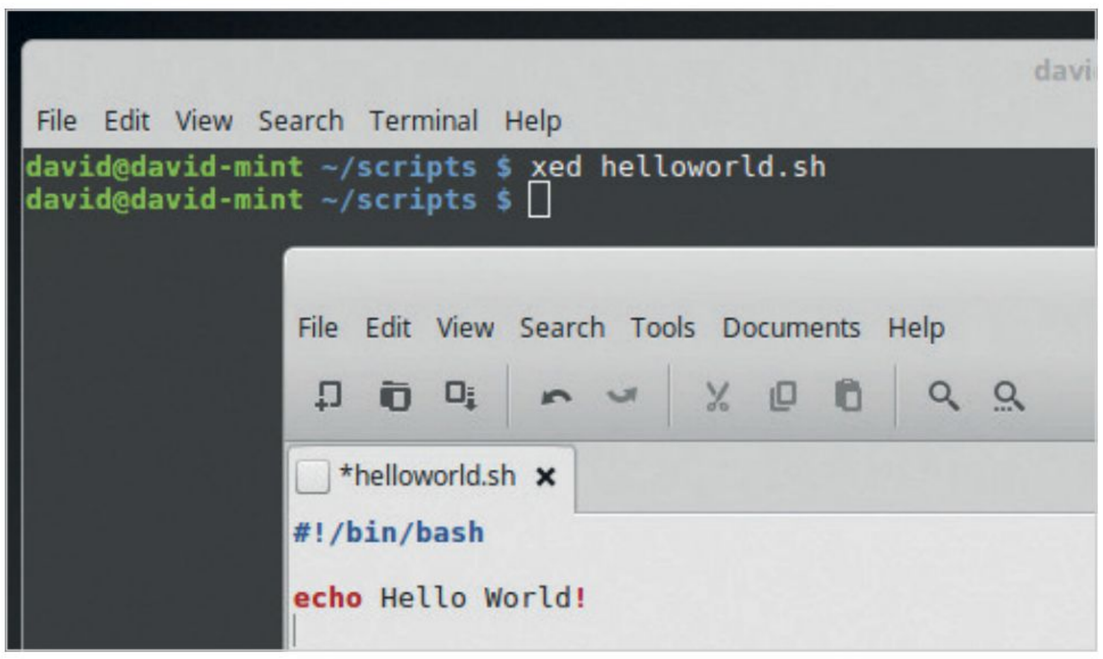
STEP 3 To begin with, and before you start to write any scripts, you need to create a folder where you can put all our scripts into. Start with `mkdir scripts`, and enter the folder `cd scripts/`. This will be our working folder and from here you can create sub-folders if you want of each script you create.



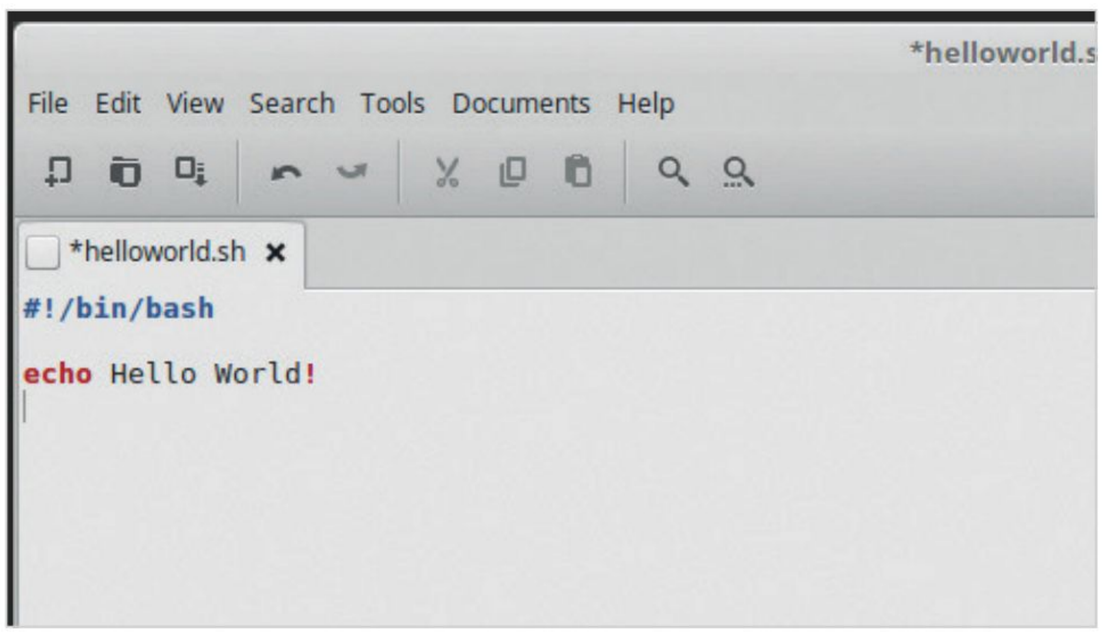
STEP 4 Windows users will be aware that in order for a batch file to work, as in be executed and follow the programming within it, it needs to have a .BAT file extension. Linux is an extension-less operating system but the convention is to give scripts a .sh extension.



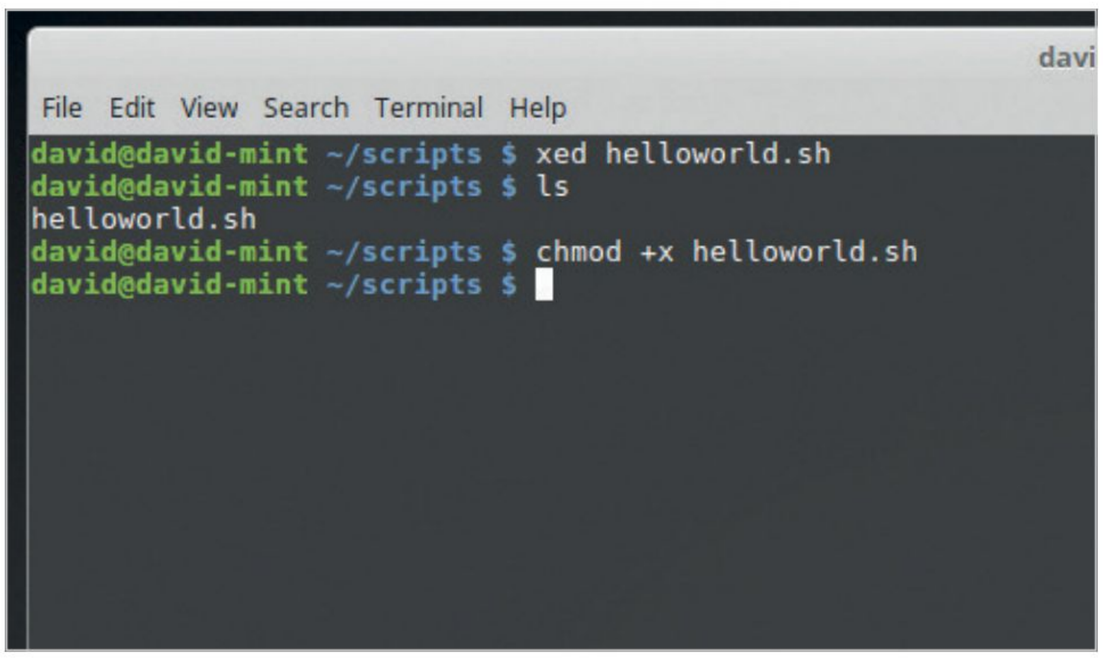
STEP 5 Let's start with a simple script to output something to the Terminal. Enter `xed helloworld.sh`. This will launch Xed and create a file called helloworld.sh. In Xed, enter the following: `#!/bin/bash`, then on a new line: `echo Hello World!`.



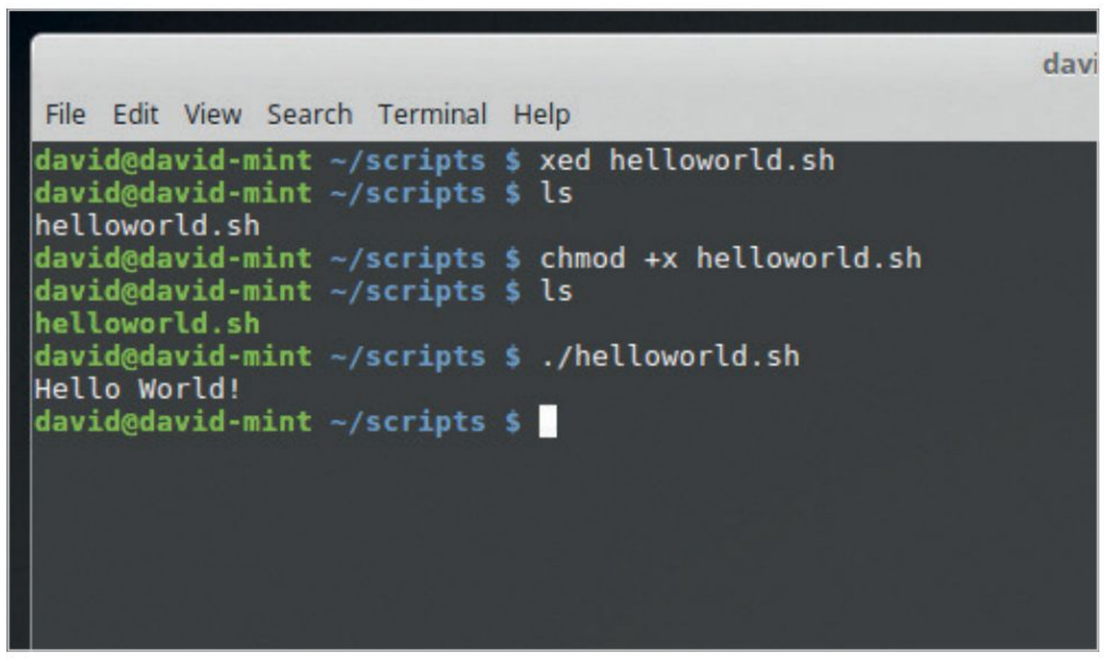
STEP 6 The `#!/bin/bash` line tells the system what Shell you're going to be using, in this case Bash. The hash (#) denotes a comment line, one that is ignored by the system, the exclamation mark (!) means that the comment is bypassed and will force the script to execute the line as a command. This is also known as a Hash-Bang.



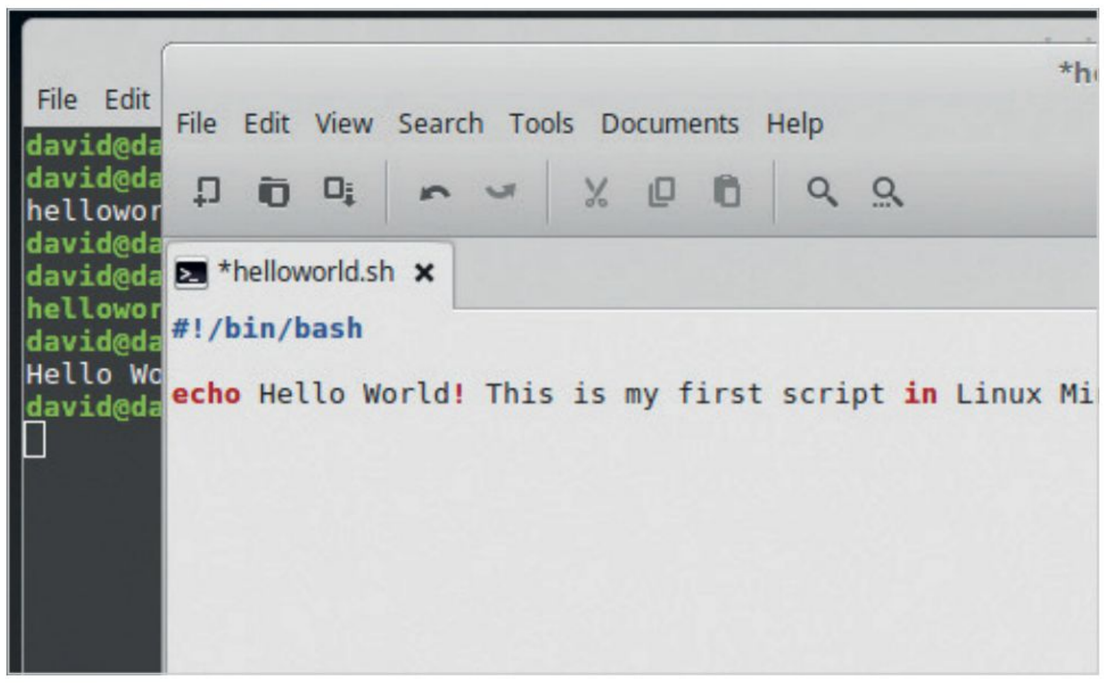
STEP 7 You can save this file, clicking File > Save, and exit back to the Terminal. Entering `ls`, will reveal the script in the folder. To make any script executable, and able to run, you need to modify its permissions. Do this with `chmod +x helloworld.sh`. You need to do this with every script you create.



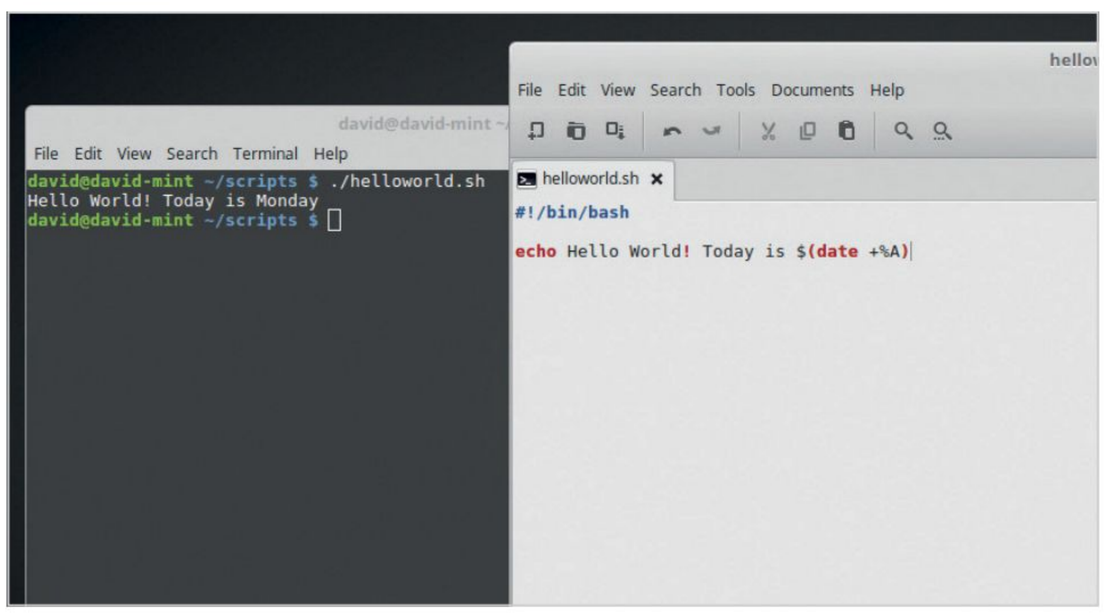
STEP 8 When you enter `ls` again, you can see that the helloworld.sh script has now turned from being white to green, meaning that it's now an executable file. To run the script, in other words make it do the things you've typed into it, enter: `./helloworld.sh`.



STEP 9 Although it's not terribly exciting, the words 'Hello World!' should now be displayed in the Terminal. The echo command is responsible for outputting the words after it in the Terminal, as we move on you can make the echo command output to other sources.



STEP 10 Think of echo as the old BASIC Print command. It displays either text, numbers or any variables that are stored in the system, such as the current system date. Try this example: `echo Hello World! Today is $(date +%A)`. The $(date +%A) is calling the system variable that stores the current day of the week.



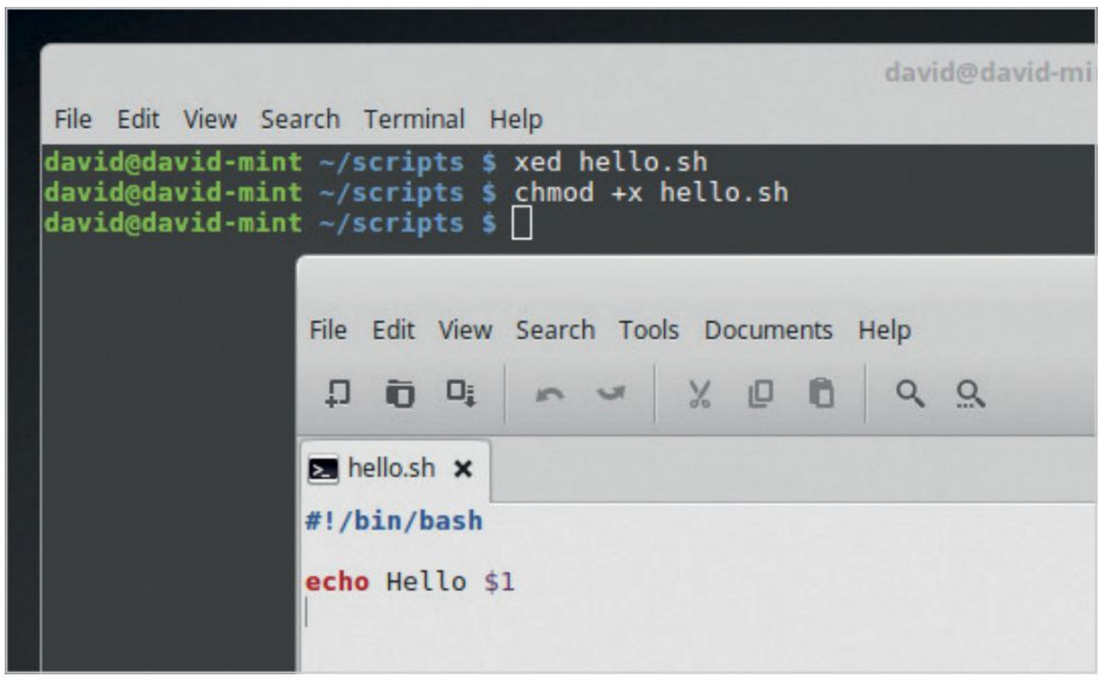
Creating Bash Scripts – Part 2

Previously we looked at creating your first Bash script, Hello World, and adding a system variable. Now you can expand these and see what you can do when you start to play around with creating your own unique variables.

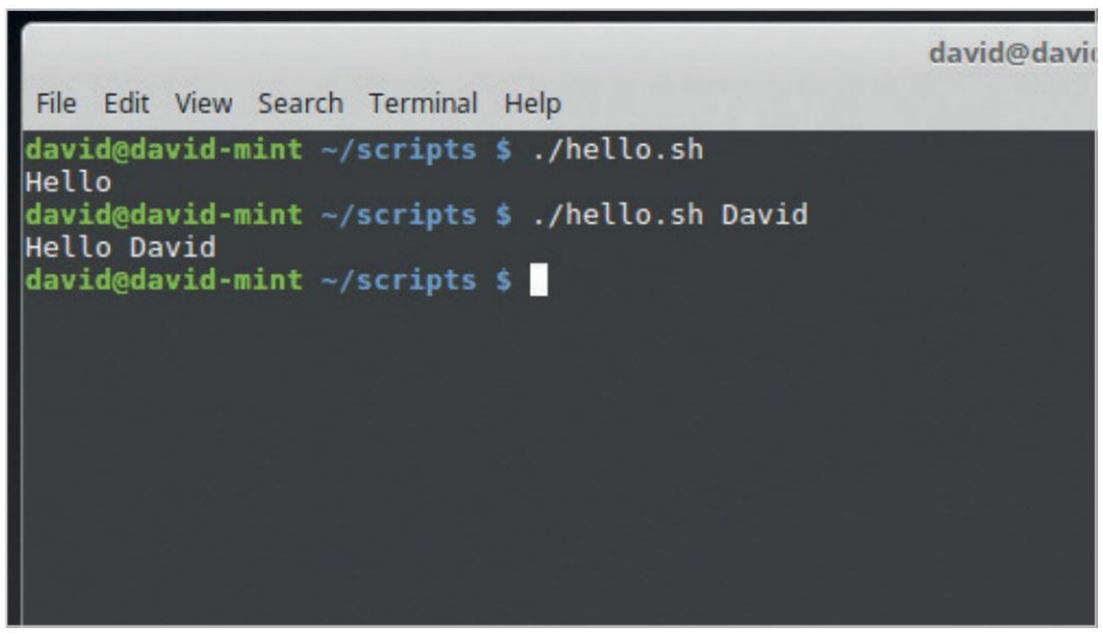
VARIABLES

Just as in every other programming language a Bash script can store and call certain variables from the system, either generic or user created.

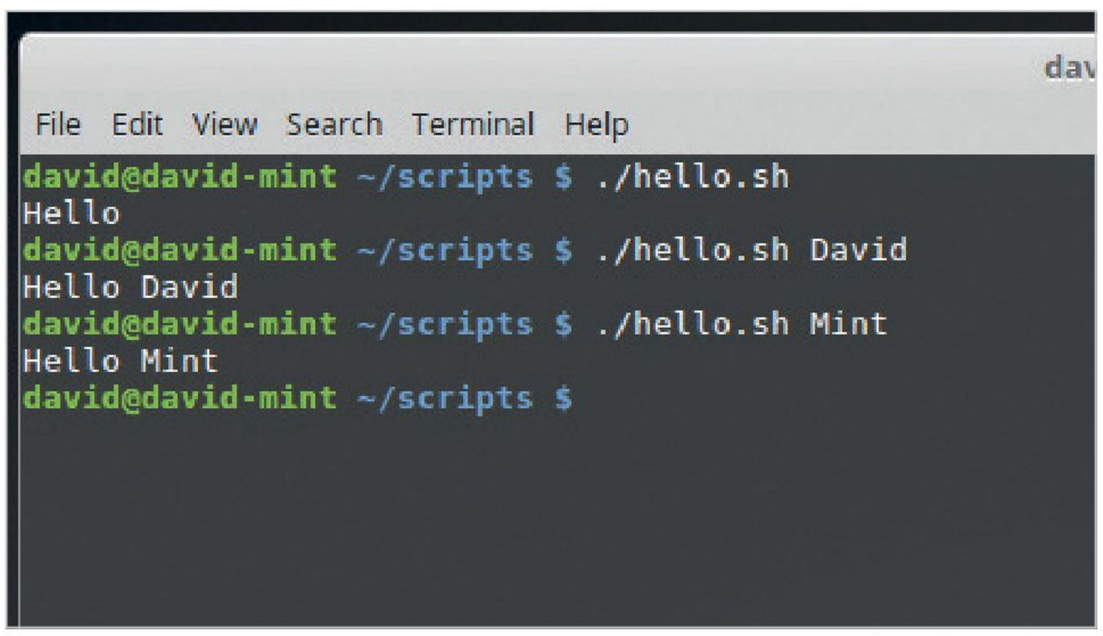
STEP 1 Let's start by creating a new script called hello.sh; `xed hello.sh`. In it enter: `#!/bin/bash`, then, echo `Hello $1`. Save the file and exit Xed. Back in the Terminal make the script executable with: `chmod +x hello.sh`.



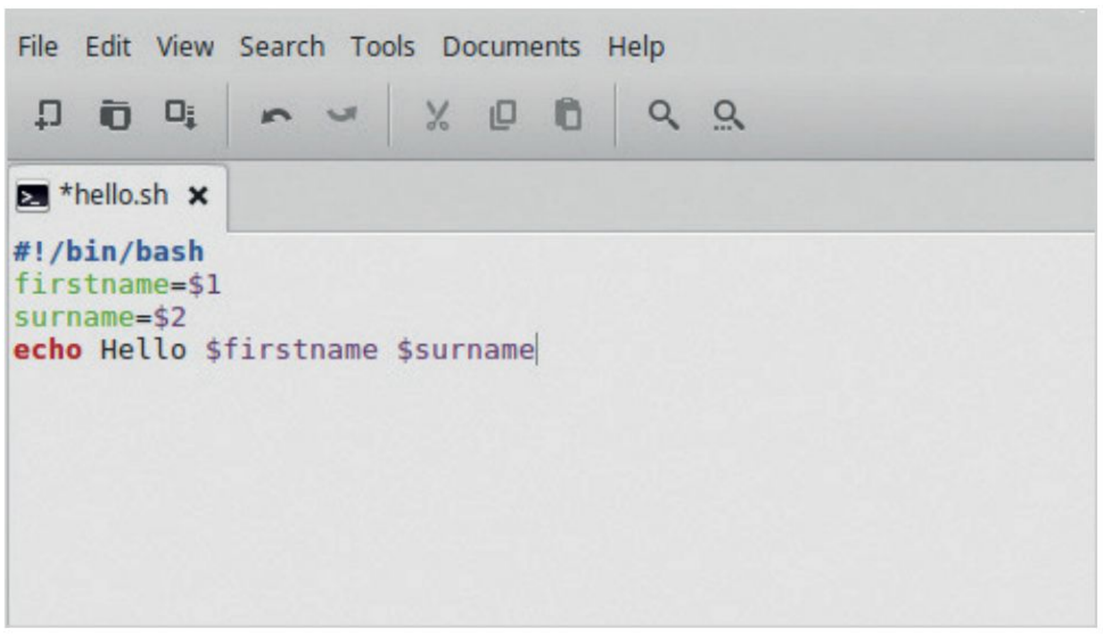
STEP 2 As the script is now executable, run it with `./hello.sh`. Now, as you probably expected a simple 'Hello' is displayed in the Terminal. However, if you then issue the command with a variable, it begins to get interesting. For example, try `./hello.sh David`.



STEP 3 The output now will be Hello David. This is because Bash automatically assigns variables for the user, which are then held and passed to the script. So the variable '$1' now holds 'David'. You can change the variable by entering something different: `./hello.sh Mint`.



STEP 4 You can even rename variables. Modify the hello.sh script with the following: `firstname=$1, surname=$2, echo Hello $firstname $surname`. Putting each statement on a new line. Save the script and exit back into the Terminal.



STEP 5 When you run the script now you can use two custom variables: `./hello.sh David Hayward`. Naturally change the two variables with your own name; unless you're also called David Hayward. At the moment we're just printing the contents, so let's expand the two-variable use a little.

```
File  Edit  View  Search  Terminal  Help
david@david-mint ~/scripts $ ./hello.sh David Hayward
Hello David Hayward
david@david-mint ~/scripts $ ./hello.sh Linux Mint
Hello Linux Mint
david@david-mint ~/scripts $
```

STEP 6 Create a new script called `addition.sh`, using the same format as the hello.sh script, but changing the variable names. Here we've added `firstnumber` and `secondnumber`, and used the echo command to output some simple arithmetic by placing an integer expression, `echo The sum is $(($firstnumber+$secondnumber))`. Save the script, and make it executable `(chmod +x addition.sh)`.

addition.sh

File Edit View Search Tools Documents Help

addition.sh

```
#!/bin/bash
firstnumber=$1
secondnumber=$2
echo The sum is $(($firstnumber+$secondnumber))
```

STEP 7 When you now run the addition.sh script we can enter two numbers: `./addition.sh 1 2`. The result will hopefully be 3, with the Terminal displaying 'The sum is 3'. Try it with a few different numbers and see what happens. See also if you can alter the script and rename it do multiplication, and subtraction.

```
File  Edit  View  Search  Terminal  Help
david@david-mint ~/scripts $ ./addition.sh 1 2
The sum is 3
david@david-mint ~/scripts $ ./addition.sh 34 45
The sum is 79
david@david-mint ~/scripts $ ./addition.sh 65756 1456
The sum is 67212
david@david-mint ~/scripts $ ./multiplication.sh 2 8
The sum is 16
david@david-mint ~/scripts $
```

STEP 8 Let's expand things further. Create a new script called `greetings.sh`. Enter the scripting as below in the screenshot, save it and make it executable with the `chmod` command. You can see that there are a few new additions to the script now.

greetings.sh

File Edit View Search Tools Documents Help

greetings.sh

```
#!/bin/bash

echo -n "Hello, what is your name? "
read firstname
echo -n "Thank you, and what is your surname? "
read surname
clear
echo Hello $firstname $surname, how are you today?
```

STEP 9 We've added a `–n` to the echo command here which will leave the cursor on the same line as the question, instead of a new line. The `read` command stores the users' input as the variables firstname and surname, to then read back later in the last `echo` line. And the `clear` command clears the screen.

```
File  Edit  View  Search  Terminal  Help
Hello David Hayward, how are you today?
david@david-mint ~/scripts $
```

STEP 10 As a final addition, let's include the date variable we used in the last section. Amend the last line of the script to read: `echo Hello $firstname $surname, how are you on this fine $(date +%A)?`. The output should display the current day of the week, calling it from a system variable.

greetings.sh

File Edit View Search Tools Documents Help

greetings.sh

```
#!/bin/bash

echo -n "Hello, what is your name? "
read firstname
echo -n "Thank you, and what is your surname? "
read surname
clear
echo Hello $firstname $surname, how are you on this fine $(dat
```

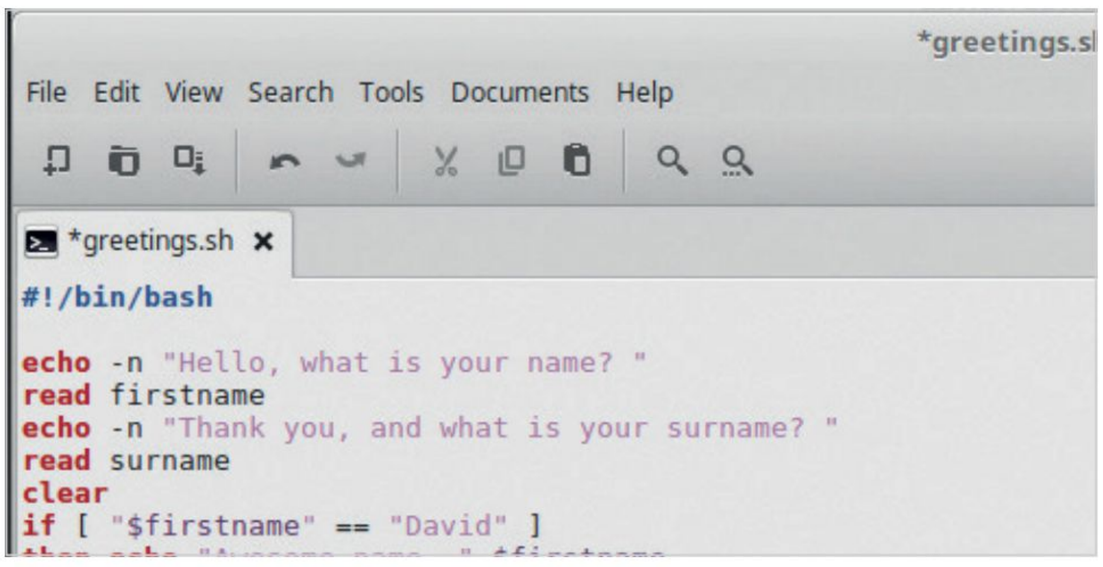
Creating Bash Scripts – Part 3

In the previous pages we looked at some very basic Bash scripting, which involved outputting text to the screen, getting a user's input, storing it and outputting that to the screen; as well as including a system variable using the Date command. Now let's combine what you've achieved so far and introduce Loops.

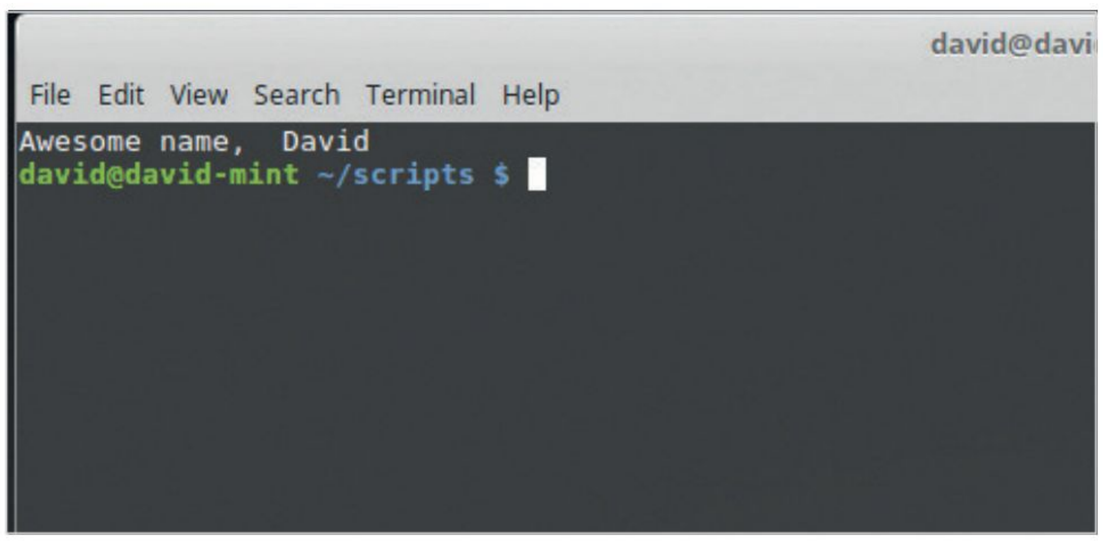
IF, THEN, ELSE

With most programming structures there will come a time where you need to loop through the commands you've entered to create better functionality, and ultimately a better program.

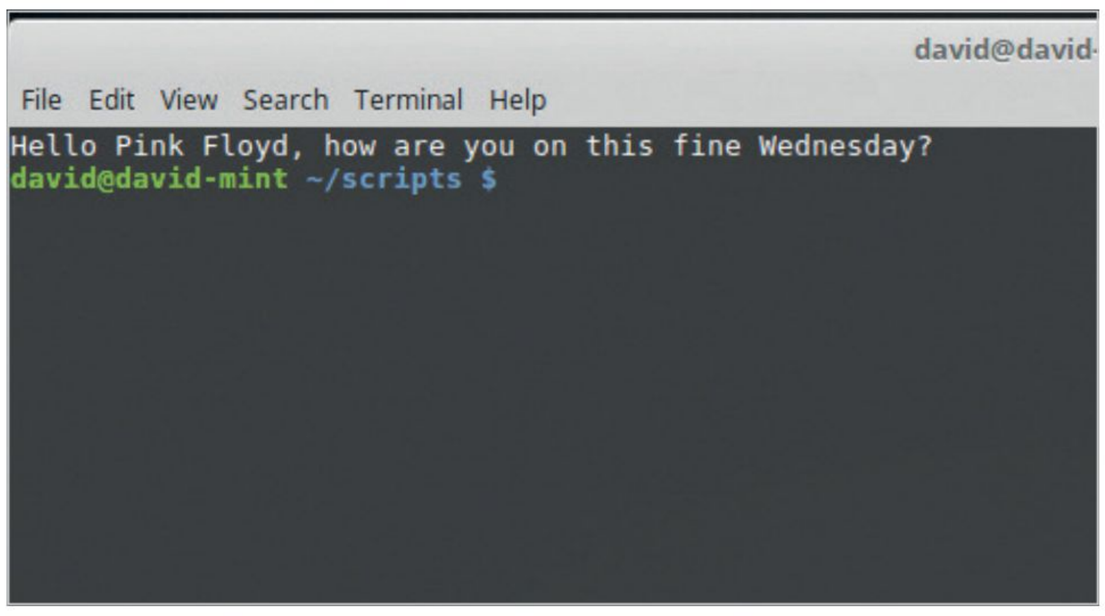
STEP 1 Let's look at the If, Then and Else statements now, which when executed correctly, compare a set of instructions and simply work out that IF something is present, THEN do something, ELSE do something different. Create a new script called `greeting2.sh` and enter the text in the screenshot below into it.



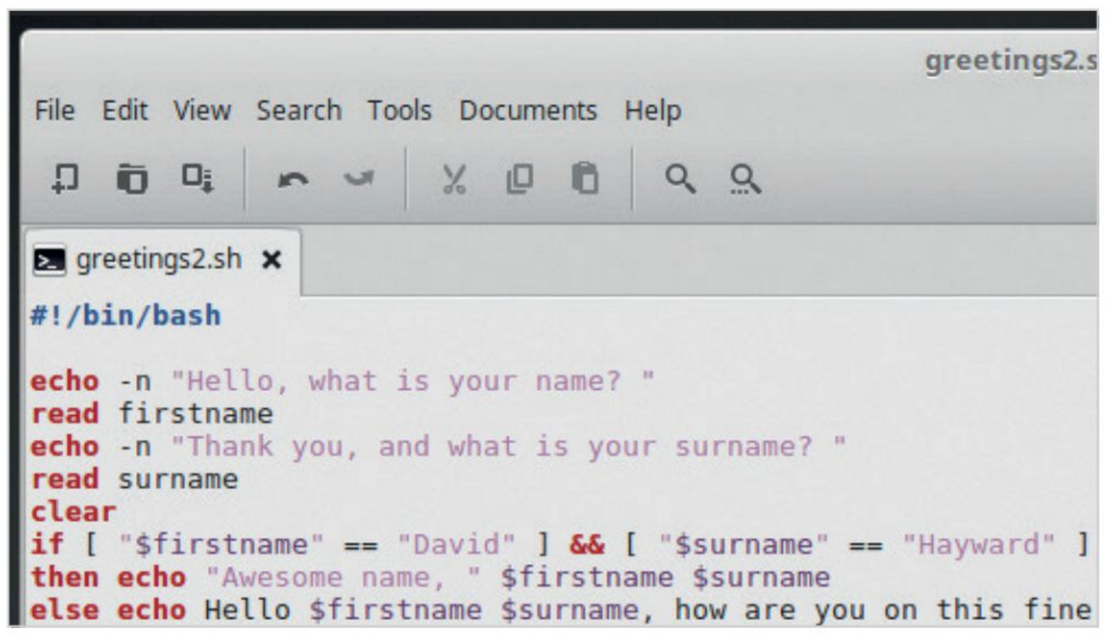
STEP 2 Greeting2.sh is a copy of greeting.sh but with a slight difference. Here we've added a loop starting at the if statement. This means, IF the variable entered is equal to David the next line, THEN, is the reaction to what happens, in this case it will output to the screen 'Awesome name,' followed by the variable (which is David).



STEP 3 The next line, ELSE, is what happens if the variable doesn't equal 'David'. In this case it simply outputs to the screen the now familiar 'Hello…'. The last line, the FI statement, is the command that will end the loop. If you have an If command without a Fi command, then you get an error.



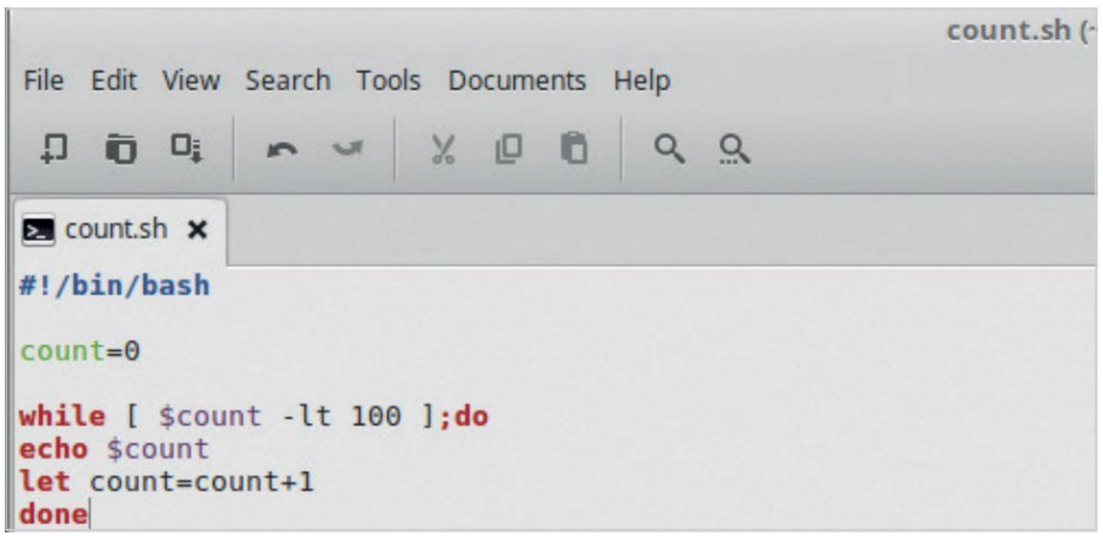
STEP 4 You can obviously play around with the script a little, changing the name variable that triggers a response; or maybe even issuing a response where the first name and surname variables match a specific variable.



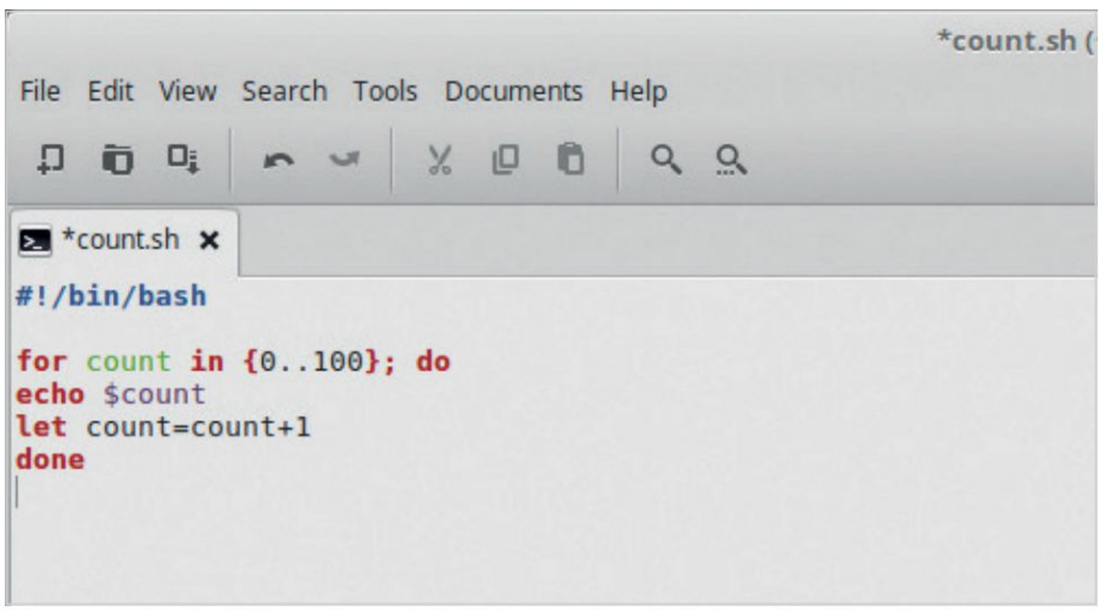
MORE LOOPING

You can loop over data using the FOR, WHILE and UNTIL statements. These can be handy if you're batch naming, copying or running a script where a counter is needed.

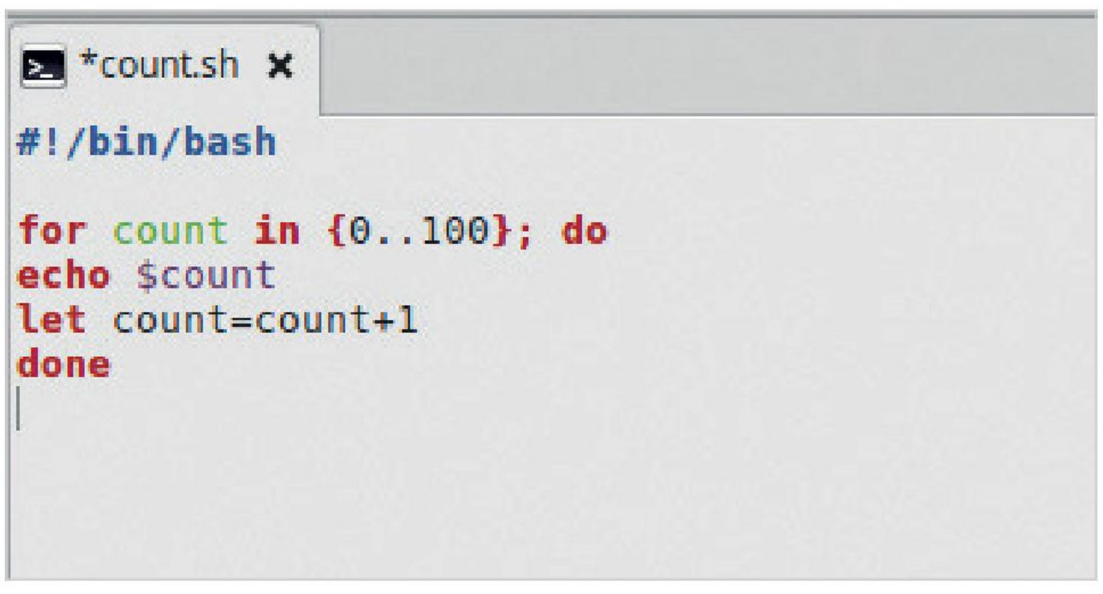
STEP 1 Create a new script called `count.sh`. Enter the text in the screenshot below, save it and make it executable. This creates the variable 'count' which at the beginning of the script equals zero. Then start the WHILE loop, which WHILE count is less than (the LT part) 100 will print the current value of count in the echo command.



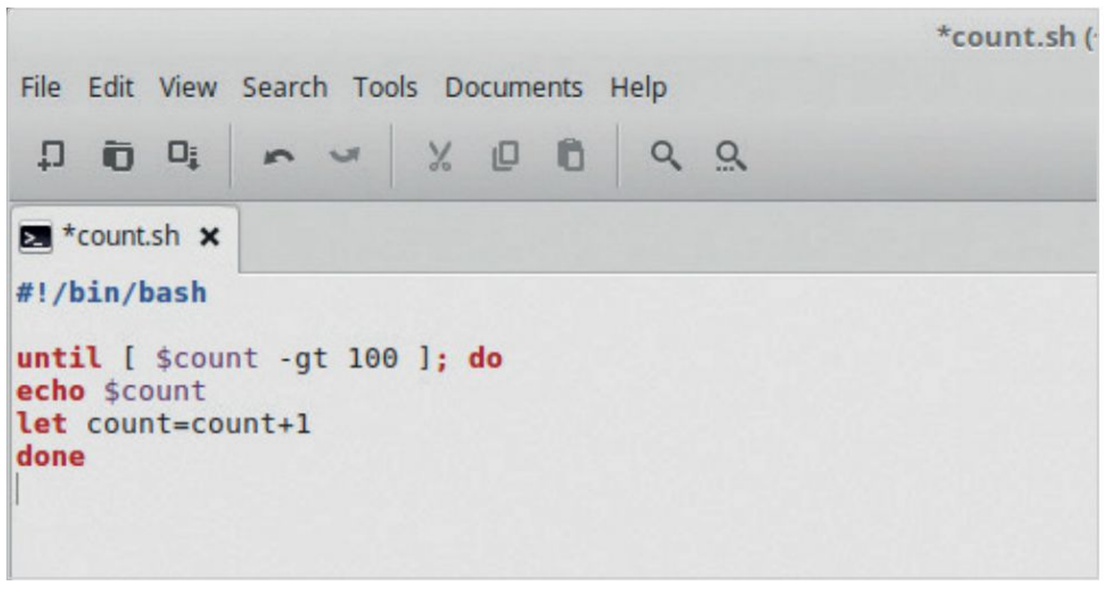
STEP 2 Executing the count.sh script will result in the numbers 0 to 99 listing down the Terminal screen; when it reaches 100 the script will end. Modifying the script with the FOR statement, makes it work in much the same way. To use it in our script, enter the text from the screenshot into the count.sh script.



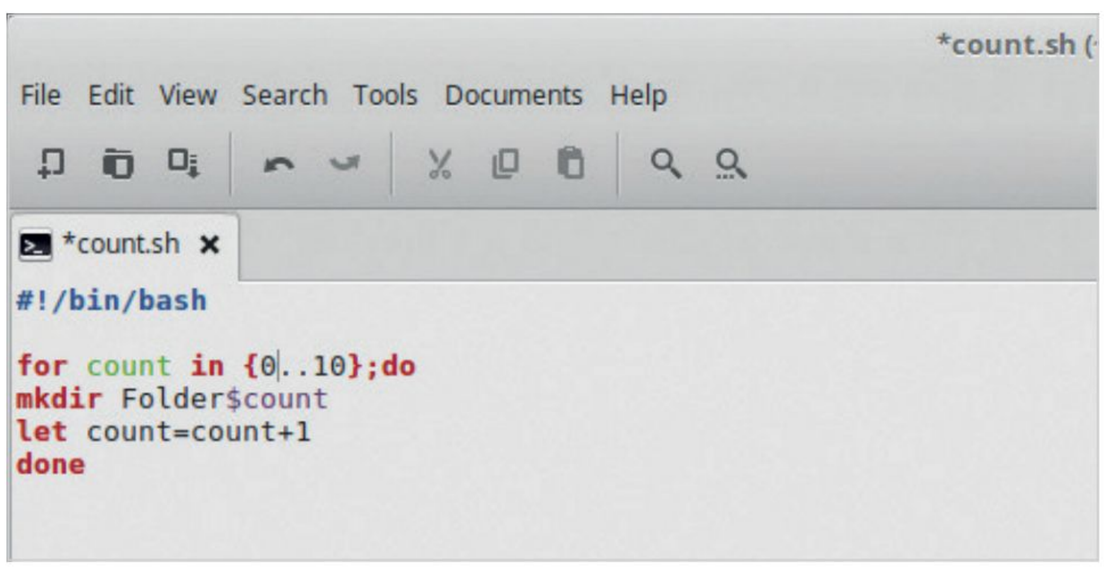
STEP 3 The addition we have here is: `for count in {0..100}; do`. Which means: FOR the variable 'count' IN the numbers from zero to one hundred, then start the loop. The rest of the script is the same. Run this script, and the same output should appear in the Terminal.



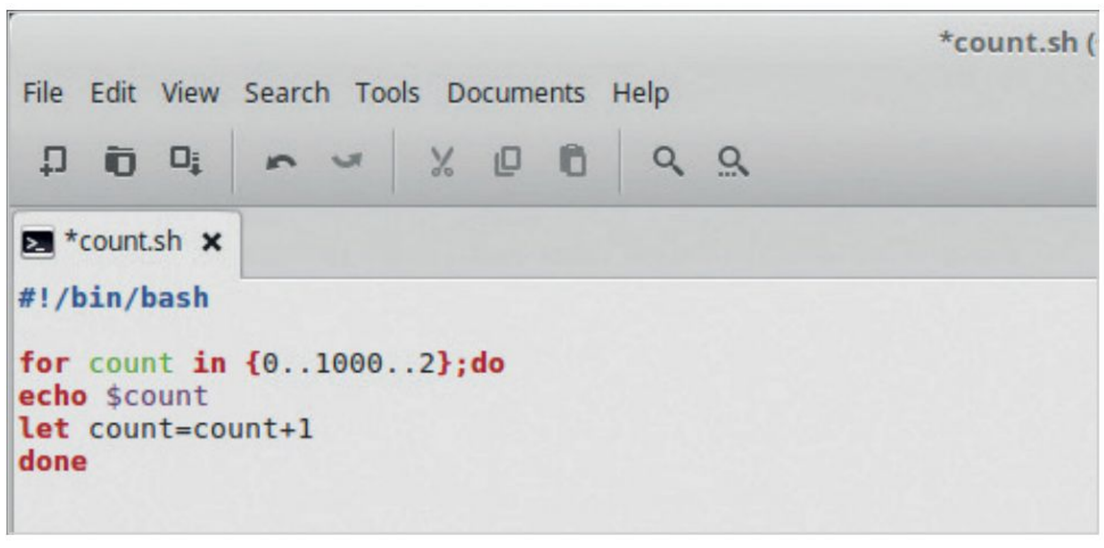
STEP 4 The UNTIL loop works much the same way as the WHILE loop only, more often than not, in reverse. So our counting to a hundred, using `UNTIL, would be: until [ $count -gt 100 ]; do`. The difference being, UNTIL count is greater than (the gt part) one hundred, keep on looping.



STEP 5 You're not limited to numbers zero to one hundred. You can, within the loop, have whatever set of commands you like and execute them as many times as you want the loop to run for. Renaming a million files, creating fifty folders etc. For example, this script will create ten folders named folder1 through to folder10 using the FOR loop.



STEP 6 Using the FOR statement once more, we can execute the counting sequence by manipulating the {0..100} part. This section of the code actually means {START..END..INCREMENT}, if there's no increment then it's just a single digit up to the END. For example, we could get the loops to count up to 1000 in two's with: `for count in {0..1000..2}; do`.



Creating Bash Scripts – Part 4

You've encountered user interaction with your scripts, asking what the user's name is and so on. You've also looked at creating loops within the script to either count or simply do something several times. Let's combine and expand some more.

CHOICES AND LOOPS

Let's bring in another command, CHOICE, along with some nested IF and ELSE statements. Start by creating a new script called `mychoice.sh`.

STEP 1

The mychoice.sh script is beginning to look a lot more complex. What we have here is a list of four choices, with three possible options. The options: Mint, Is, and Awesome will be displayed if the user presses the correct option key. If not, then the menu will reappear, the fourth choice.

```
mycho
File  Edit  View  Search  Tools  Documents  Help
mychoice.sh
#!/bin/bash

choice=4

echo "1. Mint"
echo "2. Is"
echo "3. Awesome"
echo -n "Please choose an option (1, 2 or 3) "

while [ $choice -eq 4 ]; do

read choice

if [ $choice -eq 1 ] ; then
    echo "You have chosen: Mint"
else
    if [ $choice -eq 2 ] ; then
        echo "You have chosen: Is"
    else
        if [ $choice -eq 3 ] ; then
            echo "You have chosen: Awesome"
        else
            echo "Please make a choice between 1 to 3"
            echo "1. Mint"
            echo "2. Is"
            echo "3. Awesome"
            echo -n "Please choose an option (1, 2 or 3)
            choice=4
        fi
    fi
fi
done
```

STEP 2

If you follow the script through you soon get the hang of what's going on, based on what we've already covered. WHILE, IF, and ELSE, with the FI closing loop statement will run through the options and bring you back to the start if you pick the wrong option.

```
david@david-mint ~/scripts
File  Edit  View  Search  Terminal  Help
david@david-mint ~/scripts $ ./mychoice.sh
1. Mint
2. Is
3. Awesome
Please choose an option (1, 2 or 3) 1
You have chosen: Mint
david@david-mint ~/scripts $ ./mychoice.sh
1. Mint
2. Is
3. Awesome
Please choose an option (1, 2 or 3) 2
You have chosen: Is
david@david-mint ~/scripts $ ./mychoice.sh
1. Mint
2. Is
3. Awesome
Please choose an option (1, 2 or 3) 3
You have chosen: Awesome
david@david-mint ~/scripts $ ./mychoice.sh
1. Mint
2. Is
3. Awesome
```

STEP 3

You can, of course, increase the number of choices but you need to make sure that you match the number of choices to the number of IF statements. The script can quickly become a very busy screen to look at. This lengthy script is another way of displaying a menu, this time with a fancy colour scheme too.

```
#/bin/bash

     E='echo -e';e='echo -en';trap "R;exit" 2
   ESC=$( $e "\e")
  TPUT(){ $e "\e[${1};${2}H";}
 CLEAR(){ $e "\ec";}
 CIVIS(){ $e "\e[?25l";}
  DRAW(){ $e "\e%@\e(0";}
 WRITE(){ $e "\e(B";}
  MARK(){ $e "\e[7m";}
UNMARK(){ $e "\e[27m";}
     R(){ CLEAR ;stty sane;$e "\ec\e[37;44m\e[J";};
  HEAD(){ DRAW
          for each in $(seq 1 13);do
          $E "   x                                          x"
          done
          WRITE;MARK;TPUT 1 5
          $E "BASH SELECTION MENU                          ";UNMARK;}
  FOOT(){ MARK;TPUT 13 5
          printf "ENTER - SELECT,NEXT                       ";UNMARK;}
 ARROW(){ read -s -n3 key 2>/dev/null >&2
          if [[ $key = $ESC[A ]];then echo up;fi
          if [[ $key = $ESC[B ]];then echo dn;fi;}
    M0(){ TPUT  4 20; $e "Login info";}
    M1(){ TPUT  5 20; $e "Network";}
    M2(){ TPUT  6 20; $e "Disk";}
    M3(){ TPUT  7 20; $e "Routing";}
    M4(){ TPUT  8 20; $e "Time";}
    M5(){ TPUT  9 20; $e "ABOUT   ";}
    M6(){ TPUT 10 20; $e "EXIT    ";}
     LM=6
  MENU(){ for each in $(seq 0 $LM);do M${each};done;}
   POS(){ if [[ $cur == up ]];then ((i--));fi
          if [[ $cur == dn ]];then ((i++));fi
          if [[ $i -lt 0   ]];then i=$LM;fi
          if [[ $i -gt $LM ]];then i=0;fi;}
REFRESH(){ after=$((i+1)); before=$((i-1))
          if [[ $before -lt 0  ]];then before=$LM;fi
          if [[ $after -gt $LM ]];then after=0;fi
          if [[ $j -lt $i      ]];then UNMARK;M$before;else UNMARK;M$after;fi
          if [[ $after -eq 0 ]] || [ $before -eq $LM ];then
          UNMARK; M$before; M$after;fi;j=$i;UNMARK;M$before;M$after;}
  INIT(){ R;HEAD;FOOT;MENU;}
    SC(){ REFRESH;MARK;$S;$b;cur=`ARROW`;}
    ES(){ MARK;$e "ENTER = main menu ";$b;read;INIT;};INIT
while [[ "$O" != " " ]]; do case $i in
      0) S=M0;SC;if [[ $cur == "" ]];then R;$e "\n$(w         )\n";ES;fi;;
      1) S=M1;SC;if [[ $cur == "" ]];then R;$e "\n$(ifconfig )\n";ES;fi;;
      2) S=M2;SC;if [[ $cur == "" ]];then R;$e "\n$(df -h     )\n";ES;fi;;
      3) S=M3;SC;if [[ $cur == "" ]];then R;$e "\n$(route -n )\n";ES;fi;;
      4) S=M4;SC;if [[ $cur == "" ]];then R;$e "\n$(date      )\n";ES;fi;;
      5) S=M5;SC;if [[ $cur == "" ]];then R;$e "\n$($e by oTo)\n";ES;fi;;
      6) S=M6;SC;if [[ $cur == "" ]];then R;exit 0;fi;;
esac;POS;done
```

STEP 4

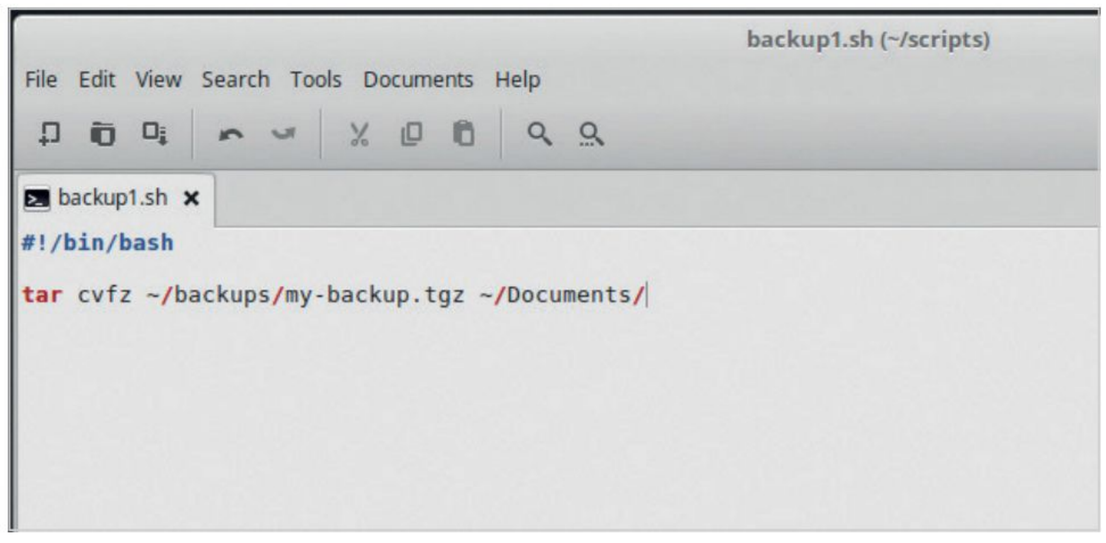
You can use the arrow keys and Enter in the menu setup in the script. Each choice is an external command that feeds back various information. Play around with the commands and choices, and see what you can come up with. It's a bit beyond what we've looked at but it gives a good idea of what can be achieved.

```
BASH SELECTION MENU

          Login info
          Network
          Disk
          Routing
          Time
          ABOUT
          EXIT

ENTER - SELECT,NEXT
```

CREATING A BACKUP TASK SCRIPT

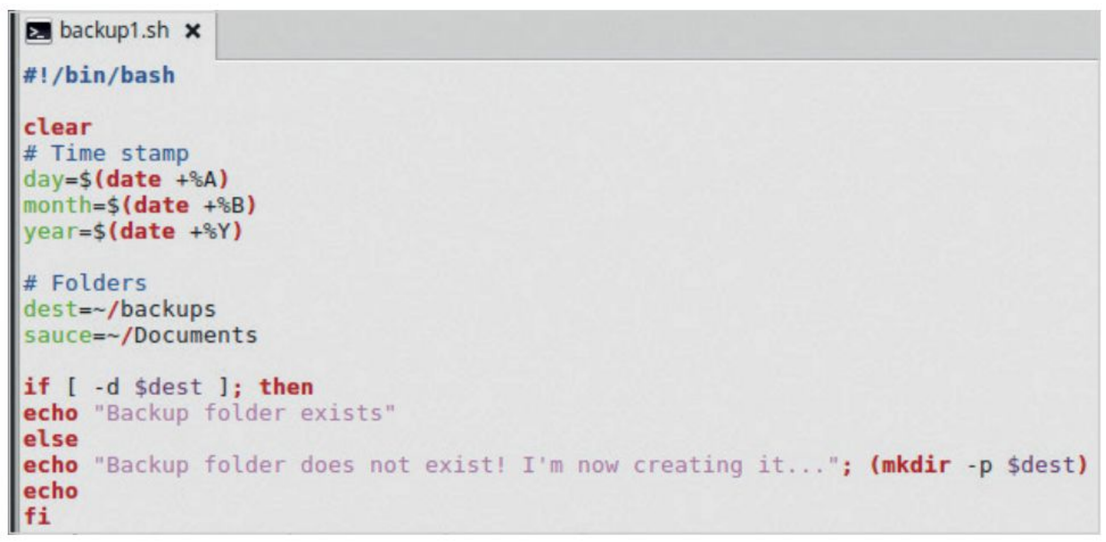
One of the most well used examples of Bash scripting is the creation of a backup routine, one that automates the task as well as adding some customisations along the way.

STEP 1 A very basic backup script would look something along the lines of: `#!/bin/bash, then, tar cvfz ~/backups/my-backup.tgz ~/Documents/`. This will create a compressed file backup of the ~/Documents folder, with everything in it, and put it in a folder called /backups with the name my-backup.tgz.

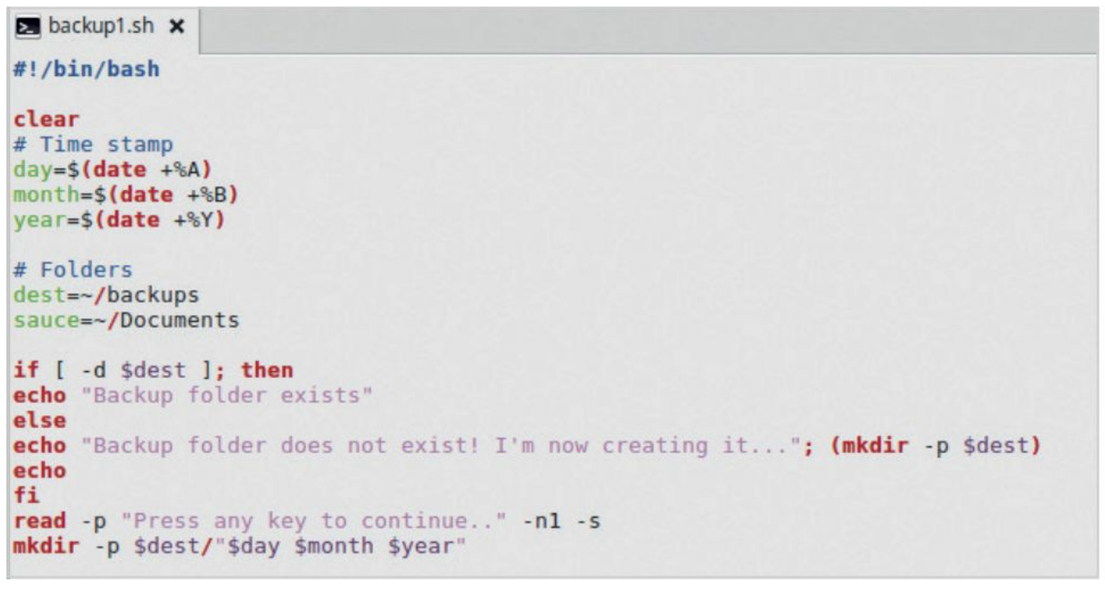


STEP 2 While perfectly fine, we can make the simple script a lot more interactive. Let's begin with defining some variables. Enter the text in the screenshot into a new backup.sh script. Notice that we've misspelt 'source' as 'sauce', this is because there's already a built-in command called 'source' hence the different spelling on our part.

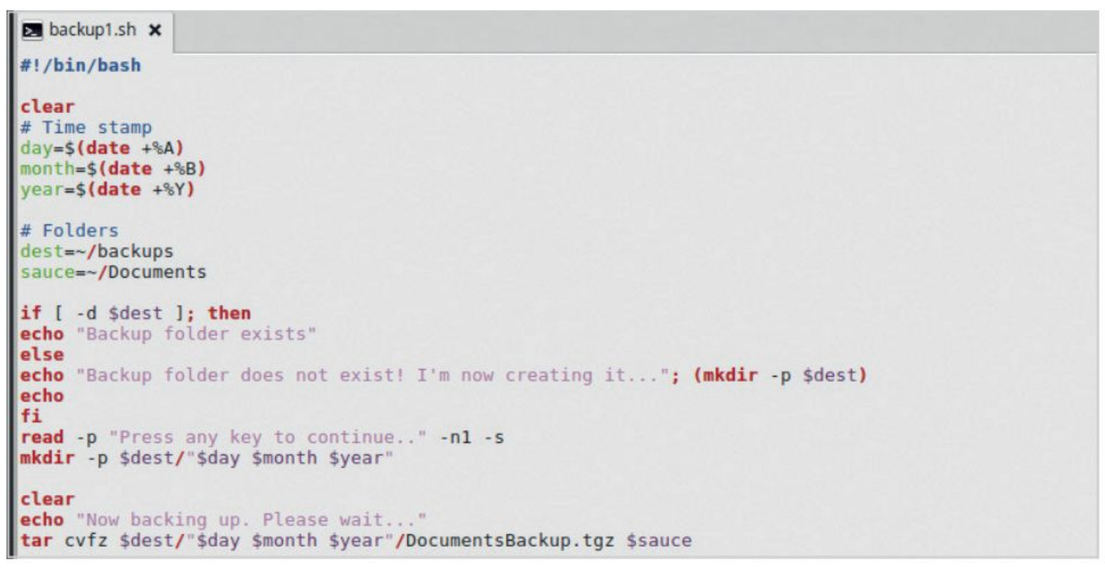
STEP 3 The previous script entries allowed you to create a Time Stamp, so you know when the backup was taken. You also created a 'dest' variable, which is the folder where the backup file will be created (~/backups). You can now add a section of code to first check if the ~/backups folder exits, if not, then it creates one.



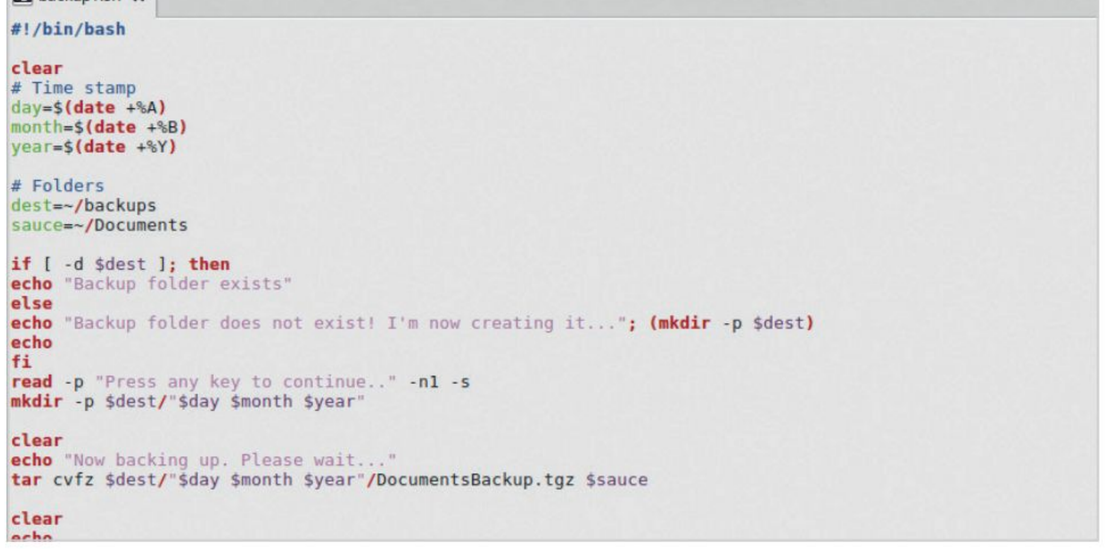
STEP 4 Once the ~/backups folder is created, we can now create a new subfolder within it based on the Time Stamp variables you set up at the beginning. Add `mkdir -p $dest/"$day $month $year"`. It's in here that you put the backup file relevant to that day/month/year.



STEP 5 With everything in place, you can now enter the actual backup routine, based on the Tar command from Step 5. Combined with the variables, you have: `tar cvfz $dest/"$day $month $year"/DocumentsBackup.tgz $sauce`. In the screenshot, we added a handy "Now backing up..." echo command.



STEP 6 Finally, you can add a friendly message: `echo "Backup complete. All done..."`. The completed script isn't too over-complex and it can be easily customised to include any folder within your Home area, as well as the entire Home area itself.



Creating Bash Scripts – Part 5

The backup script we looked at previously can be further amended to incorporate choices; or in other words, user-interaction with regards to where the backup file will be copied to and so on. Automating tasks is one of the main benefits of Bash scripting, a simple script can help you out in many ways.

EASY AUTOMATION AND HANDY SCRIPTS

Are you entering line after line of commands to retrieve system information, find a file or rename a batch of files? A script is a better answer.

STEP 1 Let's start by creating a script to help display the Mint system information; always a handy thing to have. Create a new script called `sysinfo.sh` and enter the following into Xed, or the text editor of your choice.

sysinfo.sh

```
#!/bin/bash

# -Hostname information:
echo -e "\e[31;43m***** HOSTNAME INFORMATION *****\e[0m"
hostnamectl
echo ""

# -File system disk space usage:
echo -e "\e[31;43m***** FILE SYSTEM DISK SPACE USE *****\e[0m"
df -h
echo ""

# -Free and used memory:
echo -e "\e[31;43m***** FREE AND USED MEMORY *****\e[0m"
free
echo ""

# -System uptime and performance load:
echo -e "\e[31;43m***** SYSTEM UPTIME AND LOAD *****\e[0m"
uptime
echo ""

# -Users currently logged in:
echo -e "\e[31;43m***** CURRENT USERS *****\e[0m"
who
echo ""

# -Top five processes being used by the system:
echo -e "\e[31;43m***** TOP 5 MEMORY CONSUMING PROCESSES *****\e[0m"
ps -eo %mem,%cpu,comm --sort=-%mem | head -n 6
echo ""
echo -e "\e[1;32mDone.\e[0m"
```

STEP 2 We've included a couple of extra commands in this script. The first is the -e extension for echo, this means it'll enable echo interpretation of additional instances of a new line, as well as other special characters. The proceeding '31;43m' element enables colour for foreground and background.

```
david@david-mint ~/scripts $ ./sysinfo.sh
***** HOSTNAME INFORMATION *****
   Static hostname: david-mint
         Icon name: computer-vm
           Chassis: vm
        Machine ID: 5ab3c275b7304ed3b8aeef9ffcc37eb4
           Boot ID: 61ce1baadf934f649cf5ac809abe7e18
    Virtualization: oracle
  Operating System: Linux Mint 18.1
            Kernel: Linux 4.4.0-53-generic
      Architecture: x86-64

***** FILE SYSTEM DISK SPACE USE *****
```

STEP 3 Each of the sections runs a different Terminal command, outputting the results under the appropriate heading. You can include a lot more, such as the current aliases being used in the system, the current time and date and so on. Plus, you could also pipe all that information into a handy HTML file, ready to be viewed in a browser.

```
david@david-mint ~/scripts
File  Edit  View  Search  Terminal  Help
david@david-mint ~/scripts $ ./sysinfo.sh > sysinfo.html
david@david-mint ~/scripts $
```

STEP 4 Although there are simple Terminal commands to help you look for a particular file or folder, it's often more fun to create a script to help you. Plus, you can use that script for other non-technical users. Create a new script called `look4.sh`, entering the content from the screenshot below.

look4.sh

```
#!/bin/bash

target=~/

read name

output=$( find "$target" -iname "*.$name" 2> /dev/null )

if [[ -n "$output" ]]; then
    echo "$output"
else
    echo "No match found"
fi
```

STEP 5 When executed the script waits for input from the user, in this case the file extension, such as jpg, mp4 and so on. It's not very friendly though. Let's make it a little friendlier. Add an echo, with: `echo -n "Please enter the extension of the file you're looking for: "`, just before the read command.

*look4.sh

```
#!/bin/bash

target=~/

echo -n "Please enter the extensions of the file you're looking for: "
read name

output=$( find "$target" -iname "*.$name" 2> /dev/null )

if [[ -n "$output" ]]; then
    echo "$output"
else
    echo "No match found"
fi
```

STEP 6 Here's an interesting, fun kind of script using the app espeak. Install espeak with `sudo apt-get install espeak`, then enter the text below into a new script called `speak.sh`. As you can see it's a rehash of the first greeting script we ran. Only this time, it uses the variables in the espeak output.

speak.sh

```
#!/bin/bash

echo -n "Hello, what is your first name? "
read firstname
echo -n "Thank you, and what is your surname? "
read surname
clear
espeak "Hello $firstname $surname, how are you on this fine $(date +%A)?"
```

STEP 7 We briefly looked at putting some colours in the output for our scripts. Whilst it's too long to dig a little deeper into the colour options, here's a script that outputs what's available. Create a new script called `colours.sh` and enter the text (see below) into it.

colours.sh

```
#!/bin/bash

clear
echo -e "Normal \e[1mBold"
echo -e "Normal \e[2mDim"
echo -e "Normal \e[4mUnderlined"
echo -e "Normal \e[5mBlink"
echo -e "Normal \e[7minverted"
echo -e "Normal \e[8mHidden"
echo
echo -e "\e[0mNormal Text"
echo

echo -e "Default \e[39mDefault"
echo -e "Default \e[30mBlack"
echo -e "Default \e[31mRed"
echo -e "Default \e[32mGreen"
echo -e "Default \e[33mYellow"
echo -e "Default \e[34mBlue"
echo -e "Default \e[35mMagenta"
echo -e "Default \e[36mCyan"
echo -e "Default \e[37mLight gray"
echo -e "Default \e[90mDark gray"
echo -e "Default \e[91mLight red"
echo -e "Default \e[92mLight green"
echo -e "Default \e[93mLight yellow"
echo -e "Default \e[94mLight blue"
echo -e "Default \e[95mLight magenta"
echo -e "Default \e[96mLight cyan"
echo -e "Default \e[97mWhite"
echo
echo -e "Default \e[49mDefault"
echo -e "Default \e[40mBlack"
echo -e "Default \e[41mRed"
echo -e "Default \e[42mGreen"
echo -e "Default \e[43mYellow"
echo -e "Default \e[44mBlue"
echo -e "Default \e[45mMagenta"
echo -e "Default \e[46mCyan"
echo -e "Default \e[47mLight gray"
echo -e "Default \e[100mDark gray"
echo -e "Default \e[101mLight red"
echo -e "Default \e[102mLight green"
echo -e "Default \e[103mLight yellow"
echo -e "Default \e[104mLight blue"
echo -e "Default \e[105mLight magenta"
echo -e "Default \e[106mLight cyan"
echo -e "Default \e[107mWhite"
```

STEP 8 The output from colours.sh can, of course, be mixed together, bringing different effects depending on what you want to the output to say. For example, white text in a red background flashing (or blinking). Sadly the blinking effect doesn't work on all Terminals, so you may need to change to a different Terminal.

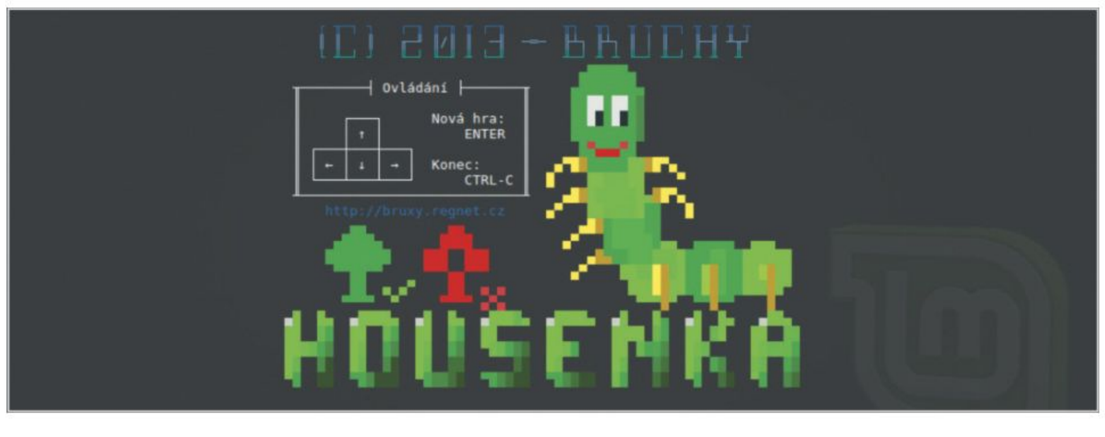
```
Normal Text

Default Default
Default Black
Default Red
Default Green
Default Yellow
Default Blue
Default Magenta
Default Cyan
Default Light gray
Default Dark gray
Default Light red
Default Light green
Default Light yellow
Default Light blue
Default Light magenta
Default Light cyan
Default White

Default Default
Default Black
Default Red
Default Green
Default Yellow
Default Blue
Default Magenta
Default Cyan
Default Light gray
Default Dark gray
Default Light red
Default Light green
Default Light yellow
Default Light blue
Default Light magenta
Default Light cyan
Default
david@david-mint ~/scripts $
```

STEP 9 Whilst we're on making fancy scripts, how about using Zenity to output a graphical interface? Enter what you see below into a new script, `mmenu.sh`. Make it executable and then run it. You should have a couple of dialogue boxes appear, followed by a final message.

mmenu.sh

```
#!/bin/bash

firstname=$(zenity --entry --title="Your Name" --text="What is your first name?")

surname=$(zenity --entry --title="Your Name" --text="What is your first surname?")

zenity --info --title="Hello!" --text="Welcome to Linux Mint.\n\n Have fun, $firstname $surname."
```

STEP 10 While gaming in a Bash script isn't something that's often touched upon, it is entirely possible, albeit, a little basic. If you fancy playing a game, enter `wget http://bruxy.regnet.cz/linux/housenka/housenka.sh`, make the script executable and run it. It's in Polish, written by Martin Bruchanov but we're sure you can modify it. Hint: the title screen is in Base64.



Command Line Quick Reference

When you start using Linux full time, you will quickly realise that the graphical interfaces of Ubuntu, Mint, etc. are great for many tasks but not great for all tasks. Understanding how to use the command line not only builds your understanding of Linux but also improves your knowledge of coding and programming in general. Our command line quick reference guide is designed to help you master Linux quicker.

TOP 10 COMMANDS

These may not be the most common commands used by everyone but they will certainly feature frequently for many users of Linux and the command line.

cd

The `cd` command is one of the commands you will use the most at the command line in Linux. It allows you to change your working directory. You use it to move around within the hierarchy of your file system. You can also use chdir.

ls

The `ls` command shows you the files in your current directory. Used with certain options, it lets you see file sizes, when files where created and file permissions. For example, `ls ~` shows you the files that are in your home directory.

cp

The `cp` command is used to make copies of files and directories. For example, `cp file sub` makes an exact copy of the file whose name you entered and names the copy sub but the first file will still exist with its original name.

pwd

The `pwd` command prints the full pathname of the current working directory (pwd stands for "print working directory"). Note that the GNOME terminal also displays this information in the title bar of its window.

clear

The `clear` command clears your screen if this is possible. It looks in the environment for the terminal type and then in the terminfo database to figure out how to clear the screen. This is equivalent to typing Control-L when using the bash shell.

mv

The `mv` command moves a file to a different location or renames a file. For example `mv file sub` renames the original file to `sub. mv sub ~/Desktop` moves the file 'sub' to your desktop directory but does not rename it. You must specify a new filename to rename a file.

chown

The `chown` command changes the user and/or group ownership of each given file. If only an owner (a user name or numeric user ID) is given, that user is made the owner of each given file, and the files' group is not changed.

cmod

The `chmod` command changes the permissions on the files listed. Permissions are based on a fairly simple model. You can set permissions for user, group and world and you can set whether each can read, write and or execute the file.

rm

The `rm` command removes (deletes) files or directories. The removal process unlinks a filename in a filesystem from data on the storage device and marks that space as usable by future writes. In other words, removing files increases the amount of available space on your disk.

mkdir

Short for "make directory", `mkdir` is used to create directories on a file system, if the specified directory does not already exist. For example, `mkdir` work creates a work directory. More than one directory may be specified when calling mkdir.

USEFUL HELP/INFO COMMANDS

The following commands are useful for when you are trying to learn more about the system or program you are working with in Linux. You might not need them every day, but when you do, they will be invaluable.

free

The `free` command displays the total amount of free and used physical and swap memory in the system. For example, `free -m` gives the information using megabytes.

sed

The `sed` command opens a stream editor. A stream editor is used to perform text transformations on an input stream: a file or input from a pipeline.

df

The `df` command displays filesystem disk space usage for all partitions. The command `df-h` is probably the most useful (the -h means human-readable).

adduser

The `adduser` command adds a new user to the system. Similarly, the addgroup command adds a new group to the system.

top

The `top` program provides a dynamic real-time view of a running system. It can display system summary information, as well as a list of processes.

deluser

The `deluser` command removes a user from the system. To remove the user's files and home directory, you need to add the `-remove-home` option.

uname-a

The `uname` command with the `-a` option prints all system information, including machine name, kernel name, version and a few other details.

delgroup

The `delgroup` command removes a group from the system. You cannot remove a group that is the primary group of any users.

ps

The `ps` command allows you to view all the processes running on the machine. Every operating system's version of ps is slightly different but all do the same thing.

man man

The `man man` command brings up the manual entry for the man command, which is a great place to start when using it.

grep

The `grep` command allows you to search inside a number of files for a particular search pattern and then print matching lines. An example would be: `grep blah file`.

man intro

The `man intro` command is especially useful. It displays the Introduction to User Commands, which is a well written, fairly brief introduction to the Linux command line.

Common Coding Mistakes

When you start something new you're inevitably going to make mistakes, this is purely down to inexperience and those mistakes are great teachers in themselves. However, even experts make the occasional mishap. Thing is, to learn from them as best you can.

X=MISTAKE, PRINT Y

There are many pitfalls for the programmer to be aware of, far too many to be listed here. Being able to recognise a mistake and fix it is when you start to move into more advanced territory.

SMALL CHUNKS

It would be wonderful to be able to work like Neo from The Matrix movies. Simply ask, your operator loads it into your memory and you instantly know everything about the subject. Sadly though, we can't do that. The first major pitfall is someone trying to learn too much, too quickly. So take coding in small pieces and take your time.

EASY VARIABLES

Meaningful naming for variables is a must to eliminate common coding mistakes. Having letters of the alphabet is fine but what happens when the code states there's a problem with x variable. It's not too difficult to name variables lives, money, player1 and so on.

```
1  var points = 1023;
2  var lives = 3;
3  var totalTime = 45;
4  write("Points: "+points);
5  write("Lives: "+lives);
6  write("Total Time: "+totalTime+" secs");
7  write("--------------------------");
8  var totalScore = 0;
9  write("Your total Score is: "+totalScore);
```

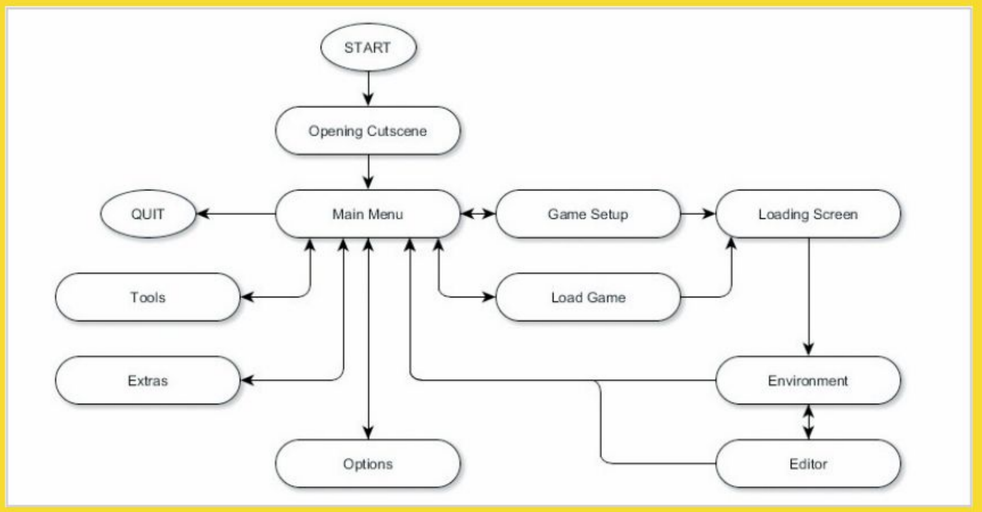
//COMMENTS

Use comments. It's a simple concept but commenting on your code saves so many problems when you next come to look over it. Inserting comment lines helps you quickly sift through the sections of code that are causing problems; also useful if you need to review an older piece of code.

```
52          orig += 2;
53          target += 2;
54          --n;
55      }
56  #endif
57    if (n == 0)
58      return;
59
60    //
61    // Loop unrolling. Here be dragons.
62    //
63
64    // (n & (~3)) is the greatest multiple of 4 n
65    // In the while loop ahead, orig will move ov
66    // increments (4 elements of 2 bytes).
67    // end marks our barrier for not falling outs
68    char const * const end = orig + 2 * (n & (~3)
69
70    // See if we're aligned for writting in 64 or
71  #if ACE_SIZEOF_LONG == 8 && \
72      !(defined(  amd64  ) || defined (  x86_64
```

PLAN AHEAD

While it's great to wake up one morning and decide to code a classic text adventure, it's not always practical without a good plan. Small snippets of code can be written without too much thought and planning but longer and more in-depth code requires a good working plan to stick to and help iron out the bugs.



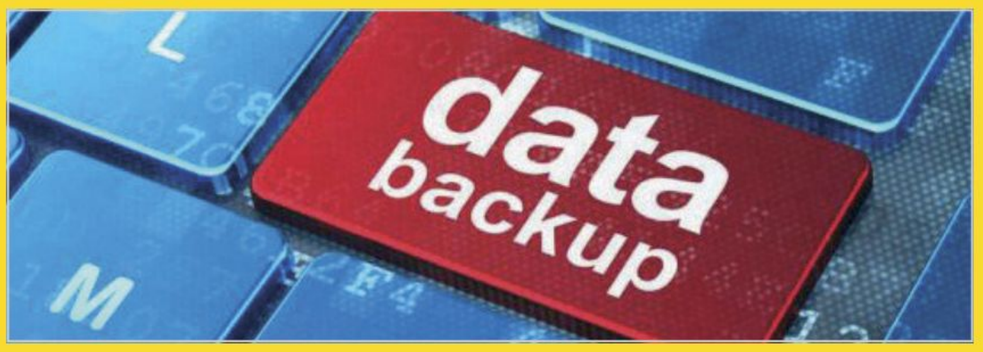
USER ERROR

User input is often a paralysing mistake in code. For example, when the user is supposed to enter a number for their age and instead they enter it in letters. Often a user can enter so much into an input that it overflows some internal buffer, thus sending the code crashing. Watch those user inputs and clearly state what's needed from them.

```
Enter an integer number
aswdfdsf
You have entered wrong input
s
You have entered wrong input
!"£"!£!"
You have entered wrong input
sdfsdf213213123
You have entered wrong input
123234234234234234
You have entered wrong input
12
the number is: 12

Process returned 0 (0x0)   execution time : 21.495 s
Press any key to continue.
```

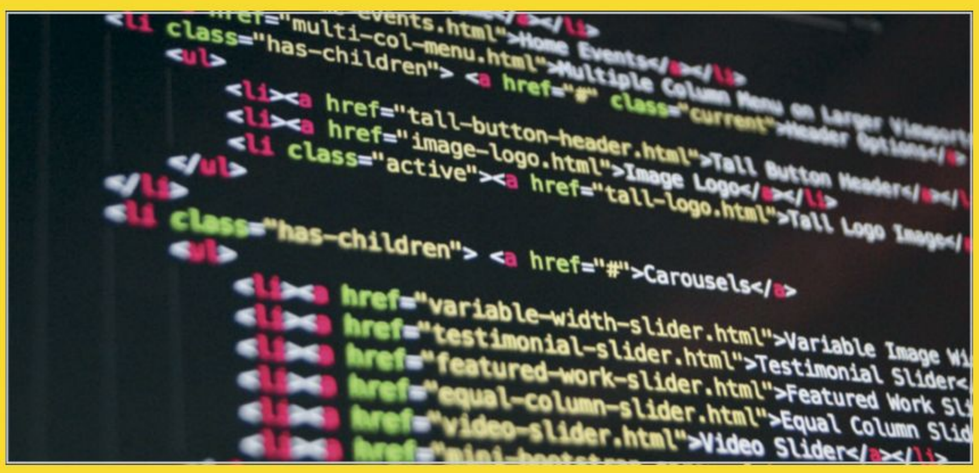
BACKUPS

Always make a backup of your work, with a secondary backup for any changes you've made. Mistakes can be rectified if there's a good backup in place to revert to for those times when something goes wrong. It's much easier to start where you left off, rather than starting from the beginning again.



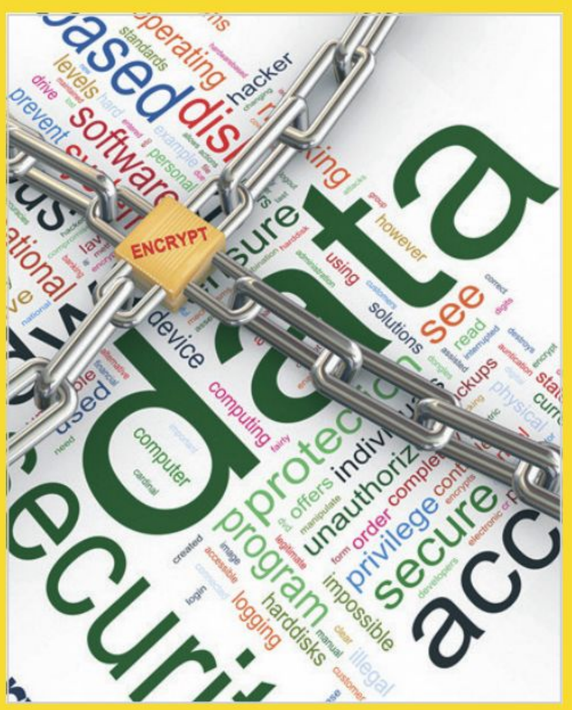
RE-INVENTING WHEELS

You can easily spend days trying to fathom out a section of code to achieve a given result and it's frustrating and often time-wasting. While it's equally rewarding to solve the problem yourself, often the same code is out there on the Internet somewhere. Don't try and re-invent the wheel, look to see if some else has done it first.



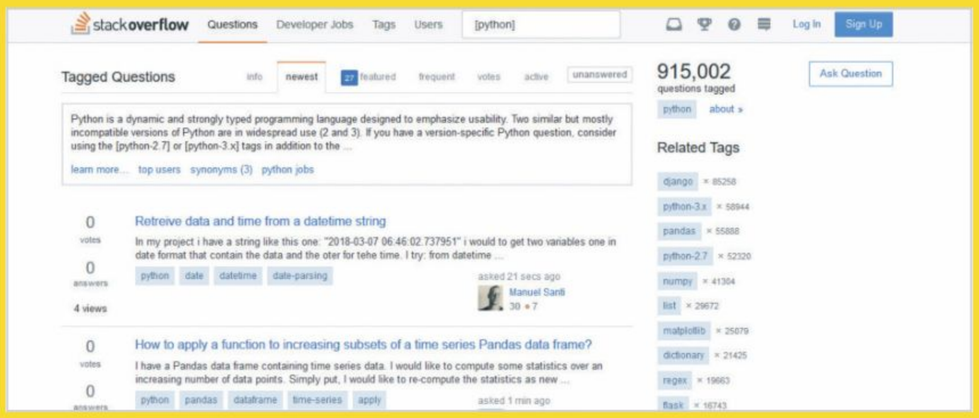
SECURE DATA

If you're writing code to deal with usernames and passwords, or other such sensitive data, then ensure that the data isn't in cleartext. Learn how to create a function to encrypt sensitive data, prior to feeding into a routine that can transmit or store it where someone may be able to get to view it.



HELP!

Asking for help is something most of us has struggled with in the past. Will the people we're asking laugh at us? Am I wasting everyone's time? It's a common mistake for someone to suffer in silence. However, as long as you ask the query in the correct manner, obey any forum rules and be polite, then your question isn't silly.



MATHS

If your code makes multiple calculations then you need to ensure that the maths behind it is sound. There are thousands of instances where programs have offered incorrect data based on poor mathematical coding, which can have disastrous effects depending on what the code is set to do. In short, double check your code equations.

```
set terminal x11
set output

rmax = 5
nmax = 100

complex (x, y) = x * {1, 0} + y * {0, 1}
mandel (x, y, z, n) = (abs (z)> rmax || n>= 100)? n: mandel (x, y, z * z + complex (x, y), n + 1)

set xrange [-0.5:0.5]
set yrange [-0.5:0.5]
set logscale z
set samples 200
set isosample 200
set pm3d map
set size square
a= #A#
b= #B#
splot mandel(-a/100,-b/100,complex(x,y),0) notitle
```

Python Beginner's Mistakes

Python is a relatively easy language to get started in where there's plenty of room for the beginner to find their programming feet. However, as with any other programming language, it can be easy to make common mistakes that'll stop your code from running.

DEF BEGINNER(MISTAKES=10)

Here are ten common Python programming mistakes most beginners find themselves making. Being able to identify these mistakes will save you headaches in the future.

VERSIONS

To add to the confusion that most beginners already face when coming into programming, Python has two live versions of its language available to download and use. There is Python version 2.7.x and Python 3.6.x. The 3.6.x version is the most recent, and the one we'd recommend starting. But, version 2.7.x code doesn't always work with 3.6.x code and vice versa.

INDENTS, TABS AND SPACES

Python uses precise indentations when displaying its code. The indents mean that the code in that section is a part of the previous statement, and not something linked with another part of the code. Use four spaces to create an indent, not the Tab key.

```
MOVESPEED = 11
MOVE = 1
SHOOT = 15

# set up counting
score = 0

# set up font
font = pygame.font.SysFont('calibri', 50)

def makeplayer():
    player = pygame.Rect(370, 635, 60, 25)
    return player

def makeinvaders(invaders):
    y = 0
    for i in invaders:
        x = 0
        for j in range(11):
            invader = pygame.Rect(75+x, 75+y, 50, 20)
            i.append(invader)
            x += 60
        y += 45
    return invaders

def makewalls(walls):
    wall1 = pygame.Rect(60, 520, 120, 30)
    wall2 = pygame.Rect(246, 520, 120, 30)
    wall3 = pygame.Rect(432, 520, 120, 30)
    wall4 = pygame.Rect(618, 520, 120, 30)
```

THE INTERNET

Every programmer has and does at some point go on the Internet and copy some code to insert into their own routines. There's nothing wrong with using others' code, but you need to know how the code works and what it does before you go blindly running it on your own computer.

Create/delete a .txt file in a python program

0

I have created a program to grab values from a text file. As you can see, depending on the value of the results, I have an if/else statement printing out the results of the scenario.

My problem is I want to set the code up so that the if statement creates a simple .txt file called data.txt to the C:\Python\Scripts directory.

In the event the opposite is true, I would like the else statement to delete this .txt file if it exists.

I'm a novice programmer and anything I've looked up or tried hasn't worked for me, so any help or assistance would be hugely appreciated.

```
import re

x = open("test.txt","r")
california = x.readlines(11)
dublin = x.readlines(125)

percentage_value = [float(re.findall('\d+\.\d+(?=\%)|\d+\.\d+(?=\s\%)', i[-1])[0]) for i in [ca

print(percentage_value)

if percentage_value[0] <= percentage_value[1]:
    print('Website is hosted in Dublin')
else:
```

COMMENTING

Again we mention commenting. It's a hugely important factor in programming, even if you're the only one who is ever going to view the code, you need to add comments as to what's going on. Is this function where you lose a life? Write a comment and help you, or anyone else, see what's going on.

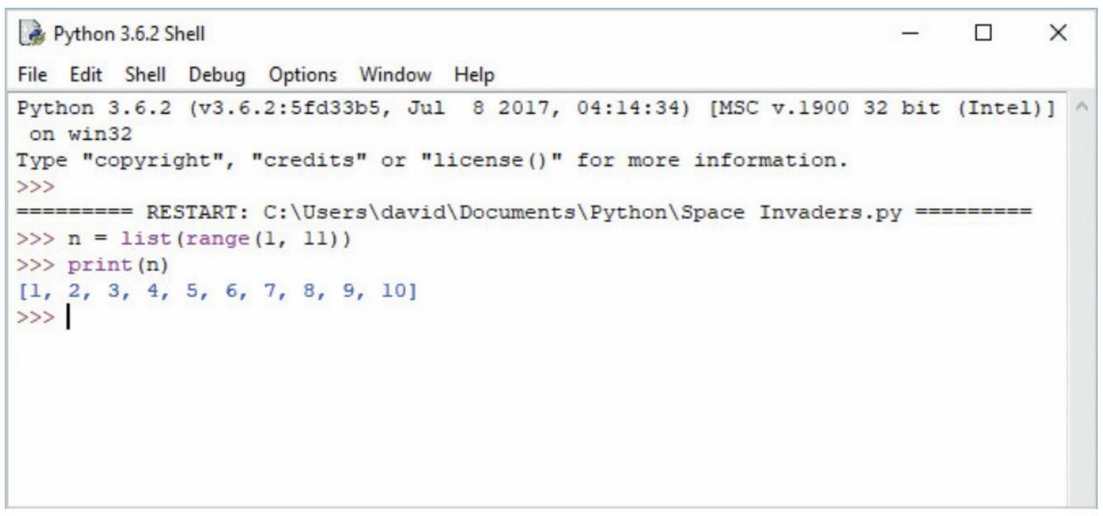
```
# set up pygame
pygame.init()
mainClock = pygame.time.Clock()

# set up the window
width = 800
height = 700
screen = pygame.display.set_mode((width, height), 0, 32)
pygame.display.set_caption('caption')

# set up movement variables
moveLeft = False
moveRight = False
moveUp = False
moveDown = False

# set up direction variables
DOWNLEFT = 1
DOWNRIGHT = 3
```

COUNTING LOOPS

Remember that in Python a loop doesn't count the last number you specify in a range. So if you wanted the loop to count from 1 to 10, then you will need to use:

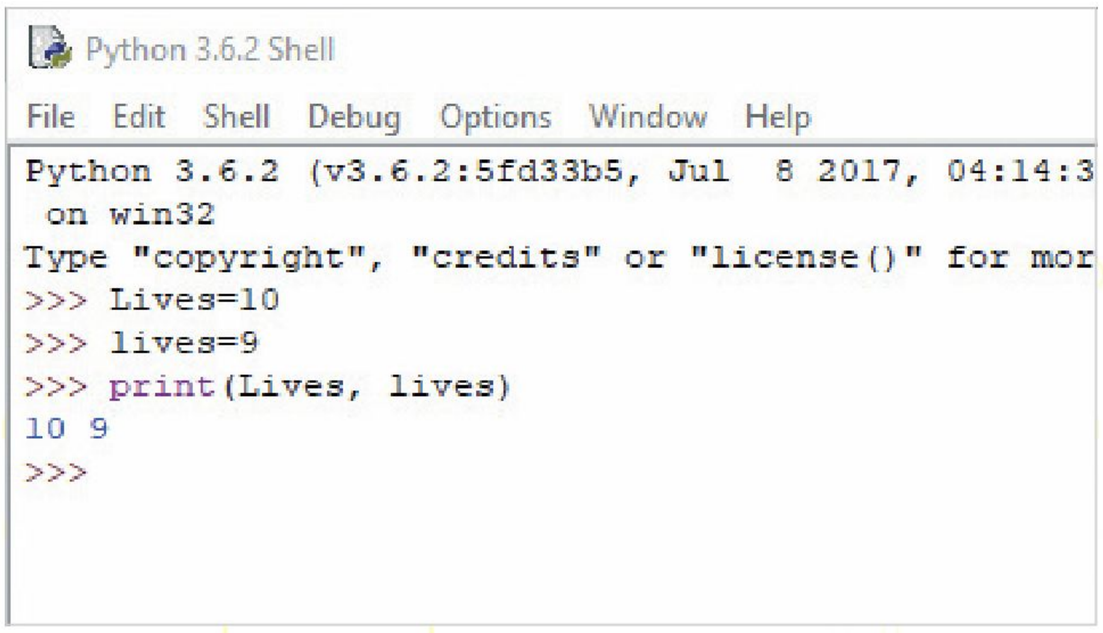
```
n = list(range(1, 11))
```

Which will return 1 to 10.



CASE SENSITIVE

Python is a case sensitive programming language, so you will need to check any variables you assign. For example, `Lives=10` is a different variable to lives=10, calling the wrong variable in your code can have unexpected results.



BRACKETS

Everyone forgets to include that extra bracket they should have added to the end of the statement. Python relies on the routine having an equal amount of closed brackets to open brackets, so any errors in your code could be due to you forgetting to count your brackets; including square brackets.

```
def print_game_status(self):
        print (board[len(self.missed_letters)])
        print ('Word: ' + self.hide_word())
        print ('Letters Missed: ',)
        for letter in self.missed_letters:
                print (letter,)
        print ()
        print ('Letters Guessed: ',)
        for letter in self.guessed_letters:
                print (letter,)
        print ()
```

COLONS

It's common for beginners to forget to add a colon to the end of a structural statement, such as:

```
class Hangman:
def guess(self, letter):
```

And so on. The colon is what separates the code, and creates the indents to which the following code belongs to.

```
class Hangman:
        def __init__(self,word):
                self.word = word
                self.missed_letters = []
                self.guessed_letters = []

        def guess(self,letter):
                if letter in self.word and letter not in self.guessed_letters:
                        self.guessed_letters.append(letter)
                elif letter not in self.word and letter not in self.missed_letters:
                        self.missed_letters.append(letter)
                else:
                        return False
                return True

        def hangman_over(self):
                return self.hangman_won() or (len(self.missed_letters) == 6)

        def hangman_won(self):
                if '_' not in self.hide_word():
                        return True
                return False

        def hide_word(self):
                rtn = ''
                for letter in self.word:
                        if letter not in self.guessed_letters:
                                rtn += '_'
                        else:
                                rtn += letter
                return rtn
```

OPERATORS

Using the wrong operator is also a common mistake to make. When you're performing a comparison between two values, for example, you need to use the equality operator (a double equals, ==). Using a single equal (=) is an assignment operator that places a value to a variable (such as, lives=10).

```
1 b = 5
2 c = 10
3 d = 10
4 b == c #false because 5 is not equal to 10
5 c == d #true because 10 is equal to 10
```

OPERATING SYSTEMS

Writing code for multiple platforms is difficult, especially when you start to utilise the external commands of the operating system. For example, if your code calls for the screen to be cleared, then for Windows you would use `cls`. Whereas, for Linux you need to use `clear`. You need to solve this by capturing the error and issuing it with an alternative command.

```
# Code to detect error for using a different OS
run=1
while(run==1):
    try:
        os.system('clear')
    except OSError:
        os.system('cls')
    print('\n>>>>>>>>>>Python 3 File Manager<<<<<<<<<<\n')
```

C++ Beginner's Mistakes

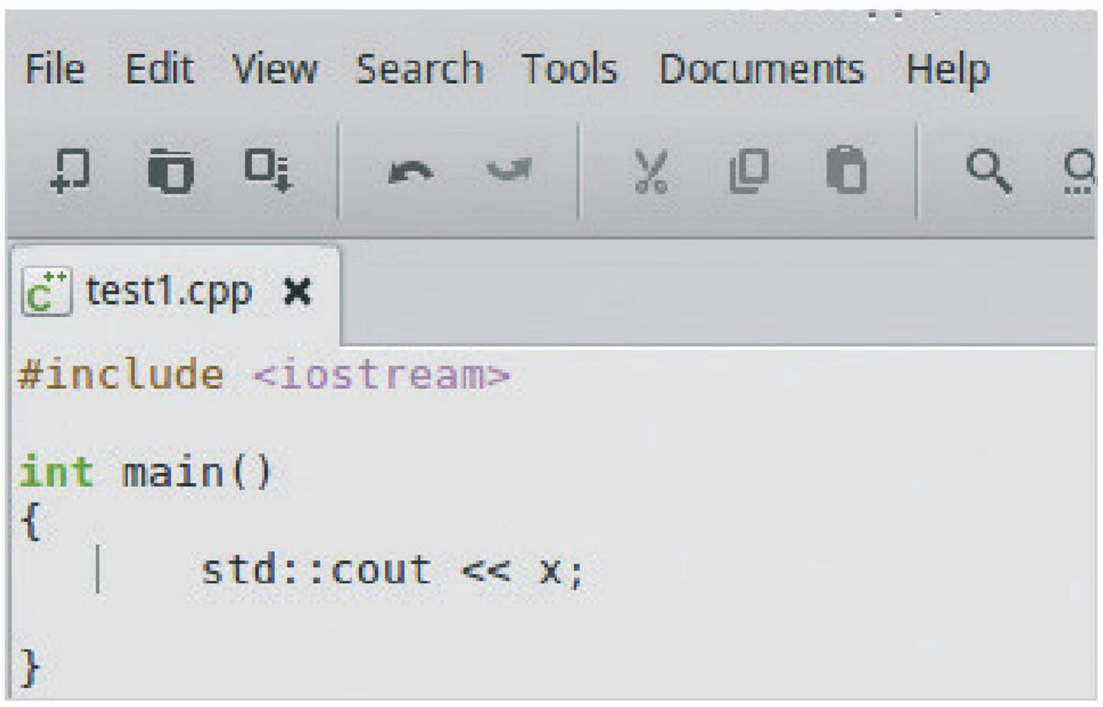
There are many pitfalls the C++ developer can encounter, especially as this is a more complex and often unforgiving language to master. Beginners need to take C++ a step at a time and digest what they've learned before moving on.

VOID(C++, MISTAKES)

Admittedly it's not just C++ beginners that make the kinds of errors we outline on these pages, even hardened coders are prone to the odd mishap here and there. Here are some common issues to try and avoid.

UNDECLARED IDENTIFIERS

A common C++ mistake, and to be honest a common mistake with most programming languages, is when you try and output a variable that doesn't exist. Displaying the value of x on-screen is fine but not if you haven't told the compiler what the value of x is to begin with.



STD NAMESPACE

Referencing the Standard Library is common for beginners throughout their code, but if you miss the std:: element of a statement, your code errors out when compiling. You can combat this by adding:

```
using namespace std;
```

Under the #include part and simply using cout, cin and so on from then on.

```
#include <iostream>
using namespace std;

int main()
{
    int a, b, c, d;
    a=10;
    b=20;
    c=30;
    d=40;

    cout << a, b, c, d;

}
```

SEMICOLONS

Remember that each line of a C++ program must end with a semicolon. If it doesn't then the compiler treats the line with the missing semicolon as the same line with the next semicolon on. This creates all manner of problems when trying to compile, so don't forget those semicolons.

```
#include <iostream>


int main()
{
    int a, b, c, d;
    a=10;
    b=20;
    c=30
    d=40;

    std::cout << a, b, c, d;

}
```

GCC OR G++

If you're compiling in Linux then you will no doubt come across gcc and g++. In short, gcc is the Gnu Compiler Collection (or Gnu C Compiler as it used to be called) and g++ is the Gnu ++ (the C++ version) of the compiler. If you're compiling C++ then you need to use g++, as the incorrect compiler drivers will be used.

```
david@mint-mate ~/Documents
File  Edit  View  Search  Terminal  Help
david@mint-mate ~/Documents $ gcc test1.cpp -o test
/tmp/ccA5zhtg.o: In function `main':
test1.cpp:(.text+0x2a): undefined reference to `std::cout'
test1.cpp:(.text+0x2f): undefined reference to `std::ostream::
/tmp/ccA5zhtg.o: In function `__static_initialization_and_dest
)':
test1.cpp:(.text+0x5d): undefined reference to `std::ios_base:
test1.cpp:(.text+0x6c): undefined reference to `std::ios_base:
collect2: error: ld returned 1 exit status
david@mint-mate ~/Documents $ g++ test1.cpp -o test
david@mint-mate ~/Documents $
```

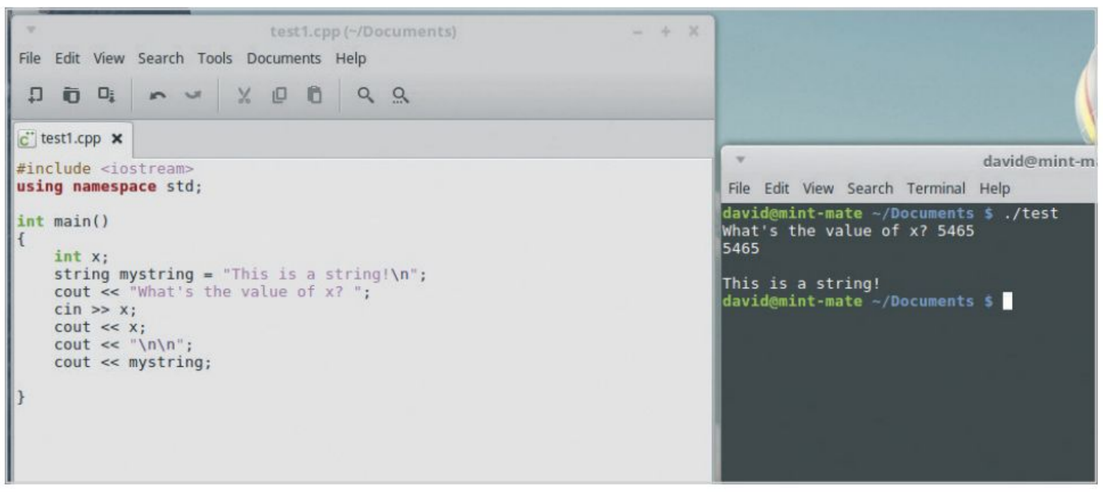
COMMENTS (AGAIN)

Indeed the mistake of never making any comments on code is back once more. As we've previously bemoaned, the lack of readable identifiers throughout the code makes it very difficult to look back at how it worked, for both you and someone else. Use more comments.

```
#include <iostream>
#include <vector>
#include <algorithm>
using namespace std;

int main()
{
    vector<double> v;

    double d;
    while(cin>>d) v.push_back(d);   // read elements
    if (!cin.eof()) {           // check if input failed
        cerr << "format error\n";
        return 1;                   // error return
    }

    cout << "read " << v.size() << " elements\n";

    reverse(v.begin(),v.end());
    cout << "elements in reverse order:\n";
    for (int i = 0; i<v.size(); ++i) cout << v[i] << '\n';

    return 0;                       // success return
}
```

QUOTES

Missing quotes is a common mistake to make, for every level of user. Remember that quotes need to encase strings and anything that's going to be outputted to the screen or into a file, for example. Most compilers errors are due to missing quotes in the code.



EXTRA SEMICOLONS

While it's necessary to have a semicolon at the end of every C++ line, there are some exceptions to the rule. Semicolons need to be at the end of every complete statement but some lines of code aren't complete statements. Such as:

`#include`
`if lines`
`switch lines`

If it sounds confusing don't worry, the compiler lets you know where you went wrong.

```
// Program to print positive number entered by the user
// If user enters negative number, it is skipped

#include <iostream>
using namespace std;

int main()
{
      int number;
      cout << "Enter an integer: ";
      cin >> number;

      // checks if the number is positive
      if ( number > 0)
      {
            cout << "You entered a positive integer: " << number << endl;
      }

      cout << "This statement is always executed.";
      return 0;

}
```

TOO MANY BRACES

The braces, or curly brackets, are beginning and ending markers around blocks of code. So for every { you must have a }. Often it's easy to include or miss out one or the other facing brace when writing code; usually when writing in a text editor, as an IDE adds them for you.

```
#include <iostream>
using namespace std;

int main()
{
      int x;
      string mystring = "This is a string!\n";
      cout << "What's the value of x? ";
      cin >> x;
      cout << x;
      {
      cout << "\n\n";
      cout << mystring;

}
```

INITIALISE VARIABLES

In C++ variables aren't initialised to zero by default. This means if you create a variable called x then, potentially, it is given a random number from 0 to 18,446,744,073,709,551,616, which can be difficult to include in an equation. When creating a variable, give it the value of zero to begin with: `x=0`.

```
#include <iostream>
using namespace std;

int main()
{
      int x;
      x=0;

      cout << x;


}
```

A.OUT

A common mistake when compiling in Linux is forgetting to name your C++ code post compiling. When you compile from the Terminal, you enter:

`g++ code.cpp`

This compiles the code in the file code.cpp and create an a.out file that can be executed with ./a.out. However, if you already have code in a.out then it's overwritten. Use:

`g++ code.cpp -o nameofprogram`

```
david@mint-mate ~/Documents
File Edit View Search Terminal Help
david@mint-mate ~/Documents $ g++ test1.cpp
david@mint-mate ~/Documents $ ./a.out
0
david@mint-mate ~/Documents $ g++ test1.cpp -o printzero
david@mint-mate ~/Documents $ ./printzero
0
david@mint-mate ~/Documents $
```

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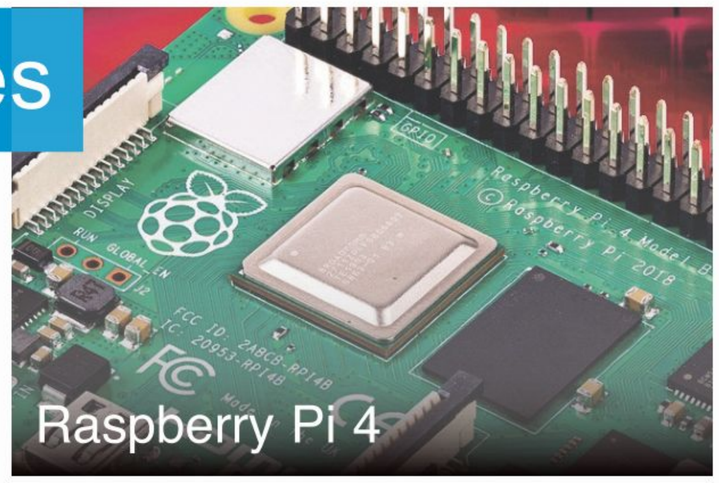

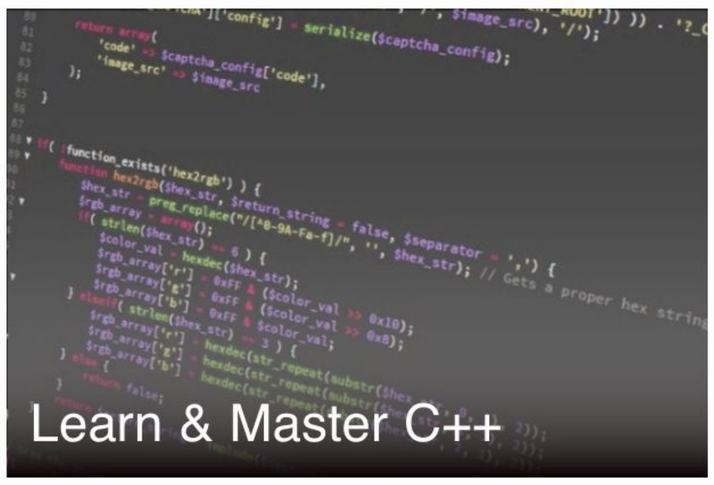

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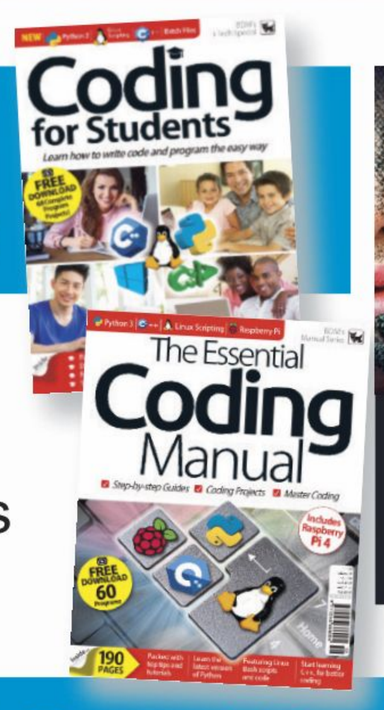

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