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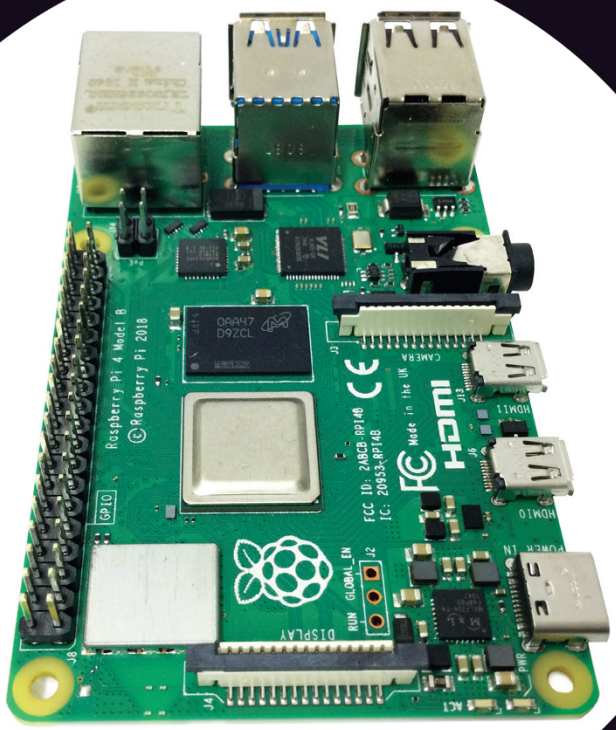

Connect the Raspberry Pi and configure the OS

Create games, explore electronics, make music, and more

Start programming with Scratch™ and Python®

Sean McManus
Mike Cook

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Raspberry Pi®

4th Edition

by Sean McManus and Mike Cook

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Raspberry Pi® For Dummies®

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Introduction

Raspberry Pi computers are at the forefront of the maker movement, where people make their own inventions using a mixture of traditional craft skills and modern coding and electronics knowledge. They've also given more and more people access to a computer that provides a gateway into programming, electronics, and the world of Linux — the technically powerful (and free) rival to Windows and Mac OS. As a supercheap computer, the Raspberry Pi is also being pressed into service in media centers and as a family computer for games, music, photo editing, and word processing.

You might be a geek who relishes learning new technologies, or you might be someone who wants a new family computer to use with the children. In either case, *Raspberry Pi For Dummies*, 4th Edition, helps you get started with your Raspberry Pi and teaches you about some of the many fun and inspiring things you can do with it.

About This Book

Raspberry Pi For Dummies, 4th Edition, provides a concise and clear introduction to the terminology, technology, and techniques that you need to get the most from your Pi. With this book as your guide, you'll learn how to

- Set up your Raspberry Pi.
- Discover and install great free software you can use on your Raspberry Pi.
- Use the desktop environment to run programs, manage files, surf the web, and view photos.
- Use the Linux command line to manage your Raspberry Pi and its files.
- Use the Raspberry Pi as a productivity tool.
- Edit photos.
- Play music and video.
- Create animations and arcade games with the child-friendly Scratch programming language.

- Write your own games and other programs using the Python programming language.
- Compose music by programming with Sonic Pi.
- Get started with electronics, from an introduction to soldering to the design and creation of electronic projects controlled by the Raspberry Pi.

Incidentally, within this book, you may note that some web addresses break across two lines of text. If you're reading this book in print and want to visit one of these web pages, simply key in the web address exactly as it's noted in the text, pretending as though the line break doesn't exist. If you're reading this as an ebook, you've got it easy — just click or tap the web address to be taken directly to the web page.

Foolish Assumptions

Raspberry Pi For Dummies, 4th Edition, is written for beginners, by which we mean people who have never used a similar computer. However, we do have to make a few assumptions in writing this book, because we wouldn't have enough space for all its cool projects if we had to start by explaining what a mouse is! Here are our assumptions:

- **You are familiar with other computers, such as Windows or Apple computers.** In particular, we assume that you're familiar with using windows, icons, and the keyboard and mouse, and that you know the basics of using your computer for things like browsing the Internet, installing software, or copying files.
- **The Raspberry Pi is not your only computer.** At times, you'll need to have access to another computer — for example, to create your SD or microSD card for the Pi. (See Chapter 2.) When it comes to networking, we assume you already have a router set up with an Internet connection and a spare port that you can plug the Raspberry Pi into if you're using a wired connection.
- **The Raspberry Pi is your first Linux-based computer.** If you're a Linux ninja, this book still gives you a solid reference on the Raspberry Pi and the version of Linux it uses, but no prior Linux knowledge is required.
- **You share our excitement.** The Raspberry Pi can open up a world of possibilities to you!

Other than these assumptions, we hope this book is approachable for everyone. The Raspberry Pi is being adopted in classrooms and youth groups, and this book

is a useful resource for teachers and students. The Raspberry Pi is also finding its way into many homes, where people of all ages (from children to adults) are using it for education and entertainment.

Icons Used in This Book

If you've read other *For Dummies* books, you know that they use icons in the margin to call attention to particularly important or useful ideas in the text. In this book, we use four such icons:

The Tip icon highlights expert shortcuts or simple ideas that can make life easier for you.

Although we'd like to think that reading this book is an unforgettable experience, we've highlighted some points that you might want to particularly commit to memory. They're either important takeaways, or they're fundamental to the project you're working on.

As you would do on the road, slow down when you see a Warning icon. It highlights an area where things could go wrong.

Arguably, the whole book talks about technical stuff, but this icon highlights something that's *particularly* technical. We've tried to avoid unnecessary jargon and complexity, but some background information can give you a better understanding of what you're doing, and sometimes we do need to get quite techy, given the sophistication of the projects you're doing. Paragraphs highlighted with this icon might be worth rereading, to make sure you understand, or you might decide that you don't need to know that much detail. It's up to you!

Beyond the Book

In addition to what you're reading right now, this book comes with a free access-anywhere Cheat Sheet with tips on installing software and using Scratch. To get this Cheat Sheet, simply go to `www.dummies.com` and type **Raspberry Pi Dummies Cheat Sheet** in the Search box.

Also be sure to check out this book's companion website (www.dummies.com/go/raspberrypifd4e), where you can download the code listings that appear throughout this book.

Both of us maintain our own personal websites too, which contain some additional information on the Raspberry Pi. Mike's is at www.thebox.myzen.co.uk/Raspberry/Punnet.html, and Sean's is at www.sean.co.uk.

Where to Go from Here

It's up to you how you read this book. It's been organized to take you on a journey from acquiring and setting up your Raspberry Pi to learning the software that comes with it, and from writing your own programs to finally creating your own electronics projects. Some chapters build on knowledge gained in earlier chapters, especially the sections on Scratch and Python — and all of Part 5.

We understand, though, that some projects or topics might interest you more than others, and you might need help in some areas right now. When a chapter assumes knowledge from elsewhere, we include cross-references to help you quickly find what you might have missed. We also include some signposts to future chapters, so you can skip ahead to a later chapter if it provides the quickest answer for you.

If you haven't set up your Pi yet, start with Part 1. If you have your Pi up and running, Part 2 shows you how to use the software on it. Part 3 covers productivity, creativity, and entertainment software. To flex your programming muscles, perhaps for the first time, read Part 4. You can learn Scratch, Python, or Sonic Pi here, and feel free to start with any one of those languages. The Python chapters provide a good foundation for Part 5, where you can start building your own electronics projects.

1 Setting Up Your Raspberry Pi

IN THIS PART . . .

Get to know the Raspberry Pi and what other equipment you will need to be able to use it.

Download the Linux operating system and prepare a microSD card for use on your Raspberry Pi.

Connect your Raspberry Pi to the power, keyboard, mouse, and screen.

Install and test the Raspberry Pi Camera Module.

Change the settings on your Raspberry Pi.

IN THIS CHAPTER

- Getting up close and personal with the Raspberry Pi
- Taking stock of your Raspberry Pi
- Purchasing your very own Raspberry Pi
- Figuring out what else you need

Chapter 1

Introducing the Raspberry Pi

The Raspberry Pi is perhaps the most inspiring computer available today. Although most of the computing devices being used (including phones, tablets, and game consoles) are designed to stop people from tinkering with them, the Raspberry Pi is exactly the opposite. It invites you to prod it, play with it, and create with it. It comes with the tools you need to start creating your own software (or *programming*), and you can connect your own electronic inventions to it. Some models are cheap enough that breaking them won't break the bank, so you can experiment with confidence.

Lots of people are fired up about the Raspberry Pi's potential, and they're discovering exciting new ways to use it. Dave Akerman (`www.daveakerman.com`) and friends attached one to a weather balloon and sent it nearly 40 kilometers high to take pictures of the Earth from near space using a webcam. (You can read about Dave's ballooning project in Chapter 20.)

Professor Simon Cox and his team at the University of Southampton connected 64 Raspberry Pi boards to build an experimental supercomputer, held together by Lego bricks. In the supercomputer (see Figure 1-1), the Raspberry Pis work together to solve a single problem. The project has been able to cut the cost of a supercomputer from millions of dollars to thousands or even hundreds of dollars, making supercomputing much more accessible to schools and students. Others

have also experimented with combining the processing power of multiple Pis. There's even an off-the-shelf kit you can use to combine four Raspberry Pi Zeros with a full-size Raspberry Pi (the Cluster HAT from Pimoroni) so that you can experiment with running programs across multiple Pis at the same time.

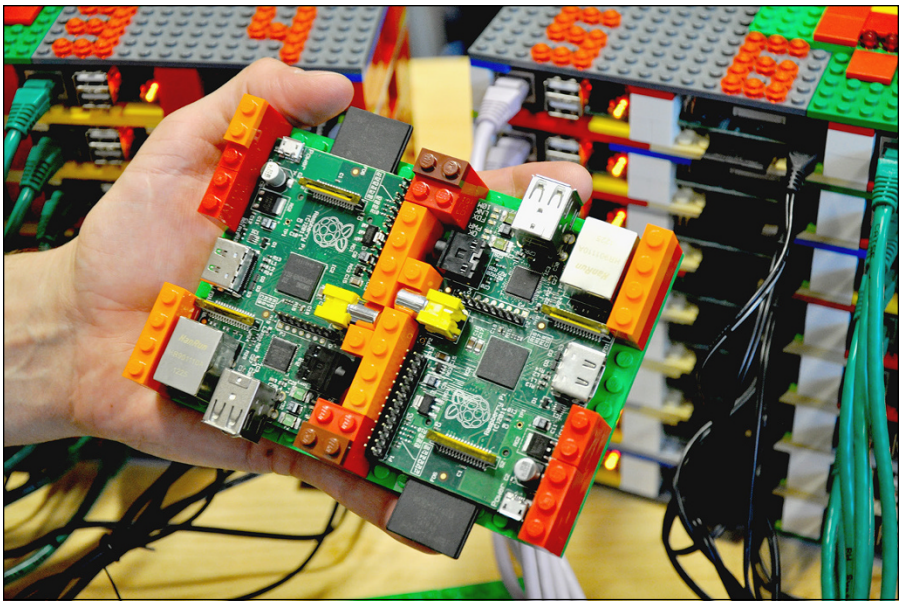

FIGURE 1-1: Two of the Raspberry Pi boards used in the University of Southampton's supercomputer, with the rest of the supercomputer in the background.

Courtesy of Simon Cox and Glenn Harris, University of Southampton.

The Pi is also being used to make fitness gadgets, gaming devices, electric skateboards, and much more, as you discover in Chapter 20.

Although those projects are grabbing headlines, another story is less visible but more important: the thousands of people of all ages who are taking their first steps in computer science, thanks to the Raspberry Pi.

Both of the authors of this book used computers in the 1980s, when the notion of a home computer first became a reality. Back then, computers were less friendly than they are today. When you switched them on, you were faced with a flashing cursor and had to type something in to get it to do anything. As a result, though, a whole generation grew up knowing at least a little bit about how to give the computer commands, and how to create programs for it. As computers started to use mice and windows, people didn't need those skills any more, and they lost touch with them.

Eben Upton, designer of the Raspberry Pi, noticed the slide in skill levels when he was working at Cambridge University's computer laboratory in 2006. Students

applying to study computer science started to have less experience with programming than students of the past did. Upton and his university colleagues hatched the idea of creating a computer that would come supplied with all the tools needed to program it — and would sell for a target price of $25 (about £20). It had to be able to do other interesting things, too, so that people were drawn to use it, and it had to be robust enough to survive being pushed in and out of school bags hundreds of times.

That idea started a six-year journey that led to the Raspberry Pi you probably have on your desk you as you read this book. It was released in February 2012, and sold half a million units by the end of the quarter. By July 2017, there were more than 14 million Raspberry Pis in homes, schools, and workplaces, 10 million of them made in the UK. More than 30 million Raspberry Pi computers have now been sold. It is, by a large margin, the best-selling British computer of all time.

Introducing the Raspberry Pi Range

Over the years, the Raspberry Pi has evolved, increasing its memory, improving its performance, and adding features. So which one should you get? Here's an overview designed to help you decide.

Raspberry Pi 4 Model B

This model is a circuit board with components and sockets stuck on it, as shown in Figure 1-2. In an age when most computing devices are sleek and shiny boxes, the spiky Pi, with tiny codes printed in white all over it, seems alien. That's a big part of its appeal, though: Many of the cases you can buy for the Raspberry Pi are transparent because people love the look of it.

The Raspberry Pi 4 is the latest Raspberry Pi board. It features the following:

- Up to 8GB of memory
- Four USB ports (two USB 2 ports and two higher-speed USB 3 ports)
- Built-in Wi-Fi and Bluetooth and a Gigabit Ethernet port for a wired Internet or network connection
- A headphones-style audio-out socket
- 40 general-purpose input/output (GPIO) pins, which you can use to connect your own electronics projects or specially designed add-ons (see Chapter 21)

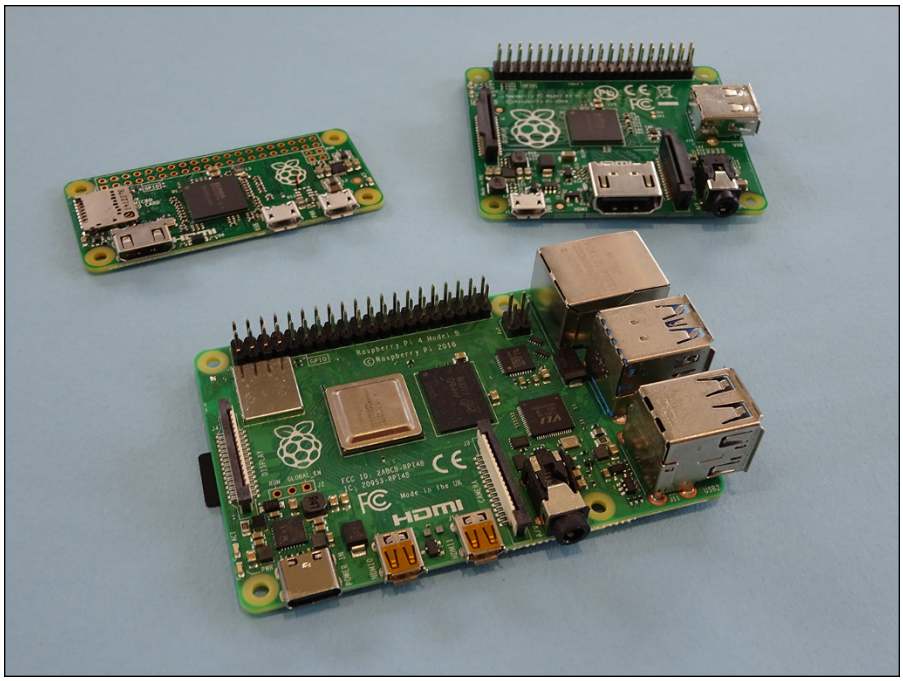

FIGURE 1-2: The Raspberry Pi 4 Model B (center), Model A+ (top right), and Pi Zero W (top left).

- Support for two monitors at resolutions of up to 4K
- Compatibility with the Raspberry Pi Camera Module
- Power over Ethernet (PoE) support when used with the Raspberry Pi PoE HAT, which enables you to use your Ethernet cable for both networking and powering your Pi

Like previous Pi models, the Raspberry Pi 4 is about the size of a deck of cards. As with any current Raspberry Pi, it uses a microSD card for storage. Its price is around $35 for 2GB of memory or $75 for 8GB of memory.

The Raspberry Pi Desktop Kit is also available, which includes the accessories you'll need, except for the monitor.

The Raspberry Pi 4 is our recommendation for the most powerful budget-friendly Raspberry Pi. You may be able to use it with your own keyboard and mouse to save money. The GPIO pins are great for electronics projects.

TECHNICAL STUFF

It's called the Model B, incidentally, as a tribute to the BBC Microcomputer that was popular in the UK in the 1980s. It's sobering to think that the BBC Micro cost about ten times the price of a Raspberry Pi, which, thanks to 40 years of progress in computer science, has more than 15,600 times more memory.

Raspberry Pi 400

The Raspberry Pi 400 (see Figure 1-3) takes even more inspiration from the classic computers of the '80s by building the Raspberry Pi 4 computer into a computer keyboard. It makes the whole setup much more compact, because you don't have the separate Pi unit on the table, with a cable going to the keyboard.

FIGURE 1-3: The Raspberry Pi 400 hides the computer inside the keyboard.

There are performance improvements, too. The Raspberry Pi 400 is faster than the Raspberry Pi 4, and it's designed with passive cooling built in.

The Raspberry Pi 400 is a white keyboard, with all the sockets on the back of it. It features the following:

- 4GB of memory.
- Three external USB ports (one USB 2 port and two higher-speed USB 3 ports). This is fewer than the four ports you get on a Raspberry Pi 4. The fourth port is used to connect the keyboard inside the case.
- Built-in Wi-Fi and Bluetooth and a Gigabit Ethernet port for a wired Internet or network connection.

- 40 GPIO pins, but these are on the back of the case, not on the top surface. You'll need to use an extension cable or board to use the pins easily and to use add-on boards (see Chapter 21). Although add-on boards can be connected directly, few will work well because their top surface will face away from you.
- Support for two monitors at resolutions of up to 4K.
- No compatibility with the Raspberry Pi Camera Module. You can use a USB camera, as you can on any Raspberry Pi computer.

There is no audio out socket, so you'll need to pass audio through your monitor.

The Raspberry Pi 400 costs $70. The Raspberry Pi 400 Personal Computer Kit adds the accessories you'll need, except for the monitor. The Raspberry Pi 400 is a fantastic value, but it's more expensive than the bare board. We recommend the Raspberry Pi 400 if your budget will bear it and you plan to use the Raspberry Pi as a desktop computer. For electronics projects, we find the bare board easier to use.

TIP

The official Raspberry Pi keyboard and the Raspberry Pi 400 look the same. If you have both on your desk, put a sticker on one of them; otherwise, you'll waste time trying to use the wrong one!

Raspberry Pi 3 Model A+

The Model A+ is a cut-down bare-board Raspberry Pi. It's useful for projects that need lower power consumption — typically battery-based projects. It is suitable for robots and projects in remote locations, where a wired electricity supply isn't viable and batteries must be used instead.

It features the following:

- 512MB of memory
- One USB 2 port
- Built-in Wi-Fi and Bluetooth
- A headphones-style audio-out socket
- 40 GPIO pins
- Compatibility with the Raspberry Pi Camera Module