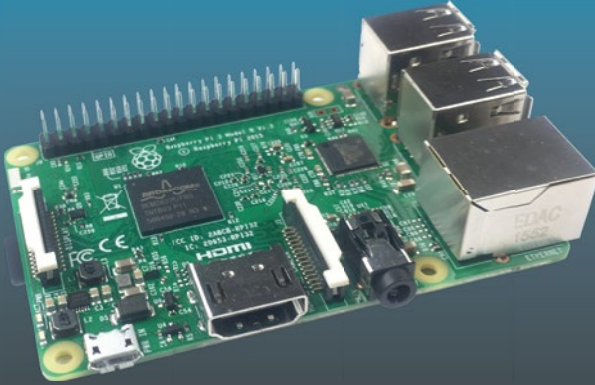


TECHNOLOGY IN ACTION™



Deploying Raspberry Pi in the Classroom



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Guy Hart-Davis

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Deploying Raspberry Pi in the Classroom



Guy Hart-Davis

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Deploying Raspberry Pi in the Classroom

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About the Author



Guy Hart-Davis is the author of more than 100 computer books, including *Learn Office 2016 for Mac*, *Learn Excel 2016 for Mac*, and *Pro Office for iPad*.

About the Technical Reviewer



Massimo Nardone has more than 22 years of experiences in security, web/mobile development, and cloud and IT architecture. His true IT passions are security and Android.

He has been programming and teaching how to program with Android, Perl, PHP (Hypertext Preprocessor), Java, VB (Visual Basic), Python, C/C++, and MySQL (Structured Query Language) for more than 20 years.

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- SPi Global for creating the index

Introduction

The Raspberry Pi has become a computing phenomenon. This single-board miniature computer, first released in February 2012 by the Raspberry Pi Foundation, has grown into a series of nearly a dozen models that have sold a total of more than 10 million units in five years.

Inexpensive to buy and to run, Raspberry Pi computers are great for enthusiasts, good for games, and fun for children. Raspberry Pi computers are also terrific in the classroom, enabling you to put on each desk an easily-manageable computer on which students can do everything from learning Internet use and essential office software skills, through grasping programming basics in an easy-to-learn format, to performing full-on programming in Python, Java, C, and other languages. Better yet, you can install all the software needed for those activities automatically alongside the operating system.

Who Is This Book For?

This book is for anybody who's looking to deploy Raspberry Pi computers in a classroom or lab situation.

Most likely you're a teacher or educator in a school or college, and that's the scenario this book and its examples aim at. But even if your situation and aims for deploying multiple Raspberry Pi computers are different, you'll find useful information in this book. For example, you might run a community computing club providing Internet access, or you might offer private computing lessons to small groups.

What Does This Book Cover?

This book contains eight chapters that take you from planning a classroom deployment of Raspberry Pi computers to managing the classroom and troubleshooting the computers.

Chapter 1, "Planning Your Raspberry Pi Classroom Deployment," walks you through planning your deployment of Raspberry Pi computers in your classroom or lab. The chapter briefly discusses what the Raspberry Pi boards are, the capabilities of the computers that you can build with them, and what Raspberry Pi computers are suitable for in the classroom. The chapter also discusses the key questions you will likely need to research and answer in order to plan your Raspberry Pi deployment: How you will use the Raspberry Pi computers, which ones to get, which operating system or systems to install, how to manage the computers, and so on.

Chapter 2, “Choosing Raspberry Pi Hardware,” discusses the hardware you’ll typically want for deploying a fleet of Raspberry Pi computers in a classroom. First, you’ll need the Raspberry Pi boards, plus essential hardware—such as power sources, SD cards, and cases—to turn the boards into working computers. Next, you’ll need peripherals, such as displays, keyboards, and pointing devices; your educational establishment may have some or all of these, so the chapter covers how to get existing (and possibly legacy) peripherals working with your Raspberry Pi computers. Last, you’ll need wired (Ethernet) or wireless (Wi-Fi) network connections for the Raspberry Pi computers.

Chapter 3, “Choosing Operating Systems for Raspberry Pi,” lays out your main choices of operating systems. Raspberry Pi computers can run an impressive range of operating systems, most of which are based on the widely used Linux operating system. The Raspberry Pi Foundation provides a helpful installer called NOOBS (New Out Of Box Software) that enables you to install not only Raspbian, the version of Linux customized for the Raspberry Pi, and Raspbian Lite but also two media-center operating systems—LibreELEC and OSMC—and Windows 10 IoT Core, a version of Windows for building projects and apps for devices. Beyond these, you can install other Linux desktop operating systems, Linux server operating systems, the blazing fast but rather limited RISC OS, and versions of the UNIX-like BSD operating system.

Chapter 4, “Brief Tutorial on Raspberry Pi Essentials,” makes sure you know how to use and configure a Raspberry Pi computer running the Raspbian operating system. The chapter covers everything from startup, shutdown, and restart to configuring your pointing device, keyboard, and network connection; using the Raspberry Pi Configuration tool to configure the Raspberry Pi; navigating and customizing the desktop, exploring the file system using the File Manager app, and configuring File Manager to work the way you prefer.

Chapter 5, “Building the Raspberry Pi Computers and Installing Software,” discusses how to build your Raspberry Pi computers—essentially, putting the Raspberry Pi boards into the cases you’ve chosen—and how to install operating systems on them. The chapter shows you how to get the NOOBS installer, use it to install Raspbian and the other operating systems that NOOBS supports, and how to perform “headless” installs on remote computers using Virtual Network Computing (VNC). You also learn how to use Recovery Mode and how to perform advanced moves with NOOBS, such as installing an operating system automatically and creating a custom version of Raspbian for your school.

Chapter 6, “Connecting the Raspberry Pi Computers to the Network,” shows you how to set up your Raspberry Pi computers in your classroom or lab, connect them to your establishment’s network, and verify that the computers and the network are working to your satisfaction. Coverage includes setting hostnames and static IP addresses and connecting to Wi-Fi networks.

Chapter 7, “Administering and Managing Your Raspberry Pi Network,” shows you how to run your Raspberry Pi network either individually or by using the free PiNet server system. You’ll learn how to create user accounts, how to set up remote access to computers you want to administer remotely, how to install and configure PiNet, and how to control your computers—and maybe your students—using the free Epopotes classroom-management app.

Chapter 8, “Troubleshooting Raspberry Pi Computers in the Classroom,” shows you how to deal with the problems you’re most likely to encounter with Raspberry Pi computers deployed in classroom situations. The chapter starts by recommending a restart-and-replace strategy designed to keep your classroom functioning smoothly and avoid disruption from trying to troubleshoot problems that seem minor but turn thorny. The chapter then covers how to keep the system software on Raspberry Pi computers up to date; how to deal with issues involving startup, SD cards, and network connections; and how to resolve problems with displays, keyboards and pointing devices, and audio output.

The Appendix, “Raspberry Pi Resources and Training for Educators,” gives you brief lists of resources for deploying, running, and managing Raspberry Pi computers, plus information on training for educators.

Involving Your Students

One of the great things about Raspberry Pi computers is that they’re well suited to having students build them and set them up as well as simply use them as classroom computers. So this book suggests several points at which you may want to involve your students in setting up and maintaining your classroom deployment of Raspberry Pi computers. These include:

- **Building the Raspberry Pi computers.** Because each Raspberry Pi board contains a full computer system—processor, graphics processor, memory (RAM), networking, USB, and so on—which greatly reduces the potential for damage and mistakes. Building a Raspberry Pi computer involves only putting the Raspberry Pi board in a suitable case, not installing multiple sensitive components using a variety of technician tools.
- **Setting up the Raspberry Pi computers in the classroom.** Having students help you with setting up the Raspberry Pi computers at the workstations, distributing peripherals, and connecting the devices and cables can not only save you time but also develop students’ skills.
- **Testing the Raspberry Pi computers and the network.** After setting up the computers and the network, you can have students power on the computers and run through a list of tests that you specify, to make sure that the computers are running correctly and that they are able to access the Internet.

These are activities that many students should be capable of. But the Raspberry Pi computers also offer many other opportunities for you to involve your older or more able students. For example, you may want to have more advanced students learn to troubleshoot problems that occur frequently with Raspberry Pi computers, or at least have them replace failed (or problem) SD cards, peripherals, or computers when the need arises.

Additions and Errata

If you have suggestions for additions or improvements you'd like to see in future editions of this book, please send them in. Go to the Apress website (www.apress.com), enter this book's number (9781484223031) in the Search box, and click the Go button. Click the book's cover or the View Book button to get to the book's page.

Click the Errata tab to display a list of the errata and additions available so far. On this tab, you'll also find the e-mail address to which you can submit corrections or suggestions for additions or improvements.

CHAPTER 1



Planning Your Raspberry Pi Classroom Deployment

In this chapter, we'll quickly look at how to plan your deployment of Raspberry Pi computers in the classroom.

We'll begin by making sure you know what the Raspberry Pi is. After that, we'll examine what the capabilities of Raspberry Pi computers are and what Raspberry Pi computers are suitable for in the classroom. Last, we'll look at the key questions you will likely need to research and answer to plan your Raspberry Pi deployment in the classroom.

Understanding What the Raspberry Pi Is

Raspberry Pi is a family of computers designed by the Raspberry Pi Foundation, a UK-based charity. The Raspberry Pi Foundation has released multiple models of Raspberry Pi, each with somewhat different specifications. Each Raspberry Pi model uses a System on a Chip (SoC), a single microchip that contains all the essential components of a computer system; for the Raspberry Pi, the SoC contains a processor and a graphics processing unit (GPU).

Each of the Raspberry Pi models is the size of a credit card, except for the Raspberry Pi Zero, which is half that size. This book refers to the standard-size Raspberry Pi models as “full-size” to distinguish them from the half-size Raspberry Pi Zero. Figure 1-1 shows the Raspberry Pi 3 Model B, which is the latest full-size Raspberry Pi model as of this writing.

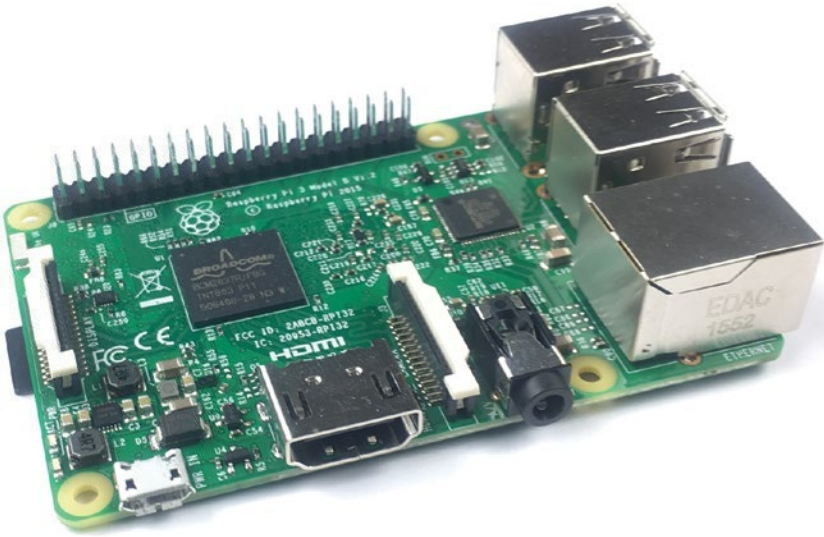


Figure 1-1. Each Raspberry Pi model comes as a complete system on a board. This is the Raspberry Pi 3 Model B.

Each Raspberry Pi model comes as a system on a board—a computer motherboard that has the processor, random access memory (RAM), graphics processor, network controller, USB (universal serial bus) controller, and so on built into it. The system is not upgradeable without technician-level skills.

Each Raspberry Pi board also has a wide variety of input and output connectors already connected to it, such as an HDMI (high-definition multimedia interface) connector for a monitor; USB ports for connecting keyboards, mice, and other devices; and an Ethernet port for connecting a network cable. So all you need do to turn a Raspberry Pi board into a complete central processing unit (CPU) is to put it in a case. You can then connect a monitor, keyboard, mouse, and other components to the Raspberry Pi. Figure 1-2 shows the Raspberry Pi 3 Model B in a clear acrylic case, looking from an angle that shows the Ethernet port and the four USB ports.



Figure 1-2. You can get a wide variety of cases for the Raspberry Pi models including clear cases and ones that give easy access to the internal ports.

■ **Note** It's possible to run the Raspberry Pi boards without a case, but normally you'd want to do so only in a lab setting. If you're planning to deploy Raspberry Pi computers in the classroom or in other locations in the wild, you'll need to put cases on them.

Understanding the Capabilities of Raspberry Pi Computers

Despite its diminutive size, the Raspberry Pi is a full-size computer capable of running a “proper” operating system. The Raspberry Pi Foundation supplies a customized operating system called *Raspbian* for the Raspberry Pi models, but you can install and run other operating systems as well if you prefer. Raspbian is based on the widely used Debian distribution of Linux.

■ **Note** Chapter 3 explains the main operating systems you can install and run on the Raspberry Pi models.

The standard-size Raspberry Pi models make a highly cost-effective solution for computing in schools, colleges, and clubs. The following subsections discuss some of the uses for which Raspberry Pi computers are suited.

The Raspberry Pi Zero *can* run desktop apps, but its diminutive size, fewer ports, and more limited connection options make it more suitable for projects. See the section “Planning and Executing Computing Projects,” later in this chapter for examples of projects for both full-size Raspberry Pi boards and Raspberry Pi Zero boards.

Learning Desktop Computing Skills

A Raspberry Pi computer running the Raspbian operating system is a great tool for learning standard desktop computing skills. For example, using a Raspberry Pi computer, students can learn to

- Perform standard operations such as starting up, logging in and out, shutting down, and restarting.
- Navigate the desktop, run apps, and manage windows. Figure 1-3 shows the default Raspbian desktop, which you’ll explore in detail in Chapter 4.
- Create documents using apps and manage files using the File Manager app.
- Browse the Web and communicate via e-mail.
- Work with the command-line interface either at the computer itself or by connecting via remote technologies such as Secure Shell (SSH).
- Connect peripherals and establish a network connection.
- Control services such as remote access and file sharing.
- Work remotely using the graphical interface via technologies such as Virtual Network Computing (VNC).

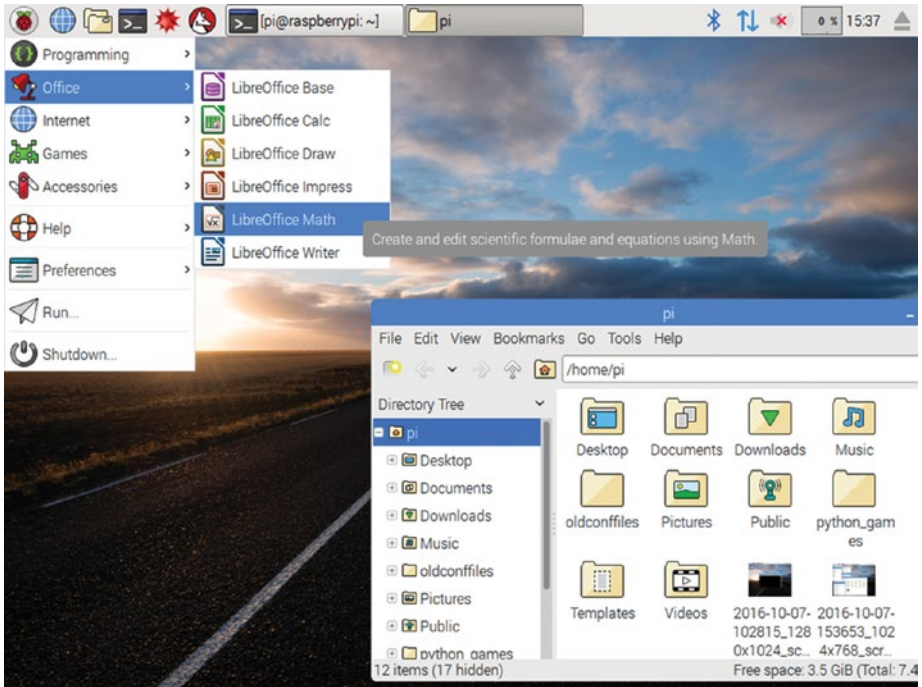


Figure 1-3. Raspbian's default desktop has a taskbar-like panel at the top of the screen and a Menu button that provides access to apps, settings, and commands.

■ **Note** The Raspbian interface varies somewhat between versions. Figure 1-3 shows the Raspbian version as of this writing (December 2016) in which the app windows have slightly rounded corners. Older versions of Raspbian, including those used by the PiNet server system (discussed in Chapter 7), have windows with square corners like those shown in some of the figures later in this chapter.

Learning Office Skills

Raspbian includes the LibreOffice software suite, which provides a full set of office apps for learning office skills such as word processing, creating spreadsheets, developing presentations, and building databases and entering data in them. LibreOffice contains the following six modules:

- *LibreOffice Base*: LibreOffice Base is a database app that enables you to build relational databases.

- *LibreOffice Calc*: LibreOffice Calc is a spreadsheet app that lets you develop spreadsheet-based workbooks for calculations and data processing. Figure 1-4 shows LibreOffice Calc.

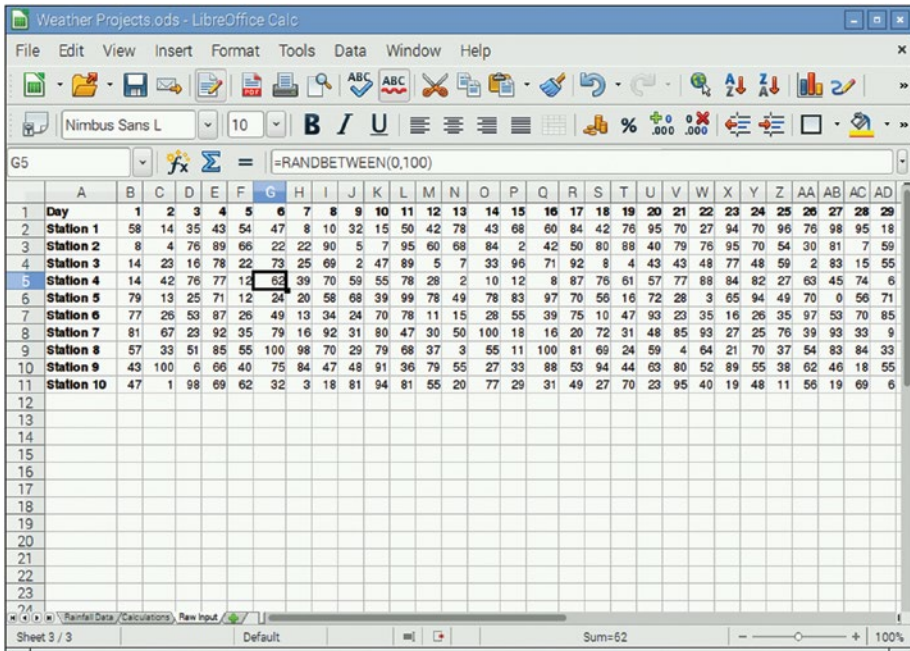


Figure 1-4. The LibreOffice office software suite includes the LibreOffice Calc app for creating spreadsheets.

- *LibreOffice Draw*: LibreOffice Draw is a drawing app that allows you to create diagrams, sketches, and plans.
- *LibreOffice Impress*: LibreOffice Impress is a presentation app that you can use to create slideshows and deliver presentations.
- *LibreOffice Math*: LibreOffice Math is a formula editor that enables you to create formulas and math elements for inclusion in your documents, spreadsheets, and presentations.
- *LibreOffice Writer*: LibreOffice Writer is a word-processing app that lets you create anything from short documents to long and complex documents including graphics, tables of contents, indexes, and other features.

The LibreOffice suite is a great tool for students to master because not only is it free, but it also runs on Windows and on the Mac as well as on Linux. So any student with a computer at home can use LibreOffice at home as well as at school. The LibreOffice modules don't have every single feature that their Microsoft Office equivalents have, but they have more than enough features for most needs, whether at home, at school, or at work.

LIBREOFFICE PROVIDES COMPATIBILITY WITH MICROSOFT OFFICE

Each LibreOffice app has a native file format; for example, the Writer app's native file format is called *ODF (Open Document Format) Text Document*, and the Calc app's native file format is called *ODF Spreadsheet*. But the LibreOffice apps also have impressively high compatibility with the Microsoft Office file formats, not to mention compatibility with other widely used formats (such as HTML).

For example, the Writer app can open documents in Microsoft Word's .docx format and .doc format and can save documents in these formats; similarly, the Calc app can open and save files in Excel's .xlsx and .xls file formats; and the Impress app can open and save files in PowerPoint's .pptx and .ppt file formats.

Learning the Essentials of Programming with Scratch

Raspbian includes the Scratch tool for teaching the fundamentals of programming in an engaging and accessible environment. Scratch was developed by the Lifelong Kindergarten Group at the Massachusetts Institute of Technology (MIT) Media Lab as a tool for teaching youngsters, but it works effectively for all ages. You can use Scratch inside or outside the classroom as a first step to grasping programming concepts without having to worry about syntax. Figure 1-5 shows the Scratch interface.

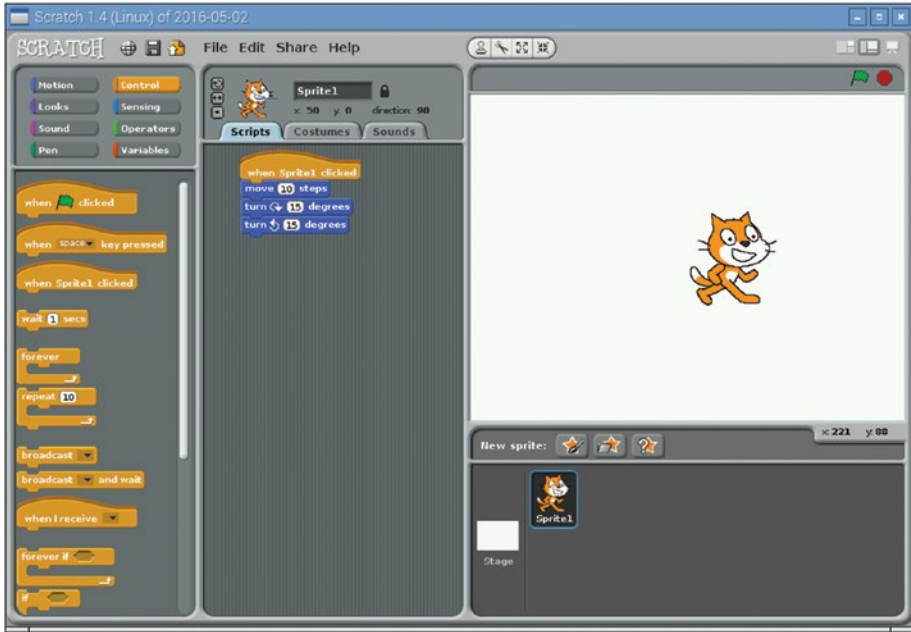
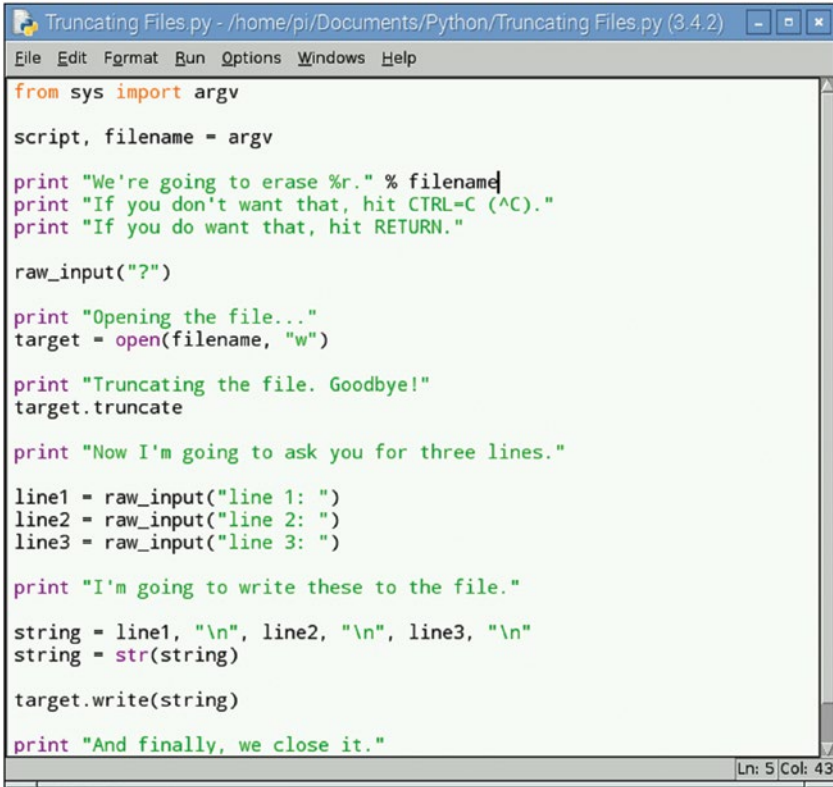


Figure 1-5. Scratch is an easy-to-grasp and graphical tool for coming to grips with the essentials of programming.

Programming in Python

Raspbian includes integrated development environment (IDE) apps for programming in Python, a programming language widely used for purposes such as 2-D games, web applications, and small databases. As of this writing, Raspbian includes versions of the IDLE (Integrated Development and Learning Environment) IDE for Python 2 and for Python 3. Figure 1-6 shows a Python script open in the IDLE IDE.


 A screenshot of the IDLE Python IDE. The title bar reads 'Truncating Files.py - /home/pi/Documents/Python/Truncating Files.py (3.4.2)'. The menu bar includes 'File', 'Edit', 'Format', 'Run', 'Options', 'Windows', and 'Help'. The code editor contains the following Python code:


```

from sys import argv

script, filename = argv

print "We're going to erase %r." % filename
print "If you don't want that, hit CTRL-C (^C)."
print "If you do want that, hit RETURN."

raw_input("?")

print "Opening the file..."
target = open(filename, "w")

print "Truncating the file. Goodbye!"
target.truncate()

print "Now I'm going to ask you for three lines."

line1 = raw_input("line 1: ")
line2 = raw_input("line 2: ")
line3 = raw_input("line 3: ")

print "I'm going to write these to the file."

string = line1, "\n", line2, "\n", line3, "\n"
string = str(string)

target.write(string)

print "And finally, we close it."
  
```

 The status bar at the bottom right shows 'Ln: 5 Col: 43'.

Figure 1-6. Raspbian includes the IDLE integrated development environment for coding in Python 2 and Python 3.

Programming in Java

Raspbian includes two apps for programming in Java:

- *BlueJ*: BlueJ is an editor for creating code and working with objects. Figure 1-7 shows BlueJ with one of its sample projects open.

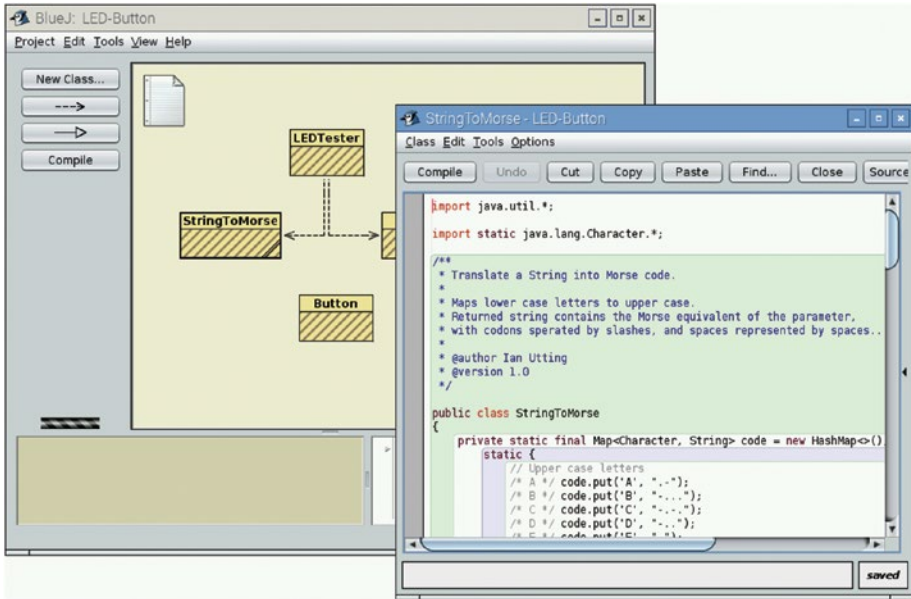


Figure 1-7. BlueJ is an editor for programming in Java.

- **Greenfoot:** Greenfoot is an IDE for building Java scenarios. Figure 1-8 shows Greenfoot with one of its sample projects, lunarlander, open and running.