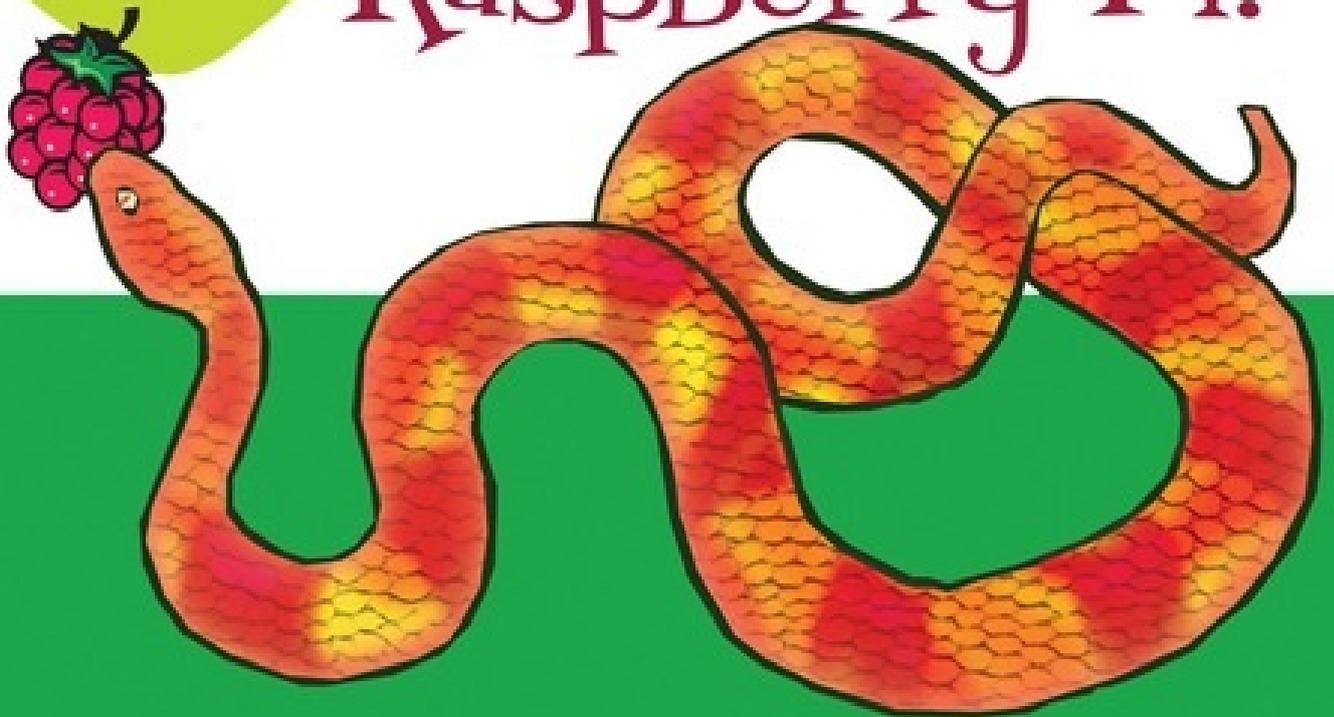


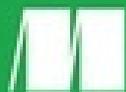
Python programming for kids and other beginners

Hello

Raspberry Pi!™



Ryan Heitz



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# Hello Raspberry Pi!: Python programming for kids and other beginners

Ryan Heitz



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# Dedication

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To Juliana, Daniel, and John

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# Preface

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In 2013, a parent and friend of mine asked if I would teach a Python course to middle school students at a local school. My friend gently asked if I could somehow use the Raspberry Pi computer in the course. I love learning new things and I had been reading a lot about the Raspberry Pi. So as you can imagine, I was tremendously excited at the opportunity of using it and emphatically said “Yes!” That event began my journey of developing a course for kids on programming in Python and using the Raspberry Pi and later, this book.

Quickly, as I worked with the Raspberry Pi, I became a disciple of the Raspberry Pi inventors: the best way for kids to learn programming is by giving them an affordable, ready-to-program computer. It was the perfect platform to learn how to program.

As a teacher of computer science, I grew to deeply appreciate Python. I became convinced that it was not only a great programming language, but its focus on readability and simplicity made it perfect for kids to learn as their first programming language.

Fast forward in time—after teaching Python using the Raspberry Pi to many classes of kids, I had developed a set of engaging and funny projects that the kids enjoyed. Just as important, the students learned! The feedback from the kids and the parents was fantastic! Imagine kids rushing to take part in a programming class. It was wonderful!

A few months after developing my course, Nicole Butterfield and Robin de Jongh of Manning Publications contacted me about turning it into a book. I was thrilled at the prospect of bringing the activities and projects from the computer lab into the hands of kids everywhere. What is more, this book would fill an important gap. What I had found when I originally started teaching my course was that there were no books on the Raspberry Pi and programming in Python that were designed for kids. Since the main reason for inventing the Raspberry Pi was to get more kids programming, I was enthusiastic to work on this project.

Nearly two years later, and several versions of the Raspberry Pi later, I’m proud to present this book to the kids and other beginners who want to learn to program. I hope you enjoy using this book and it starts you on your own journey in computer science!

# Acknowledgments

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Thank you to my wife, Juliana, and our two children, Daniel and John, for their endless support and patience through the long days, nights, and weekends I needed to write this book.

I'd also like to thank Manning Publications for having the vision to pursue this project. In particular, thanks to Robin de Jongh and Nicole Butterfield who kicked off this project by finding and encouraging me; to publisher Marjan Bace for his commitment to me and to this book; to Ozren Harlovic for orchestrating the book review process; to Kevin Sullivan and Mary Piergies for overseeing production; to Chuck Larson for the wonderful work on the graphics; to Tiffany Taylor for her outstanding copyediting; to Alyson Brener for her thorough proofreading; to Candace Gillhoolley and Ana Romac for promoting the book; to technical development editors Donald Bailey, Joel Kotarski, Jeanne Boyarsky, and John Hyaduck; and to Romin Irani, technical proofreader.

This book was significantly improved by my editor at Manning, Dan Maharry, who helped to develop and edit the book from concept to finished product. I'd like to thank Dan for his excellent insights, support, encouragement, and guidance throughout the process.

A big thank you to all the technical reviewers who read the manuscript at various stages of its development and contributed invaluable feedback: Adam Hinden, Antonio Mas Rodriguez, Betsy Hoofnagle, Catherine Freytag, Dr. Christian Mennerich, Dan Kacendar, David Kerns, Ema Battista, Fanick Atchia, Grace Kacendar, Henry Freytag, Jaqueline Currie, John Pentakalos, Keenan Hom, Kevin Adjaho Atchia, Matthew Giblin, Nathan Sperry, Odysseas Pentakalos, Sam Kerns, Richard Freytag, Savannah Wilson, and Scott M. King.

Thank you also to all the readers who bought and read the MEAP (Manning Early Access Program) versions of the chapters and who took the time to post comments in the Author Online forum. You helped make this a better book!

The Raspberry Pi Foundation, original inventors, and community deserve a special mention. Thank you for designing something that is helping children to learn computer science. I'd also like to thank Guido van Rossum, the inventor of Python; the Python Software Foundation; and the Python user community, for creating and maintaining a simple and useful programming language for everyone.

# About this book

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The Raspberry Pi is a small, low-cost computer invented in the U.K. by the Raspberry Pi Foundation. It provides an easy-to-use tool for learning to program in Python. The Raspberry Pi, with its companion memory card, is preloaded with all the software you need to jump into programming in Python. The Raspberry Pi is made for you to learn to code by playing with it. It includes many input and output ports to give you flexibility in how you connect it. Much like a desktop computer, you need to connect a keyboard, mouse, monitor, and power cable to get started.

This book will teach you how to set up your Raspberry Pi, to write programs in Python, and to use your Raspberry Pi and Python to complete some projects. We'll cover the basics of Python: displaying text, gathering input, repeating commands, creating logic, as well as using the input and output pins of your Raspberry Pi for projects.

This book does not cover advanced Python topics, nor act as a comprehensive reference for Python. Since it is a book for beginners, these topics have been left out for clarity and brevity. If you'd like to learn more Python, there are links to online resources throughout the book.

This book is for kids and other beginners who would like to learn to program. It's also for kids who have a Raspberry Pi and want to learn what they can do with it. We'll introduce you to your Raspberry Pi and teach you Python in a natural, playful way, introducing topics and giving you activities to do using your Raspberry Pi. You don't need to have any prior programming experience. As long as you know how to use a mouse and open up programs by clicking on icons or menu items, you'll do great.

This book requires a Raspberry Pi, cables, and some other parts to complete the projects and activities. These items are needed throughout the book:

- Raspberry Pi 2 Model B
- 8 GB SD memory card, preloaded with the Raspberry Pi Foundation's NOOBS (New Out of the Box Software)
- USB power supply with micro USB cable (must deliver 1.2 A @ 5 V)
- USB keyboard
- USB mouse
- TV or monitor
- Cable to connect to TV or monitor (specific cables for your TV or monitor are discussed in [chapter 1](#))

To complete the projects in [part 3](#), you'll also need these parts:

- Solderless breadboard
- GPIO ribbon cable for the Raspberry Pi 2 Model B (40 pin)
- GPIO breakout board
- 1 dozen jumper wires, male-to-male
- 1 red LED (light-emitting diode)
- 1 green LED
- 1 blue LED

- 1 red, green, blue (RGB) LED
  - ~~3 push buttons~~
  - 3 resistors, 10K ohm
  - 3 resistors, 180 ohm (or between 100 and 300 ohms)
  - Headphones or powered computer speakers
- 

You can typically find all these items in a Raspberry Pi starter kit or available individually through online retailers and stores that sell the Raspberry Pi, such as CanaKit, Sparkfun, or Adafruit.

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# Roadmap

This book is divided into three parts.

[Part 1](#) introduces you to the Raspberry Pi, shows you how to set it up, and provides an introduction to the Python programming language:

- [Chapter 1](#) provides an overview of the Raspberry Pi and how to set it up for the first time.
- [Chapter 2](#) shows you how to write your first Python programs and introduces you to doing math and displaying text with Python.

[Part 2](#) shows you how to build different text-based games while learning how to gather input, display information, make decisions, and repeat instructions in Python:

- [Chapter 3](#) teaches you how to create your first interactive Python game, the Silly Sentence Generator 3000, by asking users to type in something and then displaying funny messages to the screen.
- [Chapter 4](#) explores how to give your programs logic and use repeating loops as you create a Norwegian Blue Guessing Game.
- [Chapter 5](#) demonstrates how to build a Cave Adventure Game, give users multiple choices, check input from users, and create your own Python functions.

[Part 3](#) involves making your Raspberry Pi interact with the world around it:

- [Chapter 6](#) explains setting up your Pi with an electronics breadboard, building a simple circuit, and controlling an LED (light) using your Raspberry Pi and Python.
- [Chapter 7](#) dives into creating an interactive guessing game that uses lights to respond to a player's input, letting them know with different colors whether their answer is right or wrong.
- [Chapter 8](#) teaches you how to listen to your Pi's input pins by making a project that combines light and sound to make your own DJ Raspi sound mixer.

---

## Code conventions and downloads

All source code in this book is in a `fixed-width font like this`, which sets it apart from the surrounding text. In many listings, the code is annotated to point out key concepts. I have tried to format the code so that it fits within the available page space in the book by adding line breaks and using indentation carefully.

The code accompanying this book is hosted at the GitHub repository: <https://github.com/rheitz/hello-raspberry-pi>. It is also available for download as a zip file from the publisher's website at [www.manning.com/books/hello-raspberry-pi](http://www.manning.com/books/hello-raspberry-pi).

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## Author Online

Purchase of *Hello Raspberry Pi!* includes free access to a private web forum run by Manning Publications where you can make comments about the book, ask technical questions, and receive help from the author and other users. To access the forum and subscribe to it, point your web browser to [www.manning.com/books/hello-raspberry-pi](http://www.manning.com/books/hello-raspberry-pi). This Author Online (AO) page provides information on how to get on the forum once you're registered, what kind of help is available, and the rules of conduct on the forum.

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The AO forum and the archives of previous discussions will be accessible from the publisher's website as long as the book is in print.

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## About the author

Ryan Heitz is a teacher, programmer, maker, father, and big kid. He is the cofounder of Ideaventions a Science Center for kids, and Ideaventions Academy for Mathematics and Science, a private school focused on science and technology. He specializes in teaching kids how to experience computer science in a fun and engaging way. As a programmer, Ryan has developed software for everything from NASA data collection systems to web mapping applications.

# Part 1. Getting started

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Get ready to explore Python using your Raspberry Pi! You'll need a Raspberry Pi and a few other parts and cables for [part 1](#). Here's your shopping list:

- Raspberry Pi 2 Model B
- 8 GB SD memory card, preloaded with the Raspberry Pi Foundation's NOOBS (New Out Of the Box Software)
- USB power supply with micro USB cable (must deliver 1.2 A @ 5 V)
- USB keyboard
- USB mouse
- TV or monitor
- Cable to connect to TV or monitor (specific cables for your TV or monitor are discussed in [chapter 1](#))

Optional item:

- Raspberry Pi case

[Part 1](#) will get you on your way to using your Raspberry Pi and launch you into programming it with Python. In [chapter 1](#), you'll set up your Raspberry Pi, learn how to start (or boot) it up, and then look around inside the Pi's desktop. [Chapter 2](#) is where you'll start exploring the Python language. You'll create your first programs and learn to give instructions to your Raspberry Pi using Python.

By the end of [part 1](#), you'll know how to get a Raspberry Pi up and running. You'll be able to write a Python program and interact with your Pi to make it do things like figure out the cost of a cheeseburger meal and display silly messages on the screen.

# Chapter 1. Meet Raspberry Pi

---

**In this chapter, you'll learn how to**

- *Set up your Raspberry Pi*
- *Install an operating system—Raspbian—on your Pi*
- *Find and open applications*
- *Write your first bit of code in Python*

What kinds of things do you think you can do with a Raspberry Pi?

1. Play games.
2. Watch videos.
3. Create a video game.
4. Listen to music.
5. Make a sound mixer for a dance party.
6. Build a robot.

Believe it or not, these are all projects you can do yourself, and if you learn to program in Python, the sky is the limit. You can achieve quite a lot on your Pi, as long as you can write a program to do it. But before we talk about that, let's take a look at a Raspberry Pi and discover what makes it tick.

---

## What is the Raspberry Pi?

The *Raspberry Pi*, sometimes referred to as the *Pi*, is a small, low-cost computer invented in the U.K. by the Raspberry Pi Foundation. It provides an easy-to-use tool to help you learn to code in Python (the *Pi* part of its name came from the focus on using it to code in Python).

About the size of a deck of cards, it isn't as powerful as a laptop or desktop computer; its computing power is more similar to that of a smart phone. But what it lacks in processing power, it makes up for in its many features:

- Its readiness for programming in Python
- The many ways you can use it
- Its small size and cost

The Pi, with its companion memory card, is preloaded with all the software you need to jump into programming in Python. Type in commands, and see what happens. Enter a program you find on the internet or in a magazine, run it, and see how it works. The Pi is made for you to learn to code by playing with it, using it, and interacting with it.

Once you learn to program in Python, you can use your Pi as a base for all sorts of projects—with your imagination, the possibilities are endless! The Pi's small size makes it easy to carry around and include in projects. Hide it on a shelf or mount it on a wall with a camera to make a security system; power it with a rechargeable battery pack if you need it to be portable; or even attach it to a remote-controlled car or helicopter. And if you happen to mess something up, it's simple to recover. Even if you manage to break the Pi, it's pretty cheap to replace.

At its core, the Raspberry Pi is a circuit board that has all the components found in many computers. The next section checks out the components of the Pi and explores what they do. Let's go!

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