Building Telegram Bots

Develop Bots in 12 Programming Languages using the Telegram Bot API

Nicolas Modrzyk

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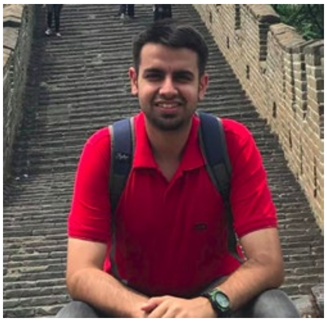
About the Author

Nicolas Modrzyk has more than 15 years of IT experience in Asia, Europe, and the United States and is currently CTO of an international consulting company in Tokyo, Japan. He is the author of four other published books, mostly focused on the Clojure language and expressive code. When not bringing new ideas to customers, he spends time with his two fantastic daughters, Mei and Manon, and playing live music internationally.

About the Technical Reviewers



Dushyant Rathore is currently working as a firmware engineer with Western Digital. His experience includes full-stack web development, machine learning, decentralized applications, and others. Dushyant has worked on several kinds of projects related to IoT, chatbots, web sites, scrapers, command-line tools, and machine learning projects, among others, at various startups. He has participated in national and international hackathons and has won a few of them. He is a big cloud computing enthusiast.

Sham Satyaprasad has been a full-stack software developer for more than four years, having completed a master's degree in embedded systems from Manipal University. He prides himself on writing highly efficient, readable, and maintainable code and strongly believes that coding is an art as much as it is science. Sham has recently developed a keen interest in NLP, ML, and data science and has been busy wrapping his head around these topics.

Acknowledgments

It’s been yet another typing race to get this book out on time and beat the odds. Divya and Nikhil, thank you so much for teaming up again. I’m really looking forward to our next collaboration!

I received support from so many people that it would take another book just to write the list of names. Nevertheless…

Thank you to my sister, Emily, my brother, Gregor, Mum and Dad, family, cousins, uncles, aunts, friends, Abe-san, Sawada-san, Gucci, Marshall, Momo, my soulmate Sachiko, soccer friends (I would break a knee for you), the Irish crew still enjoying Guinness (one more for me!), the awesome people in America (who always find the LPs I’m missing), Chris and the Biners, the French team that’s always there to support me, even without being asked, and the people deep in my heart, for your *never-ending* support. I could not have finished this without you. I appreciate you all so much.

And, of course, thank you to my two wonderful daughters, Mei and Manon, for keeping up and always doing your best, even during hard times. You rock! I love you.

Introduction

With a hundred ways to do a dozen things, why not try it all?

—Julian Casablancas

Have you ever wondered how you could accomplish more by doing less, how you could have a sort of double who does all the work while you enjoy some cool beachside or spend more outdoor time with your beautiful children? I always have.

I am a big fan of the Telegram chat platform. Let's call it a platform, because it is more than a simple chat service with which you can stay in touch with people who matter to you most. It also enables you to think in ways you haven't before.

For example, living in Tokyo, you always care about what time the last train home is going to depart. I guess most people in big cities around the globe probably have that same concern. Checking the clock only every so often can result in a terrible and/or expensive taxi ride, so I started wanting something that automatically offered me a bunch of options to get home.

The first bot I wrote was to tell me the schedule of the last few trains home and some different options, from the easiest to reach before the last few departures to the very latest, which I would have to dash to catch. That saved me quite a bit of money.

The second bot I wrote was slightly more IoT-oriented. It used a webcam to send me via Telegram pictures of people who rang my doorbell.

The third one, I also remember, was kind of stupid. It was to use a mini projector to display the most recent message coming through a Telegram chat room. (It's very entertaining to view random messages during a small party at home.)

But there are so many things for which to try to build a bot—search for a plane ticket, check your fridge, etc. Having a bot is a simple way to facilitate all the things you do daily, using the same kind of simple Telegram chat rooms to get answers to questions related to daily life or to issue commands and conquer the world.

This relatively short book is about learning how to write Telegram bots in several different programming languages. Why not use one and stick to it? you might ask. Well, because there's not one answer to all questions, and what's right for others might not be suitable for you. Exploring different programming languages is also a fun way to examine the strengths of each language while performing the same tasks. Each of the Telegram concepts can be introduced one after the other, in a simple fashion.

Or, you could just jump in and choose the language you want to try and get started in no time. Some people want it to happen; some wish it would happen; others make it happen. So, enjoy reading this book, and make it happen.

CHAPTER 1

Week 1: Ruby

Mindful Monday Humans, may your coffee kick in before reality does.

—Napz Cherub Pellazo

Ruby took the world by storm a while ago, owing to the ease and concision of the code you can write with it. Most programmers have a sweet spot for Ruby, and when their shell scripts and day-to-day lives get too messy, they are usually very quick to switch to Ruby.

This first chapter is a bit special, because on top of creating a client for our bot, I must also introduce you to how to create the bot itself. Throughout the book, this first bot will be reused at will, although, of course, the same steps used to make it could be used to create a bot army and conquer the world!

Chatting with the BotFather

To register your own Telegram bot, you must talk to the father of all bots. This bot father has a name, BotFather; Brad or Vladimir just doesn't cut it. He can be reached via Telegram as @BotFather.

BotFather does not sleep and can be reached at any time of day. BotFather does take showers and always looks fresh. Here is the last profile picture we have of this handsome bot (Figure 1-1).

N. Modrzyk, *Building Telegram Bots*, https://doi.org/10.1007/978-1-4842-4197-4_1

Figure 1-1. *BotFather's latest profile picture*

Finding BotFather is not so difficult; you just have to type his name, "@BotFather," in the Telegram list of people in the search box of your Telegram client (Figure 1-2).

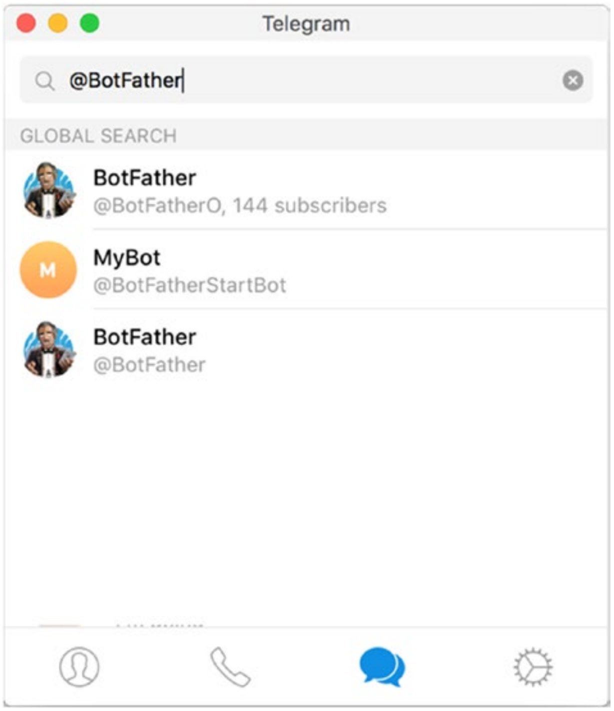
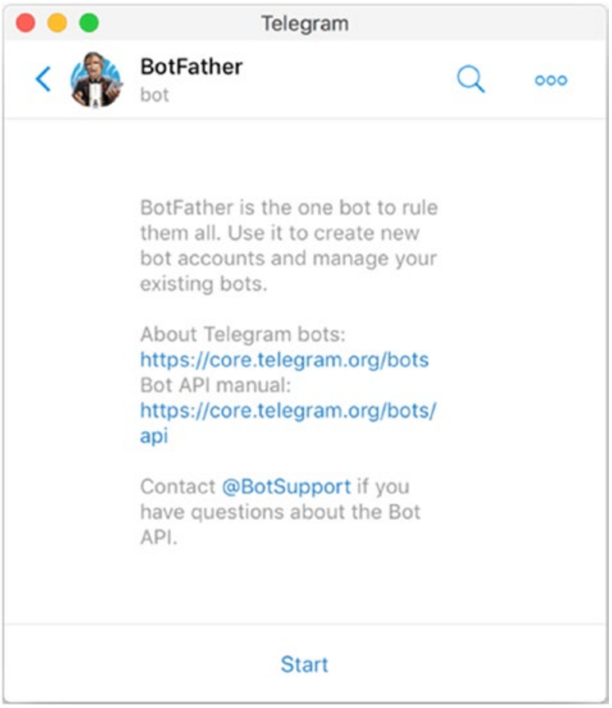


Figure 1-2. *Looking for BotFather*

In the preceding list, the name is the one at the bottom. Next, start a new chat with BotFather by clicking it.

Once the chat is started, you will also be welcomed by our handsome bot, with a cordial message about APIs, free help, and an invitation to start the chat (Figure 1-3).



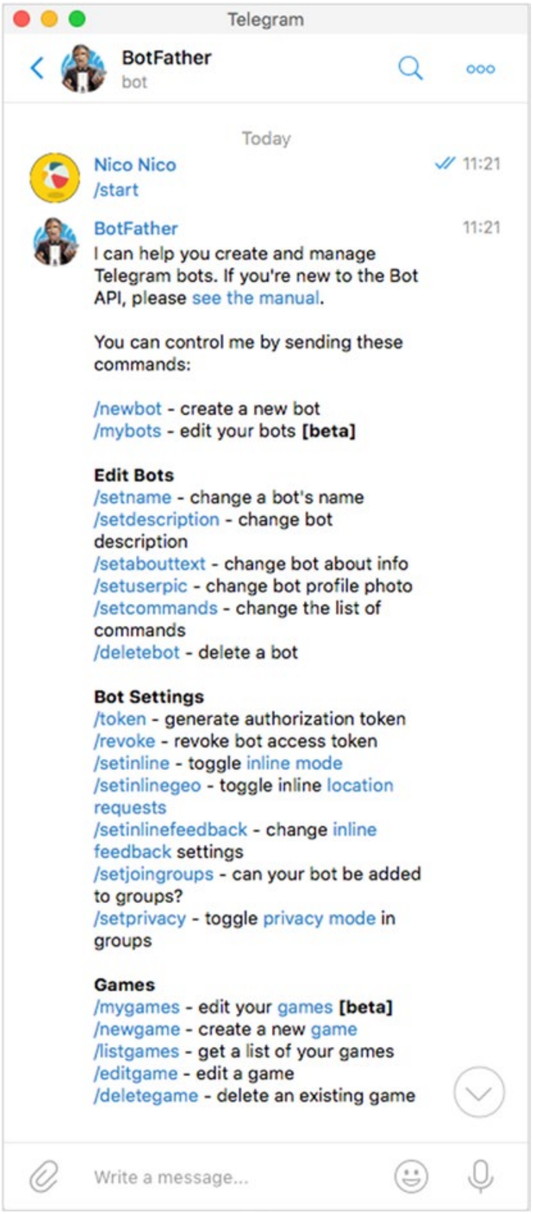
BotFather is the one bot to rule them all. Use it to create new bot accounts and manage your existing bots.

About Telegram bots: https://core.telegram.org/bots
Bot API manual: https://core.telegram.org/bots/api

Contact @BotSupport if you have questions about the Bot API.

Figure 1-3. *Ready?*

Once the chat has begun (by pressing the Start button that you can see at the bottom), you are welcomed by BotFather with a bunch of options on how to create or edit your list of bots (Figure 1-4).



Nico Nico 11:21
/start

BotFather 11:21
I can help you create and manage Telegram bots. If you're new to the Bot API, please see the manual.

You can control me by sending these commands:

/newbot - create a new bot
/mybots - edit your bots **[beta]**

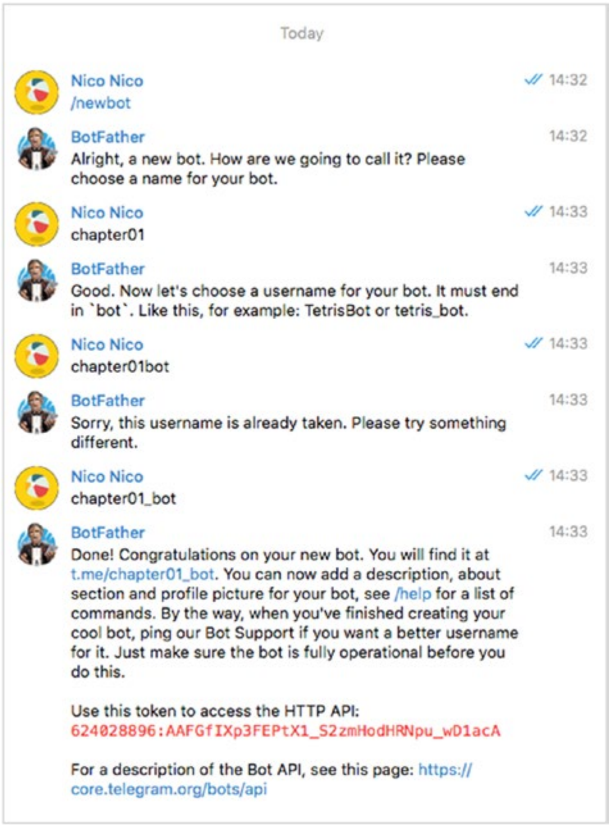
Edit Bots
/setname - change a bot's name
/setdescription - change bot description
/setabouttext - change bot about info
/setuserpic - change bot profile photo
/setcommands - change the list of commands
/deletebot - delete a bot

Bot Settings
/token - generate authorization token
/revoke - revoke bot access token
/setinline - toggle inline mode
/setinlinegeo - toggle inline location requests
/setinlinefeedback - change inline feedback settings
/setjoingroups - can your bot be added to groups?
/setprivacy - toggle privacy mode in groups

Games
/mygames - edit your games **[beta]**
/newgame - create a new game
/listgames - get a list of your games
/editgame - edit a game
/deletegame - delete an existing game

Figure 1-4. *Say hello to BotFather*

Great! I won't review the full list of options now but will start just by creating our new bot. This is done here by typing in the `/newbot` command and then following a simple conversation, such as the one in Figure 1-5.



Today

Nico Nico 14:32
/newbot

BotFather 14:32
Alright, a new bot. How are we going to call it? Please choose a name for your bot.

Nico Nico 14:33
chapter01

BotFather 14:33
Good. Now let's choose a username for your bot. It must end in `bot`. Like this, for example: TetrisBot or tetris_bot.

Nico Nico 14:33
chapter01bot

BotFather 14:33
Sorry, this username is already taken. Please try something different.

Nico Nico 14:33
chapter01_bot

BotFather 14:33
Done! Congratulations on your new bot. You will find it at t.me/chapter01_bot. You can now add a description, about section and profile picture for your bot, see /help for a list of commands. By the way, when you've finished creating your cool bot, ping our Bot Support if you want a better username for it. Just make sure the bot is fully operational before you do this.

Use this token to access the HTTP API:
624028896:AAFGfIXp3FEPtX1_S2zmHodHRNpu_wD1acA

For a description of the Bot API, see this page: https://core.telegram.org/bots/api

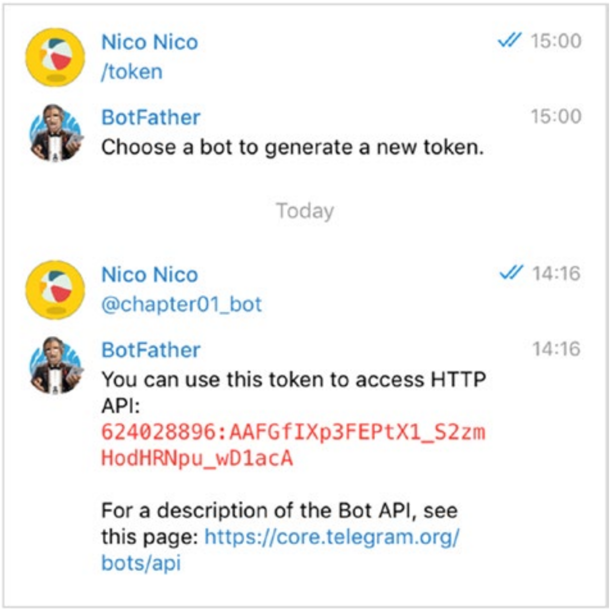
Figure 1-5. *Ask BotFather, please, please, for a new bot*

Your bot is now ready to use. Can you see in red something like a secret code? This is the bot token, which is a chain of characters that will be used to uniquely identify and authenticate your bot against the Telegram platform. **Do not give away this token**. Don't write it in a book or allow it to hang somewhere on GitHub, especially now that Microsoft owns it.

In our case, in the preceding chat, the token that was generated and given to use is the one following:

```
624028896:AAFGfIXp3FEPtX1_S2zmHodHRNpu_wD1acA
```

If your token, like this one, ever becomes compromised, you can use the `/token` command with the bot father, to generate a new token, as shown in the conversation in Figure 1-6.



Nico Nico 15:00
/token

BotFather 15:00
Choose a bot to generate a new token.

Today

Nico Nico 14:16
@chapter01_bot

BotFather 14:16
You can use this token to access HTTP API:
624028896:AAFGfIXp3FEPtX1_S2zmHodHRNpu_wD1acA

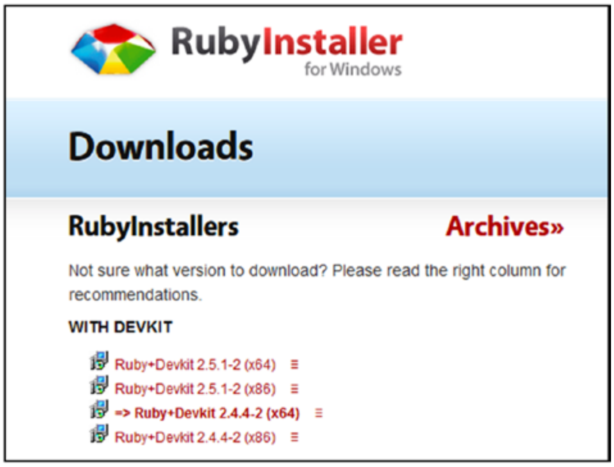
For a description of the Bot API, see this page: https://core.telegram.org/bots/api

Figure 1-6. *Chat to generate a new token*

Alright, the registration of our Telegram bot is all done. So, let's switch to a little bit of coding in Ruby.

Setting Up Ruby

Ruby, on most Unix-like platforms, including OS X, is already installed, or it can be installed using a package manager. For those running lesser operating systems, like Windows, you can download and install the Ruby installer (Figure 1-7) from the Ruby download page at `www.ruby-lang.org/en/downloads/`. Download the most recent version.



Not sure what version to download? Please read the right column for recommendations.

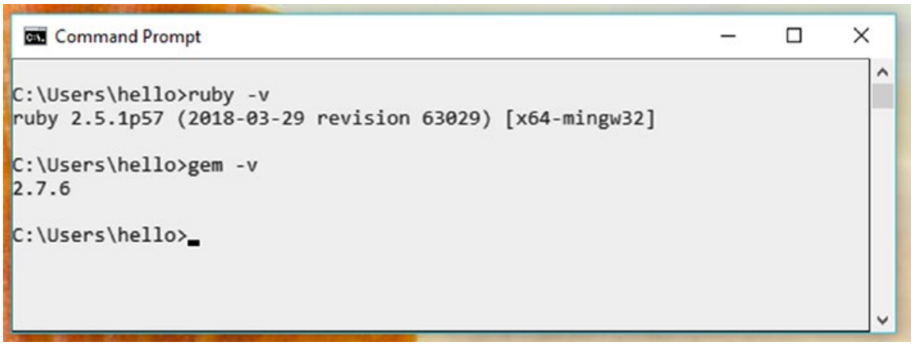
WITH DEVKIT

- Ruby+Devkit 2.5.1-2 (x64)
- Ruby+Devkit 2.5.1-2 (x86)
- => Ruby+Devkit 2.4.4-2 (x64)
- Ruby+Devkit 2.4.4-2 (x86)

Figure 1-7. *Looking for the Windows Ruby installer*

After the installation is complete, if you open a terminal (on macOS), or a command prompt on Windows (Figure 1-8), and can type in the following commands without getting an error, you are all set:

```
ruby -v
gem -v
```



```
C:\Users\hello>ruby -v
ruby 2.5.1p57 (2018-03-29 revision 63029) [x64-mingw32]

C:\Users\hello>gem -v
2.7.6

C:\Users\hello>_
```

Figure 1-8. *Checking `ruby` and `gem` versions*

If you have never used Ruby before, you may be wondering what the `gem` executable is? It's simply a Ruby-specific installer for libraries (just like `npm` is for Node and `pip` is for Python), so when you require some open source library that has been written by someone else, you would use `gem` to get it on your machine and the `ruby` executable to run it.

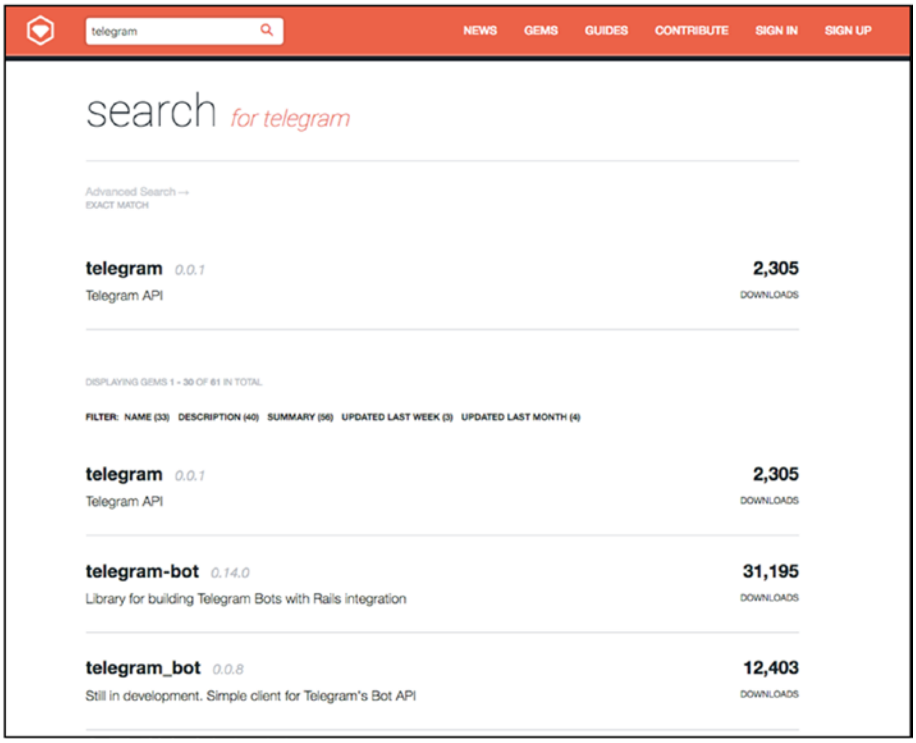
Apart from Ruby, to have some coding fun outside Notepad, you also need a text editor, so I propose to use Microsoft's Visual Studio Code (`https://code.visualstudio.com/`), but, of course, any of your favorite text editors will do.

Alright, let's get started and code our first bot.

Your First Telegram Bot

To get to talk to our first bot, we will use the Ruby library named `telegram_bot`. There are a few other famous libraries that you can find on RubyGems (`https://rubygems.org/`), but I find this library to be an easy one to start and get going with, and I hope you come to agree with me about this in time.

Actually, you can check for yourself and find your favorite Telegram library, by querying the RubyGems web site (Figure 1-9).



search *for telegram*

Advanced Search →
EXACT MATCH

telegram 0.0.1
Telegram API
2,305
DOWNLOADS

DISPLAYING GEMS 1 - 30 OF 61 IN TOTAL

FILTER: NAME (33) DESCRIPTION (40) SUMMARY (56) UPDATED LAST WEEK (3) UPDATED LAST MONTH (4)

telegram 0.0.1
Telegram API
2,305
DOWNLOADS

telegram-bot 0.14.0
Library for building Telegram Bots with Rails integration
31,195
DOWNLOADS

telegram_bot 0.0.8
Still in development. Simple client for Telegram's Bot API
12,403
DOWNLOADS

Figure 1-9. *Looking for gems*

To use a library in Ruby, you install it on your machine first, to make it available to your computer, by using the `gem install` command, and then in your Ruby code, you use the `*require*` function, to make that library available to your Ruby program.

Let's create a new folder for this first bot. Change the directory and then install the Telegram library with `gem`, as shown following:

```
mkdir chapter-01
cd chapter-01
gem install telegram_bot
```

At the terminal, the output should be something similar to this:

```
SuperPinkicious:chapter-01 niko$ gem install telegram_bot
Successfully installed telegram_bot-0.0.8
Parsing documentation for telegram_bot-0.0.8
Done installing documentation for telegram_bot after 0 seconds
1 gem installed
```

The gem is now installed and ready to be used in your code.

Now, you are going to write some code to wake up your bot and make it come alive. In a new file in that folder, which you can name step0.rb, for example, let's write the following lines of Ruby code:

```
require 'telegram_bot'

bot = TelegramBot.new(token: ENV['BOT_TOKEN'])
bot.get_updates() do |message|
    puts message.to_s
end
```

What that code does is

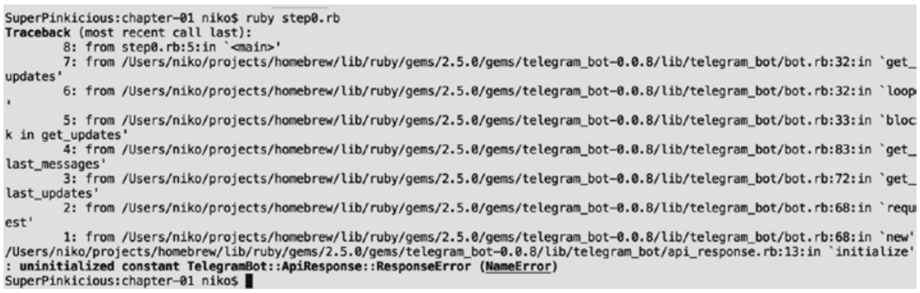
- Make the telegram_bot library, installed via gem, available to your program
- Create a new Ruby bot object, using the Telegram token exposed via an external variable. This is usually the recommended way to share your bot code without giving your bot token to everyone.
- Get the bot instance instantiated, to listen for incoming messages, using the bot object get_updates() method
- Ensure that, now, whenever a message is sent to the bot, the bot will print it on the console

To run the preceding written program on your machine, you pass the name of the program file, `step0.rb`, to the `ruby` executable. Let's do it.

At the terminal, execute the following command:

```
ruby  step0.rb
```

Observe the output (Figure 1-10).



```
SuperPinkicious:chapter-01 niko$ ruby step0.rb
Traceback (most recent call last):
        8: from step0.rb:5:in `<main>'
        7: from /Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/bot.rb:32:in `get_
updates'
        6: from /Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/bot.rb:32:in `loop
'
        5: from /Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/bot.rb:33:in `bloc
k in get_updates'
        4: from /Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/bot.rb:83:in `get_
last_messages'
        3: from /Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/bot.rb:72:in `get_
last_updates'
        2: from /Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/bot.rb:68:in `requ
est'
        1: from /Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/bot.rb:68:in `new'
/Users/niko/projects/homebrew/lib/ruby/gems/2.5.0/gems/telegram_bot-0.0.8/lib/telegram_bot/api_response.rb:13:in `initialize'
: uninitialized constant TelegramBot::ApiResponse::ResponseError (NameError)
SuperPinkicious:chapter-01 niko$
```

Figure 1-10. *Sometimes, it just does not work*

Oops! That did not go so well. We forgot to pass the Telegram token to our program.

This can be done on Linux or OS X with the following:

```
export BOT_TOKEN='585672177:AAHswpmdA2zP52ZWoJMdteGaOxQ8KeynWvE'
```

And on Windows with

```
set BOT_TOKEN=585672177:AAHswpmdA2zP52ZWoJMdteGaOxQ8KeynWvE
```

Let's run the program again. This time, it looks like the command is not finishing… This is expected, as the bot is now actually waiting for messages.

Let's be the one to start the conversation, so let's send a greeting message.

In the Telegram window, search for the bot and start chatting (Figure 1-11).

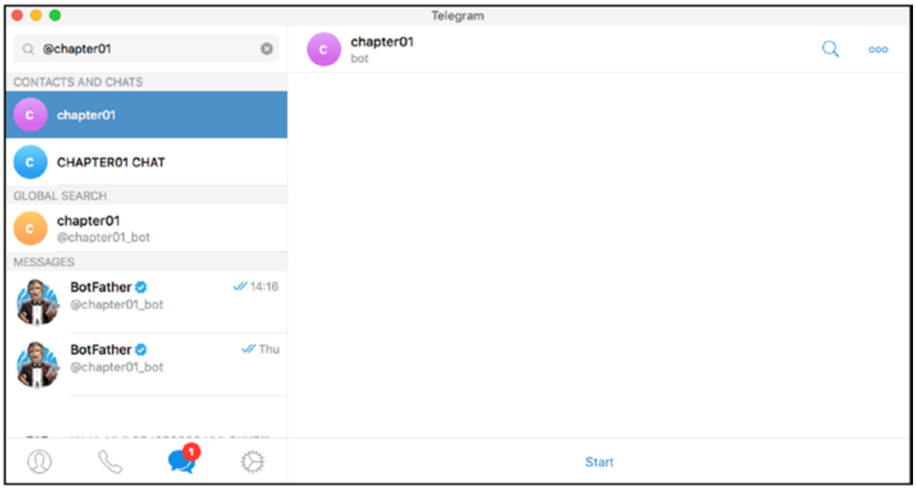
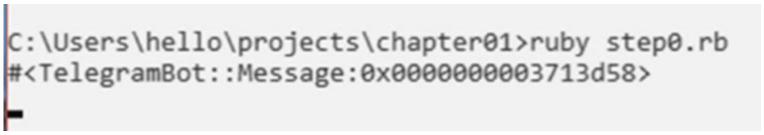


Figure 1-11. *First message to our bot*

By pressing that Start button, the bot is already receiving a message (Figure 1-12)!



```
C:\Users\hello\projects\chapter01>ruby step0.rb
#<TelegramBot::Message:0x0000000003713d58>
```

Figure 1-12. *First message from our bot!*

Hmmm, that was not very readable. With Ruby, you can display a more legible version of any object, by using the `to_yaml` function. Let's update the code and see what happens.

We call `require 'yaml'`, to import it into the Ruby namespace, and now we can call the `to_yaml` on the message the bot has received.

```
require 'telegram_bot'
require 'yaml'
bot = TelegramBot.new(token: ENV['BOT_TOKEN'])
```

```
bot.get_updates() do |message|
    # puts message.to_s
    puts message.to_yaml
end
```

You would have to type Ctrl-C to terminate the running version of the bot first and then start the new bot, by executing the `ruby` command again. Figure 1-13 shows the outcome.

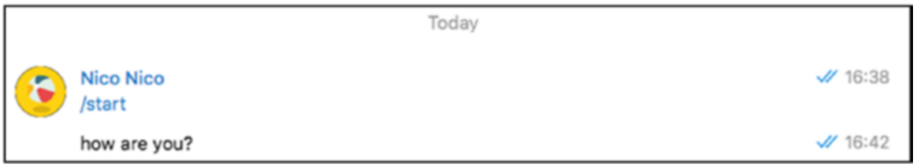

Today
Nico Nico 16:38
/start
how are you? 16:42

Figure 1-13. *How are you?*

In the console, or in the terminal where the bot was started, you now can see a more detailed version of the received message.

```
endSuperPinkicious:chapter-01 niko$ ruby step0.rb
--- !ruby/object:TelegramBot::Message
message_id: 191
from: !ruby/object:TelegramBot::User
  id: 121843071
  first_name: Nico
  last_name: Nico
  username: hellonico
chat: !ruby/object:TelegramBot::Channel
  id: 121843071
  username: hellonico
  title:
date: !ruby/object:DateTime 2018-08-31 07:42:26.000000000 Z
text: how are you?
reply_to_message:
```

Actually, whatever the programming language used, this message format is going to be quite consistent, so it's a good idea to have a look at the message fields.

Understanding Received Messages Fields

Table 1-1 briefly explains the fields we have just received via the Telegram bot.

Table 1-1. *Fields Received from the Telegram Bot*

Field	Sample Value	Explanation
`message_id`	`191`	The unique identifier of the bot message
`from`	`!ruby/object:TelegramBot::User`	The user who sent the message
`chat`	`!ruby/object:TelegramBot::Channel`	The chat/channel information
`date`	`!ruby/object:DateTime 2018-08-31 07:42:26.000000000 Z`	When the message was sent
`text`	`how are you?`	The text of the message
`reply_to_ message`	`<empty>`	The message that this message was a reply to

For standard messages, there is not much beyond what you would expect from a chat message object. You will probably use the `date`, `text`, and `from` fields most of the time.

First Reply

Again, Ruby's concision makes it quite easy to create strings from objects. With the following, you can use blocks of executable code directly within a string: #{}.

This makes it very powerful for templated messages, and in our case, for bot programming. Within the `get_updates()` call block, let's now write and send a reply.

```
    message.reply do |reply|
        reply.text = "Hello, #{message.from.first_name}!"
        reply.send_with(bot)
end
```

After restarting the bot (Ctrl-C, `ruby step0.rb`), we can start a more talkative version of this Ruby bot (Figure 1-14).

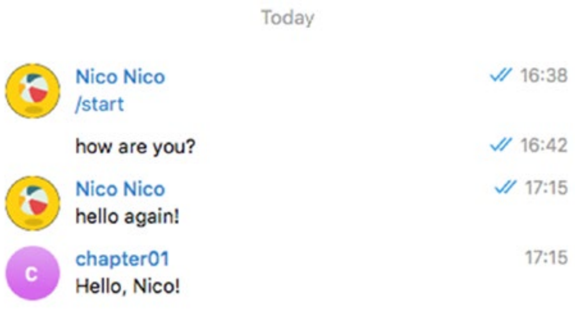

Today
Nico Nico /start 16:38
how are you? 16:42
Nico Nico hello again! 17:15
chapter01 Hello, Nico! 17:15

Figure 1-14. *Hello, Nico!*

That worked pretty smoothly, and I am happy to announce that you have moved to level 2 of this bot master course.

You have seen many things in this first chapter, the following among them:

- How to register a bot to the bot father
- How to put the bot token to use in our program
- Starting a bot and listening to messages
- Reviewing the fields of incoming messages
- Replying to an incoming message

Next week, we will build on those same concepts in the following chapter using a different programming language.

CHAPTER 2

Week 2: Nim

> *Jenner: I learned this much: take what you can, when you can.*
> *Justin: Then you have learned nothing.*
>
> —The Secret of Nimh

Nim has been on my list of adopted languages for the last two years. Visually, it looks and feels very similar to Python, but it can also be compiled to a binary, via C, C++, Objective-C, and even JavaScript. I have seen compiled binary Nim programs running *very* fast, and I really wished Nim would reach the next level of adoption.

Today, we're going to focus on building bots, runnable as a binary, built with Nim. We will, of course, start by setting up a Nim environment on your local machine.

Installing Nim

Nim can be downloaded manually from the following location: `https://nim-lang.org/docs/re.html`. It is also available through your platform package manager.

Make sure you install both Nim (the compiler) and Nimble (the package manager). At the time of writing, these are the latest available versions for both executables.

```
SuperPinkicious:APRESS niko$ nim -v
Nim Compiler Version 0.18.0 [MacOSX: amd64]
Copyright (c) 2006-2018 by Andreas Rumpf
```

```
active boot switches: -d:release -d:useLinenoise
SuperPinkicious:APRESS niko$ nimble -v
nimble v0.8.10 compiled at 2018-03-11 16:16:29
git hash: couldn't determine git hash
```

The setup used throughout this book, and thus for Nim programming too, is based on Visual Studio Code, and you will be shown the basics to get running with Nim from within Visual Studio Code.

Nim Plug-in for Visual Studio Code

Before writing a full-blown Telegram bot, you are going to be introduced to Nim, by writing some Hello World code. Let's start by creating a file named `goodmorning.nim` from within Visual Studio Code, to write our first few lines of code (Figure 2-1).

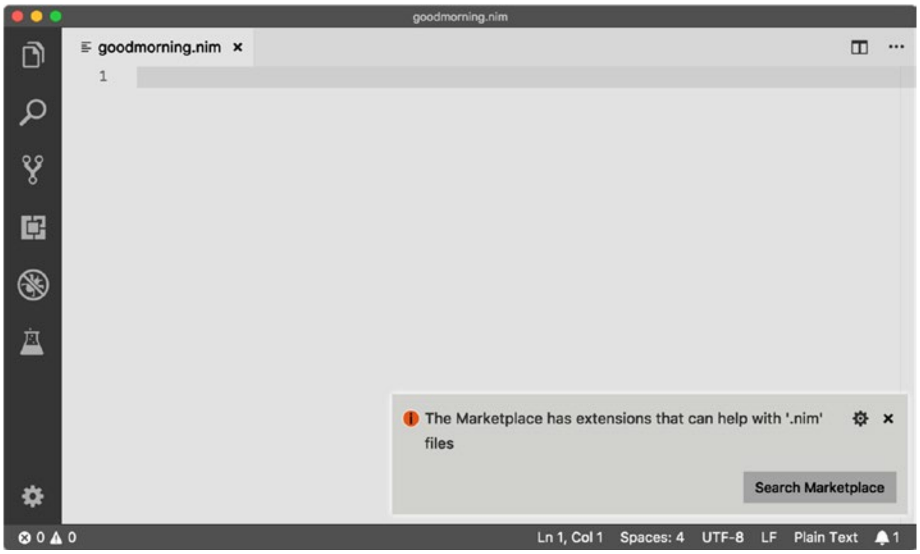
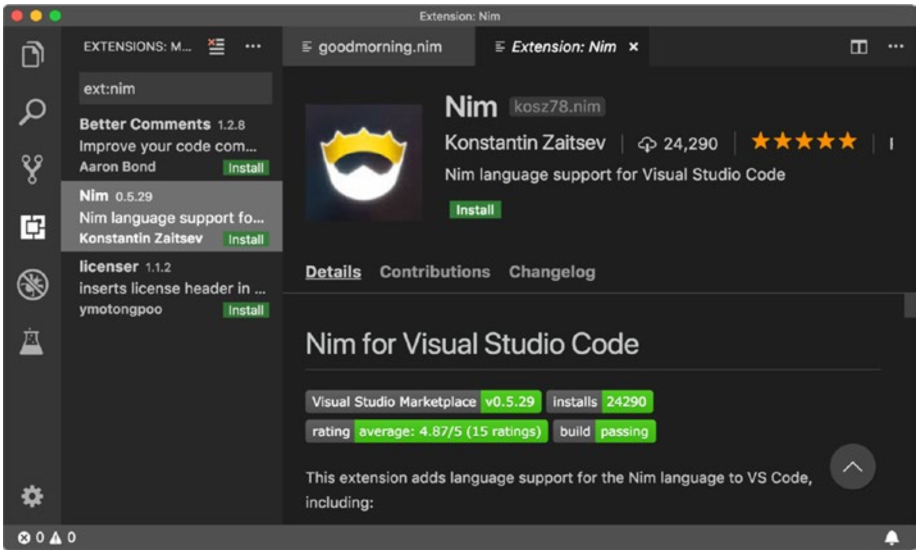


Figure 2-1. *`goodmorning.nim` file*

As you can see at the bottom right of Figure 2-1, Visual Studio Code recognizes the extension of the new file and proposes that you have a look at the Marketplace, to find an extension that supports Nim files editing. This is the same for every other language, so you may have to repeat these steps for other languages afterward.

The plug-in to install is the one written by Konstantin Zaitsev, shown in Figure 2-2.

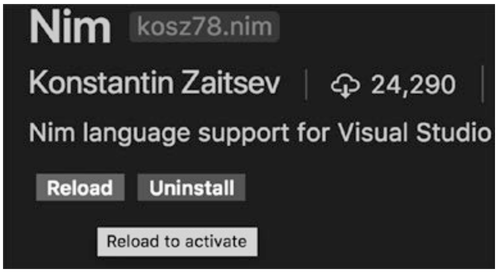


Nim for Visual Studio Code

This extension adds language support for the Nim language to VS Code, including:

Figure 2-2. *Nim plug-in*

Once Visual Studio Code has installed the plug-in, you must click the Reload button, to activate the plug-in (Figure 2-3).



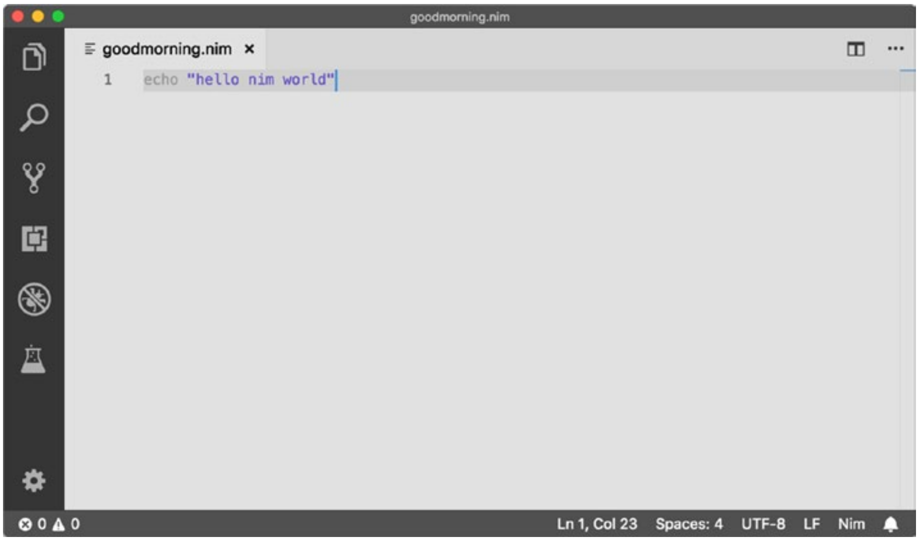
Nim language support for Visual Studio

Figure 2-3. *Activating the Nim plug-in*

Now, let's write some code!

Hello, Nim

If the install was successful, you now have a Nim-enabled editor, meaning syntax highlighting and compilation from within the editor. echo is the simplest Nim function to print to the standard output, and we'll use that to print some formal greetings (Figure 2-4).



```
echo "hello nim world"
```

Figure 2-4. *hello nim world greeting*

Once you have the code written in the file, you are now ready to execute it.

Unlike Ruby, in which you can pass in code to be executed to the `ruby` executable, Nim is a compiled language, so it is turned into a binary file first. This is a form that the computer understands and can execute by itself, including third-party libraries, then that file is executed.

To active the command that performs these two steps in Visual Studio Code, you use either one of the following:

1. Command+Shift+P or
2. Ctrl+Shift+P

This will pop up a menu with all the available Visual Studio Code commands. The one you want to use to compile and run Nim code located in the opened file is named `Nim: Run Selected file`, and it will be the first option, once you start typing "nim" in the search-like text box that popped up (Figure 2-5).

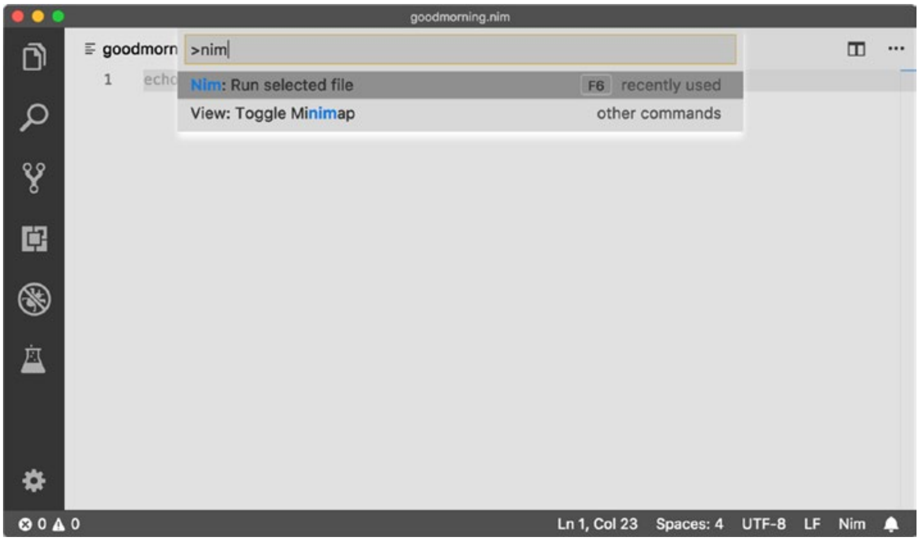
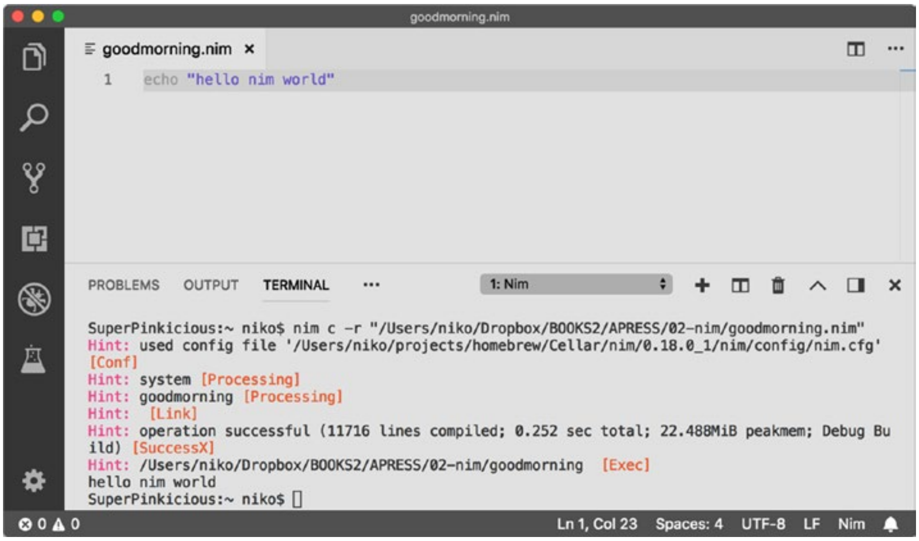


Figure 2-5. *Run selected file from the pop-up menu*

Executing the command will print out a few lines of compilation in the terminal or command prompt that has just been opened when triggering the command. At the bottom, you can see the greeting message. The code has been compiled and executed from within the text editor (Figure 2-6).



```
echo "hello nim world"
```

```
SuperPinkicious:~ niko$ nim c -r "/Users/niko/Dropbox/BOOKS2/APRESS/02-nim/goodmorning.nim"
Hint: used config file '/Users/niko/projects/homebrew/Cellar/nim/0.18.0_1/nim/config/nim.cfg'
[Conf]
Hint: system [Processing]
Hint: goodmorning [Processing]
Hint:  [Link]
Hint: operation successful (11716 lines compiled; 0.252 sec total; 22.488MiB peakmem; Debug Bu
ild) [SuccessX]
Hint: /Users/niko/Dropbox/BOOKS2/APRESS/02-nim/goodmorning  [Exec]
hello nim world
SuperPinkicious:~ niko$ 
```

Figure 2-6. *hello nim world*

Note that the actual command that was executed by the plug-in is something like

```
nim c -r goodmorning.nim
```

This is a shortcut for

- C: compile
- `-r`: run
- `goodmorning.nim`: the file to compile and run

In the folder in which the goodmorning.nim file was located, you will see that a new file has been created, named goodmorning, without a file extension.

You can re-execute the compiled file by itself, of course, without recompiling directly from the command line again.

```
SuperPinkicious:02-nim niko$ ./goodmorning
hello nim world
```

Try changing the code a bit and recompile a few times, to master this compile step from Visual Studio Code. Next let's move beyond greetings, to more meaningful code.

Second Nim Program (Still Not Bot)

In this second example, we will send an HTTP request to a remote site and print the result on the command line. This new program requires some code from a different Nim module, httpclient, which contains the object that can send HTTP requests and reads the return value. You will use the keyword import to make this happen.

The rest of the code, matching closely a Python-like syntax, is quite easy to read.

```
import httpclient

const URL = "https://api.github.com/search/repositories" &
            "?q=cat" &
            "&sort=stars" &
            "&order=desc"

let
    client = newHttpClient()

echo client.getContent(URL)
```

We see first the creation of a constant String, `URL`, which will be the target of the HTTP request. `let` defines a scoped variable, the HTTP client. Finally, we retrieve the body coming from the HTTP `get` request, with `getContent` called on the HTTP client.

Let's run this now, by calling the `Nim: Run selected file` command from the palette (Figure 2-7).

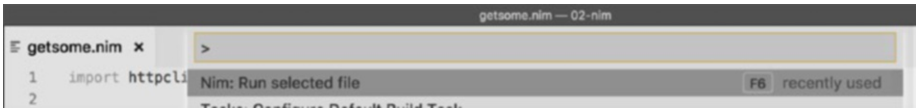
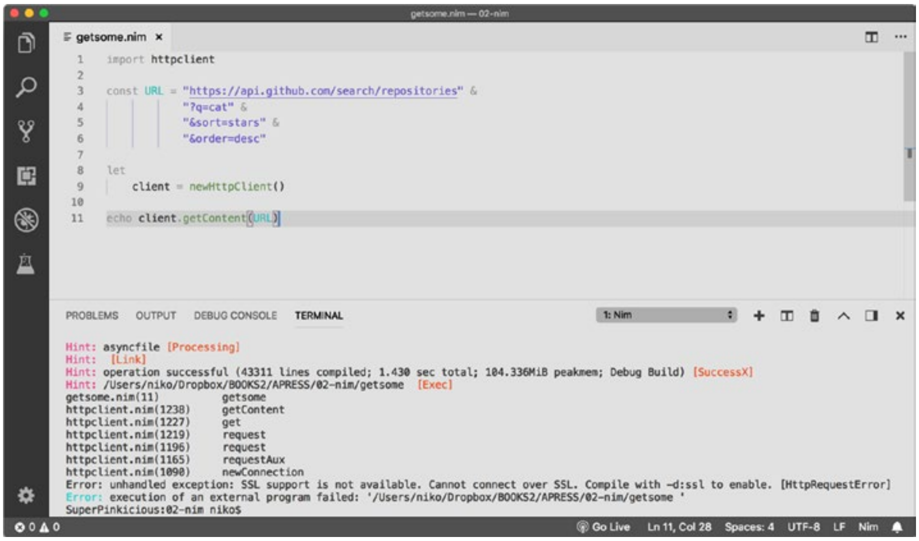


Figure 2-7. *Running the HTTP client*

Unfortunately, things did not seem to fare too well, and a message with red text is showing, as in Figure 2-8.



```
import httpclient

const URL = "https://api.github.com/search/repositories" &
            "?q=cat" &
            "&sort=stars" &
            "&order=desc"

let
    client = newHttpClient()

echo client.getContent(URL)
```

```
Hint: asyncfile [Processing]
Hint:  [Link]
Hint: operation successful (43311 lines compiled; 1.430 sec total; 104.336MiB peakmem; Debug Build) [SuccessX]
Hint: /Users/niko/Dropbox/BOOKS2/APRESS/02-nim/getsome  [Exec]
getsome.nim(11)          getsome
httpclient.nim(1238)     getContent
httpclient.nim(1227)     get
httpclient.nim(1219)     request
httpclient.nim(1196)     request
httpclient.nim(1165)     requestAux
httpclient.nim(1090)     newConnection
Error: unhandled exception: SSL support is not available. Cannot connect over SSL. Compile with -d:ssl to enable. [HttpRequestError]
Error: execution of an external program failed: '/Users/niko/Dropbox/BOOKS2/APRESS/02-nim/getsome '
SuperPinkicious:02-nim niko$
```

Figure 2-8. *Failed execution*

Fortunately, it tells you explicitly what's wrong, which is quite unusual for a programming language. Go ahead and ask Java developers.

What happened is that the HTTP connection requires SSL, as we are connecting over HTTPS. SSL is not included by default during the compilation step of Nim source files.

To include SSL support, we must define a symbol, using the `-d:ssl` flag, for the `nim` command, so that it will include the required code to execute the HTTPS request.

If you want to try this on the command line or in a terminal, you can use the following full command:

```
nim c -d:ssl -r getsome.nim
```

The preceding command will compile and run the code, as expected, finally outputting many lines of JSON returned from the `get` request. But…I know how you feel. You would like to run this command from Visual Studio Code itself. This is done using Visual Studio Code Custom tasks.

Creating Visual Studio Code Build Tasks

To create your own task in Visual Studio Code, follow a few steps from the command palette, which will create a JSON file from a template (Figures 2-9, 2-10, 2-11).

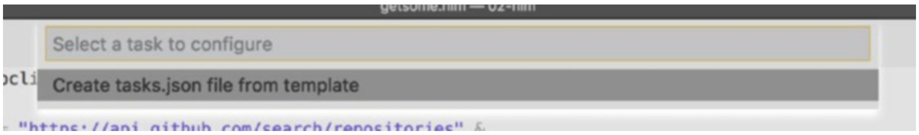

Select a task to configure
Create tasks.json file from template

Figure 2-9. *Creating the `tasks.json` file from the template*

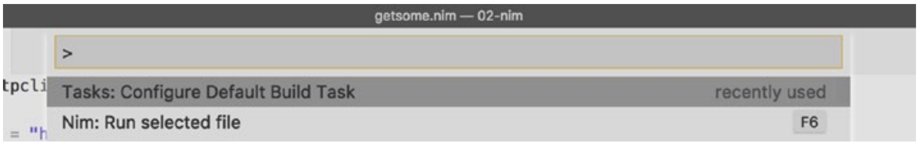
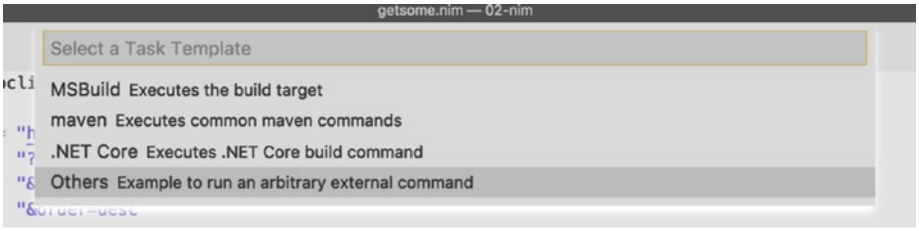


Figure 2-10. *Configuring the default build task*



MSBuild Executes the build target
maven Executes common maven commands
.NET Core Executes .NET Core build command
Others Example to run an arbitrary external command

Figure 2-11. *Running an arbitrary external command*

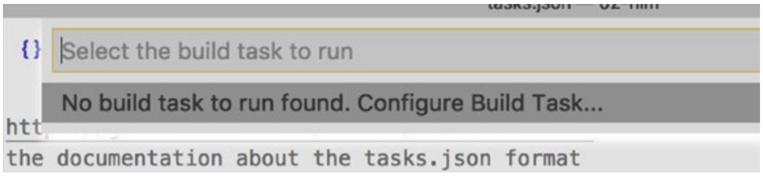
At this end of the sequence, you will have a new file, `.vscode/tasks.json`, with something similar to the following content:

```
{
    // See https://go.microsoft.com/fwlink/?LinkId=733558
    // for the documentation about the tasks.json format
    "version": "2.0.0",
    "tasks": [
        {
            "label": "echo",
            "type": "shell",
            "command": "echo Hello",
            "problemMatcher": []
        }
    ]
}
```

Basically, this task executes a shell command that displays “hello” on the terminal or command prompt. Not a very useful command by itself, in general, but, hey, who knows.

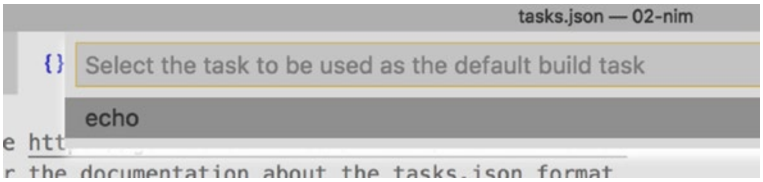
Now, we want to use that to the default build command, so let’s trigger the palette again with Command+Shift+B, Ctrl+Shift+B.

This will ask you a few more questions along the lines of those shown in Figures 2-12 and 2-13.



```
{} Select the build task to run
   No build task to run found. Configure Build Task...
htt
the documentation about the tasks.json format
```

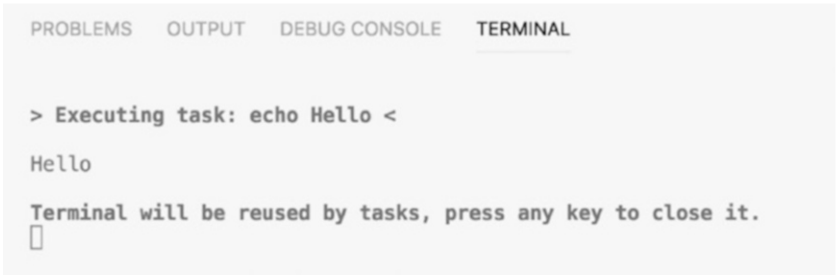
Figure 2-12. *Configuring the build task*



```
tasks.json — 02-nim
{} Select the task to be used as the default build task
   echo
e htt
r the documentation about the tasks.json format
```

Figure 2-13. *echo*

The custom build task hello is now configured within Visual Studio Code. The next time you type "Command+Shift+B," a terminal will show up with the output of the echo command (Figure 2-14).



```
> Executing task: echo Hello <

Hello

Terminal will be reused by tasks, press any key to close it.
```

Figure 2-14. *Hello*

"Hello" is usually good enough for a first time, but, yes, now it's probably the time to get back to compiling and executing Nim files.

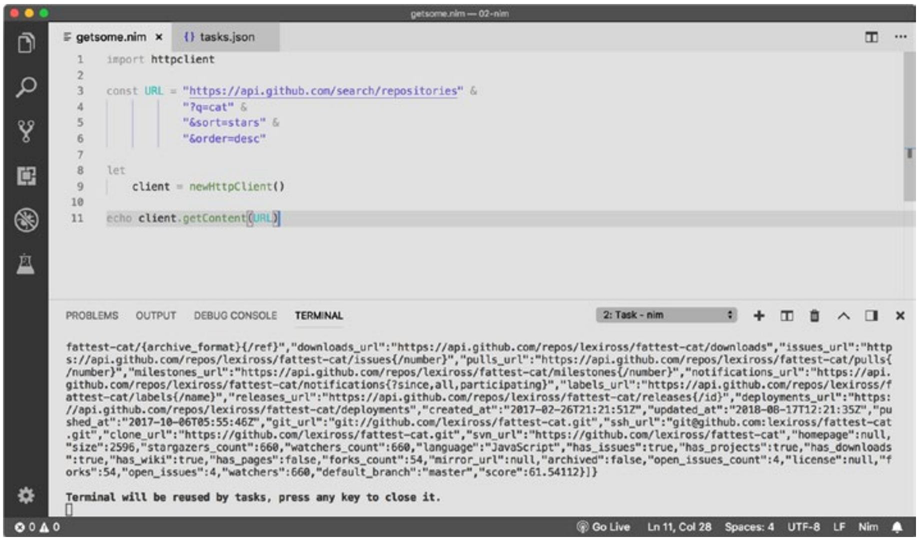
So, let's replace the content of the `.vscode/tasks.json` file with the following:

```
{
    "version": "2.0.0",
    "tasks":
        [
          {
            "label": "nim",
            "command": "nim",
            "args": [
              "c",
              "-d:ssl",
              "-r",
              "${file}"
            ],
            "options": {
              "cwd": "${workspaceRoot}"
            },
            "group": {
              "kind": "build",
              "isDefault": true
            }
          }
        ]
      }
```

Note that you have just created a task labeled `nim`, for which the command is the one you saw just a few pages ago.

```
nim c -d:ssl -r ${file}
```

`${file}` in Visual Studio Code is a parameter that contains the currently opened file. Now, we can execute the `getsome.nim` directly from the editor (Figure 2-15).



```nim
import httpclient

const URL = "https://api.github.com/search/repositories" &
            "?q=cat" &
            "&sort=stars" &
            "&order=desc"

let
    client = newHttpClient()

echo client.getContent(URL)
```

```
fattest-cat/{archive_format}{/ref}","downloads_url":"https://api.github.com/repos/lexiross/fattest-cat/downloads","issues_url":"http
s://api.github.com/repos/lexiross/fattest-cat/issues{/number}","pulls_url":"https://api.github.com/repos/lexiross/fattest-cat/pulls{
/number}","milestones_url":"https://api.github.com/repos/lexiross/fattest-cat/milestones{/number}","notifications_url":"https://api.
github.com/repos/lexiross/fattest-cat/notifications{?since,all,participating}","labels_url":"https://api.github.com/repos/lexiross/f
attest-cat/labels{/name}","releases_url":"https://api.github.com/repos/lexiross/fattest-cat/releases{/id}","deployments_url":"https:
//api.github.com/repos/lexiross/fattest-cat/deployments","created_at":"2017-02-26T21:21:51Z","updated_at":"2018-08-17T12:21:35Z","pu
shed_at":"2017-10-06T05:55:46Z","git_url":"git://github.com/lexiross/fattest-cat.git","ssh_url":"git@github.com:lexiross/fattest-cat
.git","clone_url":"https://github.com/lexiross/fattest-cat.git","svn_url":"https://github.com/lexiross/fattest-cat","homepage":null,
"size":2596,"stargazers_count":660,"watchers_count":660,"language":"JavaScript","has_issues":true,"has_projects":true,"has_downloads
":true,"has_wiki":true,"has_pages":false,"forks_count":54,"mirror_url":null,"archived":false,"open_issues_count":4,"license":null,"f
orks":54,"open_issues":4,"watchers":660,"default_branch":"master","score":61.54112}]}

Terminal will be reused by tasks, press any key to close it.
```

Figure 2-15. *Executing `getsome` directly from Visual Studio Code*

Great! This custom task was actually required to compile and run code that includes the third-party Telegram library we are going to use. But how do we install external packages again?

This is done via Nimble. Let's see how that works.

Installing Nim Packages with Nimble

Remember that you installed Nimble at the beginning of this chapter. You are going to use it now to install a wrapper for the Telegram API.

You can use Nimble to find packages, using the `search` subcommand, as shown following:

```
nimble search telegram
```

This returns a list of libraries matching the search keywords, plus some information related to each library.

```
SuperPinkicious:02-nim niko$ nimble search telegram
telebot:
  url:         https://github.com/ba0f3/telebot.nim (git)
  tags:        telebot, telegram, bot, api, client, async
  description: Async Telegram Bot API Client
  license:     MIT
  website:     https://github.com/ba0f3/telebot.nim

nim_telegram_bot:
  url:         https://github.com/juancarlospaco/nim-
               telegram-bot (git)
  tags:        telegram, bot, telebot, async, multipurpose, chat
  description: Generic Configurable Telegram Bot for Nim, with
               builtin basic functionality and Plugins
  license:     MIT
  website:     https://github.com/juancarlospaco/nim-telegram-bot
```

To build our bot, we will use the first, most widely used library, `telebot`, and this is done using the Nimble `install` command.

```
nimble install telebot
```

This results in the following output:

```
SuperPinkicious:02-nim niko$ nimble install telebot
Downloading https://github.com/ba0f3/telebot.nim using git
  Verifying dependencies for telebot@0.4.2
 Installing telebot@0.4.2
   Success: telebot installed successfully.
```

You can, of course, check that the package is installed on your machine, with

```
nimble list -i
```

or remove the package with `uninstall`:

```
nimble uninstall telebot
```

Now that everything you require is on your machine, let's finally start writing our bot in Nim!

First Nim Bot

In Nim, you define a function or procedure using `proc`. `proc` takes a function name, here, `updateHandler`; some parameters, here, `b` of type `telebot` and `u` of type `Update` (both from the `telebot` module); and sometimes some metadata (or pragma), here, `{.async.}`.

You can find the documentation for any module on `nim-lang.org`. For example, the `asyncdispatch` module is here:

https://nim-lang.org/docs/asyncdispatch.html

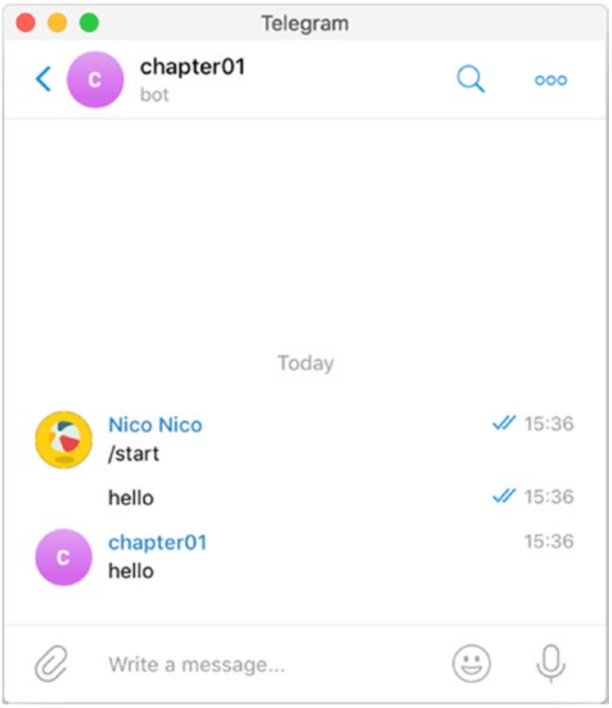
The reason we use the async module here is to write our Telegram bot.

Note Asynchronous procedures remove the pain of working with callbacks. They do this by allowing you to write asynchronous code the same way as you would synchronous code.

The `slurp` function takes the content of a file and turns it into a string—here, the bot `API_KEY` that you receive from BotFather in the previous chapter. And, yes, you should paste your key in a new `secret.key` file. That gives the following few lines of code for a simple bot that returns "hello" to whatever you sent to him.

```
import telebot, asyncdispatch, options

const API_KEY = slurp("secret.key")

proc updateHandler(b: Telebot, u: Update) {.async.} =
    let
     response = u.message.get
     message = newMessage(response.chat.id, "hello")
    discard await b.send(message)

let bot = newTeleBot(API_KEY)
bot.onUpdate(updateHandler)
bot.poll(300)
```

Starting a new chat with your existing bot, or a new bot registered with the bot father, would result in a conversation such as that shown in Figure 2-16.



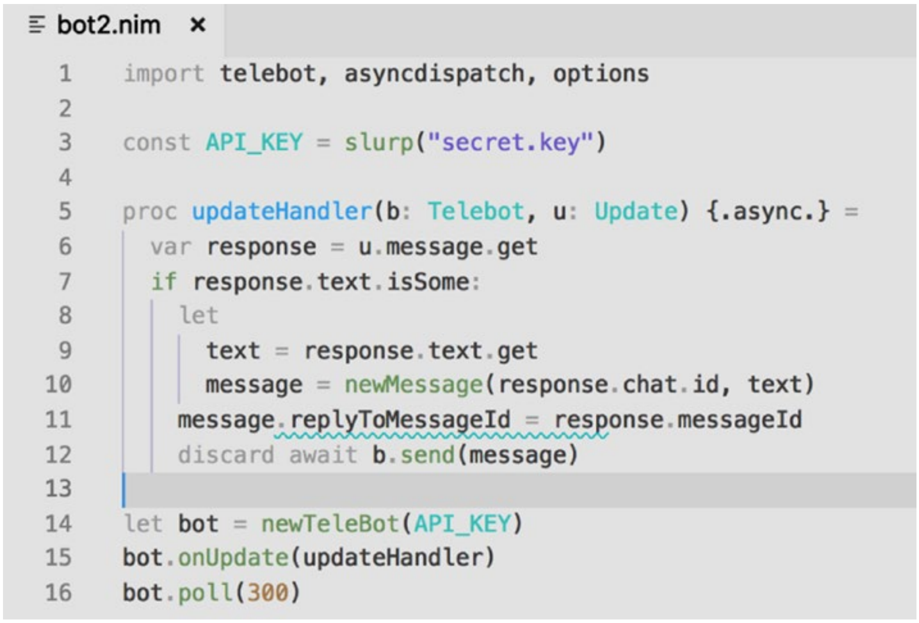
Nico Nico 15:36
/start
hello 15:36
chapter01 15:36
hello

Figure 2-16. *hello*

Replying to Nim Bot

Now that you have the whole setup at hand, creating the second Nim bot is going to be fairly simple. This new bot will inline the reply, as when you are replying directly to a message sent by another user. This is done by setting the `replyToMessageId` property on the created message object.

Note that if you keep the message object declared in the `let` block, the compiler will "compilain" (pun intended) that the message cannot be updated, because it is immutable (Figure 2-17).



bot2.nim

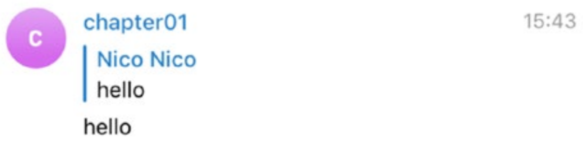
```
import telebot, asyncdispatch, options

const API_KEY = slurp("secret.key")

proc updateHandler(b: Telebot, u: Update) {.async.} =
  var response = u.message.get
  if response.text.isSome:
    let
      text = response.text.get
      message = newMessage(response.chat.id, text)
    message.replyToMessageId = response.messageId
    discard await b.send(message)

let bot = newTeleBot(API_KEY)
bot.onUpdate(updateHandler)
bot.poll(300)
```

Figure 2-17. *Compilation error that results when using `let` instead of `var`*

This is because it was created with `let`, which makes the object immutable. To work around this problem, you simply declare the message object with `var` instead.

```
import telebot, asyncdispatch, options

const API_KEY = slurp("secret.key")

proc updateHandler(b: Telebot, u: Update) {.async.} =
  var response = u.message.get
  if response.text.isSome:
    let
      text = response.text.get
    var message = newMessage(response.chat.id, text)
    message.replyToMessageId = response.messageId
    discard await b.send(message)

let bot = newTeleBot(API_KEY)
bot.onUpdate(updateHandler)
bot.poll(300)
```

The bot now tells you which message it is replying to (Figure 2-18).


chapter01 15:43

Nico Nico
hello

hello

Figure 2-18. *hello, hello*

Cats and Dogs Nim Bot

This next bot is only a slight update from the previous bot. Instead of creating a message with `newMessage`, we will use `newPhoto`, which allows us to embed a picture in the message sent to the user.

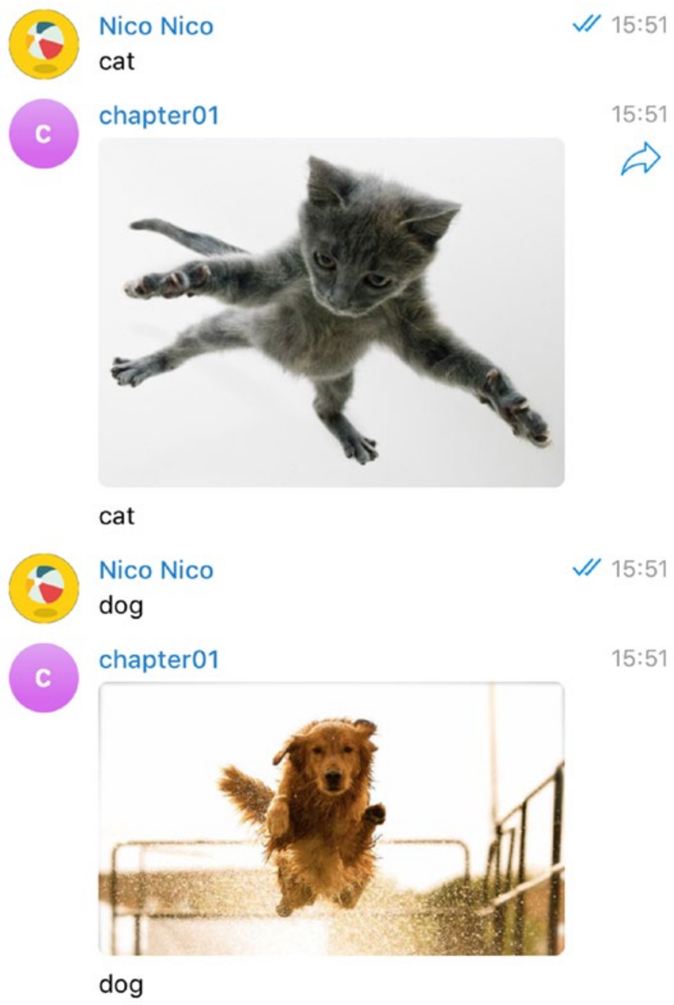
For this to work, you must have pictures of animals located along the Nim file (`cat.jpg` and `dog.jpg`, for example).

In the Nim code, the path to the file is prefixed with `file://`, and we also add a caption to the picture, by setting the caption field of the photo message.

This gives

```
import telebot, asyncdispatch, options

const API_KEY = slurp("secret.key")

proc updateHandler(bot: TeleBot, update: Update) {.async.} =
  var response = update.message.get
  if response.text.isSome:
    let
         animal = response.text.get
         file = "file://" & animal & ".jpg"
    var message = newPhoto(response.chat.id, file)
    message.caption = animal
    discard await bot.send(message)

let
  bot = newTeleBot(API_KEY)
bot.onUpdate(updateHandler)
bot.poll(300)
```

After starting this bot, when you send keywords to it, it will reply with a loaded picture of the given keyword, along with a caption of the animal (Figure 2-19).



Nico Nico 15:51
cat

chapter01 15:51

cat

Nico Nico 15:51
dog

chapter01 15:51

dog

Figure 2-19. *Cat and dog*

Of course, if you enter an animal that does not have a corresponding file, the bot won't be able to answer.

So, a small exercise would be to send a response to the user, such as "The file could not be found."

There was a lot of time spent on setting up Visual Studio Code in this Nim chapter, but now you are more ready than ever to tackle bots in other languages.

CHAPTER 3

Week 3: Crystal

Comets, importing change of times and states,
Brandish your crystal tresses in the sky,...

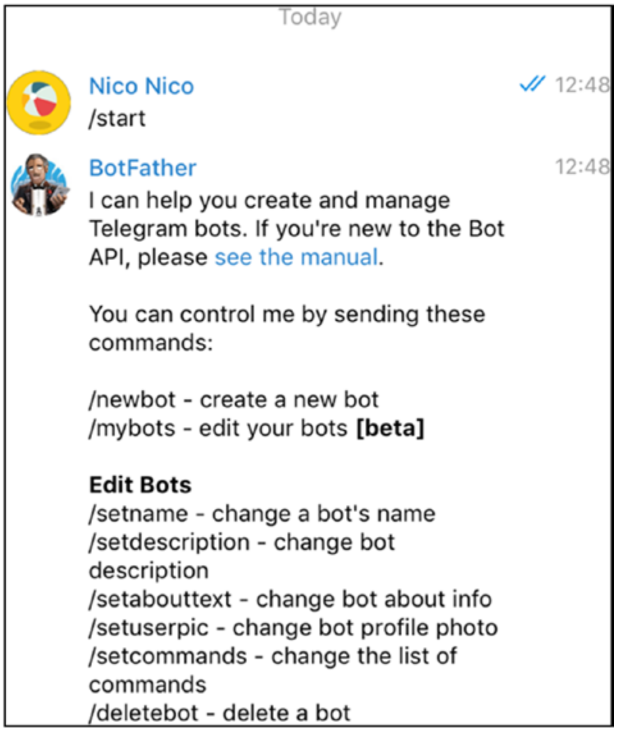
—William Shakespeare
Henry VI, Part 1, Act 1, Scene 1

Crystal is a new programming language with a syntax heavily influenced by Ruby, to the point that it feels just like writing Ruby. The main difference with Ruby is that Crystal is compiled to C and is, therefore, quite blazingly fast.

Crystal comes with many advantages, such as full support for easy concurrency models, macros, heavy type checks, and one of my favorites: full support for dependencies, via direct Git access, without the need for packaging, and the always-breaking central repository.

In this chapter, in addition to playing with Crystal to develop bots, you will also be introduced to writing your first bot commands. You will remember what commands are. We used them when talking to the bot father, to create our bots. Yes, those are the same! (See Figure 3-1.)

N. Modrzyk, *Building Telegram Bots*, https://doi.org/10.1007/978-1-4842-4197-4_3


Today

Nico Nico 12:48
/start

BotFather 12:48
I can help you create and manage Telegram bots. If you're new to the Bot API, please see the manual.

You can control me by sending these commands:

/newbot - create a new bot
/mybots - edit your bots **[beta]**

Edit Bots
/setname - change a bot's name
/setdescription - change bot description
/setabouttext - change bot about info
/setuserpic - change bot profile photo
/setcommands - change the list of commands
/deletebot - delete a bot

Figure 3-1. *BotFather commands*

Setting Up Crystal

There are already a bunch of installation steps on the Crystal web site, so we will keep those to a minimum here.

`https://crystal-lang.org/docs/installation/index.html`

Note, however, that for Windows users, Crystal can only be used with the Windows Subsystem for Linux (WSL), which requires a recent version of Windows 10. On macOS, Crystal is easily installed via the homebrew, as follows:

```
brew install crystal
```

When you install Crystal with the homebrew, you can see that the Crystal compiler is itself written in Crystal, `.cr` being the common extension for Crystal files.

```
bin/crystal build -D without_openssl -D without_zlib -o .build/
crystal src/compiler/crystal.cr --release --no-debug
```

On my favorite Arch Linux–based Manjaro Linux, Pacman has it straight out of the box as well.

```
pacman -S crystal shards
```

On other distributions, you must install a new repository, before running `yum`, `apt-get`, and the likes.

Once Crystal is installed, you should check that `crystal`, but also `shards`, the Crystal package manager, is installed.

```
SuperPinkicious:withcrystal niko$ crystal --version
Crystal 0.26.1 (2018-09-06)
LLVM: 6.0.1
Default target: x86_64-apple-macosx

SuperPinkicious:withcrystal niko$ shards --version
Shards 0.8.1 (2018-09-06)
```

Short Walk in the Playground

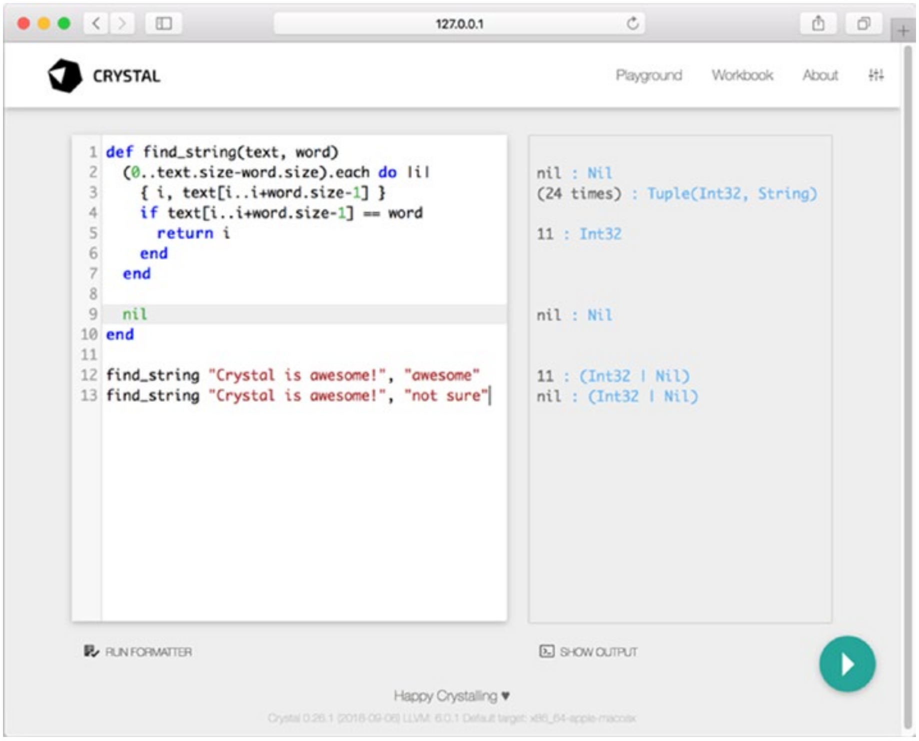
Once installed, Crystal can actually be enjoyed as a stand-alone, in what is called a playground. You can start up a training environment as a web server, using the `play` command.

```
crystal play
```

This will start a web server on the default port 8080. You can also start the playground on a different port, using the `-p` flag.

```
crystal play -p 8090
```

You can type code inside the left panel and directly see the results of the line-by-line execution on the right-hand side (Figure 3-2).

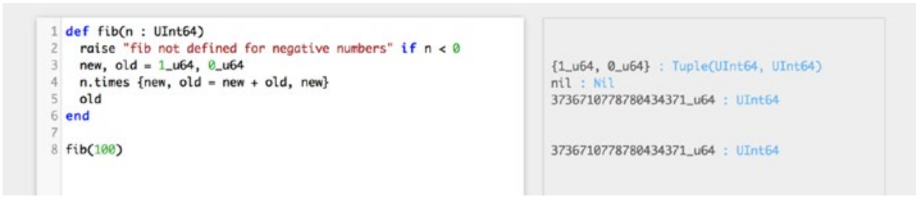


```
def find_string(text, word)
  (0..text.size-word.size).each do |i|
    { i, text[i..i+word.size-1] }
    if text[i..i+word.size-1] == word
      return i
    end
  end

  nil
end

find_string "Crystal is awesome!", "awesome"
find_string "Crystal is awesome!", "not sure"
```

```
nil : Nil
(24 times) : Tuple(Int32, String)

11 : Int32



nil : Nil


11 : (Int32 | Nil)
nil : (Int32 | Nil)
```

Figure 3-2. *Crystal embedded development environment*

The sheer speed of Crystal can be appreciated quite quickly by running some CPU-intensive function, for example, good old Fibonacci (Figure 3-3).



```
def fib(n : UInt64)
  raise "fib not defined for negative numbers" if n < 0
  new, old = 1_u64, 0_u64
  n.times {new, old = new + old, new}
  old
end

fib(100)
```

```
{1_u64, 0_u64} : Tuple(UInt64, UInt64)
nil : Nil
3736710778780434371_u64 : UInt64


3736710778780434371_u64 : UInt64
```

Figure 3-3. *Fibonacci*

The listing with the benchmark code included gives the following:

```
require "benchmark"

def fib(n : UInt64)
  raise "fib not defined for negative numbers" if n < 0
  new, old = 1_u64, 0_u64
  n.times {new, old = new + old, new}
  old
end

def time(&block)
  puts Benchmark.measure(&block).real
end

time { fib(1000000000_u64) }
```

When executed, as here, on a simple MacBook, it took way fewer than five seconds. So, here we are, Crystal is a language of simplicity and speed.

But let's go back and appreciate it while working and typing code in with Visual Studio Code.

Going Visual Studio Code Again

You are going to write a small program fetching URLs of GitHub projects, based on a GitHub search query. The data returned from an HTTP request to GitHub would be in JSON format, so we will have to decode that too, using some JSON parsing.

In a new file, `requesting.cr`, let's write the code that will send the request and display it in the console.

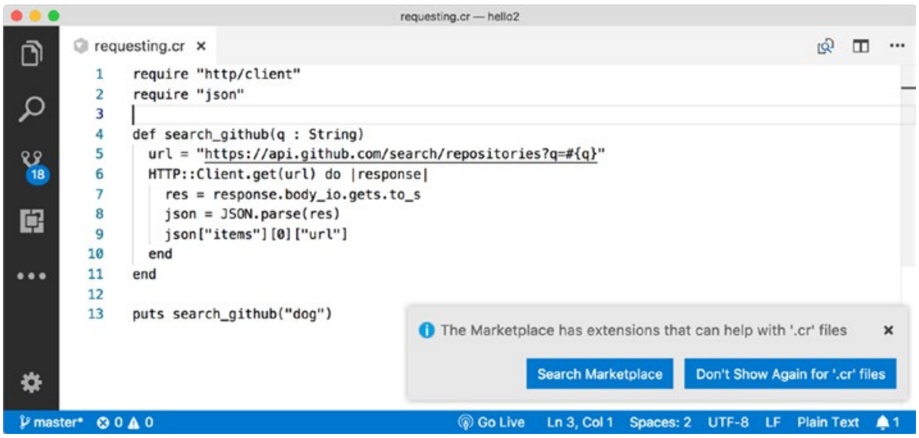
```
require "http/client"
require "json"
```

```
def search_github(q : String)
  url = "https://api.github.com/search/repositories?q=#{q}"
  HTTP::Client.get(url) do |response|
    res = response.body_io.gets.to_s
    json = JSON.parse(res)
    json["items"][0]["url"]
  end
end

puts search_github("dog")
```

As you can appreciate, the syntax is really, really close to Ruby. Also, note the optional typing of the parameter(s), `q : String`.

The HTTP client and the JSON parser are part of the core language, and thus, no third-party library is required to run the snippet.

Once you have typed the code in the file, Visual Studio Code will, as usual, propose that you find a plug-in in the Marketplace (Figure 3-4).

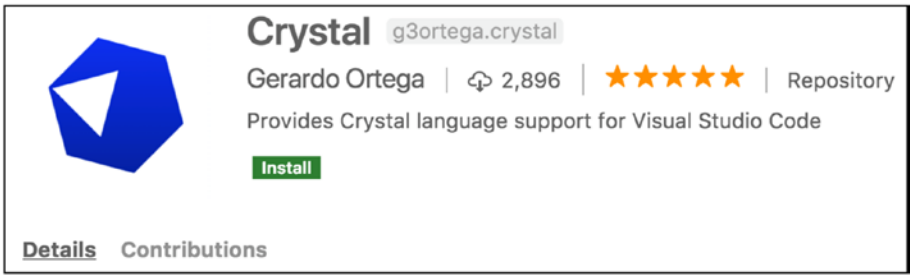


```
require "http/client"
require "json"

def search_github(q : String)
  url = "https://api.github.com/search/repositories?q=#{q}"
  HTTP::Client.get(url) do |response|
    res = response.body_io.gets.to_s
    json = JSON.parse(res)
    json["items"][0]["url"]
  end
end

puts search_github("dog")
```

The Marketplace has extensions that can help with '.cr' files

Figure 3-4. *Looking for crystals in the Marketplace*

I have been having a great experience with the Crystal plug-in of Gerardo Ortega (Figure 3-5), but, of course, feel free to try others.



Provides Crystal language support for Visual Studio Code

Figure 3-5. *Crystal plug-in*

You may remember from Chapter 2 that you also need a `tasks.json` file, very similar to the one that was used for Nim, to run and execute code, but this time for Crystal. The command to execute/run a file from the command line uses the `crystal` command directly.

```
crystal run <file_name>
```

So, let's write the equivalent command in Visual Studio Code's task file.

```
{
    "version": "2.0.0",
    "tasks":
        [
            {
                "label": "cr",
                "command": "crystal",
                "args": [
                    "run",
                    "${file}"
                ],
                "options": {
                    "cwd": "${workspaceRoot}"
                },
                "group": {
                    "kind": "build",
                    "isDefault": true
                }
            }
        ]
    }
```

Note Actually, on macOS, you must modify the `LIBRARY_PATH` variable, so that Crystal can compile the C code properly.

This is done by adding the following line to the Visual Studio Code user settings.

```
 "terminal.integrated.env.osx": {
       "LIBRARY_PATH": "/Users/niko/projects/homebrew/lib"
}
```

The settings can be edited, as shown in Figure 3-6, Figure 3-7, and Figure 3-8.

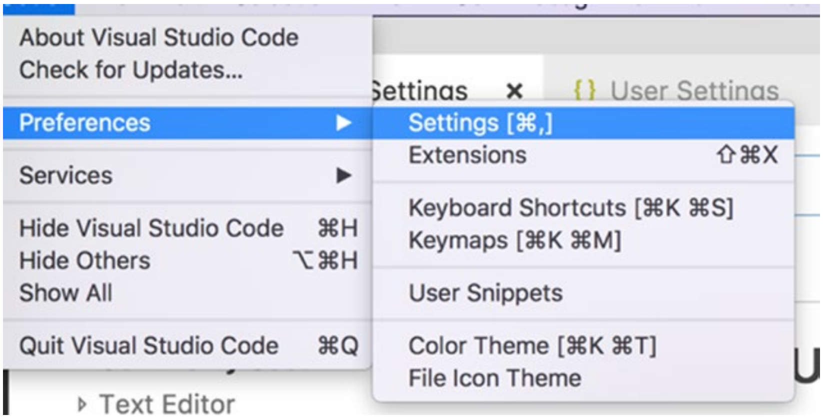


Figure 3-6. *Access the settings*

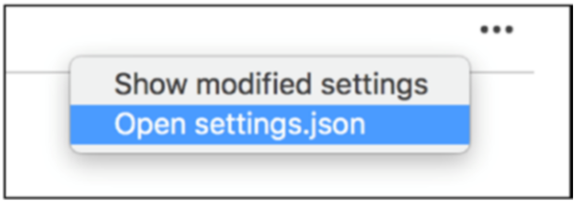
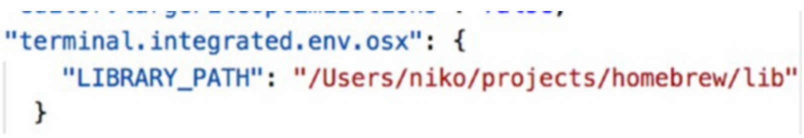


Figure 3-7. *Edit the json file*



```
"terminal.integrated.env.osx": {
    "LIBRARY_PATH": "/Users/niko/projects/homebrew/lib"
 }
```

Figure 3-8. *Add the line*

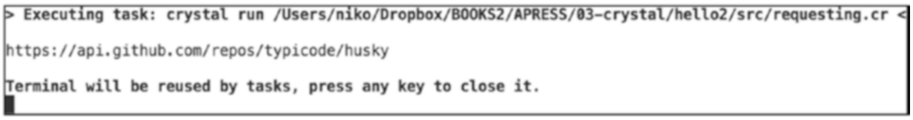
Note that when you execute from the command line, you will also have to set the same variable somewhere in your shell environment, using the following:

```
export LIBRARY_PATH=/Users/niko/projects/homebrew/lib
```

This is a unique workaround for macOS and can be safely ignored on other environments.

You are all set now, so a familiar Command+Shift+B (Ctrl+Shift+B) will execute the Crystal code.

The integrated console/terminal of Visual Studio Code will execute the command and display the result of the GitHub query (Figure 3-9).



```
> Executing task: crystal run /Users/niko/Dropbox/BOOKS2/APRESS/03-crystal/hello2/src/requesting.cr <

https://api.github.com/repos/typicode/husky

Terminal will be reused by tasks, press any key to close it.
```

Figure 3-9. *First Crystal command*

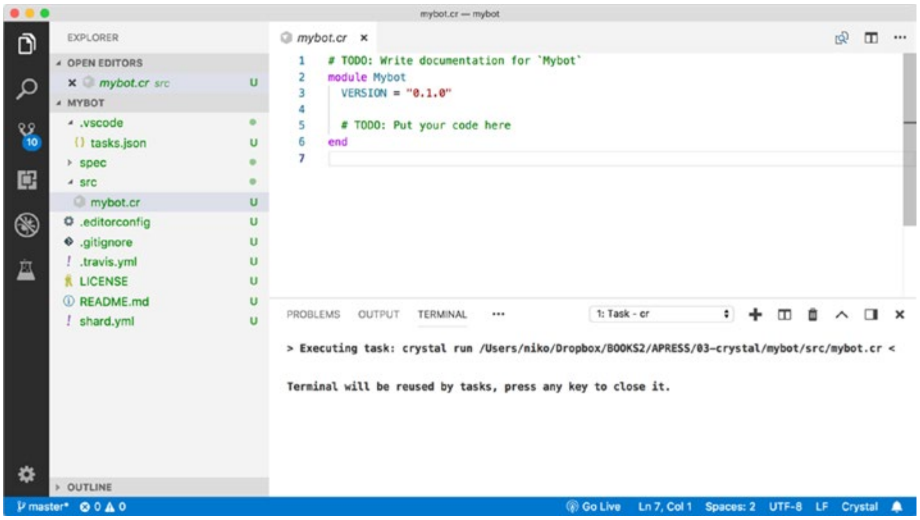
Now, to write the Telegram bot, we are going to require a third-party library. For this to work, we will create a Crystal project, using the built-in command.

Creating a Crystal Project

To create a layout of files for a new Crystal project, you can use the `init` subcommand.

```
SuperPinkicious:crystal niko$ crystal init app mybot
    create  mybot/.gitignore
    create  mybot/.editorconfig
    create  mybot/LICENSE
    create  mybot/README.md
    create  mybot/.travis.yml
    create  mybot/shard.yml
    create  mybot/src/mybot.cr
    create  mybot/spec/spec_helper.cr
    create  mybot/spec/mybot_spec.cr
Initialized empty Git repository in /Users/niko/APRESS/crystal/
mybot/.git/
```

Now, if you open the folder in Visual Studio Code and re-create the `tasks.json` to run Crystal code, you should be able to open and execute the (almost empty) `mybot.cr` file (Figure 3-10).



```
# TODO: Write documentation for `Mybot`
module Mybot
  VERSION = "0.1.0"

  # TODO: Put your code here
end
```

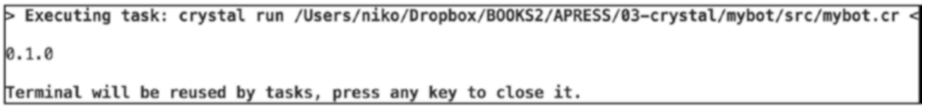
```
> Executing task: crystal run /Users/niko/Dropbox/BOOKS2/APRESS/03-crystal/mybot/src/mybot.cr <

Terminal will be reused by tasks, press any key to close it.
```

Figure 3-10. *Empty—really, really empty—bot*

That is probably not the most exciting program you've ever seen. Let's update the code of `mybot.cr` just a little bit, by adding a print statement at the bottom of the file.

```
puts Mybot::VERSION
```

You can execute this directly from Visual Studio Code, of course (Figure 3-11).



```
> Executing task: crystal run /Users/niko/Dropbox/BOOKS2/APRESS/03-crystal/mybot/src/mybot.cr <
0.1.0
Terminal will be reused by tasks, press any key to close it.
```

Figure 3-11. *Printing the version*

You can also execute from the command line, using the `run` subcommand.

```
SuperPinkicious:mybot niko$ crystal run src/mybot.cr
0.1.0
```

The interesting part is that you can also compile the same code to a binary file, using the `build` command.

```
crystal build src/mybot.cr
```

Then, directly invoking the compiled file will execute the same print statement, but this time, as a binary file, without dependencies on the Crystal build system.

```
./mybot
>0.1.0
```

Any code you compile with the `build` command gives you an executable you can reuse at will. This includes the soon-to-arrive Telegram `bot.Sweet`.

Now, the reason we really wanted to create a Crystal project in the first place was to be able to add the bot API dependency to write Crystal code. In the project folder, there was a file named `shard.yml`. This is the metadata file responsible for handling the project, similar to `pom.xml` or `build.gradle` in Java or the `package.json` file in JavaScript.

The content of the file `shard.yml` is shown following, with the added `telegram_bot` dependency toward the end.

```
name: mybot
version: 0.1.0
authors:
  - Nicolas Modrzyk <hellonico at gmail.com>
targets:
  mybot:
    main: src/mybot.cr
```

```
crystal: 0.26.1
license: MIT

dependencies:
  telegram_bot:
    github: hangyas/telegram_bot
```

The dependency being defined in the `shard.yml` file of the project, you can now retrieve that dependency, using the package manager for Crystal, the `shards` command.

```
SuperPinkicious:mybot niko$ shards
Fetching https://github.com/hangyas/telegram_bot.git

Installing telegram_bot (0.1.0 at HEAD)
```

You will notice a lock file has been created, containing the dependency, and the hash of the commit that was referenced for each dependency.

```
version: 1.0
shards:
  telegram_bot:
    github: hangyas/telegram_bot
    commit: 722bab24876d13a661f513b09c4569916f7a81c1
```

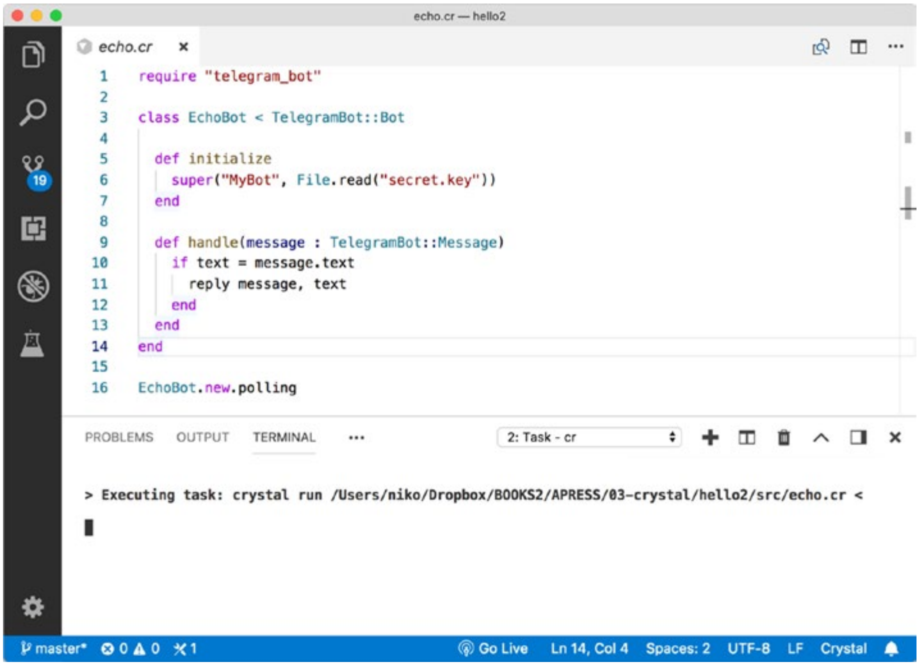
That's pretty much all you require to write your Crystal-based Telegram bot, so let's see all this in action, with a simple echo bot.

Echo Bot

With all that you have seen so far in this chapter and the previous one, the upcoming code should not be too complicated to read. We start by setting up the name and secret Telegram API key of the bot in the constructor, the `initialize` function. We then move on to implement the `handle` (message) function, which gets a message as a parameter and replies using the text that was read in the incoming message. Last, we create a new bot, and define its connection as polling.

```
require "telegram_bot"

class EchoBot < TelegramBot::Bot

  def initialize
    super("MyBot", File.read("secret.key"))
  end

  def handle(message : TelegramBot::Message)
    if text = message.text
      reply message, text
    end
  end
end

EchoBot.new.polling
```

Then we execute the bot, by using the Command(Ctrl)+Shift+B key shortcut again (Figure 3-12).

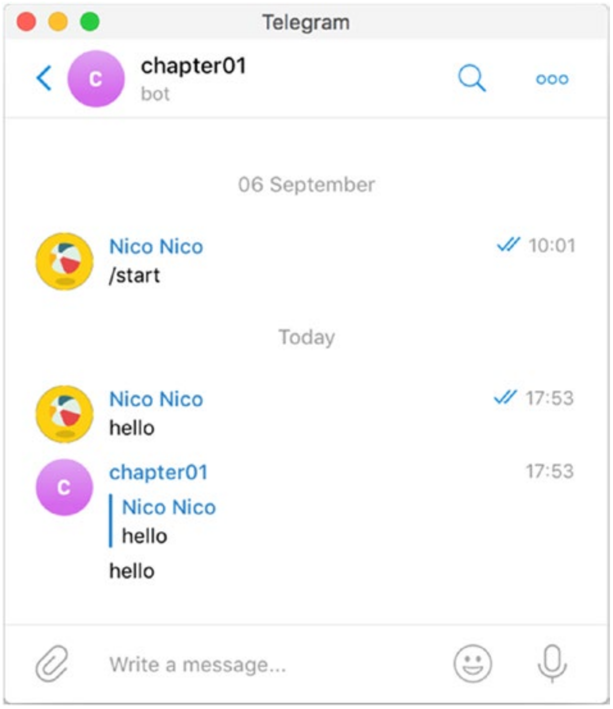


```
require "telegram_bot"

class EchoBot < TelegramBot::Bot

  def initialize
    super("MyBot", File.read("secret.key"))
  end

  def handle(message : TelegramBot::Message)
    if text = message.text
      reply message, text
    end
  end
end

EchoBot.new.polling
```

```
> Executing task: crystal run /Users/niko/Dropbox/BOOKS2/APRESS/03-crystal/hello2/src/echo.cr <
```

Figure 3-12. *Starting the bot*

Back to chatting to this new bot. You can confirm that a nice parrot has been found, and whatever you say will be repeated (Figure 3-13).



06 September

Nico Nico 10:01
/start

Today

Nico Nico 17:53
hello

chapter01 17:53
Nico Nico
hello
hello

Figure 3-13. *echo, echo, hello, hello*

That was an easy bot. Let's move on to something more exciting, with the command bot.

Command Bot

Telegram understands the notion of commands. To put it simply, a command is a message to a bot. We know, however, that this accepts a bunch of parameters, and this helps us to write code that is easier to read, without the need for complex parsing of the message.

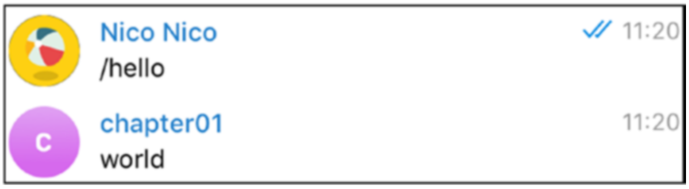
When it's an incoming message, the bot will try to find an implemented command for it first. If none is found, it will use the standard `handle` function.

Our first bot will implement a `hello` command, which takes no parameter, and just reply to the message, as the `handle` function would have done.

The code is the following:

```
require "telegram_bot"

class CommandOneBot < TelegramBot::Bot
  include TelegramBot::CmdHandler

  def initialize
    super("MyBot", File.read("secret.key"))

    cmd "hello" do |msg|
      send_message msg.chat.id, "world"
    end
  end

end

my_bot = CommandOneBot.new
my_bot.polling
```

The only difference with the code you have seen up to now is the cmd block. The block takes a string for identifier, and its simplest form, the message, as parameter of the block. Sending a command from the chat simply requires a prefix and the name of the command sent to the bot (Figure 3-14).



Nico Nico 11:20
/hello

chapter01 11:20
world

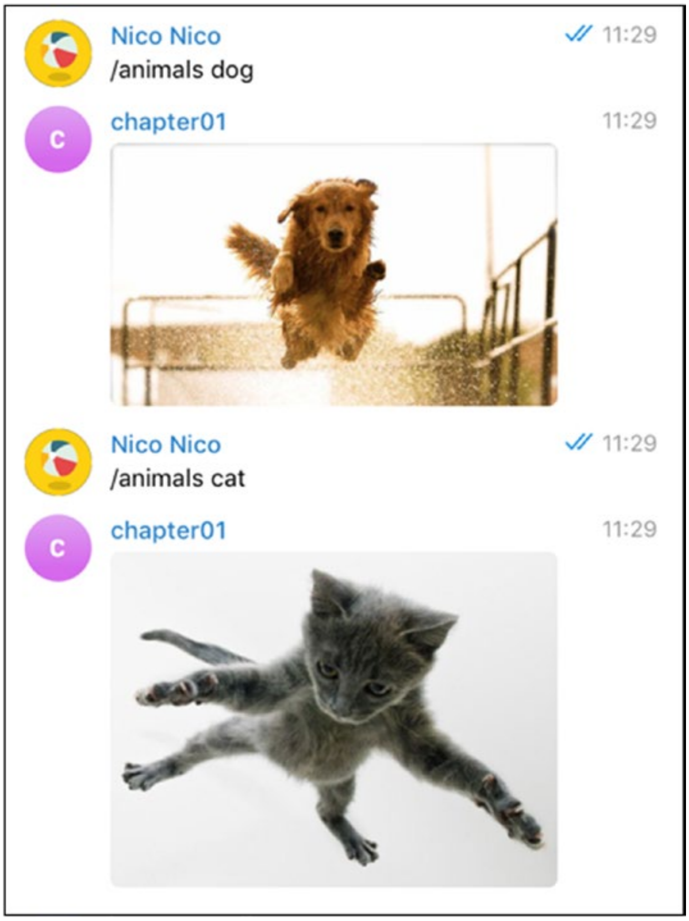
Figure 3-14. *hello command*

Now, on to our second bot. The second bot is going to use the parameters passed to the command to send an image as a reply.

This time, instead of using `send_message`, we'll use `send_photo`, to send an image back to the chat, depending on the parameter.

```
require "telegram_bot"

class CommandOneBot < TelegramBot::Bot
  include TelegramBot::CmdHandler

  def initialize
    super("MyBot", File.read("secret.key"))

    cmd "animals" do |msg, params|
        send_photo msg.chat.id, File.new("#{params[0]}.jpg")
    end
  end

end

my_bot = CommandOneBot.new
my_bot.polling
```

Now, provided you have a few images in the project folder to match the animals' names, the `/animals` command will fetch the image as a file and send it back to the chat room (Figure 3-15).



Nico Nico 11:29
/animals dog

chapter01 11:29

Nico Nico 11:29
/animals cat

chapter01 11:29

Figure 3-15. *`/animals` are cute!*

Now, you can try a few different commands, using other bot API functionalities.

Most of the Telegram bot APIs are implemented in Crystal's `telegram_bot`, and following is a list of the different functions that can be used to send types of messages and media to the chat.

- `send_message`
- `send_photo`

- `send_audio`
- `send_document`
- `send_sticker`
- `send_video`
- `send_voice`
- `send_video_note`
- `send_media_group`
- `send_location`
- `send_venue`
- `send_contact`
- `send_chat_action`
- `send_game`
- `send_invoice`

But now you'll have to wait until next week, before you can see inline messages in action.

CHAPTER 4

Week 4: Rust

No great movement designed to change the world can bear to be laughed at or belittled. Mockery is a rust that corrodes all it touches.

—Milan Kundera

If you have not heard about the Rust programming language yet, I think you should. Rust won first place for "most-loved programming language" in the Stack Overflow Developer Survey in 2016, 2017, and 2018.

As noted on the Rust web site (`www.rust-lang.org`), the language has a long list of advantages, such as the following:

- Zero-cost abstractions
- Move semantics
- Guaranteed memory safety
- Threads without data races
- Trait-based generics
- Pattern matching
- Type inference
- Minimal runtime
- Efficient C bindings

N. Modrzyk, *Building Telegram Bots*, https://doi.org/10.1007/978-1-4842-4197-4_4

Rust is sponsored by Mozilla, but more than just being backed by a single company, it is also coded by a very supportive and active community. Rust is very much concerned with robust threaded environments and related memory safety concerns. These are especially suited to solving problems related to developing a concurrent end point for bots, as this chapter will explore.

Rust Installation and First Steps

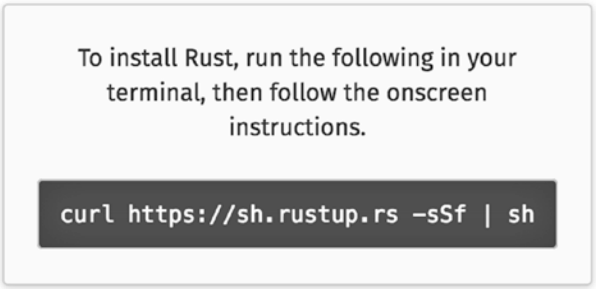
Rust is maintained and managed on your local machine using `rustup`. Yes, this is an environment manager specific to Rust. It is similar to Ruby Version Manager (RVM) but fully part of the Rust tool chain and not a third-party team, so it feels very integrated.

Installation

The following two links are the entry points to get `rustup` and, thus, Rust installed on your machine:

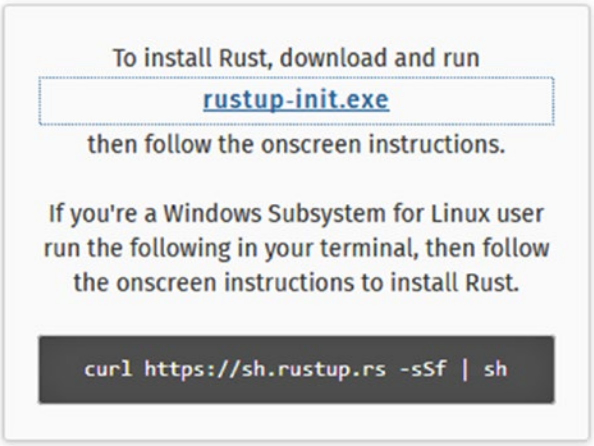
```
www.rust-lang.org/en-US/install.html
www.rust-lang.org/en-US/other-installers.html
```

Depending on whether you are on macOS/Linux (Figure 4-1) or Windows (Figure 4-2), you will get a different page, but the installation process is quite similar.


To install Rust, run the following in your terminal, then follow the onscreen instructions.

```
curl https://sh.rustup.rs -sSf | sh
```

Figure 4-1. *Installation box on OSX/Linux*

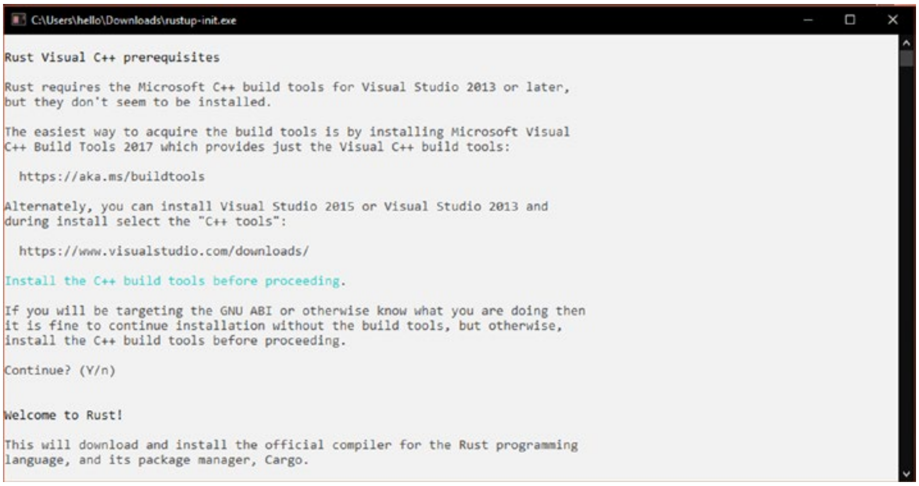

To install Rust, download and run rustup-init.exe then follow the onscreen instructions.

If you're a Windows Subsystem for Linux user run the following in your terminal, then follow the onscreen instructions to install Rust.

```
curl https://sh.rustup.rs -sSf | sh
```

Figure 4-2. *Installation box on Windows*

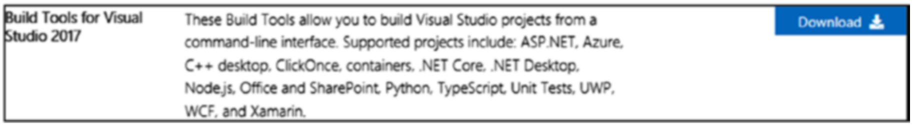
On Windows, you also require some extra tooling, such as the Microsoft C++ build tools (Figure 4-3).



```
C:\Users\hello\Downloads\rustup-init.exe

Rust Visual C++ prerequisites

Rust requires the Microsoft C++ build tools for Visual Studio 2013 or later,
but they don't seem to be installed.

The easiest way to acquire the build tools is by installing Microsoft Visual
C++ Build Tools 2017 which provides just the Visual C++ build tools:

  https://aka.ms/buildtools

Alternately, you can install Visual Studio 2015 or Visual Studio 2013 and
during install select the "C++ tools":

  https://www.visualstudio.com/downloads/

Install the C++ build tools before proceeding.

If you will be targeting the GNU ABI or otherwise know what you are doing then
it is fine to continue installation without the build tools, but otherwise,
install the C++ build tools before proceeding.

Continue? (Y/n)


Welcome to Rust!

This will download and install the official compiler for the Rust programming
language, and its package manager, Cargo.
```

Figure 4-3. *C++ tooling required on Windows*

As indicated in the console output, the Microsoft build tools can be found on the following web site: `https://aka.ms/buildtools`. You can download and install (Figure 4-4 and Figure 4-5) by following the download link.



Build Tools for Visual Studio 2017

These Build Tools allow you to build Visual Studio projects from a command-line interface. Supported projects include: ASP.NET, Azure, C++ desktop, ClickOnce, containers, .NET Core, .NET Desktop, Node.js, Office and SharePoint, Python, TypeScript, Unit Tests, UWP, WCF, and Xamarin.

Figure 4-4. *Build tools for Visual Studio*

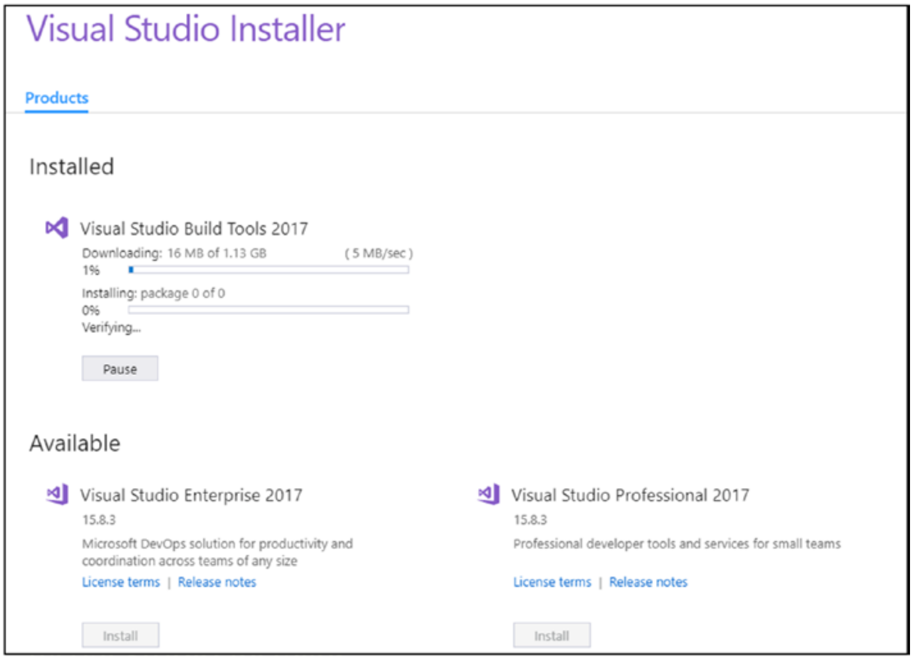

Visual Studio Installer
Products
Installed
Visual Studio Build Tools 2017
Downloading: 16 MB of 1.13 GB (5 MB/sec)
1%
Installing: package 0 of 0
0%
Verifying...
Pause
Available
Visual Studio Enterprise 2017
15.8.3
Microsoft DevOps solution for productivity and coordination across teams of any size
License terms | Release notes
Install
Visual Studio Professional 2017
15.8.3
Professional developer tools and services for small teams
License terms | Release notes
Install

Figure 4-5. *Installing the build tools*

Rust has a fast-paced six-week update cycle, so by the time you read this, the version will be different, but at the time of writing, this is the Rust current version, obtained with the `rustupshow` command:

```
SuperPinkicious:rust-01 niko$ rustup show
Default host: x86_64-apple-darwin

stable-x86_64-apple-darwin (default)
rustc 1.28.0 (9634041f0 2018-07-30)
```

Now let's see how to compile your first Rust program.

First Rust or Two

The first Rust program will print a simple Hello World message. This isn't complicated, but it will help you get used to the Rust compilation and execution tool chain.

Hello Rust

This, our first Rust program,

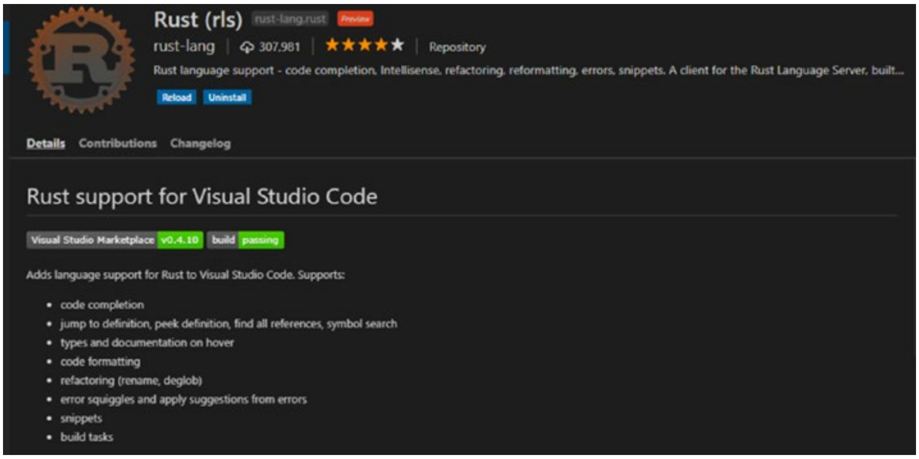
- Declares a `main` function, using `fn`
- Prints to the standard output with the `println!` function (note the exclamation point)
- Ends statements with a semicolon (`;`)

This gives you the following simple and short code snippet:

```
fn main() {
    println!("Hello World!");
}
```

You can save the snippet in a file named `first.rs`, for example.

As a side note, if you type the preceding snippet in Visual Studio Code, the editor will recognize the `rs` file extension and will ask you to install a related plug-in, to handle `rs` files (Figure 4-6).


Rust (rls) rust-lang.rust Preview
rust-lang | 307,981 | ★★★★★ | Repository
Rust language support - code completion, Intellisense, refactoring, reformatting, errors, snippets. A client for the Rust Language Server, built...
Reload Uninstall
Details Contributions Changelog

Rust support for Visual Studio Code

Visual Studio Marketplace v0.4.10 build passing

Adds language support for Rust to Visual Studio Code. Supports:

- code completion
- jump to definition, peek definition, find all references, symbol search
- types and documentation on hover
- code formatting
- refactoring (rename, deglob)
- error squiggles and apply suggestions from errors
- snippets
- build tasks

Figure 4-6. *Visual Studio Code Rust plug-in*

Rust being a compiled language, you must first handle a compilation step before execution of the code. This is done using the `rustc` command, which is installed when you install `rustup`. The command is as follows:

```
rustc first.rs
```

In the same folder in which you run the command, you will notice that you now have a new binary file, without the `.rs` file extension. Executing the binary is just a matter of typing the command name.

```
$ ./first
Hello World!
```

This works both for Windows and macOS/Linux, but, of course, you cannot bring one and make it run onto the other as is. You'll have to compile things again. While `rustup` can help you cross-compile for other platforms, that is beyond the scope of this book.

For other ramp-up examples, make sure to review the excellent Rust by Example web site (https://doc.rust-lang.org/rust-by-example/hello.html), which has all you need to get started with the language's constructs.

Going forward, let's review how good old Fibonacci numbers can be expressively generated with Rust.

Fibonacci

Rust has very convenient pattern-matching branching, which can be written with the appropriately named `match`. We will use the construct to write the Fibonacci generators.

In a new file, `fibo.rs`, we declare the `fibonacci` function, including the parameter types for input and output—here, 64-bit integers for both inputs and outputs—to avoid overflows.

Also, note, in the following code snippet, how you use _ to match any other value for `n`.

```
fn fibonacci(n: u64) -> u64 {
    match n {
        0 => 0,
        1 => 1,
        _ => fibonacci(n - 1) + fibonacci(n - 2)
    }
}
```

Let's put this code with a main function, so that we can call the program with an input from the command line.

```
use std::env;

fn main() {
    if let Some(arg1) = env::args().nth(1) {
        let myint = arg1.parse().unwrap();
        println!("{}", fibonacci(myint));
    } else {
        println!("missing input")
    }
}
```

In the preceding code snippet, note how explicit null checks are avoided by using `Some` and how the string parameter is turned into an integer, `myint`, using `parse` and `unwrap`.

`unwrap` is used to turn the `Some(something_inside)` to `something_inside`. Here, we have the `aif/else` block to confirm whether we have a value as an argument.

If you are not sure whether you have a value after `Sum`, you can also use `unwrap_or`, to give a default value.

Compiling gives you an executable, as in the previous Hello World example.

```
rustc fibo.rs
```

Running shows that the Fibonacci generator program works as expected.

```
$ ./fibo 10
55
$ ./fibo 15
610
$ ./fibo 30
832040
```

While Rust can be enjoyed on its own, you usually resort to `cargo`, the Rust build tool, to create a project structure and manage project dependencies.

Ride the cargo

cargo is a command-line tool that is also installed and set up by rustup. cargo is responsible for creating new projects, managing the project structure, adding dependencies, generating binaries, running code, testing code, etc.

A list of the most important cargo subcommands is shown following:

```
Some common cargo commands are (see all commands with --list):
    build       Compile the current project
    clean       Remove the target directory
    doc         Build this project's and its dependencies'
                documentation
    new         Create a new cargo project
    init        Create a new cargo project in an existing
                directory
    run         Build and execute src/main.rs
    test        Run the tests
    bench       Run the benchmarks
    update      Update dependencies listed in Cargo.lock
    search      Search registry for crates
    publish     Package and upload this project to the registry
    install     Install a Rust binary
    uninstall   Uninstall a Rust binary
```

As a first cargo test, let's write a program that displays Coordinated Universal Time (UTC) and local times, using a third-party library named chrono.

We Have Time

Obviously, before we add a library to a project, we first require a project. This is done via the new subcommand of cargo.

```
$ cargo new we-have-time
Created binary (application) `we-have-time` project
```

The type of project generated by cargo is a binary application by default, but you can also prepare a library without a runnable entry point. Once you have the project generated, you can see a very basic project structure and a few files and folders.

```
$ tree -L 2
.
├── Cargo.toml
└── src
    └── main.rs
```

In the preceding, Cargo.toml is the project metadata, and main.rs is the same kind of Rust source file we have seen up to now. Cargo.toml is the location to add the dependencies.

```
$ cat Cargo.toml
[package]
name = "we-have-time"
version = "0.1.0"
authors = ["Nicolas Modrzyk <myemail@gmail.com>"]

[dependencies]
```

Now as we would like to play with dates and time zones, let's use cargo again, to search for a time library.

```
$ cargo search time
    Updating registry `https://github.com/rust-lang/crates.
    io-index`
time = "0.1.40"              # Utilities for working with time-
                             related functions in Rust.
```

```
exonum-time = "0.9.2"       # The time oracle service for
                              Exonum.
chrono = "0.4.6"            # Date and time library for Rust
faster_path = "0.0.2"       # Alternative to Pathname
specs_time = "0.5.1"        # time resource for specs
... and 1738 crates more (use --limit N to see more)
```

chrono makes it easy to display dates in different time zones, so we'll just use that library. To make chrono available to your project, you add its name and version to the Cargo.toml file, in the dependencies section.

This gives

```
[dependencies]
chrono = "0.4.6"
```

After adding a library, or to validate the code written in your project, you can usually make use of cargo check. This also comes in handy after adding a dependency, to make sure it has been downloaded and installed properly on your local machine.

```
$ cargo check
   Compiling num-traits v0.2.5
   Compiling num-integer v0.1.39
    Checking libc v0.2.43
    Checking time v0.1.40
    Checking chrono v0.4.6
    Checking we-have-time v0.1.0 (file:///Users/niko/Dropbox/
    BOOKS2/APRESS/04-rust/we-have-time)
    Finished dev [unoptimized + debuginfo] target(s) in 7.69s
```

Now let's move on to coding and update the Rust code, located in main.rs, to make use of the chrono library.

1. First, we must tell the program that we are using an external library, which Rust calls `crate`. This is done using the `extern crate chrono` notation. This is done only once in the lifetime of a program.
2. Next, we must import the Rust symbols in the current file/namespace, and this is done via `use`.
3. `let` defines immutable variables, each with its own type.
4. And, as before, `println!` prints this on the standard output.

This gives the following code snippet (again in the `main.rs` file):

```
extern crate chrono;
use chrono::prelude::*;

fn main() {
    let utc: DateTime<Utc> = Utc::now();
    println!("{}", utc);
    let local: DateTime<Local> = Local::now();
    println!("{}", local);
}
```

Because we are using `cargo` to manage our project, there are now a few shortcuts we can take advantage of to play with the run, such as running code directly, by using `cargorun`.

```
$ cargo run
   Compiling num-traits v0.2.5
   Compiling num-integer v0.1.39
   Compiling libc v0.2.43
   Compiling time v0.1.40
   Compiling chrono v0.4.6
   Compiling we-have-time v0.1.0 (file://we-have-time)
    Finished dev [unoptimized + debuginfo] target(s) in 9.11s
     Running `target/debug/we-have-time`
2018-09-12 05:41:56.872180 UTC
2018-09-12 14:41:56.872309 +09:00
```

See the two dates displayed at the end of the compilation steps? These are the standard output of the program.

`run` is the de facto subcommand for writing and running Rust programs quickly. To create the final version, `cargo` has the built-in subtask `build`. `build` is responsible for creating a stand-alone binary file.

```
$ cargo build
Finished dev [unoptimized + debuginfo] target(s) in 0.16s
```

Note, too, that `cargo` supports incremental compilation and will only recompile code that was changed since the last execution.

Running the binary gives the same output—everything is working so well. This is actually refreshing.

```
$ ./target/debug/we-have-time
2018-09-12 06:01:54.100082 UTC
2018-09-12 15:01:54.100176 +09:00
```

You will also see later how to generate a release version of your program, using the same `cargo build` command, but with extra flags.

For now, let's sidestep and see how we can declare multiple targets within the same cargo project, meaning different entry points for execution.

Multiple Cargo Targets

You may have noticed that each of the commands run is taking the `main.rs` file as the default input. For some time, I have been looking for a way to run different files, and you actually cannot pass a file directly to `cargo`. In the `Cargo.toml` file, you must define what is known as a binary target. This is done by defining a block in the `.toml` file, using `[[bin]]`.

At a minimum, the block takes a name and a path, so let's define two binary targets, one with the existing `main.rs` file and another with a new Rust source code file: `main2.rs`.

```
[[bin]]
name = "main1"
path = "src/main.rs"

[[bin]]
name = "main2"
path = "src/main2.rs"
```

For the purpose of multiple targets, we will keep the `main2.rs` source code ultra-minimal here, only outputting the current date in the UTC time zone, but, of course, it could be as complicated as you can code it.

```
extern crate chrono;

use chrono::prelude::*;

fn main() {
    let utc: DateTime<Utc> = Utc::now();
    println!("{}", utc);
}
```

Now, when running cargo commands, you can specify which binary target to run by specifying the `--bin` flag to `cargo`, as shown twice in the following code, once with target binary `main1`

```
$ cargo run --bin main1
    Finished dev [unoptimized + debuginfo] target(s) in 0.16s
     Running `target/debug/main1`
```

```
2018-09-12 06:26:11.634208 UTC
2018-09-12 15:26:11.634336 +09:00
```

and a second time with target binary `main2`

```
$ cargo run --bin main2
    Finished dev [unoptimized + debuginfo] target(s) in 0.05s
     Running `target/debug/main2`
2018-09-12 06:26:13.387135 UTC
```

As a bonus, here is the `tasks.json` you can use within Virtual Studio Code to run any of the two binary targets from visual code.

```
{
    "version": "2.0.0",
    "tasks":
        [
            {
                "label": "main1",
                "command": "cargo",
                "args": [
                    "run",
                    "--bin",
                    "main1"
                ],
                "options": {
                    "cwd": "${workspaceRoot}"
                },
                "group": {
                    "kind": "build",
                    "isDefault": true
                }
            },
            {
                "label": "main2",
                "command": "cargo",
                "args": [
                    "run",
                    "--bin",
                    "main2"
                ],
                "options": {
                    "cwd": "${workspaceRoot}"
                },
                "group": {
                    "kind": "build",
                    "isDefault": true
                }
            }
        ]
    }
```

In addition, by using Command(Ctrl)+Shift+B, you can now select which cargo binary target to run (Figure 4-7).

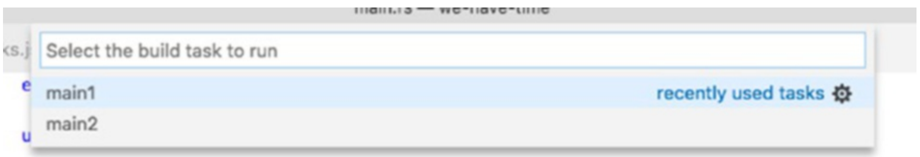


***Figure 4-7.** Binary target from Visual Studio Code*

Now you have all you need to start enjoying writing bots in Rust. So, let's bot.

Rust Bot Number 1: Reply to Me

To create bots, we'll again make use of a Telegram wrapper. To find one, remember how you used cargo to search for a dependency: the cargo search command.

```
$ cargo search telegram
    Updating registry `https://github.com/rust-lang/crates.
    io-index`
telegram = "0.2.0"                # Unofficial Telegram API
                                  Library
telegram-bot = "0.6.1"            # A library for creating
                                  Telegram bots
telegram-bot-raw = "0.6.1"        # Telegram Bot API types
teleborg = "0.1.32"               # A Telegram bot API.
... and 35 crates more (use --limit N to see more)
```

We'll go for the telegram-bot version "0.6.1". So, having created a new project with cargo, we will update Cargo.toml accordingly.

```
[dependencies]
telegram-bot = "0.6"
tokio-core = "0.1.17"
futures = "0.1.23"
```

Ah, yes, you'll also have to spawn threads (futures) and have a cool messaging system (tokio-core), so we add those two in the dependencies section too.

In the same Cargo.toml file, we will also define a first binary target.

```
[[bin]]
name = "bot1"
path = "src/bot1.rs"
```

I will let you define more binary targets (and update the tasks.json), as you delve further into this chapter.

The core purpose of the bot is, as usual, to get an update from the Telegram servers, by polling, and handle the message associated with the update. Here, we retrieve the text of a pure text message, as well as references to the first name of the person who wrote the message. match, which you have seen with Fibonacci, is again used to match on the message type—here, MessageKind::Text.

Finally, once we have all the elements, we must send a reply (first_name, test data), then call text_reply inside a newly spawned thread—here, in fire-and-forget mode.

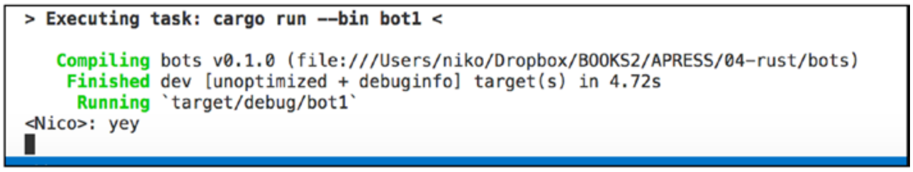
```
if let UpdateKind::Message(message) = update.kind {
            match message.kind {
                MessageKind::Text {ref data, ..} => {
                        api.spawn(message.text_reply(
                            format!("Hi, {}! You just wrote
                            '{}'",
&message.from.first_name, data)
                        ));
                },
                _ => {println!("which message?")}
            }
}
```

In case the type of the message is not a text message, we just ignore it altogether, with the default section _ of the match block. The rest of the code involves some gymnastics, to get the bot to be in a threaded environment with message passing, as described in more detail on the telegram_botgithub page.

This is not that important to write the bot, so we'll just assume we have to write it. Finally, the full listing of `bot1.rs` is shown following:

```
extern crate futures;
extern crate telegram_bot;
extern crate tokio_core;

use std::env;

use futures::Stream;
use tokio_core::reactor::Core;
use telegram_bot::*;

fn main() {
    let mut core = Core::new().unwrap();

    let token = env::var("TELEGRAM_BOT_TOKEN").unwrap();
    let api = Api::configure(token).build(core.handle()).unwrap();

    let future = api.stream().for_each(|update| {

        if let UpdateKind::Message(message) = update.kind {

            if let MessageKind::Text {ref data, ..} = message.
            kind {
                println!("<{}>: {}", &message.from.first_name,
                data);

                api.spawn(message.text_reply(
                    format!("Hi, {}! You just wrote '{}'",
                          &message.from.first_name, data)
                ));
            }
        }
        Ok(())
    });

    core.run(future).unwrap();
}
```

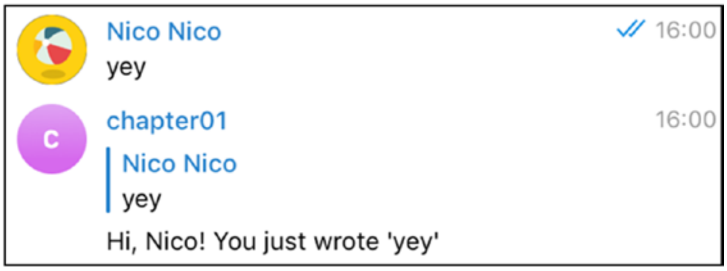
Now you can start this bot from the command line or from Visual Studio Code (Figure 4-8).



```
> Executing task: cargo run --bin bot1 <

   Compiling bots v0.1.0 (file:///Users/niko/Dropbox/BOOKS2/APRESS/04-rust/bots)
    Finished dev [unoptimized + debuginfo] target(s) in 4.72s
     Running `target/debug/bot1`
<Nico>: yey
```

Figure 4-8. *Starting the Rust bot from Visual Studio Code*

And confirm the usual output from a Telegram chat, as shown in Figure 4-9.



Nico Nico 16:00
yey

chapter01 16:00
Nico Nico
yey
Hi, Nico! You just wrote 'yey'

Figure 4-9. *Your first Rust bot*

Rust Bot Number 2: Where Is Tokyo?

It's always nice to have a bot that tells you where something is or where to head. The next bot will send you a live location, with a time-out directly in the chat.

While the main function is almost identical to that in the previous example, in terms of preparing the bot and setting up the channeling, the meat of the following exercise, is actually to send the live location.

This is done using the `location_reply` function on the Rust object message. We can also specify directly here how long the location live stream will run.

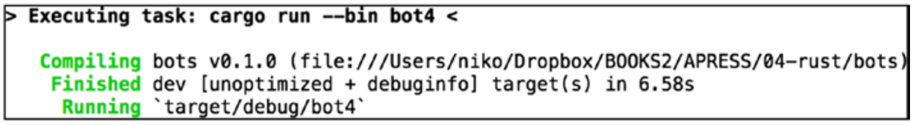
In the following code, we stream the location of Tokyo (lat 35.652832° N, long 139.839478° E) for 60 seconds.

Again, most of this Rust Telegram API is based on preparing `futures`, an object from the `futures` library ready to be executed in a separate thread and spawned using `tokio` handles.

The `core` bot handle and message answers are done this way. Following is the code snippet for the location bot.

```
extern crate futures;
extern crate telegram_bot;
extern crate tokio_core;

use std::env;

use futures::{Future, Stream};
use tokio_core::reactor::{Handle, Core};
use telegram_bot::*;

fn where_is_tokyo(api: Api, message: Message, handle: Handle) {
    let api_future = || Ok(api.clone());
    let future = api.send(message.location_reply(35.652832,
    139.839478).live_period(60)).join(api_future());
    handle.spawn(future.then(|_| Ok(())))
}

fn main() {

    let token = env::var("TELEGRAM_BOT_TOKEN").unwrap();
    let mut core = Core::new().unwrap();
    let handle = core.handle();
    let api = Api::configure(token).build(core.handle()).unwrap();

    let future = api.stream().for_each(|update| {
        if let UpdateKind::Message(message) = update.kind {
where_is_tokyo(api.clone(), message.clone(), handle.clone())
        }
        Ok(())
    });

    core.run(future).unwrap();
}
```

With the bot started from Visual Studio Code again (task setup is left to the reader), we can see the compilation steps succeeding and running the compiled target directly (Figure 4-10).



```
> Executing task: cargo run --bin bot4 <

   Compiling bots v0.1.0 (file:///Users/niko/Dropbox/BOOKS2/APRESS/04-rust/bots)
    Finished dev [unoptimized + debuginfo] target(s) in 6.58s
     Running `target/debug/bot4`
```

Figure 4-10. *Starting location bot*

I did not specify any filtering or specific message handling, so sending any message to the bot will do. Here, a brief “hello” message notifies the bot that we want to know where it is (Figure 4-11).

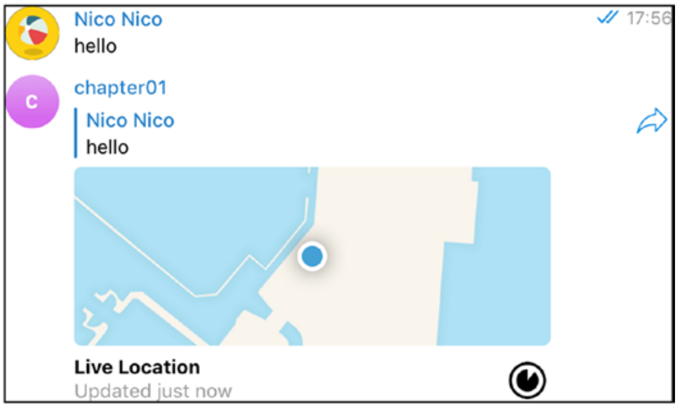

Nico Nico
hello
17:56
chapter01
Nico Nico
hello
Live Location
Updated just now

Figure 4-11. *Live from Tokyo*

Notice, too, in the figure how the clock-looking timer is slowly decreasing, depending on the amount of time we told the live location to run for. A fun exercise using the first version of this bot is actually to edit the location along the way.

Now, let's say we want to send a location in central Tokyo first, and then slowly move east across Japan. We'll use a bunch of the same patterns to run a call asynchronously, join on the newly spawn thread with a time-out, make sure the call is finished, join again, and move on to the next location update.

This is handled as follows:

```
let future = api.send(message.location_reply(35.652832,
139.839478).live_period(60))
        .join(api_future()).join(timeout(10))
        .and_then(|((message, api), _)| api.send(message.edit_
        live_location(35.652832, 138.839478)))
        .join(api_future()).join(timeout(10))
        .and_then(|((message, api), _)| api.send(message.edit_
        live_location(35.652832, 137.839478)))
        .join(api_future()).join(timeout(10))
        .and_then(|((message, api), _)| api.send(message.edit_
        live_location(35.652832, 136.839478)));
```

On the Telegram desktop client, it appeared that the Telegram map was not updating in real time very well, but on the native Android and iOS apps, location was updated in real time. The updates on an Android-based handset are shown in Figures 4-12 and 4-13.

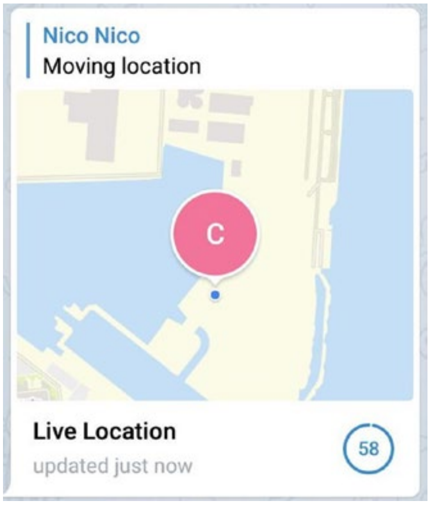


Figure 4-12. *Tokyo*

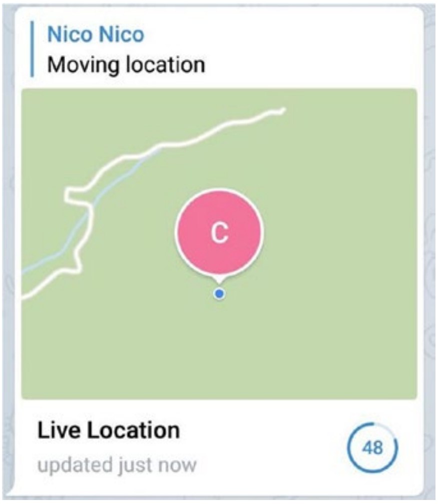


Figure 4-13. *East of Tokyo*

Rust Bot Number 3: Chained Reaction

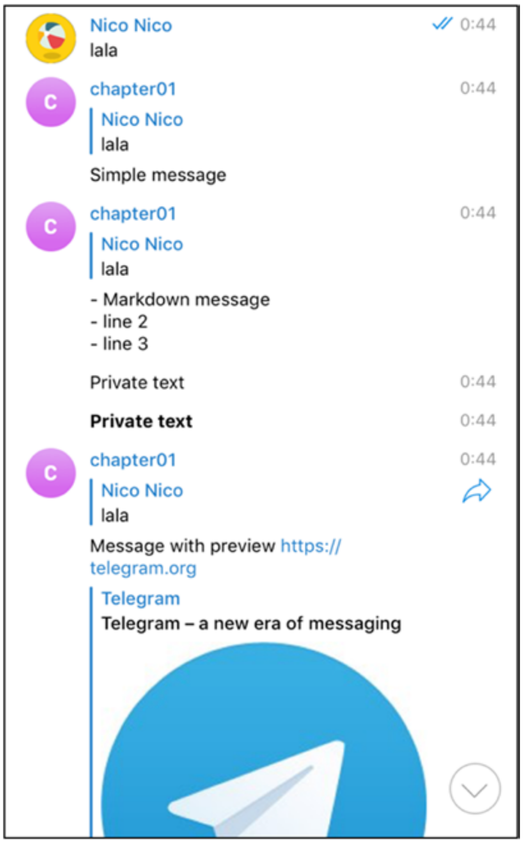
In the same vein, you could also chain messages for your chat flow, as needed. This new `multiple_messages` function presents multiple ways to send messages and chain them to the chat, one after the other.

Here, we'll employ similar constructs, with some changes to how the text is parsed, or not, before sending the message. `text_reply` can be substituted with `message.from.text`, to avoid this reply-looking message sent in many examples.

```
fn multiple_messages(api: Api, message: Message, handle:
&Handle) {

    let simple =
        api.send(message.text_reply("Simple message"));
    let markdown =
        api.send(message.text_reply("- Markdown message \n-
        line 2\n- line 3").parse_mode(ParseMode::Markdown));
    let html =
        api.send(message.text_reply("<b>Bold HTML message
        </b>").parse_mode(ParseMode::Html));
    let private =
        api.send(message.from.text("Private text"));
    let private_html =
        api.send(message.from.text(format!("<b>Private text
        </b>")).parse_mode(ParseMode::Html));
    let preview =
        api.send(message.text_reply("Message with preview
        https://telegram.org"));

    handle.spawn({
        let future = simple
            .and_then(|_| markdown)
```

```
                .and_then(|_| private)
                .and_then(|_| private_html)
                .and_then(|_| preview)
                .and_then(|_| html);

            future.map_err(|_| ()).map(|_| ())
        })
}
```

Now, finally, when chatting with this new Telegram bot, you can observe all the messages popping up, queued one by one in Figure 4-14.



Nico Nico 0:44
lala

chapter01 0:44
Nico Nico
lala
Simple message

chapter01 0:44
Nico Nico
lala
- Markdown message
- line 2
- line 3

Private text 0:44

Private text 0:44

chapter01 0:44
Nico Nico
lala
Message with preview https://telegram.org
Telegram
Telegram – a new era of messaging

Figure 4-14. *All different types of send requests from Rust*

Once you have fully finished developing your Rust bot, do not forget to generate a binary for it.

Compiling for Release

Compiling for release with `cargo` is easier than it seems. It is done simply by passing the `--release` flag to the `cargo build` command. This will have the side effect of rebuilding all the dependencies in release mode as well.

```
$ cargo build --bin bot2 --release
```

In the following, you can see how this `build` command in release mode is followed by a bunch of compiling lines:

```
Compiling nodrop v0.1.12
   Compiling cfg-if v0.1.4
   Compiling libc v0.2.42
   Compiling byteorder v1.2.3
   Compiling scopeguard v0.3.3
   Compiling memoffset v0.2.1
   Compiling lazy_static v1.0.2
   Compiling lazycell v0.6.0
   Compiling slab v0.4.0
   Compiling futures v0.1.23
   ...
```

The optimized compiled code can be run in the same way as its debug counterpart.

```
$ ./target/release/bot2
```

You should also appreciate the difference in size between the debug and release versions of the program. The release version is at least one-third the size of the debug one.

CHAPTER 5

Week 5: D

"As for difficulties," replied Ferguson, in a serious tone, "they were made to be overcome."

—Jules Verne

Five Weeks in a Balloon

To be honest, I haven't yet used the D language for heavyweight projects, but after a few small coding challenges, I have been very impressed by D's sheer speed of execution.

D is a statically typed language, which very much resembles C++ and Java, with some additional conveniences. The learning curve would not be that steep for those experienced in either of those two languages.

On the list quoted on the D language web site (`https://tour.dlang.org/`), the following features are highlighted:

- *High-level* constructs for great modeling power
- *High-performance*, compiled language
- Static typing
- Direct interface to the operating system APIs and hardware
- Blazingly fast compile times
- Memory-safe subset (SafeD)

- *Maintainable, easy-to-understand* code
- Gradual learning curve (C-like syntax, similar to Java and others)
- Compatible with the C application binary interface
- Limited compatibility with the C++ application binary interface
- Multi-paradigm (imperative, structured, object-oriented, generic, functional programming purity, and even assembly)
- Built-in error detection (contracts, unittests)

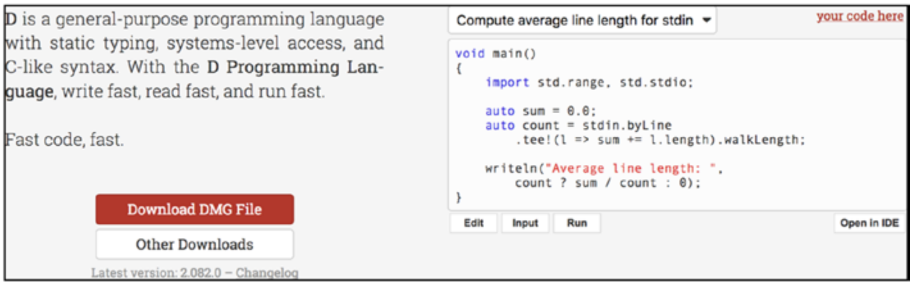
D also comes with a highly multi-threaded web framework named `vibe.d`, which I won't cover in detail here, but you should have a look at the simplicity of the servers built with it.

Before I move on to bot programming, we'll look over some basic D constructs and code examples, including, of course, some Fibonaccis.

In addition, once you have mastered some D coding and project dependencies management, we will be moving to the core of every chapter of this book, Telegram bot coding.

Installation and First D Steps

The D language comes with all sorts of packages and installers, which are available from its web site at `https://dlang.org.html` (Figure 5-1).



D is a general-purpose programming language with static typing, systems-level access, and C-like syntax. With the **D Programming Language**, write fast, read fast, and run fast.

Fast code, fast.

Download DMG File
Other Downloads
Latest version: 2.082.0 – Changelog
Compute average line length for stdin
your code here

```
void main()
{
    import std.range, std.stdio;

    auto sum = 0.0;
    auto count = stdin.byLine
        .tee!(l => sum += l.length).walkLength;

    writeln("Average line length: ",
        count ? sum / count : 0);
}
```

Edit
Input
Run
Open in IDE

Figure 5-1. *D language download page, with samples*

Once you have finished downloading and installing, you should have two main binaries available to you, namely:

- `dmd`: The reference D compiler
- `dub`: The build tool that goes along with `dmd`

Our first D program is going to exhibit some courtesy, by saying hello, as every first program should.

Import statements are quite intuitively done, using `import`, and the main entry point of the program is defined via the `main()` function. Note that there is no need to define an array of string parameters to this main function. The `return` value of the main function is also optional.

Printing to the standard output is done with `writeln`, which is located in the `std.stdio` package, which we will import beforehand.

You can save the following sample code in a `hello.d` file, with `.d` being the default extension for D source code.

```
import std.stdio;

void main() {
    writeln("hello D!");
}
```

D source code is compiled with the `dmd` command. In its two simplest forms, the command can be run as either one of the following:

```
dmd <source_file>
dmd -run <source_file>
```

The first form will generate a binary file of the same name as the entry source file. You can then execute the binary file directly on the host machine.

The second form does not generate intermediate files and does a compilation, followed by an execution cycle, in one go.

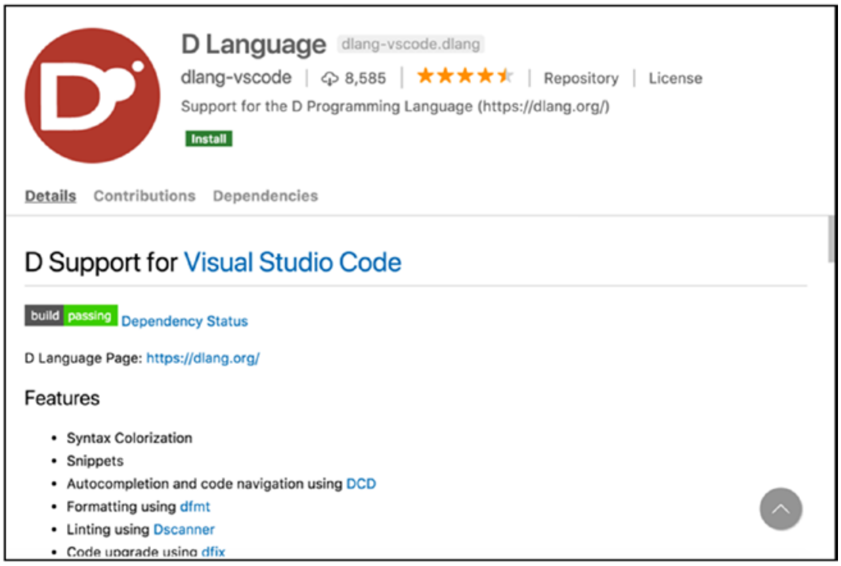
You would usually use the first form to prepare your code for a release. The second form is the one that is preferred when compiling and running code from the command line or Visual Studio Code.

For now, let's get the code to compile and run at the same time, using the second form, with the `-run` flag.

```
$ dmd -run hello.d
hello D!
```

The hello message is displayed on the standard output, and our program is now courteous.

While we are it, let's set up Visual Studio Code as well, by installing the D language plug-in, shown in Figure 5-2.


D Language dlang-vscode.dlang

dlang-vscode | 8,585 | ★★★★½ | Repository | License

Support for the D Programming Language (https://dlang.org/)

Install

Details Contributions Dependencies

D Support for Visual Studio Code

build passing Dependency Status

D Language Page: https://dlang.org/

Features

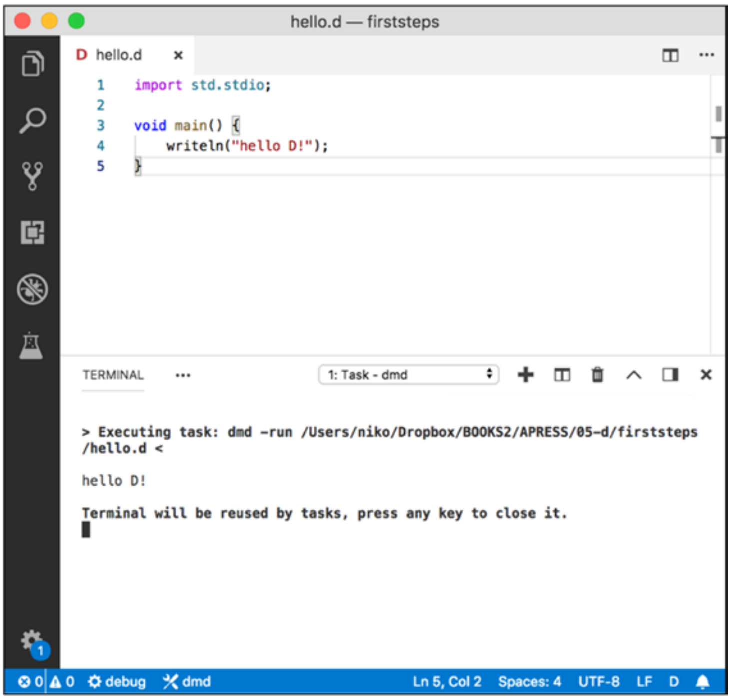
- Syntax Colorization
- Snippets
- Autocompletion and code navigation using DCD
- Formatting using dfmt
- Linting using Dscanner
- Code upgrade using dfix

Figure 5-2. *Plug-in for D language*

Along with the plug-in, you need a `tasks.json` file, to run the `build` command from inside the editor. As in the preceding code, we will be calling the `dmd` compiler with the `-run` flag, so that the code is executed directly.

```
{
    "version": "2.0.0",
    "tasks":
        [
          {
            "label": "dmd",
            "command": "dmd",
            "args": [
              "-run",
              "${file}"
            ],
          "options": {
            "cwd": "${workspaceRoot}"
          },
          "group": {
            "kind": "build",
            "isDefault": true
          }
        }
      ]
    }
```

Everything is in place for some happy coding. One more Command(Ctrl)+Shift+B to test our build setup from the editor (Figure 5-3), and we're good to go.



```
import std.stdio;

void main() {
    writeln("hello D!");
}
```

```
> Executing task: dmd -run /Users/niko/Dropbox/BOOKS2/APRESS/05-d/firststeps
/hello.d <

hello D!

Terminal will be reused by tasks, press any key to close it.
```

Figure 5-3. *Running D source files directly from Visual Studio Code*

Some Bits of D on Concurrency

Coming from the annoyance of Java with threading, you'll be thrilled by the concurrency features of D. Threads in D can be created and *spawned*, just as with regular D functions.

Simple Threading

The namespace responsible for concurrency is appropriately named `std.concurrency`, and we will use it for this first threaded test.

To spawn a thread from a function, we will simply use `spawn`, which takes a reference to a function as a parameter. This is done using an ampersand (&) in front of any standard D function. The rest of the code snippet is quite easy to follow, so here is the program with threads:

```
import std.concurrency : spawn, thisTid;
import std.stdio : writeln;

void worker()
{
    writeln("Thread ", thisTid);
}

void main()
{
    int TOTAL_WORKERS=5;
    for (int i = 0; i < TOTAL_WORKERS; ++i) {
        spawn(&worker);
    }
}
```

Executing from Visual Studio Code gives an output similar to the one following, in which each thread simply prints its own `id`.

```
> Executing task: dmd -run APRESS/05-d/firststeps/threads1.d <

Thread Tid(109655000)
Thread Tid(109655200)
Thread Tid(109655300)
Thread Tid(109655400)
Thread Tid(109655500)
```

From this short example, there are a few things worth noting.

- Every thread has a separate and uniquely assigned `id`, labeled `thisTid`.
- The function passed to `spawn` is actually a reference to the function, using `&worker`.

Next, let's see how to keep an internal state in each thread.

Thread with a State

In this second example, we define a static field inside the function that will be spawned for the thread. The defined `threadState` integer is stored locally to the thread as `ThreadLocal`. Also note that the integer `threadState` is created only once. Every subsequent time that the thread is calling itself via `worker()`, the thread state is not reinitialized.

Here is the code snippet with a local state for a thread:

```
import std.concurrency : spawn, thisTid;
import std.stdio : writeln;

void worker()
{
    static int threadState = 0;
    writeln("Thread ", thisTid,": My state = ", threadState++);
    if (threadState < 5) worker();
}

void main()
{
    for (int i = 0; i < 5; ++i) {
        spawn(&worker);
    }
}
```

And here is the slightly shortened output:

```
> Executing task: dmd -run APRESS/05-d/firststeps/threads1.d <

Thread Tid(109a2d000): My state = 0
Thread Tid(109a2d000): My state = 1
...
Thread Tid(109a2d300): My state = 3
Thread Tid(109a2d500): My state = 2
Thread Tid(109a2d400): My state = 3
Thread Tid(109a2d300): My state = 4
Thread Tid(109a2d500): My state = 3
Thread Tid(109a2d400): My state = 4
Thread Tid(109a2d500): My state = 4
```

You can see that each thread has a separate state, and that state is incremented each time the thread is looping, by calling workers again.

Now, let's see how we can share a state between all those threads and perform some safe multi-threaded sharing of data.

Shared State

The last example in our thread subsection for the D language closes in shared state, with a common counter that is increased by each thread separately. To create such a shared piece of data, the D language requires that you specifically mark the data as `shared`.

Once this is done, you can use operations from the `core.atomic` namespace, to safely update the value of that shared piece of data. The atomic operation we will use is a combination of `atomicOp` and `+=`, written as follows:

```
atomicOp!"+="
```

This creates a thread-safe version of the function `+=`.

Let's see how this is actually used, in the following snippet.

```
import std.concurrency : spawn, thisTid;
import std.stdio : writeln;
import core.atomic : atomicOp;

shared int flag = 0;

void worker()
{
    atomicOp!"+="(flag, 1);
    writeln("Thread ", thisTid,":global>",flag);
}

void main()
{
    for (int i = 0; i < 20; ++i) {
        spawn(&worker);
    }
}
```

`atomicOp!"+="` receives two parameters, the shared data variable to update and the parameter to the atomic function += just created.

When you run the preceding program, the output should be something like the following. Note the safeness of the threaded code.

```
> Executing task: dmd -run APRESS/05-d/firststeps/threads3.d <

Thread Tid(10e05c000):global>1
Thread Tid(10e05c200):global>2
Thread Tid(10e05c300):global>3
Thread Tid(10e05c400):global>4
Thread Tid(10e05c500):global>5
```

Obviously, the D language has full-featured threading capabilities not exposed in the simple examples in this chapter, but they should be easy enough, so that you can perform multi-threaded tasks with them.

Now let's sidestep threaded code and return to some simpler single-threaded examples.

A Few More Examples of D

First, let's go back to school for the basics, with examples of sorting.

Sort Me Tender, Sort Me True

Sorting arrays in D is just a matter of using the `sort` function from the `std.algorithm` namespace. Also, in the following snippet, note that the first use of `writefln`, which stands for "write format," allows you to turn various data structures and types into strings for printing out.

```
import std.stdio;
import std.algorithm;
```

```
void main()
{
    int[] arr1 = [4, 9, 7];
    writefln("%s\n", sort(arr1));
}
```

Executing the sorting preceding code surprisingly (!) gives you a sorted array.

```
> Executing task: dmd -run APRESS/05-d/firststeps/simplesort0.d
<
[4, 7, 9]
```

Sorting in reverse order can be done by passing the sorting function directly as a parameter to `sort`.

```
import std.stdio;
import std.algorithm;

void main()
{
    int[] arr1 = [4, 9, 7];
    writefln("%s\n", arr1.sort!("a > b"));
}
```

After execution, the reversed array is displayed in the output.

```
> Executing task: dmd -run APRESS/05-d/firststeps/simplesort0.d
<
[9, 7, 4]
```

I also stumbled on this great example, which must definitely be shared when presenting D to a crowd. The following code uses something named the chain function from the `std.range` namespace to sort a series of three different arrays, each time reusing the memory allocated for sorting.

```
import std.stdio;
import std.algorithm;
import std.range;

void main()
{
    int[] arr1 = [4, 9, 7];
    int[] arr2 = [5, 2, 1, 10];
    int[] arr3 = [6, 8, 3];
    sort(chain(arr1, arr2, arr3));
    writefln("%s\n%s\n%s\n", arr1, arr2, arr3);
}
```

After execution, while the output is as expected, the memory consumption should be quite considerably less when sorting big arrays.

```
> Executing task: dmd -run APRESS/05-d/firststeps/simplesort1.d
<

[1, 2, 3]
[4, 5, 6, 7]
[8, 9, 10]
```

When sorting `arr1`, `arr2`, and `arr3`, a program can sort in place, which takes less memory, but is slower, or use a temporary memory space. Using `chain`, you can tell the compiler to reuse that temporary memory to sort subsequent arrays, thus offering the advantage of both memory usage and CPU speed.

Last, before moving on to bot programming, let's see examples of implementing Fibonacci in D.

My Love for Fibonacci

In the never-ending search for the most effective Fibonacci code snippet, we may have something of a showstopper with the D language. This first snippet is the usual iterative implementation, in which the algorithm loops through the different value and iteratively computes the elements of the Fibonacci sequence.

```
auto fib(const int n)
{
    import std.bigint;
    if (n == 0)
        return BigInt(0);
    if (n == 1)
        return BigInt(1);
    BigInt next;
    for (BigInt i = 0, j = 1, count = 1; count < n; ++count)
    {
        next = i + j;
        i = j;
        j = next;
    }
    return next;
}

void main()
{
    import std.stdio;
    writeln(fib(100_000));
}
```

When you execute the preceding, you'll find that it's very fast. But the next implementation (found in the forums, implemented by Biotronic) is just blazingly fast.

```
auto fib(ulong n) {
    import std.bigint : BigInt;
    import std.meta : AliasSeq;
    import std.typecons : tuple;
    BigInt a = 0;
    BigInt b = 1;
    auto bit = 63;
    while (bit > 0) {
        AliasSeq!(a, b) = tuple(
            a * (2*b - a),
            a*a + b*b);
        if (n & (BigInt(1) << bit)) {
            AliasSeq!(a, b) = tuple(b, a+b);
        }
        --bit;
    }
    return a;
}
```

This version of generating the Fibonacci numbers uses the following:

- A different base algorithm to generate the Fibonacci numbers, named the Fast squaring algorithm
- `AliasSeq`, from the `std.meta` namespace, working with templates, which allows for compile-time improvement, with the help of the compiler.

Without going into all the details of the algorithm, this version clocks incredibly fast, even on a standard MacBook. You will appreciate the following times for `fib(1_000_000)`:

```
2 secs, 415 ms, 140 μs, and 4 hnsecs
```

And 10 million clocks in at less than 50 seconds on the same machine!

But enough with displays of speed performance. Let's get a project template ready for some Telegram bot fun with D.

Telegram Bots in D

To write a telegram bot in D, we will require the usual build tool that can handle dependencies. In D, this tool is named `dub`, and I am sure you love the tool name as much as I do.

`dub` was installed (or should have been installed) along with D, earlier in the chapter.

`dub` is responsible for

- Handling your project metadata needs
- Managing dependencies
- Compiling and running code

Meet dub

`dub init <projectname>` will almost act as a bot and ask you a few questions, in order to generate files for your new project.

Note here that we are going to announce directly during project creation that we need `telega` as a dependency. `telega` is a wrapper for the Telegram bot API in D.

```
$ dub init hellobot
Package recipe format (sdl/json) [json]: json
Name [hellobot]:
Description [A minimal D application.]:
Author name [niko]:
License [proprietary]:
Copyright string [Copyright © 2018, niko]:
Add dependency (leave empty to skip) []: telega
Added dependency telega ~>0.0.3
Add dependency (leave empty to skip) []:
Successfully created an empty project in 'hellobot'.
Package successfully created in hellobot
```

dub will then have created your basic project structure, which at this stage contains only the project metadata in dub.json and the main source file in app.d, as shown following:

```
$ tree
.
├── dub.json
└── source
    └── app.d

1 directory, 2 files
```

Inspecting the dub.json file, you can see that it contains the required project metadata and the specified telega dependency, as well as the most recent version found.

```
{
    "name": "hellobot",
    "authors": [
        "niko"
    ],
    "dependencies": {
        "telega": "~>0.0.3"
    },
    "description": "A minimal D application.",
    "copyright": "Copyright © 2018, niko",
    "license": "proprietary"
}
```

Caution That would almost work—except in those instances in which it doesn't—and at the time of writing, it did not. You may have to refer to a specific build of `telega` (or any other dependency, for that matter).

Installing a custom version of a dependency is done in two steps.

1. Checking out the package you want, in this case, `telega`

   ```
   git clone https://github.com/nexor/telega.git
   ```

2. Telling dub, with the following snippet, that you have a new version of that package:

   ```
   [niko@niko-pc hellobot]$ dub add-local ../../RESEARCH/
   telega
   Registered package: telega (version:
   0.0.3+commit.6.g87f37af)
   ```

The project should then be good to go. You can validate that the dependencies are installed properly, using `dub list`.

```
$ dub list  | grep telega
  telega 0.0.3+commit.6.g87f37af: APRESS/RESEARCH/
  telega/
  telega 0.0.3: /Users/niko/.dub/packages/telega-0.0.3/
  telega/
```

Of course, if you do not receive an error message, there's no need for all of this. The default subcommand of `dub` is `dub run`, and this tells your project to run the code located in the `source/app.d` file, with the dependency resolved from `dub.json`.

Right after creating your project, the default D source file should look like this:

```
import std.stdio;

void main()
{
    writeln("Edit source/app.d to start your project.");
}
```

Then you can execute the preceding default D file within the project with

```
dub run
```

That will pick up the file `source/app.d` inside your project folder. Finally, your output for your project is ready!

```
hellobot ~master: building configuration "application"...
Linking...
To force a rebuild of up-to-date targets, run again with
--force.
Running ./hellobot
Edit source/app.d to start your project.
```

As usual, you can run all this from Visual Studio Code, with a simple `tasks.json` file. The file needed to run the bot project with `dub` from Visual Studio Code is shown following:

```
{
    "version": "2.0.0",
    "tasks":
        [
          {
            "label": "dub",
            "command": "dub",
            "args": [
              "run"
            ],
            "options": {
              "cwd": "${workspaceRoot}"
            },
            "group": {
              "kind": "build",
              "isDefault": true
            }
          }
        ]
      }
```

Note that finding other packages using `dub` is as easy as running `dubsearch`. So, for Telegram, we simply looked for packages using the following command:

```
$ dub search telegram
```

```
==== registry at https://code.dlang.org/ (fallback ["registry
at http://code.dlang.org/", "registry at https://code-mirror.
dlang.io/", "registry at https://code-mirror2.dlang.io/",
"registry at https://dub-registry.herokuapp.com/"]) ====
paper_plane_bot (0.0.5) Telegram Dlang news notify bot
telega (0.0.3)          Telegram Bot API implementation
tg-d (0.0.2)            Telegram Bot API client library for the
                        D programming language
delegram (0.1.3)        dlang Telegram bot api
dtd (0.0.1)             A D wrapper to TDLib (Telegram Database
                        library)
```

In this case, telega, was the most updated package, with a wide range of the full Telegram bot API already implemented. You also can try to find packages for logging, for example.

```
$ dub search log | grep color
colored-logger (0.1.0)          Colored logger for TTY
```

Now on to our first D bot!

First D Bot

This first bot will perform the usual echo of a chat message.

A few things to note here:

- The main import that you haven't seen before is the one from the telega library, the botapi. We create a bot client with the key contained in the secret.key text file.
- Updates come in batches of messages, so in the listenUpdates function, we create a loop to handle those messages one by one.
- To tell the bot API we finished handling the update, we call updateProcessed, with the original update as parameter.

Cutting out the extra code from the telega example gives the following snippet:

```
import std.typecons;
import std.file;
import std.stdio;
import telega.botapi;

int main()
{
    auto botToken = readText("secret.key");
    listenUpdates(botToken);
    return 0;
}

void handleUpdate(BotApi api, Update msg) {
    if (!msg.message.isNull) {
      writefln("Update %s:%s", msg.message.chat.id, msg.
      message.text);
      api.sendMessage(update.message.chat.id, msg.message.text);
    }
    api.updateProcessed(update);
}

void listenUpdates(string token)
{
    auto api = new BotApi(token);
    while(true) {
        auto updates = api.getUpdates();
        writefln("Got %d updates", updates.length);
        foreach (update; updates) {
            handleUpdate(api, update);
        }
    }
}
```

Running the bot with the usual Visual Studio Code setup and `dub run` will obviously leave you breathless (see Figure 5-4).

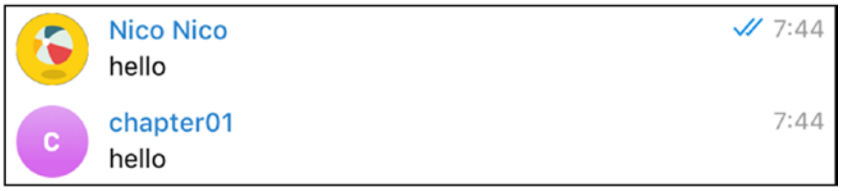

Nico Nico
hello
7:44
chapter01
hello
7:44

Figure 5-4. *Echo text messages bot in D*

More Bot API Usage

For something more fun, you can now replace the insides of the `handleUpdate` function.

The rewritten function following gives you some examples of

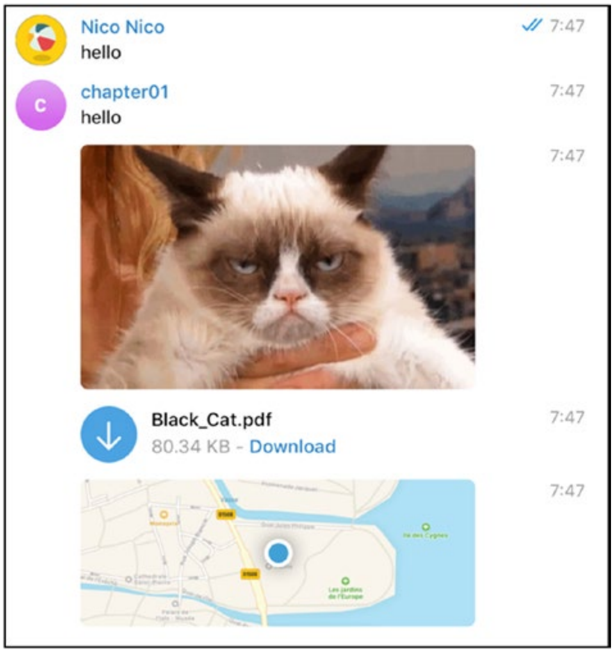
- Sending a message
- Sending a photo
- Sending a document
- Sending a location

Note, too, that while we are replying to the same chat room, using the `update.message.chat.id`, we could also reply to a different chat room, keeping records of the id we have seen so far.

Also note that most of the implementation of `telega` uses public URLs to retrieve objects and does not yet allow you to send in local files.

```
void handleUpdate(BotApi api, Update update) {
 if (!update.message.isNull) {
   api.sendMessage(update.message.chat.id, update.message.text);

   api.sendPhoto(update.message.chat.id, "https://pbs.twimg.
   com/tweet_video_thumb/Dm_YlIgXgAAbxZu.jpg");
   api.sendDocument(update.message.chat.id, "https://ibiblio.
   org/ebooks/Poe/Black_Cat.pdf");

   api.sendLocation(update.message.chat.id, 45.8992, 6.1294);

  }
  api.updateProcessed(update);
   }
```

Rerunning the bot with the new `handleUpdate` function gives you a series of message, image, document, and location, as shown in Figure 5-5.



hello

hello

Black_Cat.pdf
80.34 KB - Download

Figure 5-5. *Message, image, document, and location from your D bot*

For reference, the current set of methods implemented by `telega` is listed on the project site, but you may want to quickly put into action the functions presented following.

- `sendMessage`
- `forwardMessage`
- `sendPhoto`
- `sendAudio`
- `sendDocument`
- `sendVideo`
- `sendVoice`
- `sendVideoNote`
- `sendMediaGroup`
- `sendLocation`
- `editMessageLiveLocation`
- `stopMessageLiveLocation`
- `sendVenue`
- `sendContact`
- `setChatPhoto`

As for this book, it's now time to forge ahead to next week.

CHAPTER 6

Week 6: C++

Writing in C or C++ is like running a chainsaw with all the safety guards removed.

—Bob Gray

It was inevitable to have a chapter on C++, especially after dealing with D. What is surprising, however, is that there is a working Telegram bot API—wrapper—on the market, and what's even more surprising is that it works very well.

C++ is the language often thought of as a reference to what not to code, but I think it's always a plus to have it in your toolbox.

This chapter will focus on sending pictures from the usual echo bot to finally applying basic OpenCV calls on received images. OpenCV, if you are not familiar with this framework, is a universally known imaging library that can do everything from change colors and sizes to find objects in pictures and videos.

Requirements, Installation, and First Bot

Working with C++ usually requires a fair bit of work to set up. To work with Telegram, we will be using `tgbot-cpp`, and to work with `opencv`, you'll also be installing the imaging framework on your local machine.

`cmake` is a low-level tool used to organize your project metadata and third-party libraries, as well as generating a file that makes the build tool itself.

`boost` is a set of well-maintained and clean libraries for C++.

Install `tgbot-cpp`

Cloning the `tgbot-cpp` repository is going to be the first step in this chapter. The code of the C++ wrapper for Telegram can be found on GitHub and following.

```
git clone https://github.com/reo7sp/tgbot-cpp.git
```

To compile and install the library, you need a few tools, such as `make`, `cmake`, `ssl` development libraries, and `boost`.

On Debian/Ubuntu, this would be

```
apt-get install g++ make binutilscmakelibssl-dev libboost-
system-dev
```

Then, once in the `tgbot-cpp` cloned directory, the bot library can be easily installed with this set of three commands:

```
cmake .
make
sudo make install
```

The install defaults to `/usr/lib/`, and you can check that the Telegram library is properly installed, by looking up the presence of the following file:

```
 /usr/local/lib/libTgBot.a
```

Install OpenCV

The imaging library OpenCV is a lot easier to install these days, and while options are still a bit hard to figure out, we will leave them out for this week and keep the default settings to compile and install the library. It's really just a matter of following the installation instructions from the OpenCV web site. For reference, here are the steps for Linux and macOS:

```
# clone the opencv repository
git clone https://github.com/opencv/opencv.git
# create build folder
mkdir build && cd build
# generate make file from CMake directives
cmake .
# compile code ... takes ~15min the first time.
make -j8
# install as library
sudo make install
```

Remember where you have installed `opencv` and its `build` folder, as you will need it later, when compiling C++ programs.

To verify our setup and get excited a bit, let's start by writing a simple program that downloads a file, using the system command `curl`.

File Download Program

We will be reusing this piece of code later in the OpenCV bot, so make sure you understand how things work. To write a project using `cmake`, we first create a simple folder structure, with the `CmakeLists.txt` file, and a source folder, with the C++ code in that source folder.

```
[niko@niko-pcsamplecmake]$ tree
.
├── CMakeLists.txt
└── src
    └── main.cpp

1 directory, 2 files
```

The `CMakeLists.txt` contains your project metadata, and `main.cpp`, the C++ code. The following `CMakeLists.txt` file is a simplified version of the one we will use to run `tgbot-cpp` later on. Let's have a look.

```
cmake_minimum_required(VERSION 2.8.4)

project(samplecmake)

set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -std=c++11 -Wall")
set(Boost_USE_MULTITHREADED ON)

find_package(Threads REQUIRED)
find_package(OpenSSL REQUIRED)
find_package(Boost COMPONENTS system REQUIRED)
find_package(CURL)

include_directories(/usr/local/include ${OPENSSL_INCLUDE_DIR}
${Boost_INCLUDE_DIR})

if (CURL_FOUND)
include_directories(${CURL_INCLUDE_DIRS})
add_definitions(-DHAVE_CURL)
endif()

add_executable(samplecmakesrc/main.cpp)

target_link_libraries(samplecmake ${CMAKE_THREAD_LIBS_INIT}
${OPENSSL_LIBRARIES} ${Boost_LIBRARIES} ${CURL_LIBRARIES})
```

In Table 6-1, I list the commands used in the cmake definition files, in addition to why they are used.

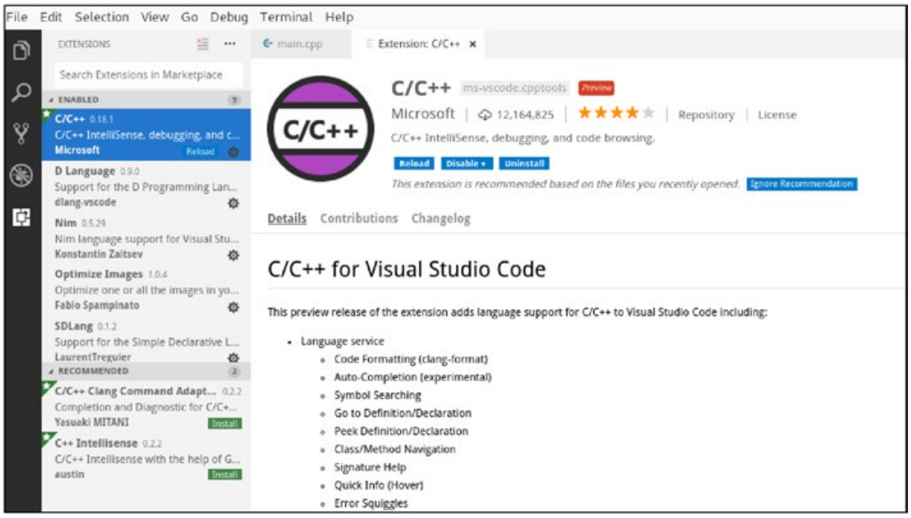
Table 6-1. *Understanding* cmake *file*

Command	**Use**
cmake_minimum_required	Defines which version of cmake to use
project	Defines the project name
set	Sets variables used during the build
find_package	Finds external libraries, i.e., finds cmake files in search paths and retrieves symbols
include_directories	More folders to retrieve header files and packages
add_executable	Creates an executable, here, samplecmake, from a given source file
target_link_libraries	Identifies libraries to link to the given executable, here again, samplecmake

With this CMakeLists.txt, you can run the cmake command and prepare the project for compilation. Here is the shortened output of the command execution:

```
$ cmake .

-- The C compiler identification is GNU 8.2.1
-- The CXX compiler identification is GNU 8.2.1
-- Check for working C compiler: /usr/bin/cc
-- Check for working C compiler: /usr/bin/cc -- works
...
-- Looking for pthread_create in pthreads
-- Looking for pthread_create in pthreads - not found
-- Looking for pthread_create in pthread
-- Looking for pthread_create in pthread - found
-- Found Threads: TRUE
-- Found OpenSSL: /usr/lib/libcrypto.so (found version
   "1.1.0i")
-- Boost version: 1.67.0
-- Found the following Boost libraries:
--   system
-- Found CURL: /usr/lib/libcurl.so (found version "7.61.1")
-- Configuring done
-- Generating done
-- Build files have been written to: /home/niko/Dropbox/BOOKS2/
   APRESS/06-cplusplus/samplecmake
```

If you are writing code from Visual Studio Code again, there is a specific and dedicated plug-in, created by Microsoft, that you can install (Figure 6-1).



C/C++ 0.18.1
C/C++ IntelliSense, debugging, and c...
Microsoft

D Language 0.9.0
Support for the D Programming Lan...
dlang-vscode

Nim 0.5.29
Nim language support for Visual Stu...
Konstantin Zaitsev

Optimize Images 1.0.4
Optimize one or all the images in yo...
Fabio Spampinato

SDLang 0.1.2
Support for the Simple Declarative L...
LaurentTreguier

C/C++ Clang Command Adapt... 0.2.2
Completion and Diagnostic for C/C+...
Yasuaki MITANI

C++ Intellisense 0.2.2
C/C++ Intellisense with the help of G...
austin

C/C++ ms-vscode.cpptools
Microsoft | 12,164,825 | ★★★★☆
C/C++ IntelliSense, debugging, and code browsing.
This extension is recommended based on the files you recently opened.

C/C++ for Visual Studio Code

This preview release of the extension adds language support for C/C++ to Visual Studio Code including:

- Language service
  - Code Formatting (clang-format)
  - Auto-Completion (experimental)
  - Symbol Searching
  - Go to Definition/Declaration
  - Peek Definition/Declaration
  - Class/Method Navigation
  - Signature Help
  - Quick Info (Hover)
  - Error Squiggles

Figure 6-1. *C/C++ plug-in for Visual Studio Code*

With the plug-in installed, you can start typing C++ code and your first C++ program of the day.

Here is a list of reminders before proceeding to look at the code:

- `#include` is used to include namespaces
- Using `namespace` will prevent you from having to insert the namespace in front of each symbol of given namespaces, thus, `std::string` will become `string`, for example.
- `intmain(intargc, char* argv[])` is the main entry point, and you can retrieve the number of `args`, as well as an array of parameters. Note that the first parameter is at index 0 and is the command name itself. Here, it will be `samplecmake`, as it was defined in the project metadata file, `CMakeLists.txt`.
- `auto url` means that we do not specify the type of the variable ourselves; the compiler does it. Here, it will actually be a `char*`, which is a pointer to an array of characters.
- We will actually download the file using a system command, `curl` (which should be installed on your machine).
- The shell command `curl` is called using the system function, with `url` as the parameter to the `curl` command.

This now gives the slightly readable code snippet following, which should be saved in a file named `main.cpp`.

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

```
intmain(intargc, char* argv[])
{
    auto url = argv[1];
printf("Downloading: %s\n", url);
    string command = string("curl --silent -O ");
const char* cmd = command.append(url).c_str();
    system(cmd);
    return 0;
}
```

To create the executable, `cmake` has generated a Makefile, a file that the `make` command understands. Running `make` will create an executable.

```
make
```

To test our program, we can pass a URL with an image (or any file, for that matter) for our newly compiled and linked program.

```
./samplecmakehttp://stuffpoint.com/cats/image/245258-cats-cute-
white-cat.jpg
```

This will download the cat shown in Figure 6-2.

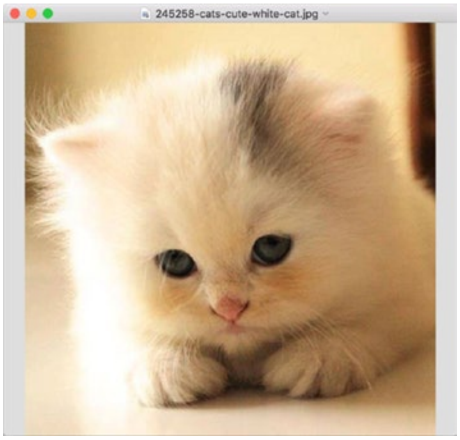


Figure 6-2. *Lovely cat*

Go ahead and try it with a few other URLs and see the files being downloaded in the project folder, as expected.

Now on to our first bot!

Echo Bot

The echo bot will, of course, echo whatever we send it. We will build on the download file project, so you can either reuse it or create a new folder with the same file and structure.

In the new `CMakeLists.txt`, you'll immediately notice three things:

- The project name has been changed.
- The name of the executable has been changed to `echobot`.
- The `target_link_libraries` section contains a reference to our installed `tgbot-cpp` library, which is packaged inside `/usr/local/lib/libTgBot.a`.

The rest is identical and should hold few surprises.

```
cmake_minimum_required(VERSION 2.8.4)
project(echobot)

set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -std=c++11 -Wall")
set(Boost_USE_MULTITHREADED ON)

find_package(Threads REQUIRED)
find_package(OpenSSL REQUIRED)
find_package(Boost COMPONENTS system REQUIRED)
find_package(CURL)
include_directories(/usr/local/include ${OPENSSL_INCLUDE_DIR}
  ${Boost_INCLUDE_DIR})
if (CURL_FOUND)
```

```
include_directories(${CURL_INCLUDE_DIRS})
add_definitions(-DHAVE_CURL)
endif()

add_executable(echobotsrc/main.cpp)

target_link_libraries(echobot /usr/local/lib/libTgBot.a
  ${CMAKE_THREAD_LIBS_INIT} ${OPENSSL_LIBRARIES}
  ${Boost_LIBRARIES} ${CURL_LIBRARIES})
```

Here again, let's run the `cmake` command

```
cmake .
```

to generate the necessary project files.

Now, on to the code. The forthcoming code is mostly taken from the `tgbot-cpp` project samples, but there are a few things to notice.

- The bot token is read from an environment variable.
- You can register as many callbacks as you want, using `.getEvents.onCommand` or `.getEvents.onAnyMessage`. Here, the bot is defined to respond to a command named `start` and on any message sent.
- On each callback, you must specify a vector of pointers that will be used in the callback, hence, `[&bot]`. We will add some more later.
- On each callback, you get a pointer to the message, which has the same structure as you have seen previously.
- Finally, the bot is set up to do polling, as usual, but it has to be made explicit with this C++ library.
- And the snippet for the echo bot is now shown following:

```
#include <tgbot/tgbot.h>

using namespace std;
using namespace TgBot;

intmain() {
    string token(getenv("TOKEN"));
printf("Token: %s\n", token.c_str());

    Bot bot(token);

bot.getEvents().onCommand("start", [&bot](Message::Ptr message)
{
bot.getApi().sendMessage(message->chat->id, "Hi!");
    });
bot.getEvents().onAnyMessage([&bot](Message::Ptr message) {
printf("User wrote %s\n", message->text.c_str());
        if (StringTools::startsWith(message->text, "/start")) {
            return;
        }
bot.getApi().sendMessage(message->chat->id, "Your message is: "
+ message->text);
    });

signal(SIGINT, [](int s) {
printf("SIGINT got\n");
exit(0);
    });

    try {
printf("Bot username: %s\n", bot.getApi().getMe()->username.
c_str());
bot.getApi().deleteWebhook();
TgLongPolllongPoll(bot);
        while (true) {
printf("Long poll started\n");
longPoll.start();
        }
    } catch (exception& e) {
printf("error: %s\n", e.what());
    }
    return 0;
}
```

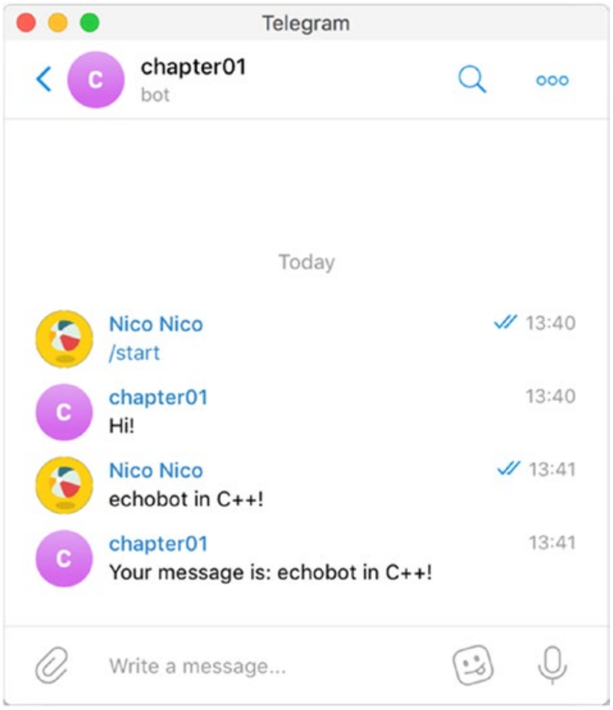
The same steps are used to compile and run. Before running the newly created executable, you must expose the bot token as `TOKEN` in the current shell.

```
export TOKEN=...
./echobot
```

On `start`, the bot, will yield a short output, to say it has started polling normally.

```
Token: ...
Bot username: chapter01bot
Long poll started
```

A sample chat session with this new bot is shown in Figure 6-3.



Nico Nico 13:40
/start

chapter01 13:40
Hi!

Nico Nico 13:41
echobot in C++!

chapter01 13:41
Your message is: echobot in C++!

Figure 6-3. *C++echobot*

C++ Bots

Now on our mission to deploy as many Telegram bots as possible, we'll create two bots.

- One bot with a Telegram inline keyboard
- Another bot that sends pictures to the chat

Bot with Inline Keyboard

This second bot is also taken from the samples of the project and is added here for reference. Inline keyboards are pretty much buttons sent to the chat room that are assigned callbacks when pressed by the user, just like a bot father. If you have started a project from scratch, there is no need to add anything new to `CMakeLists.txt`, apart from changing the project's name.

What is interesting in the bot here is the way the keyboard is registered. The rest of the code is identical to that for the echo bot and is left out for clarity.

The keyboard is created using `InlineKeyboardMarkup`, and then rows of buttons are created with the `InlineKeyboardButton` constructor. Each button has a callback, here, `check`, that must be registered in a `onCallbackQuery` block, just like commands and messages.

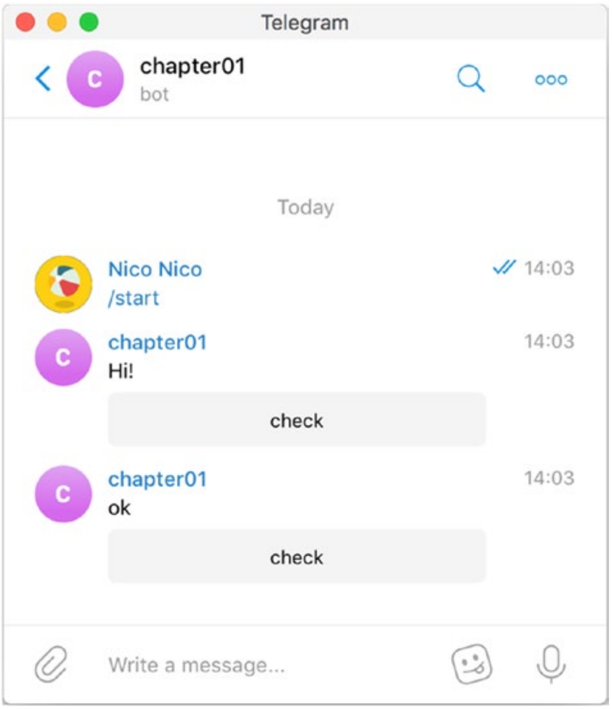
Finally, you send the keyboard to the chat, using the longer version of `sendMessage`, which accepts the created keyboard as parameter.

```
bot.getApi().sendMessage(chatid,response,false,0,keyboard,"Mark
down");
```

This gives the following snippet, which should be located inside the main method of your program:

```
    // Thanks Pietro Falessi for code

InlineKeyboardMarkup::Ptr keyboard(new InlineKeyboardMarkup);

    vector<InlineKeyboardButton::Ptr> row0;
InlineKeyboardButton::PtrcheckButton(new InlineKeyboardButton);
checkButton->text = "check";
checkButton->callbackData = "check";
    row0.push_back(checkButton);

    keyboard->inlineKeyboard.push_back(row0);

bot.getEvents().onCommand("check", [&bot, &keyboard]
(Message::Ptr message) {
        string response = "ok";
bot.getApi().sendMessage(message->chat->id, response, false, 0,
keyboard, "Markdown");
    });
bot.getEvents().onCallbackQuery([&bot, &keyboard]
(CallbackQuery::Ptr query) {
        if (StringTools::startsWith(query->data, "check")) {
            string response = "ok";
bot.getApi().sendMessage(query->message->chat->id, response,
false, 0, keyboard, "Markdown");
        }
    });
```

Now let's compile and see this new bot in action (Figure 6-4).



Nico Nico 14:03
/start

chapter01 14:03
Hi!

check

chapter01 14:03
ok

check

Figure 6-4. *Bot with inline keyboard*

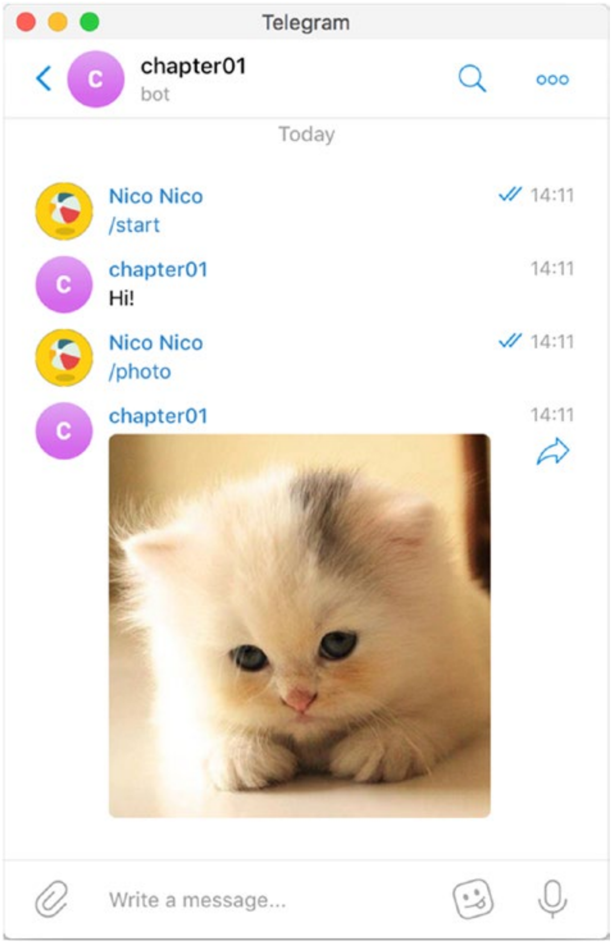
Photo Bot

The photo bot is here to present how to send pictures to the chat, using the C++ API. The Telegram API being the same for any language, you'll notice how the method name is similar to ones used in other languages.

Here, we send an `example.jpg` image, located at the root of the project folder.

```
const string photoFilePath = "example.jpg";
const string photoMimeType = "image/jpeg";
  bot
.getEvents()
.onCommand("photo", [&bot, &photoFilePath, &photoMimeType]
(Message::Ptr message) {
bot.getApi().sendPhoto(message->chat->id, InputFile::fromFile(p
hotoFilePath, photoMimeType));
    });
```

No extra change in the libraries is required, so just `make` and `run` will do here too. You can see the photo bot in action in Figure 6-5.



Nico Nico 14:11
/start

chapter01 14:11
Hi!

Nico Nico 14:11
/photo

chapter01 14:11

Figure 6-5. *Send me a cat, c++ bot*

Now let's repeat this technique of sending pictures from the photo bot, combined with the OpenCV example, to perform transformations on the pictures sent to the chat and resend them directly to the cat.

OpenCV in action

Before creating a bot, let's first try to perform a simple OpenCV transformation.

OpenCV Sample Program

This time, you will have to update the `CMakeLists.txt` a bit. Notably, you will have to include the place where the OpenCV header and library files are located and also specify to include them when linking the final binary.

So, building on the previous `CMakeLists.txt`, the following will occur:

- Change the project name! Although not required, it is always useful for us humans.
- Add the `opencv/build/include` folder to the `include_directories`.
- Add a find_package directive targeting OpenCV (be careful of the upper-/lowercase).
- In the `target_link_libraries`, add the different required `.so` files from the installed version of OpenCV. (The libraries could also be pulled from the `opencv/build/lib` folder, of course.) Here, three library files are used for OpenCV: `core`, `imgcodecs`, and `highgui`. In the future, you may need others, if you do some video, so you should adjust this accordingly.

Before running `cmake` on this new project, let's review the `CMakeLists.txt` file.

```
cmake_minimum_required(VERSION 2.8.4)
project(opencvdemo)

set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -std=c++11 -Wall")
set(Boost_USE_MULTITHREADED ON)
```

```
include_directories($HOME/projects/opencv/build/include )
include_directories(/usr/local/include ${OPENSSL_INCLUDE_DIR}
${Boost_INCLUDE_DIR})

if (CURL_FOUND)
include_directories(${CURL_INCLUDE_DIRS})
add_definitions(-DHAVE_CURL)
endif()

find_package(Threads REQUIRED)
find_package(OpenSSL REQUIRED)
find_package(Boost COMPONENTS system REQUIRED)
find_package(CURL)
find_package(OpenCV)

add_executable(opencvdemosrc/main.cpp)

target_link_libraries(opencvdemo /usr/local/lib64/libopencv_
core.so /usr/local/lib64/libopencv_imgcodecs.so /usr/local/
lib64/libopencv_highgui.so /usr/local/lib/libTgBot.a ${CMAKE_
THREAD_LIBS_INIT} ${OPENSSL_LIBRARIES} ${Boost_LIBRARIES}
${CURL_LIBRARIES})
```

Once cmake is run, we can focus on writing just a small piece of OpenCV programming code that will process a picture specified as input and transform it into its gray version. In OpenCV, this is done through an intermediate Mat object, which is a matrix object used to represent the image in-memory.

You'll need a new include statement, with opencv2/highgui, and, yes, we all love the fact that even though its opencv4, the namespace is still versioned as 2.

imread and imwrite are the two opencv methods to read and write pictures, and the second parameter of the imread tells it how many colors to use when decoding the picture. It gives the very short snippet following:

```
#include "opencv2/highgui.hpp"
using namespace cv;

intmain(intargc, char* argv[])
{
    auto bw = imread(argv[1],0);
imwrite("saved.jpg", bw);
    return 0;
}
```

Now to compile and run this short program using make.

```
make
./opencvdemo cat.jpg
```

The input picture, cat.jpg, is shown in Figure 6-6.

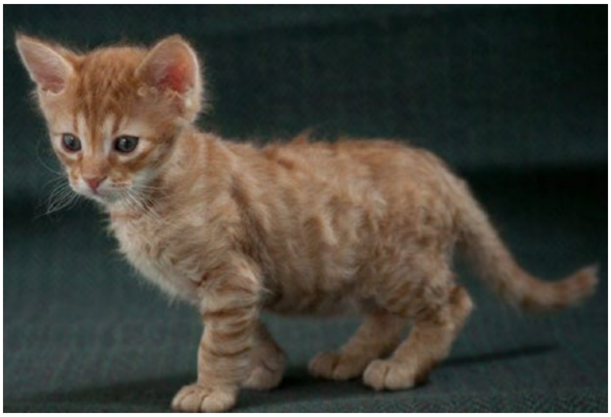


Figure 6-6. *Colored input cat*

After applying the OpenCV change of color, the gray version of the cat is shown in Figure 6-7.

Figure 6-7. *If you can see a difference, you are reading this book in colors*

Now that we know how to use `opencv` from our program, let's integrate all the pieces, to create a bot that transforms the picture sent to the chat.

OpenCV Bot

The `cmake` setup for the full OpenCV bot is the same as the previous one, so there's no need to change the `CMakeLists.txt`, apart from the project name. The thing to know ahead of programming this bot is that when the chat receives a message with a picture, the message contains a `fileId` corresponding to the file that was saved.

On the Telegram architecture, those files are hosted on different servers, thus a different API. The new location is `api.telegramorg/file/bot`.

The URL to retrieve files is then constructed from this base URL, appended with the bot token and, finally, the `fileId`.

To read a file and process the picture or file, we must perform a different request to retrieve that file. So, in this example, you will reuse the trick of running the curl command from the C++ code to perform this request.

The following function, applyOpenCV, downloads a static file from the Telegram server applies the opencv process of turning the picture to shades of gray, and, finally, saves it to a file named saved.jpg.

```
const string telegram_url = "https://api.telegram.org/file/bot";
const string tmp_file = "download.jpg";
const string saved_file = "saved.jpg";

string applyOpenCV(string token, string path) {
    string command = string("curl --silent ");
    command
.append(telegram_url)
.append(token)
.append("/")
.append(path)
.append(" -o ")
.append(tmp_file);

const char* cmd = command.c_str();
    system(cmd);

    Mat bw = imread(tmp_file,0);
imwrite(saved_file, bw);
    return saved_file;
}
```

Now, we just need an entry point to call this function. This will be called when a photo is detected in the chat.

So, in the bot callback handling the chat message, to detect whether a picture is present, we can a check the number of photo sizes included in the message. Once we know there is a picture (or pictures), we can retrieve its (their) `fileId` and then call the `applyOpenCV` function we have just defined with the `filePath` and the token.

Also, note, as I previously touched on, the vector of the reference is being added a new pointer on token. If you forget to do this, the callback does not have access to the token variable, and the compilation fails.

```
bot.getEvents().onAnyMessage([&bot, &token](Message::Ptr
message) {
 if(message->photo.size() != 0) {
PhotoSize::Ptr s = message->photo[2];
    if(s!=NULL) {
     string fileId = message->photo[2]->fileId;
File::Ptr file = bot.getApi().getFile(fileId);
     string filepath = applyOpenCV(token.c_str(), file-
>filePath.c_str());
bot.getApi().sendPhoto(
        message->chat->id,
InputFile::fromFile(filepath, "image/jpeg"));
    }
  }
}
```

The rest of the bot code is identical to that for the other bots. After executing, `make` and starting the bot, you can see the picture being sent to the chat change to black and white, as shown in Figure 6-8.

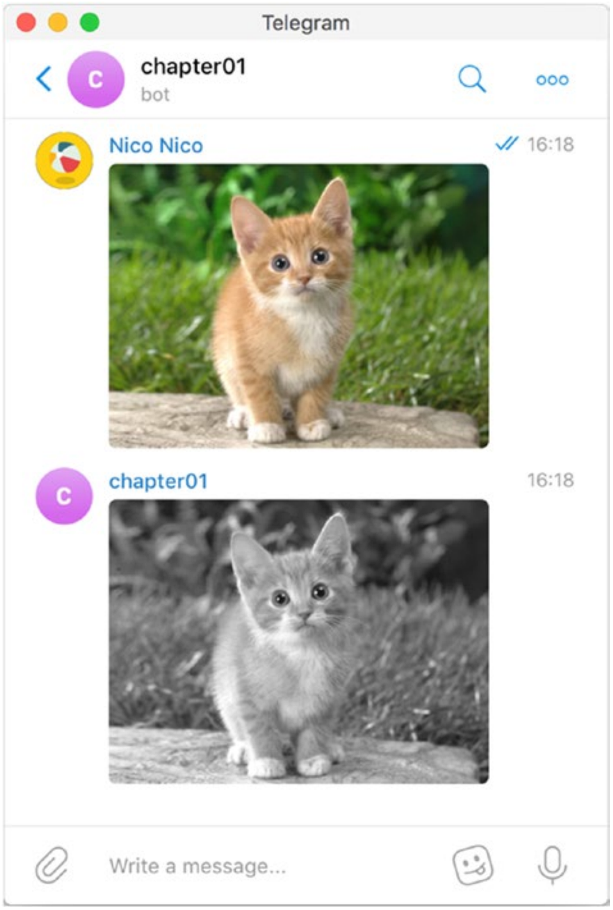


Figure 6-8. *Colored and gray cats*

Obviously, the next step is to try a few more OpenCV transformations and feed them into your bot. Creating a bot to identify specific objects in each picture is now within your reach.

CHAPTER 7

Week 7: Clojure

Sometimes a thing needed opening before closure was found.

—Hugh Howey

Shift

Clojure is the only LISP-based language presented in this book, but it's a language I use on an everyday basis. Clojure, with its share of left and right parentheses, can repel a few, but it surely never gets lost in translation.

Clojure development almost always uses a read-eval-print-loop (REPL) or, in simple terms, a shell that understands Clojure code line by line. Of course, in an editor, you can just execute block of lines of code, and I will show you how to do that in Visual Studio Code again.

Clojure makes it easy to understand the data structure passing via the Telegram server, so we will look at a few of the JSON updates coming from Telegram. To write Telegram bots in the Clojure language, we will be using another Telegram wrapper named Morse, which makes it dead easy to set up your own custom bot, by having a template project ready for you.

N. Modrzyk, *Building Telegram Bots*, https://doi.org/10.1007/978-1-4842-4197-4_7

Initial Setup and First Clojure Bot

Clojure is running on top of Java Virtual Machine, so if you do not have it installed already, head to `http://jdk.java.net`, and install a version of `openjdk` suitable for your machine. On Linux machines, almost every single package manager has a version of `openjdk`. For example, on Manjaro/Arch Linux, you can go with `yaourt -S java-openjdk-ea-bin`.

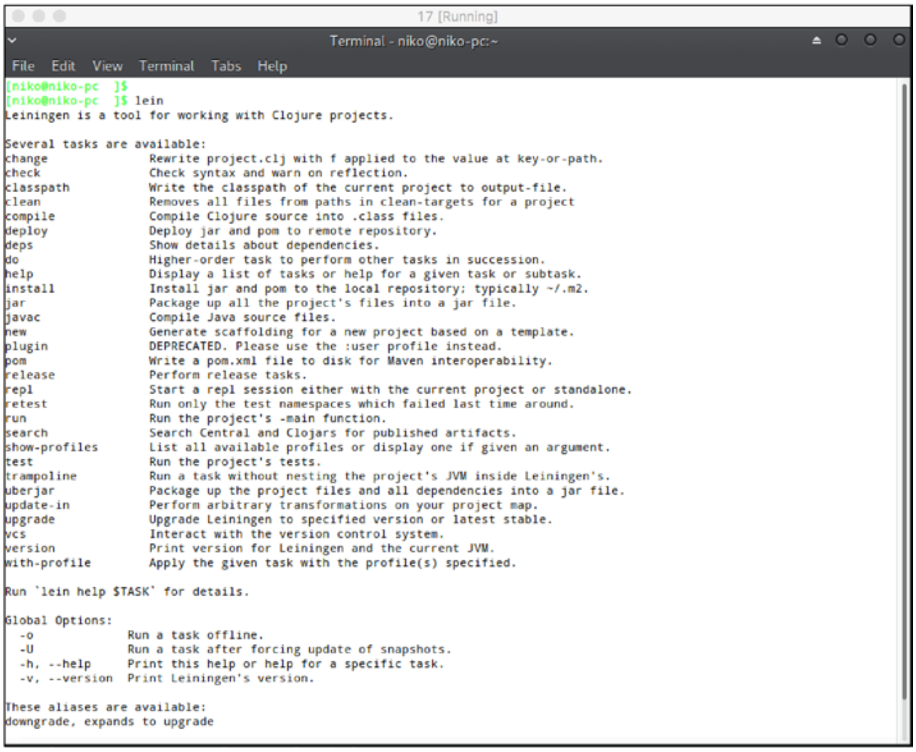
As far as setups tested for this book, JDK versions 8 to 11-ea made the cut.

Now that you have the Java Compiler, you don't need much more than Leiningen, the de facto build tool for Clojure. Installation instructions are short and available from the web site at `https://leiningen.org/`.

The main task is to install a package or a shell script that downloads and bootstraps Leiningen for you. On Manjaro/Arch, here it is:

```
yaourt -S leiningen
```

If the setup is good to go, you should now have Leiningen responding to you on the command line (Figure 7-1).



```
[niko@niko-pc  ]$
[niko@niko-pc  ]$ lein
Leiningen is a tool for working with Clojure projects.

Several tasks are available:
change              Rewrite project.clj with f applied to the value at key-or-path.
check               Check syntax and warn on reflection.
classpath           Write the classpath of the current project to output-file.
clean               Removes all files from paths in clean-targets for a project
compile             Compile Clojure source into .class files.
deploy              Deploy jar and pom to remote repository.
deps                Show details about dependencies.
do                  Higher-order task to perform other tasks in succession.
help                Display a list of tasks or help for a given task or subtask.
install             Install jar and pom to the local repository; typically ~/.m2.
jar                 Package up all the project's files into a jar file.
javac               Compile Java source files.
new                 Generate scaffolding for a new project based on a template.
plugin              DEPRECATED. Please use the :user profile instead.
pom                 Write a pom.xml file to disk for Maven interoperability.
release             Perform release tasks.
repl                Start a repl session either with the current project or standalone.
retest              Run only the test namespaces which failed last time around.
run                 Run the project's -main function.
search              Search Central and Clojars for published artifacts.
show-profiles       List all available profiles or display one if given an argument.
test                Run the project's tests.
trampoline          Run a task without nesting the project's JVM inside Leiningen's.
uberjar             Package up the project files and all dependencies into a jar file.
update-in           Perform arbitrary transformations on your project map.
upgrade             Upgrade Leiningen to specified version or latest stable.
vcs                 Interact with the version control system.
version             Print version for Leiningen and the current JVM.
with-profile        Apply the given task with the profile(s) specified.

Run `lein help $TASK` for details.

Global Options:
  -o             Run a task offline.
  -U             Run a task after forcing update of snapshots.
  -h, --help     Print this help or help for a specific task.
  -v, --version  Print Leiningen's version.

These aliases are available:
downgrade, expands to upgrade
```

Figure 7-1. *Hello Leiningen*

Leiningen has all you need to start coding with Clojure, notably the possibility of offering you an REPL, the shell to execute Clojure code. You start this REPL by using Leiningen with the `repl` subcommand.

```
lein repl
```

Once the REPL is ready, you can start typing code directly at the prompt.

```
[niko@niko-pc ~]$ lein repl
nREPL server started on port 46749 on host 127.0.0.1 -
nrepl://127.0.0.1:46749
REPL-y 0.3.7, nREPL 0.2.12
Clojure 1.8.0
```

```
OpenJDK 64-Bit Server VM 11+28
    Docs: (doc function-name-here)
          (find-doc "part-of-name-here")
  Source: (source function-name-here)
 Javadoc: (javadoc java-object-or-class-here)
    Exit: Control+D or (exit) or (quit)
 Results: Stored in vars *1, *2, *3, an exception in *e

user=> (+ 1 1)
2
user=> (println "hello world")
hello world
nil
user=>
```

Apart from writing Clojure code directly, Leiningen can also generate a full project layout, by using Leiningen templates. The third-party library we want to use for communicating with Telegram, Morse, has a template ready to prepare a new bot. This is done using the following subcommand of Leiningen:

```
lein new morse mytelegrambot
```

This will have the effect of downloading all the Clojure dependencies and creates the project structure for the bot.

```
$ lein new morse mytelegrambot
Retrieving morse/lein-template/0.1.1/lein-template-0.1.1.pom
from clojars
Retrieving morse/lein-template/0.1.1/lein-template-0.1.1.jar
from clojars
Generating fresh 'lein new' morse project.
```

Once the project has been created, you can check the existence of the project files, namely:

- `project.clj`: The usual main project metadata. It contains the project name, compilation details, dependencies, etc.
- `core.clj`: The main source file for the project (unless specified otherwise in `project.clj`)
- `core_test.clj`: Where you can write your Clojure tests

The generated project tree structure follows:

```
$ tree
.
├── CHANGELOG.md
├── LICENSE
├── project.clj
├── README.md
├── resources
├── src
│   └── mytelegrambot
│       └── core.clj
└── test
    └── mytelegrambot
        └── core_test.clj

5 directories, 6 files
```

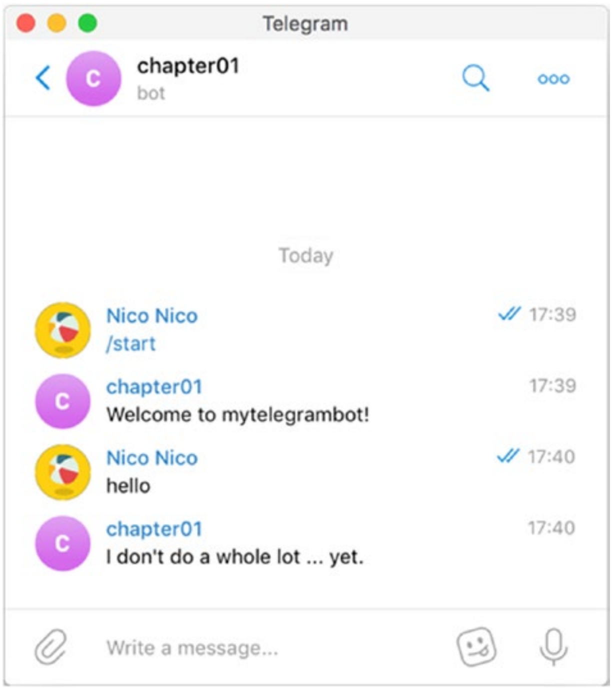
Your Clojure bot is ready to be started, this time, using the `run` subcommand of Leiningen.

This will execute the main function defined in the `core.clj` file, providing you with your Telegram token, which should make things work out of the box.

```
$ export TELEGRAM_TOKEN="585672177:..."
$ lein run
```

```
Starting the mytelegrambot
```

With the basic setup in place, you can start chatting with your Clojure Telegram bot at once (Figure 7-2).


Telegram

chapter01
bot

Today

Nico Nico 17:39
/start

chapter01 17:39
Welcome to mytelegrambot!

Nico Nico 17:40
hello

chapter01 17:40
I don't do a whole lot ... yet.

Figure 7-2. *It's been a long time*

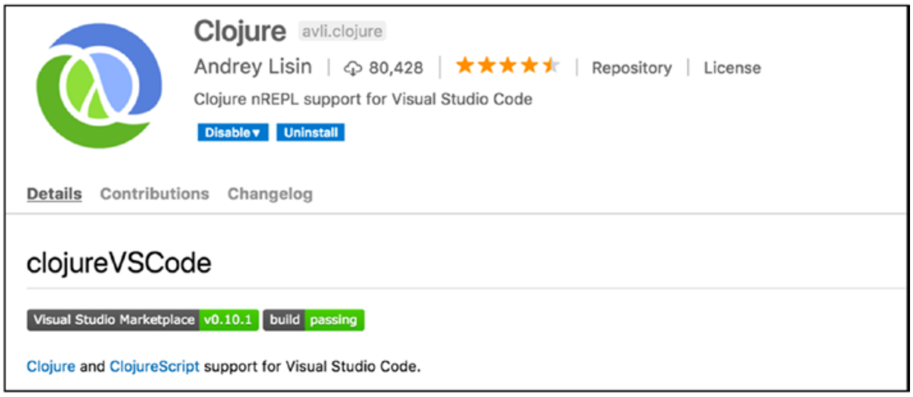
In the console where you started the bot, you can also see the following debugging messages being printed on the standard output:

```
Bot joined new chat:  {:id 121843071, :first_name Nico, :last_
name Nico, :username hellonico, :type private}
```

```
Intercepted message:  {:message_id 675, :from {:id 121843071,
:is_bot false, :first_name Nico, :last_name Nico, :username
hellonico, :language_code en-JP}, :chat {:id 121843071,
:first_name Nico, :last_name Nico, :username hellonico, :type
private}, :date 1537519211, :text hello}
```

Visual Studio Code

As a quick workflow to develop your bot, you can either start an REPL with `lein repl`, as we have seen, or use the Visual Studio Code plug-in shown in Figure 7-3.



Clojure nREPL support for Visual Studio Code

clojureVSCode

Clojure and ClojureScript support for Visual Studio Code.

Figure 7-3. *Clojure plug-in for Visual Studio Code*

The next three things to do are

- Look at `project.clj`, the metadata file of the project.
- Look at the Clojure code to handle Telegram requests.
- Look at the messages coming from Telegram.

Look deep into nature, and then you will understand everything better.

—Albert Einstein

We are now going to look at all these, and in order mentioned.

The Project Metadata in project.clj

A good point with Leiningen and Clojure is that the project metadata is in the same language as the code itself, meaning the project configuration is in Clojure. It's actually more or less a big hash map. Consistency is a key (pun intended), and it's reassuring to find the file with that constant structure.

In `project.clj`, you start by defining a Clojure project with `defproject`, passing a project name (here, `mytelegrambot`), a version number, and a map of different things, in which each key is prefixed with `:`.

Among the different things used to define a project, we can find

- *Dependencies*: A list of third-party libraries to import and use in your project
- *Plug-ins*: A list of plug-ins for Leiningen
- `main`: The main file, actually namespace, to compile and or run

Just as with project names, dependencies come with a project name and a version number, and this is actually the same format used. The full `project.clj` file that has been generated is copied here.

```
(defproject mytelegrambot "0.1.0-SNAPSHOT"
  :description "FIXME: write description"
  :url "http://example.com/FIXME"
  :license {:name "Eclipse Public License"
            :url "http://www.eclipse.org/legal/epl-v10.html"}

  :dependencies [[org.clojure/clojure "1.8.0"]
                 [environ             "1.1.0"]
                 [morse               "0.2.4"]]

  :plugins [[lein-environ "1.1.0"]]

  :main ^:skip-aot mytelegrambot.core
  :target-path "target/%s"

  :profiles {:uberjar {:aot :all}})
```

Now, let's have a look at the code itself, located in `core.clj`.

The Clojure Code in core.clj

Let's break this source file in smaller parts. First, Clojure project source files start with a namespace definition, `namedasns`, and then a list of other namespaces to use in the current context.

```
(ns mytelegrambot.core
  (:require [clojure.core.async :refer [<!!]]
            [clojure.string :as str]
            [environ.core :refer [env]]
            [morse.handlers :as h]
            [morse.polling :as p]
            [morse.api :as t])
  (:gen-class))
```

You will notice namespace for async code, string manipulation, easy retrieval of environment variables, and different namespaces from Morse, the third-party library responsible for doing low-level communication with the Telegram API. Note, too, how each namespace also defines a prefix, such as p, t, or h, which you can use as shortcuts, instead of using the full namespace name. Finally, gen-class is used to tell Clojure code that it has to turn itself into something the Java runtime understands natively, namely, a Java class.

Without knowing too much, you can feel that the following is going to retrieve the token from a Clojure environment variable that we will set in a later section. The library environ "keywordizes," or makes Clojure-friendly, variables from the external shell environment. Here, TELEGRAM_TOKEN will be turned into :telegram-token.

```
; TODO: fill correct token
(def token (env :telegram-token))
```

I will hold off on the handle definition for a bit, but for now, know that this is where you will write the meat of your bot code.

```
(h/defhandler handler
...
)
```

Finally, main, as its name implies, is the main function for the program. It checks for the existence of a Telegram token, then starts to poll for updates, using the function p/start, with parameters telegram token and the telegram handler.

```
(defn -main
  [& args]
  (when (str/blank? token)
    (println "Please provde token in TELEGRAM_TOKEN environment
    variable!")
    (System/exit 1))

  (println "Starting the mytelegrambot")
  (<!! (p/start token handler)))
```

I said that we were going to look at the handler code in a bit more detail later, and later is the new now. Reminder: Each command is handled via a `command-fn` directive, and all these are defined within the `defhandler` section of the file.

```
(h/defhandler handler
   ; your handlers here.
)
```

First, we define a simple `"start"` command for our bot. A command takes a Clojure function as callback, and the parameter from that function is (de-)constructed from the incoming message.

```
  (h/command-fn "start"
    (fn [{{id :id :as chat} :chat}]
      (println "Bot joined new chat: " chat)
      (t/send-text token id "Welcome to mytelegrambot!")))
```

Once the `start` command kicks in the chat, we simply send a message back to the chat with the `send-text` function from the `morse.api` namespace prefixed by `t` (as defined in the `require` section of the namespace).

The generated code also defines a `help` command, which is defined exactly in the same way and actually does almost exactly the same thing as the `start` command, sending back a text message.

```
  (h/command-fn "help"
    (fn [{{id :id :as chat} :chat}]
      (println "Help was requested in " chat)
      (t/send-text token id "Help is on the way")))
```

Last, we define a generic message handler, and we also get a shortcut directly on the message data structure in the callback function using the keyword `:as`.

```
(h/message-fn
  (fn [{{id :id} :chat :as message}]
    (println "Intercepted message: " message)
    (t/send-text token id "I don't do a whole lot ...
    yet.")))
```

The Token!

You may remember that there was a `lein-environ` plug-in defined in the `project.clj` file. This plug-in reads environment variables from different places, for example, `project.clj`, and then populates a file named `.lein-env` with all the necessary environment variables.

So, you can add in your `project.clj` (for one project), as follows:

```
 (defproject mytelegrambot "0.1.0-SNAPSHOT"
   ...
:env
  {:telegram-token "585672177:..."})
```

or in `$HOME/.lein/profiles` (for multiple projects)

```
{:user {:env{:telegram-token "585672177:..."}}}
```

Debugging Telegram Messages

To have a look at messages as they are coming from Telegram, we will format and output them in a log file. To do this, we will create an appending write to the file. In the `core.clj` file, let's declare a write, right below the token definition.

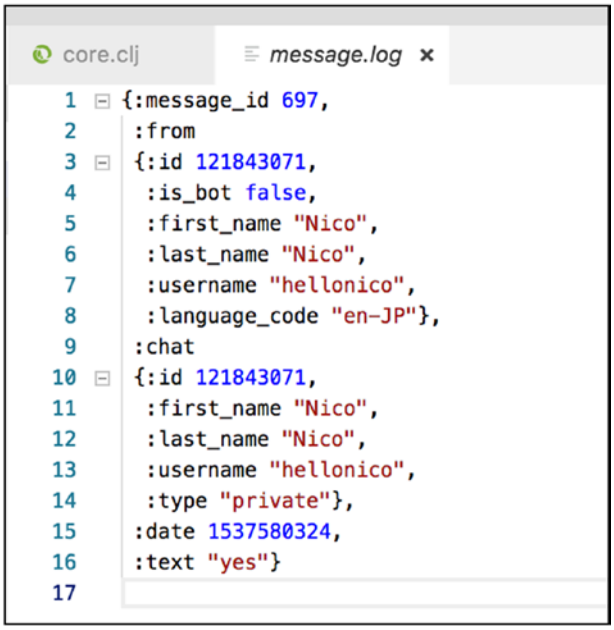
```
(def writer (clojure.java.io/writer "message.log " :append
true))
```

And in the callback function receiving the message, let's output the received message.

Clojure does the format for you, using the `pprint` function from namespace `clojure.pprint`, and you can tell it where to write messages.

```
(clojure.pprint/pprint message writer)
```

On the next message sent to the bot, the `message.log` file is being filled with the incoming messages, as shown in Figure 7-4.

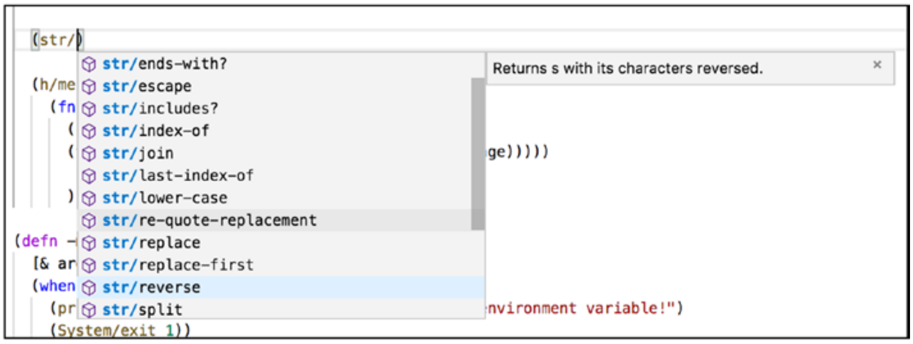


```
{:message_id 697,
 :from
 {:id 121843071,
  :is_bot false,
  :first_name "Nico",
  :last_name "Nico",
  :username "hellonico",
  :language_code "en-JP"},
 :chat
 {:id 121843071,
  :first_name "Nico",
  :last_name "Nico",
  :username "hellonico",
  :type "private"},
 :date 1537580324,
 :text "yes"}
```

Figure 7-4. *Formatted incoming messages*

Creating a Reverse Bot

Let's create a text-reversing bot now. You will remember that you have access to the Clojure string namespace, with the `str/` prefix. This namespace has many functions, one of them being `reverse` (Figure 7-5).



```
(str/)
  (h/me  str/ends-with?             Returns s with its characters reversed.
    (fn  str/escape
      (  str/includes?
      (  str/index-of
         str/join                   ge)))))
         str/last-index-of
      )  str/lower-case
         str/re-quote-replacement
(defn -  str/replace
  [& ar  str/replace-first
  (when  str/reverse
    (pr  str/split                  nvironment variable!")
    (System/exit 1))
```

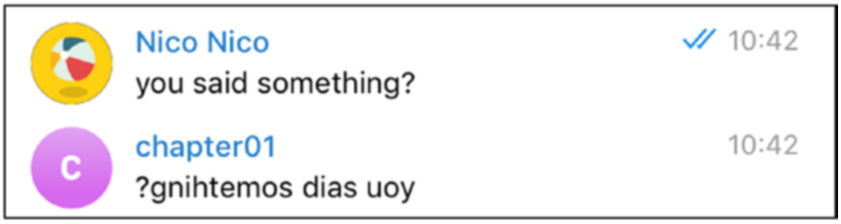
Figure 7-5. *`reverse` function, shown alongside all the `str/` functions*

To create a handler for reversing text, you can call this `reverse` function on the received text. The received text itself, if you look at the map from Figure 7-4 again, can be taken from the message with the key `:text`.

Here is the new message handler that reverses text sent to the chat:

```
(h/message-fn
    (fn [{{id :id} :chat :as message}]
      (clojure.pprint/pprint message writer)
      (t/send-text token id (str/reverse (:text message)))))
```

And now, this works nicely in the Telegram chat, in which you can try sending any kind of text (Figure 7-6).



Nico Nico 10:42
you said something?
chapter01 10:42
?gnihtemos dias uoy

Figure 7-6. *Reversed text*

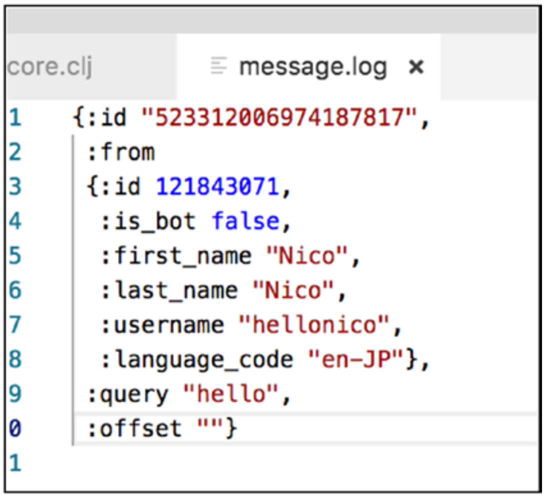
Inline Handler

You'll probably also remember how to define inline handlers from previous chapters. Following is a way to do it in Clojure with Morse.

This inline handler just logs the message, at first.

```
(h/inline-fn
(fn [inline]
  (clojure.pprint/pprint inline writer)
  inline))
```

The content of the inline message itself is shown in Figure 7-7.



```
{:id "523312006974187817",
 :from
 {:id 121843071,
  :is_bot false,
  :first_name "Nico",
  :last_name "Nico",
  :username "hellonico",
  :language_code "en-JP"},
 :query "hello",
 :offset ""}
```

Figure 7-7. *Inline message content*

Note that to answer inline, the Morse library documentation is a bit lax. Looking at the Telegram documentation on inline results makes this slightly more explicit.

https://core.telegram.org/bots/api#inlinequeryresultgif

From the official documentation, you will notice that

- You cannot specify any other type than gif.
- `thumb_url` and `gif_url` are both required.

And so, to send inline answers, you can write code similar to the following snippet. Here, we always send the same gif.

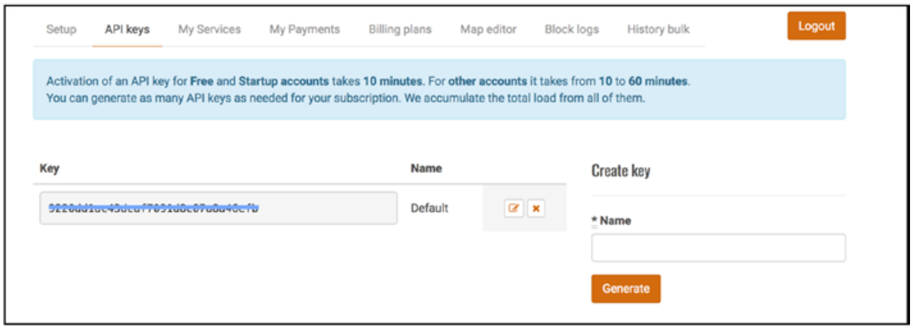
```
(t/answer-inline
     token
     (:id inline)
    [{:type "gif"
      :id "gif1"
      :thumb_url "https://bit.ly/2DtXcIi"
      :gif_url "https://bit.ly/2DtXcIi"}])
```

Run the handler to find out which one!

A Simple Weather Bot

Next, we will have a bot to receive messages containing a location, and we will retrieve weather information for that location, by sending a request to OpenWeather (https://openweathermap.org/).

Obviously, you must register to receive an API token from the OpenWeather web site, as shown in Figure 7-8.



Activation of an API key for **Free** and **Startup accounts** takes **10 minutes**. For **other accounts** it takes from **10** to **60 minutes**.
You can generate as many API keys as needed for your subscription. We accumulate the total load from all of them.

[redacted]

Figure 7-8. *OpenWeather API token*

Registration is free, and obtaining a token should only take a few minutes.

Once you have a token for OpenWeather, it is just a matter of sending an HTTP query similar to the one following:

```
http://api.openweathermap.org/data/2.5/weather?q=<city>&units=
metric&APPID=openweather-api-token
```

If you try this on Tokyo with `curl` or `httpie`, you will get a JSON response similar to the one shown following:

```
{
    "base": "stations",
    "clouds": {
        "all": 75
    },
    "cod": 200,
    "coord": {
        "lat": 35.68,
        "lon": 139.76
    },
    "dt": 1537583700,
    "id": 1850147,
    "main": {
        "humidity": 88,
        "pressure": 1009,
        "temp": 22.18,
        "temp_max": 24,
        "temp_min": 21
    },
    "name": "Tokyo",
    "sys": {
        "country": "JP",
        "id": 7619,
        "message": 0.0056,
        "sunrise": 1537561714,
        "sunset": 1537605508,
        "type": 1
    },
    "visibility": 10000,
    "weather": [
        {
            "description": "light intensity shower rain",
            "icon": "09d",
            "id": 520,
            "main": "Rain"
        }
    ],
    "wind": {
        "deg": 340,
        "speed": 4.1
    }
}
```

To do that in Clojure, we are going to

- Execute an HTTP request simply by using Clojure `slurp`, which retrieves the whole content of either a file or a URL
- Parse the slurped message using Clojure's JSON Cheshire library and its function `parse-text`, to generate a Clojure data structure
- Convert all this to a string to send back the message to the chat

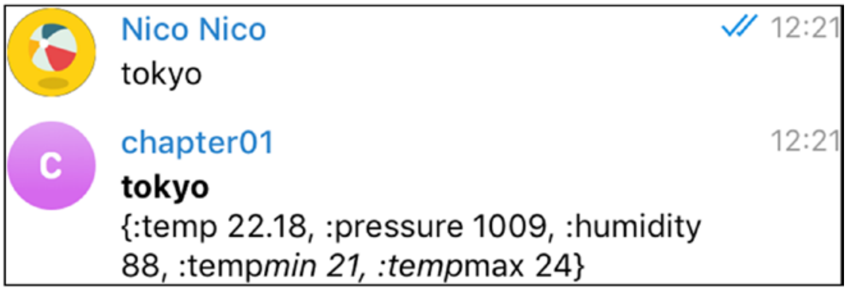
The function to retrieve the weather is

```
(defn weather[city]
   (let [request
    (str
        "http://api.openweathermap.org/data/2.5/weather?q="
        city
        "&units=metric&APPID="
        openweather-api-token )]
    (:main
        (parse-string (slurp request)
           (fn [k] (keyword k))))))
```

And the Morse/Telegram handler that can call it, retrieves the name of city from a chat message, and send the request using the `weather` function defined above.

```
(defhandler handler
 (message-fn
    (fn [{{id :id} :chat :as message}]
      (let [place (:text message)]
      (try
       (api/send-text token id
        {:parse_mode "Markdown"}
        (str "*" place "*" "\n" (weather place)))
            (catch Exception e))))))
```

The result is shown in Figure 7-9.


Nico Nico
tokyo
12:21

chapter01
tokyo
{:temp 22.18, :pressure 1009, :humidity 88, :temp*min 21, :temp*max 24}
12:21

Figure 7-9. *Send the name of the city, and receive the temperature*

Sweet! Finally, let's move to an origami bot.

OpenCV and Telegram: Origami Bot

Origami is a Clojure wrapper around the OpenCV library. To set up anything on your machine, it usually helps just to download a wrapped opencv delivered through Clojure dependencies.

To do this, we will update slightly the `project.clj`, to retrieve the Origami library and to bootstrap the opencv environment.

```
(defproject origamibot "0.1.0-SNAPSHOT"
  :injections [
   (clojure.lang.RT/loadLibrary org.opencv.core.Core/NATIVE_
   LIBRARY_NAME)
  ]
  :repositories [["vendredi" "https://repository.hellonico.
  info/repository/hellonico/"]]
  :main origamibot.core
  :license {:name "Eclipse Public License"
            :url "http://www.eclipse.org/legal/epl-v10.html"}
  :plugins [[lein-environ "1.1.0"]]
  :dependencies [
  [environ "1.1.0"]
  [cheshire "5.6.1"]
  [origami "0.1.11"]
  [hellonico/morse "0.2.4"]
  [org.clojure/clojure "1.8.0"]])
```

Now, to retrieve a picture, remember how to access the Telegram static files: from the file id retrieved in the chat message by a full message, when a picture is sent to the chat, as shown below.

```
{:message_id 851,
 :from
 {:id 121843071,
  :is_bot false,
  :first_name "Nico",
  :last_name "Nico",
  :username "hellonico",
  :language_code "en-JP"},
 :chat
 {:id 121843071,
  :first_name "Nico",
  :last_name "Nico",
  :username "hellonico",
  :type "private"},
 :date 1537587499,
 :photo
 [{:file_id "AgADBQADTqgxGxauIVWm22ogiY88fiZL1TIABM-
 as8GGX14indYDAAEC",
   :file_size 1022,
   :width 90,
   :height 57}
  ; other files
]}
```

To download a file from Telegram, remember the official documentation: https://core.telegram.org/bots/api#file.

Also, remember the request to retrieve the file from the file path, https://api.telegram.org/file/bot<token>/<file_path>, where this file path is retrieved after calling getFile with the file_id contained from a message on a chat.

This is achieved by using the api/download-file of Morse (the custom version of the library, actually: hellonico/morse), which has been added to the project.clj. The custom version diff can be found online, and the reason to use it is to download a file to the local file system. This is just for convenience, and you could, of course, code it yourself, after a few days of practice with Clojure.

All this being in place, let's add the origami package to the namespace section as origami, the core wrapper for opencv.

```
(ns origamibot.core
  (:require
    [opencv3.core :as origami]
    ;….
     [clojure.string :as str])
  (:gen-class))
```

You can then apply any opencv transformation you want. Let's define a function named apply-cv that applies a canny effect to the picture, loaded from a file. Note that the transformation is done in place in the file.

```
(defn apply-cv [filename]
         (->  filename
           (origami/imread)
           (origami/cvt-color! origami/COLOR_RGB2GRAY)
           (origami/canny! 300.0 100.0 3 true)
           (origami/bitwise-not!)
           (origami/imwrite filename)))
```

Finally, you call the OpenCV transformation on the file retrieved from the chat, by calling the previously defined apply-cv function and the downloaded file.

```
(defhandler handler
 (message-fn
    (fn [{{id :id} :chat :as message}]
      (let [fid (-> message :photo last :file_id)
filename (str fid ".png")]
       (api/download-file token fid)
       (apply-cv filename)
       (api/send-photo token id (clojure.java.io/as-file
       filename))))))
```

The rest of the story is one more picture being uploaded in the chat. You can see it in action in Figure 7-10.

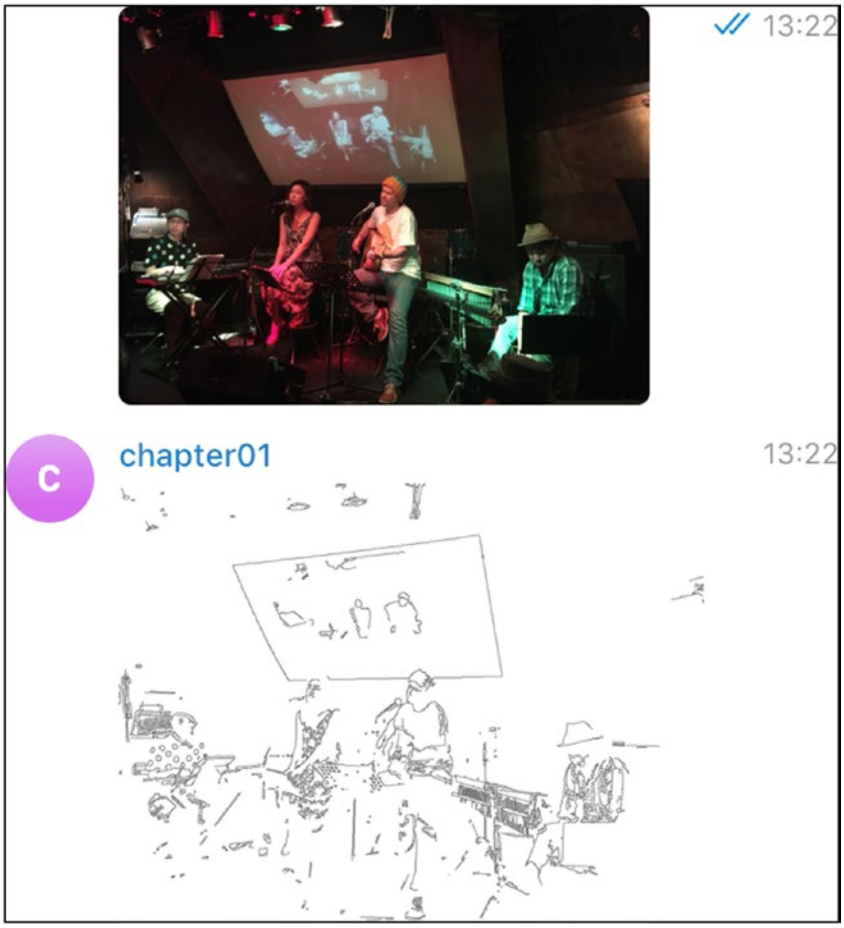


Figure 7-10. *Applying the OpenCV transformation directly from the bot handler*

CHAPTER 8

Week 8: Java

Coffee is a language in itself.

—Jackie Chan

In this chapter, we are going to tackle a Telegram bot in Java. The API in Java is not as bad as it looks, and debugging Java code in Visual Studio Code also works slightly better than expected.

The project will use the Java de facto build tool, Gradle. The library will be the `java-telegram-bot-api`.

Telegram is now proposing a payment API, so you can start selling stuff directly through Telegram. This is especially effective for selling services.

While the first part of this chapter will revisit the basics, we will then implement a bot that responds to the challenges of using the Telegram Payment API and create an example of the full payment life cycle.

Installation

Apart from Apache Maven, Gradle is the de facto build tool in Java land. It's actually the main build tool for building Android applications.

You can manually download and install Gradle on your machine, by downloading binaries available through the different package managers.

The Gradle web site (`https://gradle.org/install/`) has an extensive section on how to install the software.

sdkman is nice to use these days:

```
sdk install gradle 4.10.2
```

Homebrew is the standard on macOS.

```
brew install gradle
```

Chocolatey is the standard on Windows.

```
choco install gradle
```

Once installed, you can check whether you have the most recent version available, which, for Gradle, at the time of writing, was version 4.10.2

```
$ gradle -v

Welcome to Gradle 4.10.2!

Here are the highlights of this release:
 - Incremental Java compilation by default
 - Periodic Gradle caches cleanup
 - Gradle Kotlin DSL 1.0-RC6
 - Nested included builds
 - SNAPSHOT plugin versions in the `plugins {}` block

For more details see https://docs.gradle.org/4.10.2/release-
notes.html

------------------------------------------------------------
Gradle 4.10.2
------------------------------------------------------------

Build time:   2018-09-19 18:10:15 UTC
Revision:     b4d8d5d170bb4ba516e88d7fe5647e2323d791dd

Kotlin DSL:   1.0-rc-6
Kotlin:       1.2.61
```

```
Groovy:       2.4.15
Ant:          Apache Ant(TM) version 1.9.11 compiled on
              March 23 2018
JVM:          1.8.0_171 (Oracle Corporation 25.171-b11)
OS:           Mac OS X 10.13.6 x86_64
```

The Project Structure

A Java project using Gradle is mostly made of the `build.gradle` file, which contains metadata and build information that Gradle can understand and source files located in `src/main/java` (by default).

```
.
├── build.gradle
├── resources
│   ├── cat.jpg
│   └── token
└── src
    └── main
        └── java
            └── com
                └── hellonico
                    ├── Invoice.java
                    └── MyMain.java

6 directories, 5 files
```

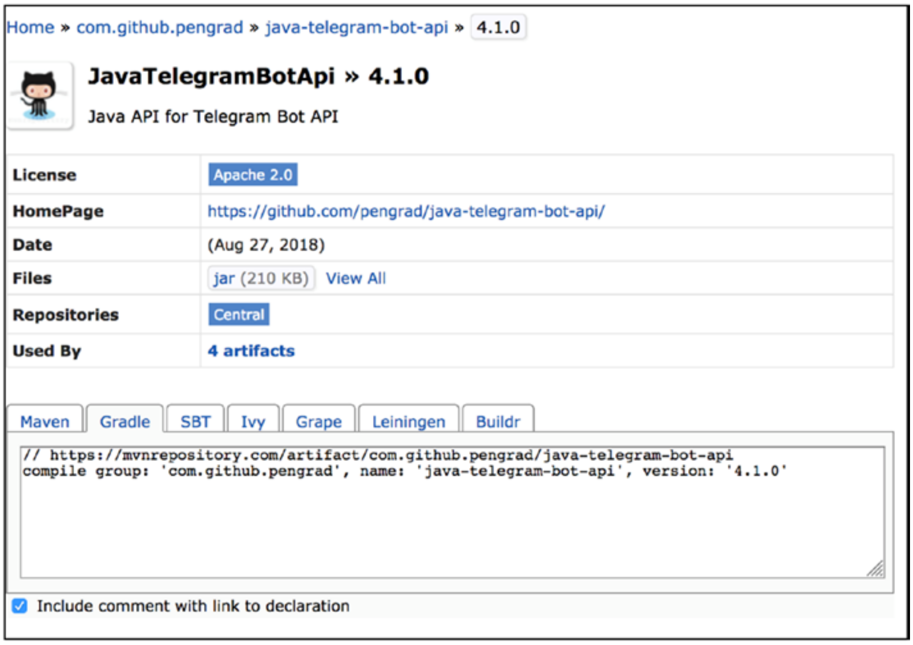
The build.gradle file

Gradle is quite versatile, and you can build pretty much anything with it. In our case, we are going to build a Java project, so we will use the Gradle plug-in for Java, with a few standard settings used for compilation, such as the file encoding and compilation compatibilities.

Dependencies are defined in the dependencies section, each of them identified by the following format:

```
<group>:<name>:<version>.
```

If you do not remember the dependency format, you can search and find any Java dependency on `mvnrepository.com`, as shown in Figure 8-1.


Home » com.github.pengrad » java-telegram-bot-api » 4.1.0

JavaTelegramBotApi » 4.1.0

Java API for Telegram Bot API

License	Apache 2.0
HomePage	https://github.com/pengrad/java-telegram-bot-api/
Date	(Aug 27, 2018)
Files	jar (210 KB) View All
Repositories	Central
Used By	4 artifacts

Maven | Gradle | SBT | Ivy | Grape | Leiningen | Buildr

```
// https://mvnrepository.com/artifact/com.github.pengrad/java-telegram-bot-api
compile group: 'com.github.pengrad', name: 'java-telegram-bot-api', version: '4.1.0'
```

☑ Include comment with link to declaration

Figure 8-1. *Details for `java-telegram-bot-api` from MvnRepository*

Here is the content of the `build.gradle` file:

```
apply plugin: 'java'

sourceCompatibility = 1.8
targetCompatibility = 1.8
```

```
compileJava {
    options.encoding = "UTF-8"
}

repositories {
    jcenter()
}

dependencies {
    compile  'com.github.pengrad:java-telegram-bot-api:4.1.0'
    compile 'com.sparkjava:spark-core:2.2'
    compile 'org.jsoup:jsoup:1.8.3'
    compile 'io.reactivex:rxjava:1.0.16'
}

apply plugin: 'application'
mainClassName = "com.hellonico.Simple"
```

The last two lines of the application plug-in and the `mainClassName` are not required, but they help, if you want to start your program simply by using

```
gradle run
```

For example, given the following simple Java class and program:

```
package com.hellonico;

public class Simple {
    public static void main(String[] args) {
        System.out.println("hello nico");
    }
}
```

if you execute the run command, the program will execute, and the following output will be shown in the terminal or command prompt:

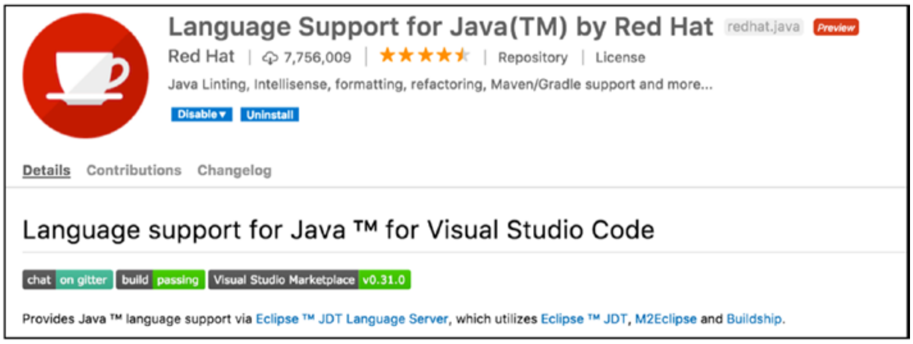
```
$ gradle run

> Task :run
hello nico

BUILD SUCCESSFUL in 1s
2 actionable tasks: 2 executed
```

This will execute the main method of the `com.hellonico.Simple` class. More on the application plug-in can be found on the Gradle web site (`https://docs.gradle.org/current/userguide/application_plugin.html`).

Visual Studio Code Setup

Because I have suggested using Gradle as the build tool for the chapter on Java, Visual Studio Code can recognize the build tool and set up the project with a close-to-perfect integration, using Java tooling.

The main plug-in for Java is shown in Figure 8-2 and can be installed through the usual Visual Studio Code marketplace.



Language Support for Java(TM) by Red Hat redhat.java Preview

Red Hat | 7,756,009 | ★★★★½ | Repository | License

Java Linting, Intellisense, formatting, refactoring, Maven/Gradle support and more...

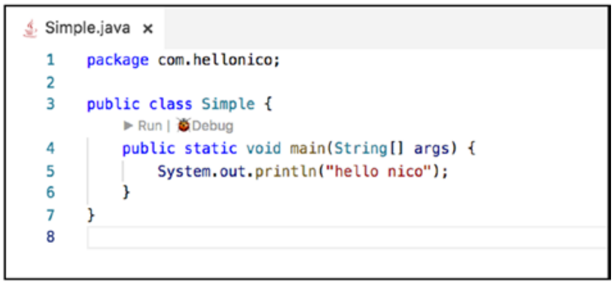
Language support for Java ™ for Visual Studio Code

chat on gitter | build passing | Visual Studio Marketplace v0.31.0

Provides Java ™ language support via Eclipse ™ JDT Language Server, which utilizes Eclipse ™ JDT, M2Eclipse and Buildship.

Figure 8-2. *Visual Studio Code Java plug-in*

The same simple Java class that was written above yields the result shown in Figure 8-3.

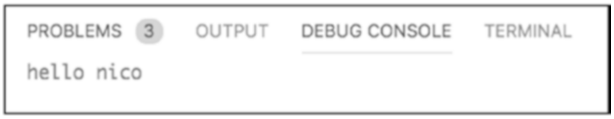


```java
package com.hellonico;

public class Simple {
    public static void main(String[] args) {
        System.out.println("hello nico");
    }
}
```

Figure 8-3. *hello nico Java program*

You now see two icons with which to run and debug your code. They will be useful when you write the Telegram bot.

To try it now, click Run, which executes the program and shows the proper output on the Visual Studio Code console (Figure 8-4).



```
hello nico
```

Figure 8-4. *Running Java from Visual Studio Code*

First Java Bot

Our first Java bot will send some text and a photo, just to make sure the full Java setup is working. The bot will be initialized with the token loaded from a resources/token file, in which you should paste the token of your bot.

Along the way, you will probably find that the Java imports are a bit hard to find, but they can be auto-imported using Visual Studio Code Organize Imports, as shown in Figure 8-5.

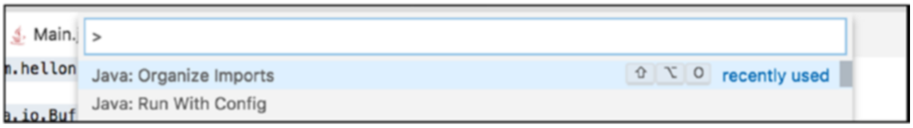


Figure 8-5. *Organize Imports*

Probably the most difficult part of the code for this first bot is the following line:

```
bot.setUpdatesListener(new UpdatesListener() {..}
```

This is where you tell the bot to poll and listen for updates. In its simplest form, the bot code is as follows:

```
package com.hellonico;

import java.io.BufferedReader;
import java.io.FileReader;
import java.io.IOException;
import java.util.List;
import java.util.stream.Collectors;

import com.pengrad.telegrambot.TelegramBot;
import com.pengrad.telegrambot.UpdatesListener;
import com.pengrad.telegrambot.model.Update;

public class Main {

    public static String streamFile_Buffer(String file) throws
Exception{
        BufferedReader reader =
new BufferedReader(new FileReader(file));
        return reader
.lines()
.collect(Collectors.joining(System.lineSeparator()));
    }
    public static void main(String[] args) throws Exception {
        TelegramBot bot =
new TelegramBot(streamFile_Buffer("resources/token"));
bot.setUpdatesListener(new UpdatesListener() {
@Override
            public int process(List<Update> updates) {
                System.out.println(updates.toString());
                  // DO SOMETHING HERE.
                return UpdatesListener.CONFIRMED_UPDATES_ALL;
            }
        });
    }
}
```

Send Some Text

Our first interaction will be to send some text to the chat. You can navigate through update messages from Telegram just as with other languages. You'll find the usual messages with the same structure seen to now.

```
[Update{update_id=573518674, message=Message{message_id=956,
from=User{id=121843071, is_bot=false, first_name='Nico', last_
name='Nico', username='hellonico', language_code='en-JP'} ,
date=1537602748, chat=Chat{id=121843071,..
```

From there, we can obtain the chat id

```
int id = updates.get(0).message().chat().id().intValue();
```

and send a message back to the chat room. Note that we are using `bot.execute` with a request and a callback, so the result is asynchronous.

```
SendMessage requestText =
new SendMessage(id, "*hello from java*").parseMode(ParseMode.
Markdown);
bot.execute(requestText, new Callback<SendMessage,
SendResponse>() {
@Override
public void onResponse(SendMessage request, SendResponse
response) {}
@Override
  public void onFailure(SendMessage request, IOException e) {}
});
```

Before starting the bot, you must organize the imports or complete the list manually. The full list is shown following and should be located at the top of the source file.

```
import java.io.BufferedReader;
import java.io.FileReader;
import java.io.IOException;
import java.util.List;
import java.util.stream.Collectors;
import com.pengrad.telegrambot.Callback;

import com.pengrad.telegrambot.TelegramBot;
import com.pengrad.telegrambot.UpdatesListener;
import com.pengrad.telegrambot.model.Update;
import com.pengrad.telegrambot.model.request.ParseMode;
import com.pengrad.telegrambot.request.SendMessage;
import com.pengrad.telegrambot.response.SendResponse;
```

Start the bot by clicking Run or Debug, which give some markdown formatted text in the chat (Figure 8-6).

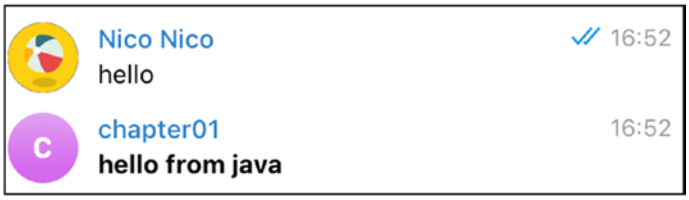

Nico Nico 16:52
hello
chapter01 16:52
hello from java

Figure 8-6. *Your Java bot is running!*

Send a Photo

Sending a photo is as easy as sending text, and this time, we will use the synchronous version of sending the request to Telegram. Because the code is not asynchronous anymore, failures are not handled in the `onFailure` callback that was available in the asynchronous version. So, it's a good idea to surround the request by a `try/catch` block.

```
SendPhoto requestPhoto = new SendPhoto(id, new File("resources/
cat.jpg"));
try {
SendResponse response = bot.execute(requestPhoto);
} catch (Exception e) {
e.printStackTrace();
}
```

And the cat picture is sent to the chat, as shown in Figure 8-7.

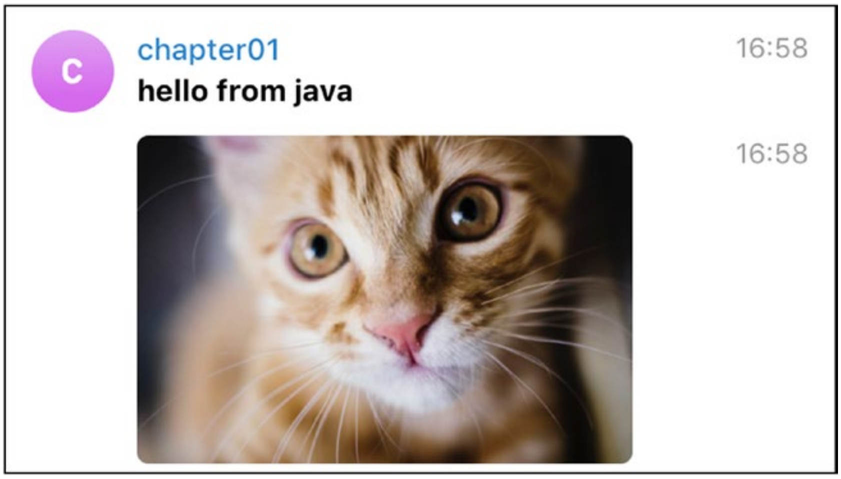

chapter01
hello from java
16:58
16:58

Figure 8-7. *The cat is back!*

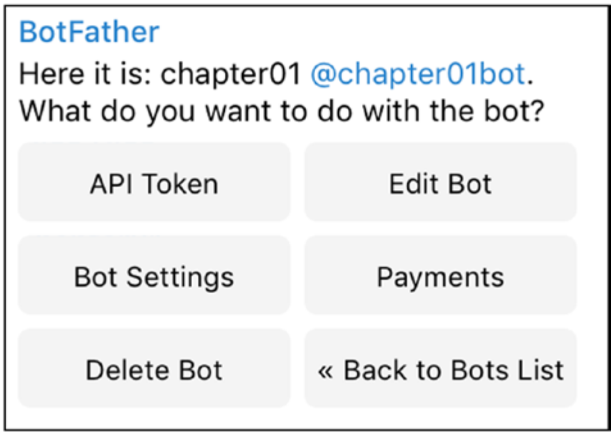
Now let's try to generate an invoice and do some payment with a Java bot.

Bot with Invoice Capabilities

Telegram has added a Payment API to accept payment directly from a chat room. This is a truly wonderful setup for sending money, and transactions in the services field will greatly benefit from its expansion.

Asking Permission

Before using these capabilities, you must obtain permission, again from the almighty BotFather, by changing the Payments settings of your bot (see Figure 8-8).

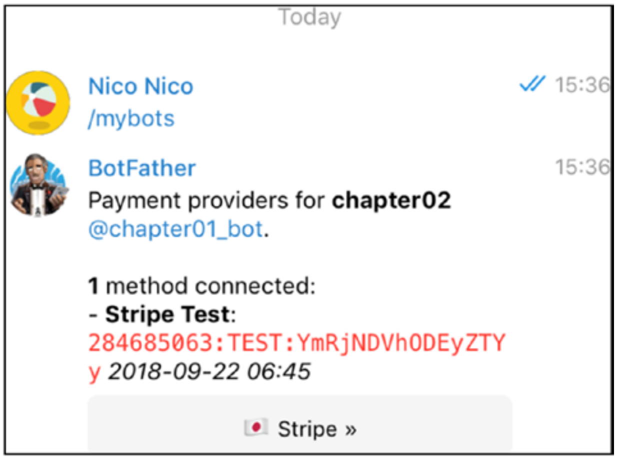


BotFather

Here it is: chapter01 @chapter01bot.
What do you want to do with the bot?

Figure 8-8. *Payment section in the bot settings of BotFather*

After payment settings for the bot have been updated, BotFather will give you a payment token, as shown in Figure 8-9.



Today

Nico Nico 15:36
/mybots

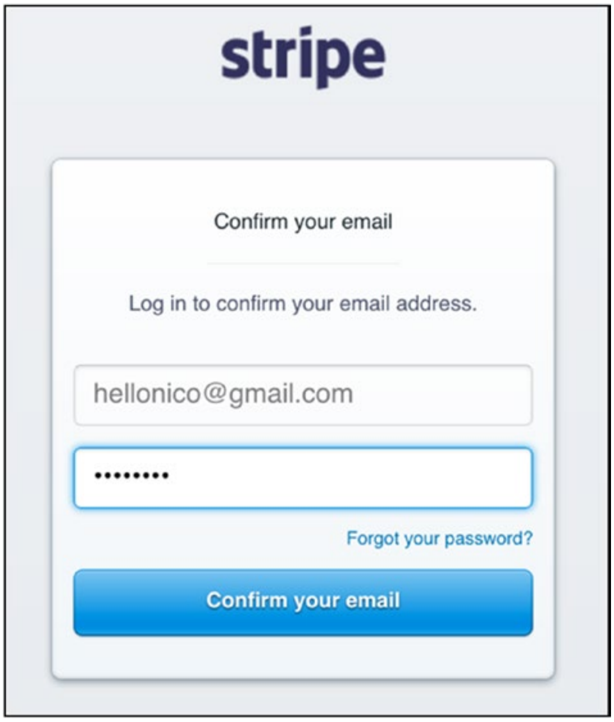
BotFather 15:36
Payment providers for **chapter02** @chapter01_bot.

1 method connected:
- **Stripe Test:** 284685063:TEST:YmRjNDVhODEyZTY y 2018-09-22 06:45

Figure 8-9. *Payment details have been updated*

Note here that another token is given to you. This is the token you will have to use when sending invoice messages.

Along the way, you will have to set up a payment account with your favorite provider. Here, we are using Stripe and testing its capabilities, as shown in Figures 8-10 and 8-11.


stripe

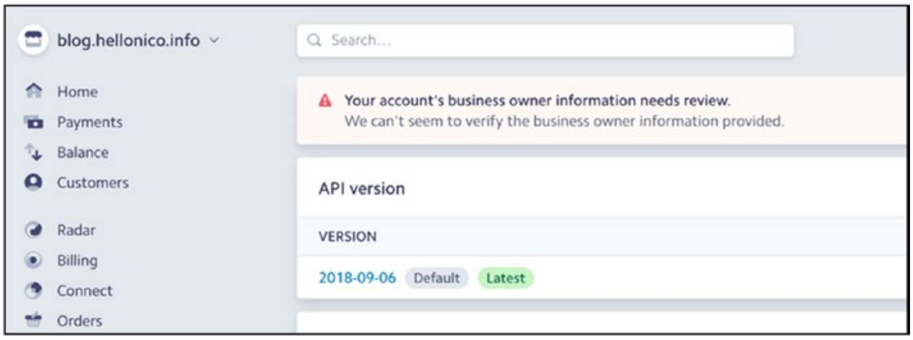
Confirm your email

Log in to confirm your email address.

hellonico@gmail.com

•••••••••

Figure 8-10. *Stripe setup*


blog.hellonico.info

Your account's business owner information needs review.
We can't seem to verify the business owner information provided.

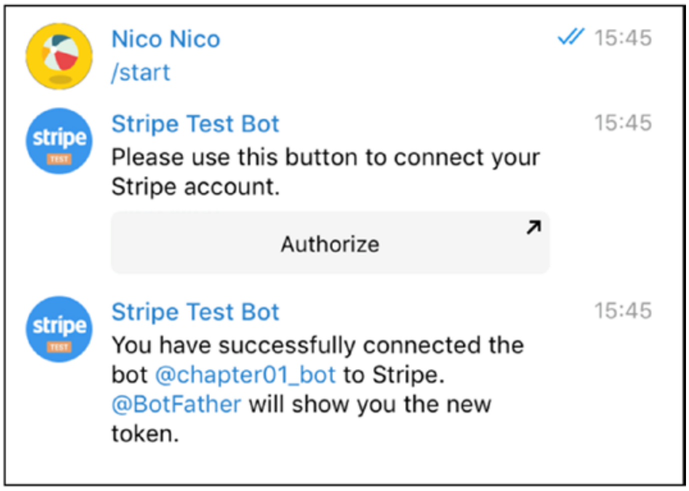
API version

VERSION

2018-09-06 Default Latest

Figure 8-11. *Stripe dashboard*

If the setup has completed properly, you well get the confirmation from the Stripe Test Bot, as shown in Figure 8-12.


Nico Nico
/start
15:45

Stripe Test Bot
Please use this button to connect your Stripe account.
15:45

Stripe Test Bot
You have successfully connected the bot @chapter01_bot to Stripe. @BotFather will show you the new token.
15:45

Figure 8-12. *Stripe Test Bot connected*

Now your bot can send invoice messages and attempt to get money from people talking to it.

Sending an Invoice Message

In the same vein as sending a photo or text, you can send invoices to the chat, using a `SendInvoice` message.

```
SendInvoice sendInvoice

= new SendInvoice(id, "Lemon", "desc", "hello","2846850
63:TEST:NDBlMjliMGM2YmQ0", "my_start_param", "JPY", new
LabeledPrice("label", 2000))

.needPhoneNumber(false)
.needShippingAddress(false)
```

```
.isFlexible(true)
.replyMarkup(new InlineKeyboardMarkup(new InlineKeyboardButton[]
{ new InlineKeyboardButton("just pay").pay(),
new InlineKeyboardButton("google it").url("www.google.com") }));
```

Again, you can execute the query synchronously or asynchronously. It is recommended that you avoid blocking the execution on the main thread.

```
// sync version
SendResponse response = bot.execute(sendInvoice);

// async version
bot.execute(sendInvoice, new Callback<SendInvoice, SendResponse>() {
@Override
public void onResponse(SendInvoice request, SendResponse
response) {}
 @Override
 public void onFailure(SendInvoice request, IOException e) {}});
```

The payment can only be made using the mobile version of the Telegram app, to which users will also have to provide their shipping details (Figure 8-13).

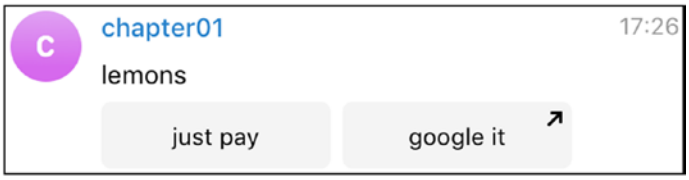


Figure 8-13. *Invoice me lemons*

In this step, clicking just pay will get the payment bot to send a request for shipping query. (Actually, only if `.isFlexible (true)` has been set.)

At this stage, we can send a few options for the shipment and send them back to the chat.

```
ShippingQuery shipping= updates.get(0).shippingQuery();
if (shipping!= null) {
    ShippingOption option =
new ShippingOption("fedex", "FedEx", new LabeledPrice("JOY", 2000));
    AnswerShippingQuery query =
new AnswerShippingQuery(shipping.id(), option);
    bot.execute(query);
    return UpdatesListener.CONFIRMED_UPDATES_ALL;
}
```

The shipment options will then show up in the chat, as shown in Figure 8-14.

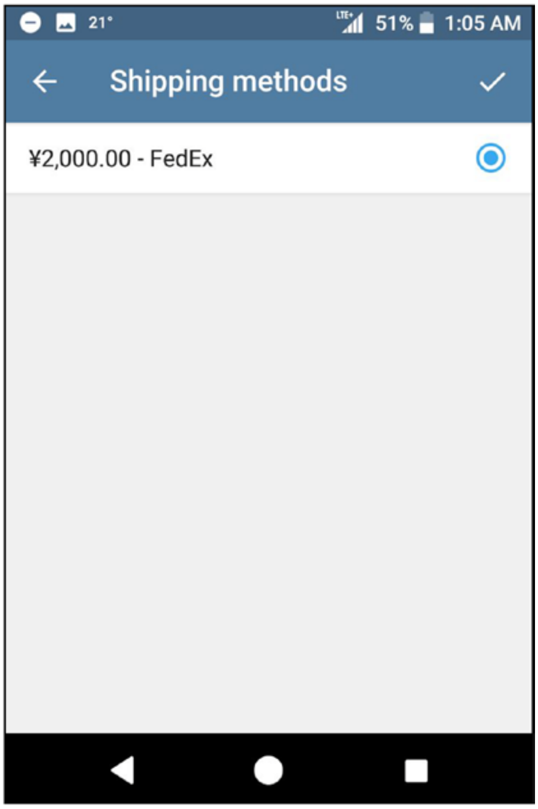
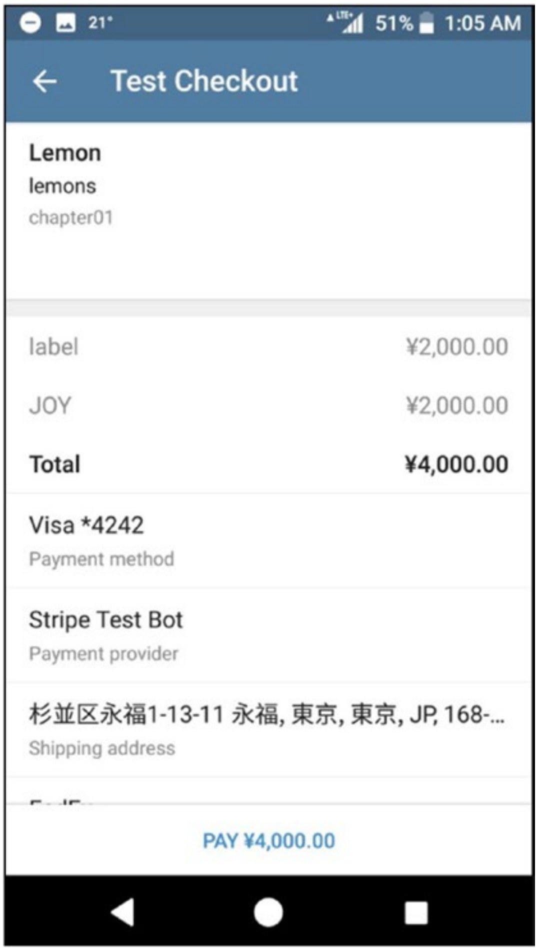


Figure 8-14. *Shipping options*

Figures 8-15 and 8-16 show the process for filling in the remaining info of the payment process.



Lemon
lemons
chapter01

label ¥2,000.00
JOY ¥2,000.00
Total **¥4,000.00**

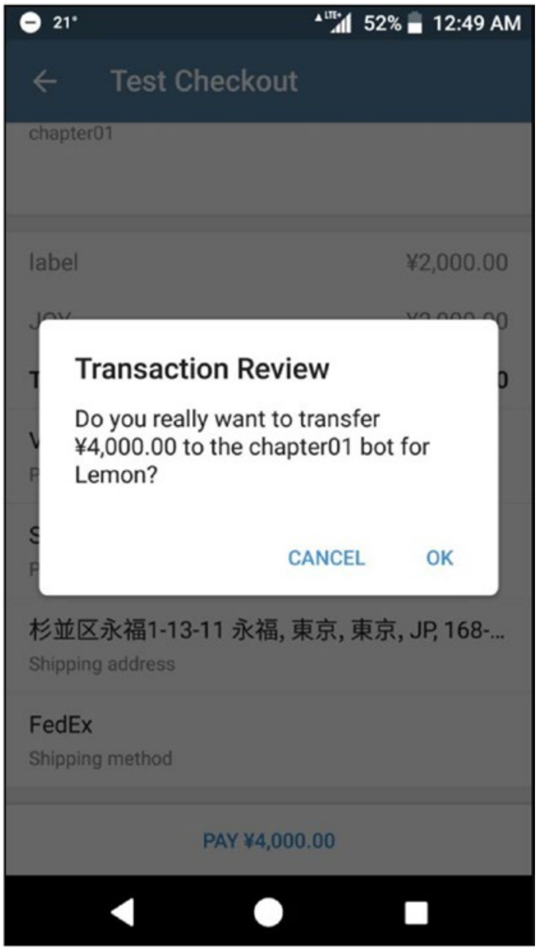
Visa *4242
Payment method

Stripe Test Bot
Payment provider

杉並区永福1-13-11 永福, 東京, 東京, JP, 168-...
Shipping address

PAY ¥4,000.00

Figure 8-15. *Full checkout screen*



chapter01

label ¥2,000.00

Transaction Review

Do you really want to transfer ¥4,000.00 to the chapter01 bot for Lemon?

杉並区永福1-13-11 永福, 東京, 東京, JP, 168-...
Shipping address

FedEx
Shipping method

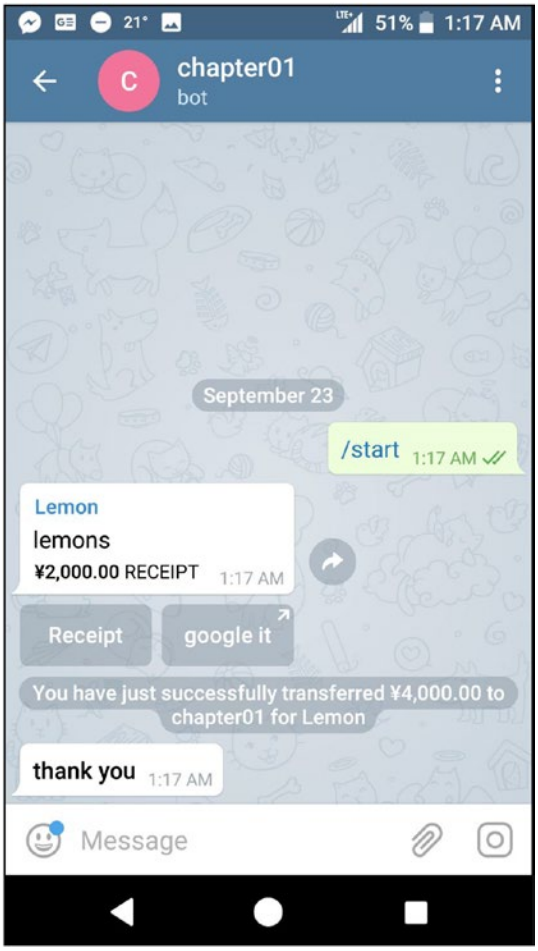
Figure 8-16. *Transaction validation*

Finally, the payment bot will send a request to your bot for pre-checkout, with all the payment details. You have to answer this request from the bot as fast as you can, and actually ten seconds is the max time limit, or the payment will be canceled.

Completion of the transaction is done by sending a `PreCheckoutQuery` with the query id, when a `preCheckoutQuery` element is received.

```
PreCheckoutQuery query = updates.get(0).preCheckoutQuery();
if (query != null) {
    AnswerPreCheckoutQuery apcq = new AnswerPreCheckoutQuery
                                (query.id());
    bot.execute(apcq);
    return UpdatesListener.CONFIRMED_UPDATES_ALL;
}
```

Figure 8-17 shows the chat after the payment has been completed.



chapter01
bot

September 23

/start 1:17 AM

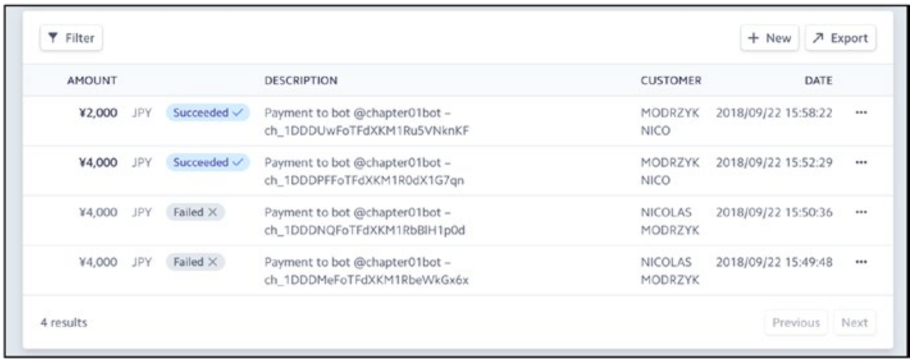
Lemon
lemons
¥2,000.00 RECEIPT 1:17 AM

You have just successfully transferred ¥4,000.00 to chapter01 for Lemon

thank you 1:17 AM

Figure 8-17. *Payment complete*

On the Stripe dashboard, in the payment section, after enabling test data, you can see the different orders coming through, as shown in Figure 8-18.



AMOUNT			DESCRIPTION	CUSTOMER	DATE	
¥2,000	JPY	Succeeded ✓	Payment to bot @chapter01bot – ch_1DDDUwFoTFdXKM1Ru5VNknKF	MODRZYK NICO	2018/09/22 15:58:22	···
¥4,000	JPY	Succeeded ✓	Payment to bot @chapter01bot – ch_1DDDPFFoTFdXKM1R0dX1G7qn	MODRZYK NICO	2018/09/22 15:52:29	···
¥4,000	JPY	Failed ✕	Payment to bot @chapter01bot – ch_1DDDNQFoTFdXKM1RbBIH1p0d	NICOLAS MODRZYK	2018/09/22 15:50:36	···
¥4,000	JPY	Failed ✕	Payment to bot @chapter01bot – ch_1DDDMeFoTFdXKM1RbeWkGx6x	NICOLAS MODRZYK	2018/09/22 15:49:48	···

4 results

Figure 8-18. *Stripe test logs*

That was quite smooth. That's it for the full payment process life cycle in Java. Now it's your turn to start selling lemons…and become rich!

CHAPTER 9

Week 9: Go

I have nine armchairs from which I can be critical.

—Rick Moranis

Go was originally created by people who were not too fond of the C++ programming language. Go is a strongly typed and compiled language, which aims mostly at being both easy to learn and fast to execute. Go is also one of the few languages to have a fantastic logo!

The logo, shown in Figure 9-1, was designed by Renée French, and I understand that I can use it here, as she is credited.

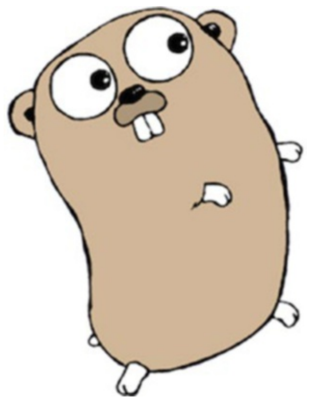
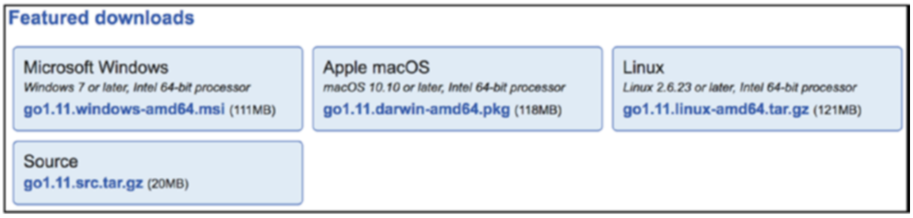


Figure 9-1. *Gopher, Renée French's logo for the Go language*

In this chapter, I will review how to install the Go binary, followed by first steps and basic Go samples, before moving on to writing a Telegram bot and, finally, writing a command-line binary to send different Telegram objects via the API.

Installation of Go

To download Go, you can use the prepackaged version from the Go web site, located at `https://golang.org/dl/`. Most platforms have an option available for download, as shown in Figure 9-2.


Featured downloads

Microsoft Windows
Windows 7 or later, Intel 64-bit processor
go1.11.windows-amd64.msi (111MB)

Apple macOS
macOS 10.10 or later, Intel 64-bit processor
go1.11.darwin-amd64.pkg (118MB)

Linux
Linux 2.6.23 or later, Intel 64-bit processor
go1.11.linux-amd64.tar.gz (121MB)

Source
go1.11.src.tar.gz (20MB)

Figure 9-2. *Go packages for your preferred platform*

Your favorite package manager should also have the Go package available.

```
# On Linux/Manjaro
-S go
# on macOS
brew install go
# on Windows
choco install golang
```

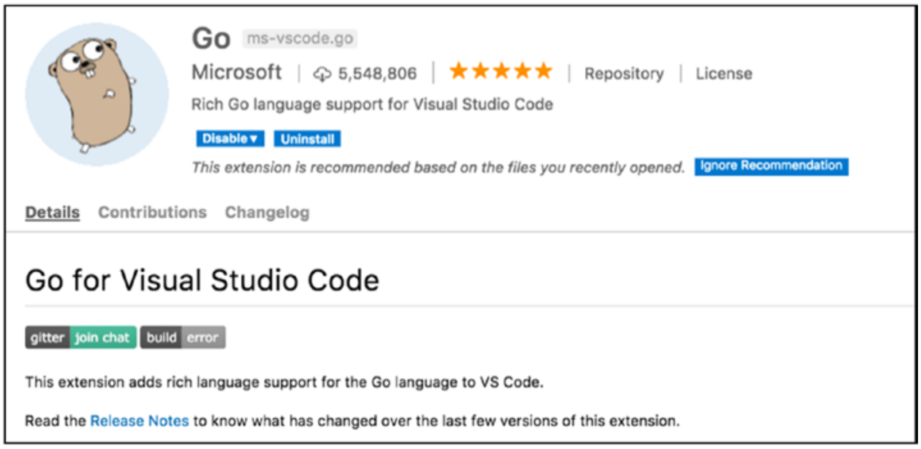
Once installed, you should check with the `version` subcommand whether you have a relatively current version.

```
# Current version
$ go version
go version go1.11 linux/amd64
```

It is usually recommended that you create a GOPATH variable, which is used so that your Go packages can be downloaded and stored in a known place.

```
export GOPATH=$HOME/go
```

Visual Studio Code has a plug-in for Go, and to install it, it is recommended that you follow this recipe. There are multiple plug-ins for Go, but the one from Microsoft is very solid and is shown in Figure 9-3.



Rich Go language support for Visual Studio Code

This extension is recommended based on the files you recently opened.

Go for Visual Studio Code

This extension adds rich language support for the Go language to VS Code.

Read the Release Notes to know what has changed over the last few versions of this extension.

Figure 9-3. *The Go plug-in for Visual Studio Code*

The Go-related tasks.json for the Visual Studio Code build tasks, and its Command+Shift+B shortcut, required to execute code from within Visual Studio Code, is written following, for convenience.

```
{
    "version": "2.0.0",
    "tasks":
```

```
    [
      {
        "label": "letsgo",
        "command": "go",
        "args": [
          "run",
          "${file}"
        ],
        "options": {
          "cwd": "${workspaceRoot}"
        },
        "group": {
          "kind": "build",
          "isDefault": true
        }
      }
    ]
  }
```

From the `tasks.json` file, you'll notice that the command to build a Go program is go `run<filename>`.

Now, let's move on to the first Go program.

Let's Go

The basic structure of a program in Go is separated into three main blocks.

- The package definition, done with `package`
- The imports, all defined in one block
- The main function that gets executed when running the `go run` command

We'll start our Go adventures with a program that will read text from a file. This technique will be reused for reading a token for our bot, later in this chapter.

The project structure for a Go project relies on a folder with only one main function and a selection of Go source files, each ending with the `.go` extension. Our first setup will have a `reading.go` file to write the go source code and a text file, `file.txt`, to read sample text from.

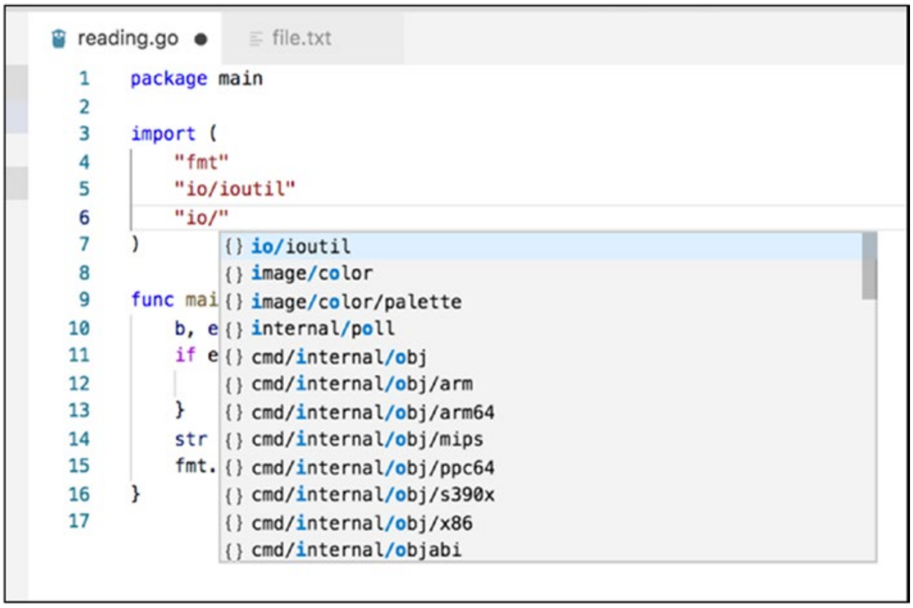
```
$ tree
.
├── file.txt
└── reading.go

0 directories, 2 files
```

Now on to the Go code itself. As presented in the preceding bulleted list, the source file has three sections, starting with the package definition. You'll also notice that if you forget to write the package definition, the Visual Studio Code plug-in will automatically add it for you on saving.

There are two imports we are going to use:

- `io/ioutil`, to read the file content
- `fmt`, which is quite classic, to print on the standard output

With the help of auto-completion, it's easy to browse your way through the different packages in Go, as shown in Figure 9-4.



```
package main

import (
    "fmt"
    "io/ioutil"
    "io/"
)

func mai
    b, e
    if e

    }
    str
    fmt.
}
```

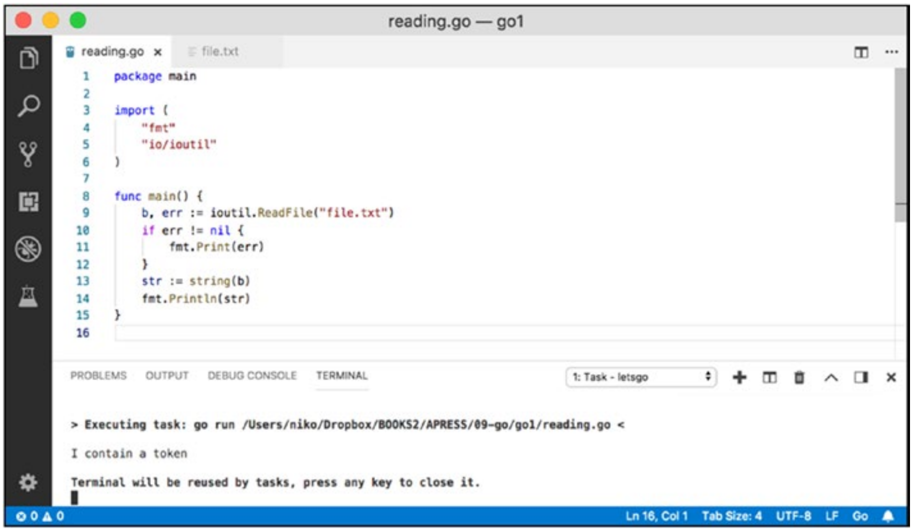
```
io/ioutil
image/color
image/color/palette
internal/poll
cmd/internal/obj
cmd/internal/obj/arm
cmd/internal/obj/arm64
cmd/internal/obj/mips
cmd/internal/obj/ppc64
cmd/internal/obj/s390x
cmd/internal/obj/x86
cmd/internal/objabi
```

Figure 9-4. *Importing packages through completion in Visual Studio Code*

Before going on and explaining the main function, let's copy and paste the following code in the `reading.go` file and execute the code first.

```
package main

import (
    "fmt"
    "io/ioutil"
)

func main() {
    b, err := ioutil.ReadFile("file.txt")
    if err != nil {
        fmt.Print(err)
    }
    str := string(b)
    fmt.Println(str)
}
```

Now open the folder containing the `reading.go` and `file.txt` files and use the Visual Studio Code `build` command defined during the installation process, as shown in Figure 9-5.



```
package main

import (
    "fmt"
    "io/ioutil"
)

func main() {
    b, err := ioutil.ReadFile("file.txt")
    if err != nil {
        fmt.Print(err)
    }
    str := string(b)
    fmt.Println(str)
}
```

```
> Executing task: go run /Users/niko/Dropbox/BOOKS2/APRESS/09-go/go1/reading.go <

I contain a token

Terminal will be reused by tasks, press any key to close it.
```

Figure 9-5. *Our first Go program reads content from a file*

So, the file does not contain a token yet, but it does contain some text that was read by the program from the main function. What was the function doing, by the way?

First, we used `ReadFile` from the `ioutil`go package, to open and read the full contents of file to an array of bytes.

```
b, err := ioutil.ReadFile("file.txt")
```

`ReadFile` actually returns two values, one for the content of the file in bytes, and one in case an error has occurred while reading those bytes from the file. As you can see, Go makes it easy to assign the returned results to multiple variables.

Now, let's see if an error occurred, by checking whether `err` is `nil`. If it's not, let's use `fmt` and its `Print` function, to display the content of the `err` variable itself in the standard output.

```
if err != nil {
fmt.Print(err)
}
```

If the code has executed till this `if` statement, we're in pretty good shape. Let's convert the byte content returned by `ReadFile` to a string and display the content of the string, again using `fmt`'s `Println`.

```
str := string(b)
fmt.Println(str)
```

Great. We're all set up, and our first Go program executed properly.

Note here that you can generate a binary file from all the source files contained in this folder, using the `build` subcommand of Go.

`Gobuild` comes in two forms, one for which you specify the file name and one for which you don't. It is usually better to separate projects into different folders and use the version of the `build` command without the parameter.

```
go build
```

After you execute the command, a new file, called `go1`, will be generated in the project's folder, as shown in Figure 9-6.

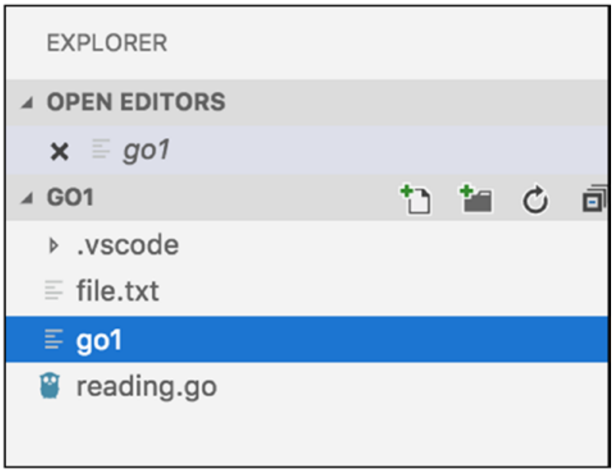


Figure 9-6. *The executable binary* `go1` *generated by the* `build` *command*

Also note that the file name of the generated binary is by default the name of the folder containing the code, not the Go source file containing the main function.

Let's quickly confirm that the binary works as expected.

```
$ ./go1
I contain a token
```

If you move one folder up, in the folder in which the `file.txt` is not present, you can also confirm that the program crashes and displays an error message, the one from the `if` block checking for `err`.

```
$ ./go1/go1
open file.txt: no such file or directory
```

Sweet! Let's move to Fib now!

Let's Fib

For this Fibonacci Go program, we will be using the recursive route. This implementation brings four new procedures, compared to the first simple program we just executed.

First, we'll define a new function separated from `main`, named `Fibonacci`, which will simply call itself recursively with different parameters, `n-1` and `n-2`. Then, we will implement the `main` function that will retrieve the first parameter that is being sent to the program. We'll then convert its value from a string to an integer, using a function named `Atoi` from the `strconv` package. Last, we'll call the `Fibonacci` function with the integer parameter and print the result of the call to the `Fibonacci` function in the standard output.

The Go code snippet is as follows:

```
package main

import (
    "fmt"
    "os"
    "strconv"
)

// Fibonacci computes fibonacci by recursion
func Fibonacci(n int) int {
    if n <= 1 {
        return n
    }
    return Fibonacci(n-1) + Fibonacci(n-2)
}

func main() {
    i, _ := strconv.Atoi(os.Args[1])
    fmt.Println(Fibonacci(i))
}
```

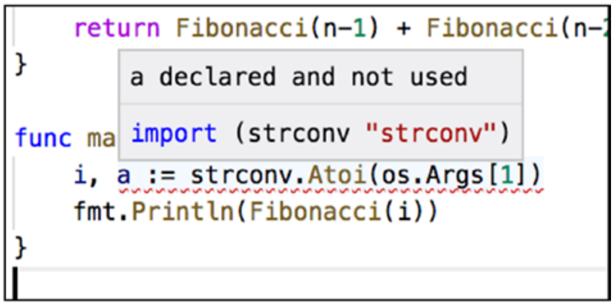
The code is relatively easy to follow at this stage, the main point being the conversion of the parameter to an integer. `os.Args` retrieves the array of parameters, which starts at 0 with the command path itself. Note that if you try to print the parameter at index 0 with

```
fmt.Println(os.Args[0])
```

you'll get the automatically generated path from Visual Studio Code.

```
/var/folders/8g/42979vpd0ml_ly722rgl3x780000gp/T/go-
build290797788/b001/exe/fib
```

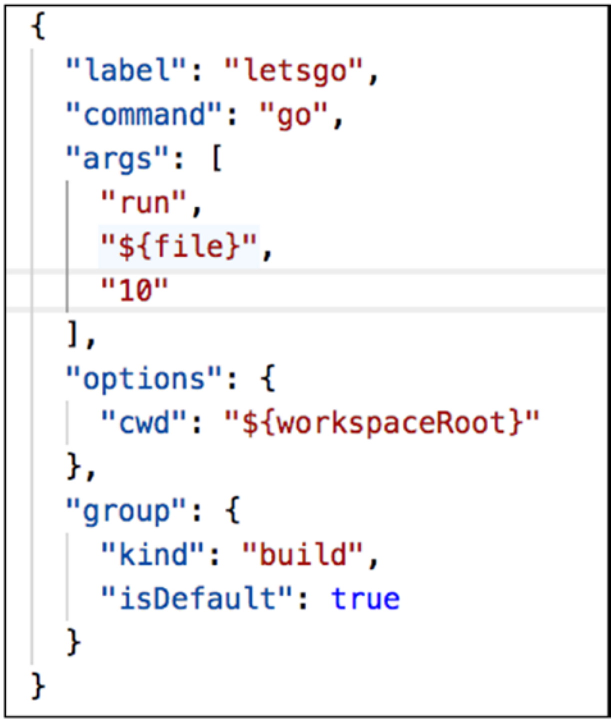
Looking a bit more closely at the `main` function, you'll see that the conversion done with `Atoi` also returns two parameters and that you can also ignore the case in which there is an error, with the symbol _. If you try to type in a variable name but do not use it, the Go compiler will complain, as shown in Figure 9-7.



```
    return Fibonacci(n-1) + Fibonacci(n-
}
                a declared and not used

func ma         import (strconv "strconv")
    i, a := strconv.Atoi(os.Args[1])
    fmt.Println(Fibonacci(i))
}
```

Figure 9-7. *In Go, you cannot declare a variable and not use it*

In Visual Studio Code, if you want to build and avoid hard-coding the parameters in the code itself, you can update the `tasks.json` a little, as shown in Figure 9-8.



```
{
  "label": "letsgo",
  "command": "go",
  "args": [
    "run",
    "${file}",
    "10"
  ],
  "options": {
    "cwd": "${workspaceRoot}"
  },
  "group": {
    "kind": "build",
    "isDefault": true
  }
}
```

Figure 9-8. *Add 10 as a parameter to the program, to execute from within the Visual Studio Code*

You can, of course, use `go build` to compile and run from the command line as well.

```
$ go build
$ ls
fib.go go2
$ ./go2 10
55
$ ./go2 100
... wait for ever
```

Recursive Fibonacci does not seem to be so performant. But I'll let you implement a faster version on your own and move on to the Telegram bot.

First Bot in Go

The Go language has one of the best libraries to interact with the Telegram Bot API. Its name is `telebot`, and you can find it on GitHub at `https://github.com/tucnak/telebot#overview`.

You don't really have to download it, because the Go command line can do that for you with the `get` subcommand. To install `telebot` on your local machine, use the following command:

```
go get -u gopkg.in/tucnak/telebot.v2
```

`-u` tells the `go get` command to connect to the network and look for updates if needed.

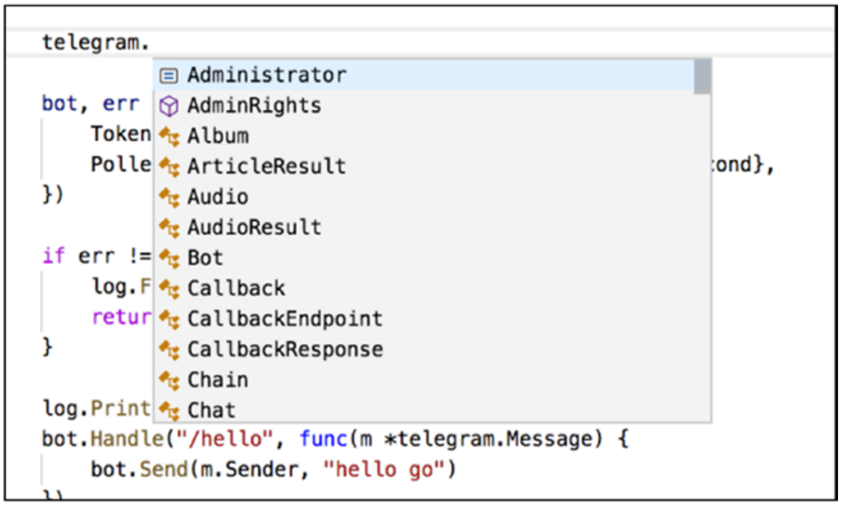
The code to follow is building on the two first examples of this chapter. In this first bot, we'll

- Require the `telebot` library
- Read the token from a file
- Use this token to initialize a polling bot
- Add a basic handler for the bot command

Note how you can give a prefix to the packages imported. The command below shows both the package name to be imported and the prefix used for all the functions, here, `telegram`.

```
telegram "gopkg.in/tucnak/telebot.v2"
```

You'll also note that the auto-completion from Visual Studio Code gives you a clean and convenient visual access to the functions exposed by the `telebot` library, as shown in Figure 9-9.



```
telegram.

bot, err   Administrator
    Token  AdminRights
    Polle  Album
})         ArticleResult                                  :ond},
           Audio
           AudioResult
if err !=  Bot
    log.F  Callback
    retur  CallbackEndpoint
}          CallbackResponse
           Chain
log.Print  Chat
bot.Handle("/hello", func(m *telegram.Message) {
    bot.Send(m.Sender, "hello go")
```

Figure 9-9. *Familiar APIs and constructs*

In the upcoming code listing, there are mainly two new constructs that you have not really seen before. First is the fact that you can assign a reference to a custom data type, or struct, instead of referencing the struct itself, using the & sign (ampersand).

```
Poller: &telegram.LongPoller{Timeout: 10 * time.Second}
```

You use a pointer instead of a struct literal in mostly two situations:

- When the struct is big and you pass it around
- When the struct is meant to be shared, that is, all modifications affect the struct, instead of affecting the copy

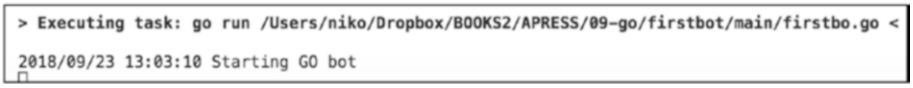
The second new piece of code relates to the definition of a callback using an anonymous function. In this case, you get a pointer to a Telegram message object, instead of passing a copy of the message.

```
    bot.Handle("/hello", func(m *telegram.Message) {
                // implement logic here
    })
```

Now that the hard parts are over, there it is: our first bot in Go. It will answer “hello go” whenever a `/hello` command is sent to the chat.

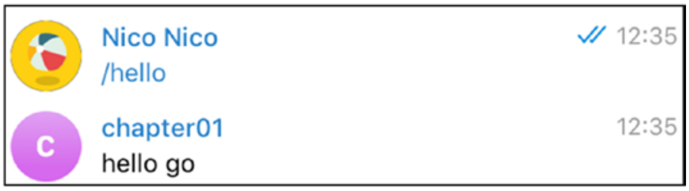
```
package main

import (
    "io/ioutil"
    "log"
    "time"

    telegram "gopkg.in/tucnak/telebot.v2"
)

func main() {
    token, _ := ioutil.ReadFile("token")

    bot, err := telegram.NewBot(telegram.Settings{
        Token:  string(token),
        Poller: &telegram.LongPoller{Timeout: 10 * time.Second},
    })

    if err != nil {
        log.Fatal(err)
        return
    }

    log.Println("Starting GO bot")
    bot.Handle("/hello", func(m *telegram.Message) {
        bot.Send(m.Sender, "hello go")
    })

    bot.Start()
}
```

If you execute from Visual Studio Code (Command+Shift+B) or from the command line (after `gobuild`), you will get a message that the bot is starting, as shown in Figure 9-10, and the bot answers properly, as shown in Figure 9-11.



```
> Executing task: go run /Users/niko/Dropbox/BOOKS2/APRESS/09-go/firstbot/main/firstbo.go <

2018/09/23 13:03:10 Starting GO bot
```

Figure 9-10. *Starting the Go bot*



Nico Nico 12:35
/hello
chapter01 12:35
hello go

Figure 9-11. *hello go*

The rest of the `telebot` documentation is well-organized, and you can refer to it for more details. For convenience, the main handlers that can be used to capture different types of messages are shown following:

```
b.Handle(tb.OnText, func(m *tb.Message) {
       // all the text messages that weren't
       // captured by existing handlers
})

b.Handle(tb.OnPhoto, func(m *tb.Message) {
       // photos only
})

b.Handle(tb.OnChannelPost, func (m *tb.Message) {
       // channel posts only
})
```

```
b.Handle(tb.Query, func (q *tb.Query) {
       // incoming inline queries
})
```

Just Sending Pictures

The second example will not create a polling bot but actually send a picture to a given user, using parameters passed from the command line. As you remember, in downloading files from the Telegram API, there is a bit of magic between `filepath` and `fileid`, etc. `telebot` has a very clean implementation to handle these files and media files properly, without doing the job twice.

Within the `telebot` documentation, examples show how to read from disk, or read document from a URL, filling in photo or video Go structs, as required.

```
p := &tb.Photo{File: tb.FromDisk("chicken.jpg")}
v := &tb.Video{File: tb.FromURL("http://video.mp4")}
```

Once the media object is created, you can send it through the `SendAlbum` function. Following is an example of sending a group a photo and a video via the chat.

```
msgs, err := b.SendAlbum(user, tb.Album{p, v})
```

We'll make use of these functions to create an object and send it to the chat.

When calling our program, we'll require two parameters.The id of the user will be the first parameter for which we'll use the already seen `os.Args` and convert the id to an integer, per the `User` struct.

```
idd, _ := strconv.Atoi(os.Args[1])
```

We then create a user using the `User` struct and only fill the `ID` field of the user.

```
user := telegram.User{ID: idd}
```

Then, to load the photo, we'll use the `telegram.Photo` struct, with the second parameter of the program, again retrieved via `os`.

```
p := &telegram.Photo{File: telegram.FromDisk(os.Args[2])}
```

Finally, as was shown in the documentation, the `SendAlbum` function makes use of both the user and the photo prepared structs to send the media object to the Telegram bot.

Here is the full listing for the picture-sending program.

```
package main

import (
    "io/ioutil"
    "os"
    "strconv"
    telegram "gopkg.in/tucnak/telebot.v2"
)

func main() {
    token, _ := ioutil.ReadFile("token")
    bot, _ := telegram.NewBot(telegram.Settings{Token:
    string(token)})
    idd, _ := strconv.Atoi(os.Args[1])
    user := telegram.User{ID: idd}
p := &telegram.Photo{File: telegram.FromDisk(os.Args[2])}
    bot.SendAlbum(&user, telegram.Album{p})

}
```

After pre-compiling the code within Visual Studio Code, you can build the program using the go binary on the command line.

```
go build
```

Finally, execute the newly created binary to send arbitrary photos to the chat rooms.

```
./thirdbot <user_id><picture_filename>
```

And see in Figure 9-12 how the picture appears, without the user having sent a message previously.

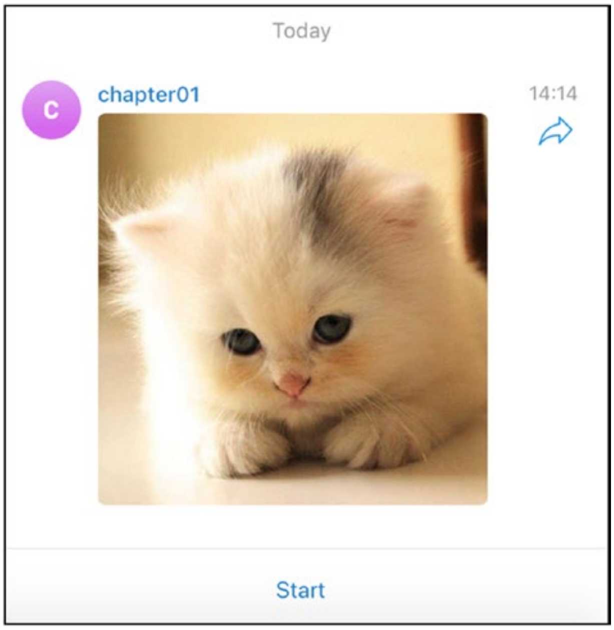


Figure 9-12. *Picture sent from the bot*

CHAPTER 10

Week 10: Elixir

Clarity in my cup. Transparency of my soul. Lucidity of myself. Elixir of the ages. Tea makes us all sages.

—Dharlene Marie Fahl

Elixir (`https://elixir-lang.org/`) is a programming language that has a syntax very similar to Ruby but runs on the highly distributed Erlang VM.

The Erlang VM was developed by Ericsson and has been around for ages, since 1986 to be exact, and over time has proven its resilience across heterogeneous and highly concurrent environments. Usually, Erlang is used for programs that require the following:

- Distribution
- Fault-tolerance
- (Soft) real-time capabilities
- Highly available nonstop applications
- Hot swapping

Two main features fall under Erlang:

- The Erlang runtime, or the virtual machine (VM)
- The Erlang programming language

Because I do not want this chapter to be only a series of bullet points, I'm going to focus on the Erlang runtime—the virtual machine, not the language. To code on the Erlang VM, we will use prefaced Elixir, a language that has a lower learning curve but exposes strong functional programming concepts as well (see Figure 10-1 for a nice logo).

Figure 10-1. *Elixir logo*

Just as with Clojure, Elixir comes with an environment that is well prepared to being edited as a read-eval-print-loop (REPL) or line by line, so you will encounter a bit of both in this chapter. And, as written in the forum,

> *There's no time like the present to jump into Elixir—the functional language that's taking the programming world by storm.*

Let's move on to installing Elixir.

Installation

The Elixir installation page can be found at `https://elixir-lang.org/install.html`. The link describes every possible way of installing the tools for Elixir, from macOS, Linux, and Windows all the way to Raspberry Pi and Docker.

```
#macOS with homebrew
brew install elixir
```

```
# manjaro with pacman
pacman -S elixir

# chocolatey
cinst elixir

...
```

Once you are set up, you should have two main commands ready for you: `iex` and `mix`.

```
$ mix --version
Erlang/OTP 21 [erts-10.0.7] [source] [64-bit] [smp:4:4]
[ds:4:4:10] [async-threads:1] [hipe] [dtrace]

Mix 1.7.3 (compiled with Erlang/OTP 21)

$ iex --version
Erlang/OTP 21 [erts-10.0.7] [source] [64-bit] [smp:4:4]
[ds:4:4:10] [async-threads:1] [hipe] [dtrace]

IEx 1.7.3 (compiled with Erlang/OTP 21)
```

`iex` is the interpreter, or REPL, for Elixir, with which you can test and write your code directly at a prompt. `mix` is the Elixir project management and build tool.

Using iex

Most of `iex` usage is for executing commands, one by one. Here are a few examples of Elixir generating output text on the standard output, using the `IO` module and reading data from file using the `File` module.

```
iex(1)> IO.puts "hello"
hello
:ok
```

```
iex(2)> File.read! "secret.key"
** (File.Error) could not read file "secret.key": no such file
or directory
    (elixir) lib/file.ex:319: File.read!/1
```

```
iex(2)> File.read! "mybot/secret.key"
"585672177:.."
```

Once you have finished your `iex` session, you can end it with Ctrl+C, followed by abort, to terminate the VM.

```
iex(7)>
BREAK: (a)bort (c)ontinue (p)roc info (i)nfo (l)oaded
       (v)ersion (k)ill (D)b-tables (d)istribution
```

Using mix

`mix` is the Elixir project management tool. You can create a new project with it using the new subcommand.

For example, for the following Telegram project, you can generate your new project with:

```
$ mix new telegrambot
```

```
* creating README.md
* creating .formatter.exs
* creating .gitignore
* creating mix.exs
* creating config
* creating config/config.exs
* creating lib
* creating lib/telegrambot.ex
* creating test
* creating test/test_helper.exs
* creating test/telegrambot_test.exs
```

```
Your Mix project was created successfully.
You can use "mix" to compile it, test it, and more:

    cd telegrambot
    mix test
```

While you're at it, you may have heard that Elixir has a very good web framework named Phoenix.

https://phoenixframework.org/

You can generate a ready-to-code project template for Phoenix, using the `phoenix.new` subcommand for `mix`.

For example:

```
mix phoenix.new hellophoenix
```

This will generate the project structure for a Phoenix application. This is beyond the scope of this chapter, but you should definitely have a look if you are curious to see a modern web framework.

Running iex with mix

Why would you want to run `iex` with `mix`? Because you can have all the project management done by `mix` within the REPL, presented by `iex`, which means that all your dependencies, configuration, and project code will be recognized, loaded, and available. The way to do that is by running the following command on the command line:

```
iex -S mix
```

The `-S` flag here tells `iex` to load `mix`, and `mix` will load itself and the project defined by the files of the generated `mix`-based project.

So, in the `telegrambot` folder that was created a few minutes ago…

```
$ iex -S mix
Erlang/OTP 21 [erts-10.0.7] [source] [64-bit] [smp:4:4]
[ds:4:4:10] [async-threads:1] [hipe] [dtrace]

Interactive Elixir (1.7.3) - press Ctrl+C to exit (type h()
ENTER for help)
```

And then you can try to execute code from the files in your project.

```
iex(1)> Telegrambot.hello
:world
```

But, by the way, what are all those project files made of?

Project Structure of a mix Project

`mix` generated a bunch of files for you, and the directory structure of the `telegrambot` folder is shown following.

```
.
├── README.md
├── config
│   └── config.exs
├── lib
│   └── telegrambot.ex
├── mix.exs
└── test
    ├── telegrambot_test.exs
    └── test_helper.exs
```

For our purposes, I will focus on describing the following Elixir files:

- `config.exs`: Your project config, defining keys, and values
- `telegrambot.ex`: Your own custom code and the entry point
- `mix.exs`: The `mix` project configuration

Note how `telegram.ex` is the only file to have the `.ex` extension, to recognize it as an entry point of the program.

config.exs

This is one of the places in which you can place the bot token.

```
use Mix.Config

# You can configure your application as:
#
#     config :telegrambot, key: :value
s#
# and access this configuration in your application as:
#
#     Application.get_env(:telegrambot, :key)
```

So, in the coming recipes, you can define your token like this:

```
config :telegrambot, token: "secret_token"
```

And in an iex session (start with `iex -S mix`), you can retrieve the token directly with

```
iex(1)> Application.get_env(:telegrambot, :token)
"secret_token"
```

There's not much else to see in the config file, so on to the project metadata.

mix.exs

A shorter version of the file is shown here for convenience.

```
defmodule Telegrambot.MixProject do
  use Mix.Project

  def project do
    [
      app: :telegrambot,
      version: "0.1.0",
      elixir: "~> 1.7",
      start_permanent: Mix.env() == :prod,
      deps: deps()
    ]
  end
  ...

  # Run "mix help deps" to learn about dependencies.
  defp deps do
    [
      # {:dep_from_hexpm, "~> 0.3.0"},
      # {:dep_from_git, git: "https://github.com/elixir-lang/
      my_dep.git", tag: "0.1.0"},
    ]
  end
end
```

Each `def` in this `mix.exs` file is an Elixir function. The `project` function returns a map of metadata, including app, project version, and the required minimal Elixir version.

`defp` is used to define a private Elixir function, and `dep()` is called only from the `project` function, so as to separate dependencies in a section on its own. We will see dependencies in a few lines.

:app is the name of the file to load from the lib folder. Although not used in this chapter, you could switch entry points, depending on environment variables.

You'll notice here again the way that the Elixir project uses Elixir as the configuration language. It's always nice to have consistency all around.

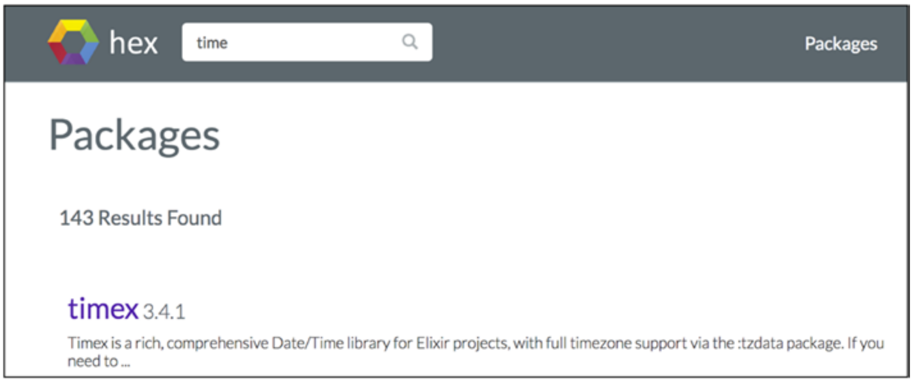
Dependencies

As you have seen just now, dependencies are defined and listed in the deps block of the mix.exs file. You will usually find your dependencies on hexdocs.

https://hexdocs.pm/timex/getting-started.html

Say, for example, that you want to add the timex library to your project, this is the way to import and use it in your project.

Why timex? Because if you search for a time library on hexdocs.pm, you'll find that timex is the first one to pop up. It also has the most downloads, as shown in Figure 10-2.



Packages

143 Results Found

timex 3.4.1

Timex is a rich, comprehensive Date/Time library for Elixir projects, with full timezone support via the :tzdata package. If you need to ...

Figure 10-2. *Never-ending search for time*

Navigating to the `timex` page, you can see the way to add this to your `mix.exs` file on the right-hand side (Figure 10-3).

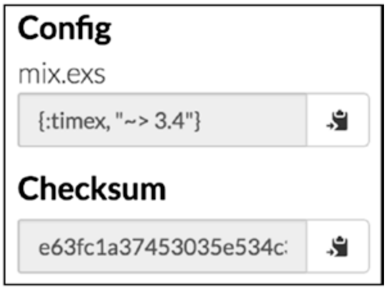


Figure 10-3. *`timex` coordinates*

You can now copy the config for `mix` into `mix.exs`, where the `dep` section of the `mix.exs` file should now look like the following:

```
defp deps do
  [
    {:timex, "~> 3.0"}
  ]
end
```

Once you have done this, you can ask `mix` to retrieve, download, and prepare the third-party libraries for you, using `mixdeps.get`.

Oh, by the way, here's quick reminder of the `mix` list of commands involved in dependencies.

```
$ mix help | grep deps
mix deps                # Lists dependencies and their status
mix deps.clean          # Deletes the given dependencies' files
mix deps.compile        # Compiles dependencies
mix deps.get            # Gets all out of date dependencies
mix deps.tree           # Prints the dependency tree
mix deps.unlock         # Unlocks the given dependencies
mix deps.update        # Updates the given dependencies
mix hex.audit          # Shows retired Hex deps for the current
                       project
mix hex.outdated       # Shows outdated Hex deps for the current
                       project
```

And so, once you have run `deps.get`, you can get to know whether the dependency is properly recognized by your project. See `timex` in the dependency tree following.

```
$ mix deps.tree
telegrambot
└── timex ~> 3.0 (Hex package)
    ├── combine ~> 0.10 (Hex package)
    ├── gettext ~> 0.10 (Hex package)
    └── tzdata ~> 0.1.8 or ~> 0.5 (Hex package)
        └── hackney ~> 1.0 (Hex package)
            ├── certifi 2.4.2 (Hex package)
            │   └── parse_trans ~>3.3 (Hex package)
            ├── idna 6.0.0 (Hex package)
            │   └── unicode_util_compat 0.4.1 (Hex package)
            ├── metrics 1.0.1 (Hex package)
            ├── mimerl 1.0.2 (Hex package)
            └── ssl_verify_fun 1.1.4 (Hex package)
```

You haven't been writing code for so long, you must be getting a bit excited by now. Let's start an elixir REPL

```
iex -S mix
```

and see if `timex` is properly loaded. `now` is the `timex` function to retrieve the current time in the current time zone, but before using a separate module, you must `use` it, as shown following:

```
$ iex -S mix
iex(1)> use Timex
Timex.Timezone

iex(2)> Timex.now
#DateTime<2018-09-24 02:31:42.450412Z>
```

Now, let's have a look at where the coding goes.

telegrambox.ex

Finally, in the list of files for the project, you have `telegrambot.ex`, in which you put all your custom code. As in Ruby, and as in the `mix.exs` file, a lot is done with the `def` module and `def`. Each `def` block defines a function. The default file generated by `mixnew` is shown as follows, where `Telegrambot` has one function.

```
defmodule Telegrambot do

  def hello do
    :world
  end

end
```

In an `iex` session, you would call that function as follows:

```
iex(1)> Telegrambot.hello
:world
```

Adding to what we have learned looking at the Timex dependency, we can use Timex and a new def block to give the time.

```
defmodule Telegrambot do
  use Timex

  def hello do
    :world
  end

  def timexnow do
    IO.puts Timex.now
  end

end
```

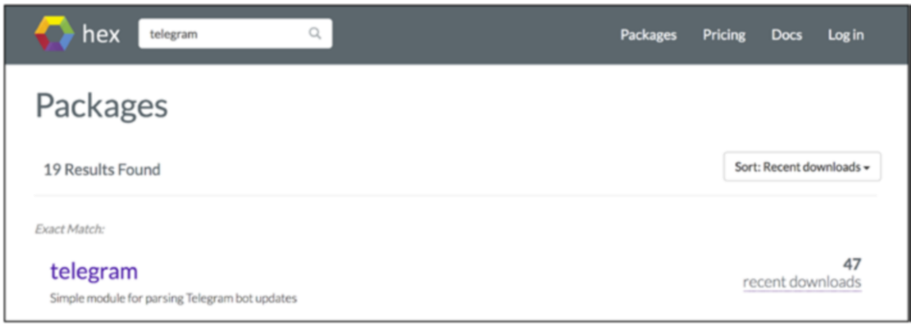
And at a new iex session,

```
iex(2)> Telegrambot.timexnow
2018-09-24 02:38:15.954175Z
:ok
```

(Back to) Dependencies

Yes, we're back! You quickly saw how to add dependencies to your project, but Elixir/mix has this wonderful way of adding dependencies directly from Git projects as well (and other source control repositories, by the way).

Searching for a library on hex.pm is easy enough (Figure 10-4).



Packages

19 Results Found

Exact Match:

telegram

Simple module for parsing Telegram bot updates

47
recent downloads

Figure 10-4. *Finding a library with Hex*

And, yes, the library we want to use for the Telegram bot is the one that was found, so go to

https://github.com/visciang/telegram

As recommended on the library web site, you can add the library directly to the `mix.exs` file, using the Git repository address and a tag, as follows:

```
{:telegram, git: "https://github.com/visciang/telegram.git",
tag: "0.5.0"}
```

By now, your deps block should look like this:

```
defp deps do
    [
      {:timex, "~> 3.0"},
      {:telegram, git: "https://github.com/visciang/telegram.
      git", tag: "0.5.0"}
    ]
  end
```

Retrieving the dep is again done with `mixdeps.get`, which will transparently check out the Telegram project locally for you. The following `mixdeps.tree` command confirms that the library is present, and you can also see the Git repository of Telegram showing up in the output of the command.

```
$ mix deps.tree
telegrambot
├── timex ~> 3.0 (Hex package)
│   ├── combine ~> 0.10 (Hex package)
│   ├── gettext ~> 0.10 (Hex package)
│   └── tzdata ~> 0.1.8 or ~> 0.5 (Hex package)
│       └── hackney ~> 1.0 (Hex package)
│           ├── certifi 2.4.2 (Hex package)
│           │   └── parse_trans ~>3.3 (Hex package)
│           ├── idna 6.0.0 (Hex package)
│           │   └── unicode_util_compat 0.4.1 (Hex package)
│           ├── metrics 1.0.1 (Hex package)
│           ├── mimerl 1.0.2 (Hex package)
│           └── ssl_verify_fun 1.1.4 (Hex package)
└── telegram (https://github.com/visciang/telegram.git)
    ├── tesla ~> 1.0 (Hex package)
    │   ├── hackney ~> 1.6 (Hex package)
    │   ├── jason >= 1.0.0 (Hex package)
    │   └── mime ~> 1.0 (Hex package)
    ├── hackney ~> 1.9 (Hex package)
    └── jason ~> 1.0 (Hex package)
```

Telegram also seems to sometimes require that the dependencies be recompiled beforehand, and this is done with `mix deps.compile` (and, if required, do`mix deps.clean`, also beforehand).

```
$ mix deps.compile
===> Compiling parse_trans
===> Compiling mimerl
===> Compiling metrics
===> Compiling unicode_util_compat
===> Compiling idna
===> Compiling ssl_verify_fun
===> Compiling certifi
===> Compiling hackney
```

Now, finally, on to some more fun with `mix` and Telegram.

Get Something

In this section, we'll have a look at sending a few requests to the Telegram API directly. For authentication, all those calls will be using the bot token.

GetMe

Let's try to simply send a request to the Telegram API with our local bot. You'll remember the following `GetMe` method:

`https://core.telegram.org/bots/api#getme`.

We will send the request from an `iex/mix` session.

```
$ iex -S mix
```

First, we load the token from the configuration file, so make sure you have your token inserted properly in `config/confix.exs` at this stage.

```
iex(1)> token = Application.get_env(:telegrambot, :token)
"585672177:.."
```

Then we can call the Telegram API, with the token, and the getMe request.

```
iex(2)> Telegram.Api.request(token, "getMe")
{:ok,
 %{
   "first_name" => "chapter01",
   "id" => 585672177,
   "is_bot" => true,
   "username" => "chapter01bot"
 }}
```

Request has gone through, and we can use the usual Telegram User object, with the bot name and the bot id.

GetChat

The getChat Telegram function documentation is located at https://core.telegram.org/bots/api#getchat. Unlike the function getMe, which can be called without a parameter, getChat requires a chat_id. Parameters to be sent along the request with the Telegram library are just appended to the request call.

Let's see that in action in the same iex session.

```
iex(8)> Telegram.Api.request(token, "getChat", chat_id: 121843071)
{:ok,
 %{
   "first_name" => "Nico",
   "id" =>1218430..,
   "last_name" => "Nico",
   "photo" => %{
     "big_file_id" =>
"AQADBQADQakxG38tQwcACAox1TIABLM4sAnsmf3pPM4AAgI",
     "small_file_id" =>
"AQADBQADQakxG38tQwcACAox1TIABCSohuBN4Zh1Os4AAgI"
   },
   "type" => "private",
   "username" => "hellonico"
 }}
```

As usual, the response status and the structure are printed in the output of the session.

GetFile

You may have noticed a file id in the user profile while calling `getChat` in the preceding snippet. Let's try to retrieve that file, with `getfile`.

The `getfile` function details are located in the bot API at

https://core.telegram.org/bots/api#getfile

And so, in the same `iex` session again, we use the following:

```
Telegram.Api.request(token, "getFile", file_id:
"AQADBQADQakxG38tQwcACAox1TIABLM4sAnsmf3pPM4AAgI")
```

```
{:ok,
 %{
   "file_id" =>
"AQADBQADQakxG38tQwcACAox1TIABLM4sAnsmf3pPM4AAgI",
   "file_path" => "profile_photos/file_10.jpg",
   "file_size" => 35814
 }}
```

Ah, right…the Telegram API always returns a file path for download from its web site.

Using Elixir’s System

To download the preceding file path, remember the trick used before, avoiding the need for an additional third-party library. We’ll just use `curl`, that should already be installed on the local machine, at this stage.

In Elixir, calling a system command is done with `System.cmd`. The HTTP URL to download a file from a `file_path` is made using the following rule:

`https://api.telegram.org/file/bot<token>/<file_path>`

with the `file_path` of the form: `profile_photos/file_10.jpg`. That gives the full listing.

```
{:ok, res} = Telegram.Api.request(token, "getChat", chat_id:
121843071)
fileId = res["photo"]["big_file_id"]
{:ok, res2} = Telegram.Api.request(token, "getFile", file_id:
"#{fileId}")
System.cmd("curl",
["-O", "https://api.telegram.org/file/bot#{token}/#{res2["file_
path"]}"])
```

And the author’s profile picture is shown (Figure 10-5).

Figure 10-5. *Beach ball, not the OS X one*

SendPhoto

Sometimes it's not what you can get but what you can give that matters. Following the same pattern, you can send a picture, using `sendPhoto` with the exact same construct.

```
token = Application.get_env(:telegrambot, :token)
chat_id = 121843071
photo = "cat.jpg"
Telegram.Api.request(token, "sendPhoto", chat_id: chat_id,
photo: {:file, photo})
```

And provided you have copied the `cat.jpg` in your project folder, the usual cat photo is showing in the Telegram chat (Figure 10-6).

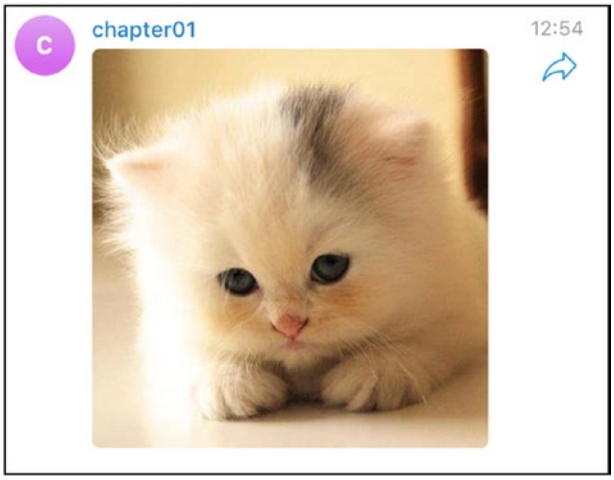
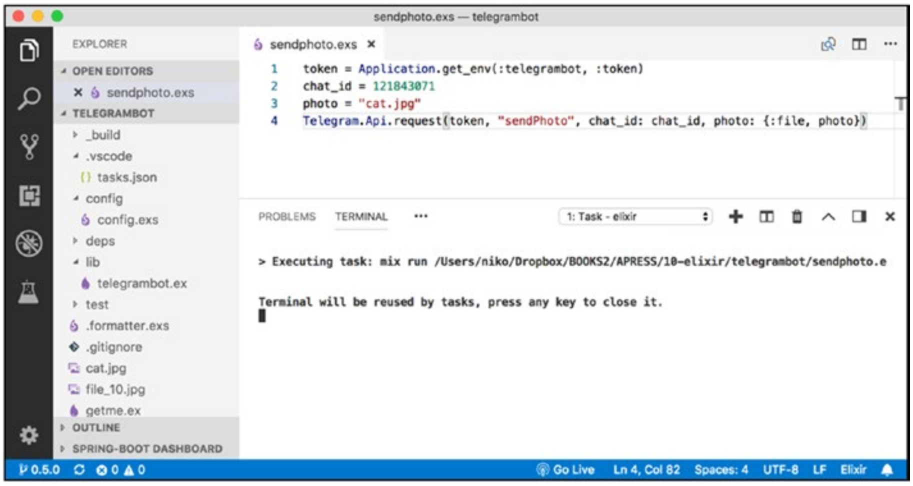


Figure 10-6. *This is not Marcel, but it is a cat*

You've probably realized that all this can run directly from Visual Studio Code, using the task defined for running .exs file at the beginning of this chapter. Try it out (Figure 10-7).



```
token = Application.get_env(:telegrambot, :token)
chat_id = 121843071
photo = "cat.jpg"
Telegram.Api.request(token, "sendPhoto", chat_id: chat_id, photo: {:file, photo})
```

```
> Executing task: mix run /Users/niko/Dropbox/BOOKS2/APRESS/10-elixir/telegrambot/sendphoto.e

Terminal will be reused by tasks, press any key to close it.
```

Figure 10-7. *Straight from your editor…*

Telegram Bot

I've exceeded the optimum number of pages for this chapter, so I'll just offer a quick look at how to create and run a bot and how to implement a few commands for this new bot.

Bot1: Anything Goes

This first bot will send the full data structure of the received update to the chat. See how the token is passed to the `Telegram.Bot` library, after calling `use`?

```
defmodule Bot1 do

  use Telegram.Bot,
    token: Application.get_env(:telegrambot, :token),
    username: "chapter01bot",
    purge: true
  message do
    request(
      "sendMessage",
      chat_id: update["chat"]["id"],
      text: "Hey! You sent me a message: #{inspect(update)}"
    )
  end

end

{:ok, _} = Bot1.start_link()
Process.sleep(:infinity)
```

The last two lines start the bot in a separate thread and tell the main thread to sleep forever. See, too, how the request to `sendMessage` is a repeat of what was done in the previous section.

Bot2: Fibonacci

Our second bot will implement a command that can compute Fibonacci for you and send the result back to the chat. Commands with the Telegram library are simply defined using `command`. The command name is the first parameter of `command`, followed by possible arguments.

The `command` block itself has access to the update object coming from Telegram. Even though you don't see it so much, Elixir has this functional program gene under the hood, and most of the calls are done using `apply`.

This shows particularly where you have to use `Enum.at` to get the index of a specific element of a list, here, the first one, so 0.

```
    command "fib", args do
        {intVal, ""} = Integer.parse(Enum.at(args,0))

         request("sendMessage", chat_id: update["chat"]["id"],
         text: "Fib[#{intVal}] = #{Fib.fib(intVal)}")
    end
```

Here, Fib is defined in a separate Fib module, as shown in the full listing, to which a simple recursive Fibonacci implementation has been added.

```
defmodule Fib do
    def fib(0) do 0 end
    def fib(1) do 1 end
    def fib(n) do fib(n-1) + fib(n-2) end
end

defmodule Bot2 do

  use Telegram.Bot,
    token: Application.get_env(:telegrambot, :token),
    username: "chapter01bot",
    purge: true

    command "fib", args do
        {intVal, ""} = Integer.parse(Enum.at(args,0))
         request("sendMessage", chat_id: update["chat"]["id"],
         text: "Fib[#{intVal}] = #{Fib.fib(intVal)}")
    end

    any do
       IO.puts "not found"
    end
end

{:ok, _} = Bot2.start_link()
Process.sleep(:infinity)
```

Also, avoid the use of any function at the bottom of this second bot, for a catch-them-all message.

At last, you can define all other supported messages of the Telegram API in your new bots, and the list of possible blocks that can go in your bot are relisted here for convenience, straight from the Telegram library.

```
  edited_message do
    # handler code
  end

  channel_post do
    # handler code
  end

  edited_channel_post do
    # handler code
  end

  inline_query _query do
    # handler code
  end

  chosen_inline_result _query do
    # handler code
  end

  callback_query do
    # handler code
  end

  shipping_query do
    # handler code
  end

  pre_checkout_query do
    # handler code
  end
```

In addition, code in the `api.ex` file has a few more code construct samples related to keyboard and inline queries.

https://github.com/visciang/telegram/blob/master/lib/api.ex

CHAPTER 11

Week 11: Node.js

"The strength of JavaScript is that you can do anything. The weakness is that you will."

—Reg Braithwaite

For the sake of completion, this book is also presenting Node.js and Telegraf, the library to deal with Telegram from Node.js. With Telegraf, Node.js may have the privilege of being one of the easiest libraries with which to interact with Telegram.

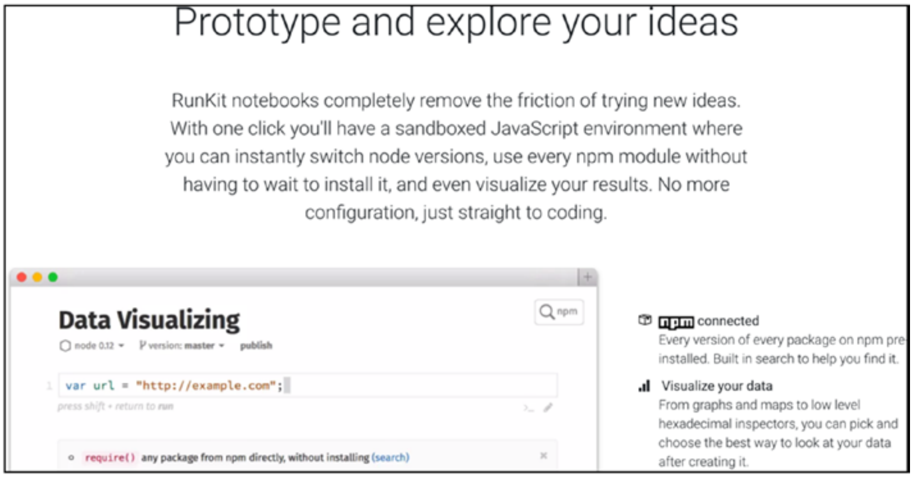
In this chapter, I will focus mostly on running Telegram Bot on `runkit.com`, a cloud service that allows you to have an instance of Node.js running in the cloud, without installing anything locally, thus reducing the time required to write and deploy Telegram bots to a matter of minutes.

Running in the cloud also allows us to have the necessary setup webhook for Telegrams. Basically, webhooks are a replacement for the Telegram bot polling method you have seen so far with a URL that the Telegram API will call on a new message, thus avoiding unnecessary polling traffic. To present a minimal running server that can answer the `POST` request from Telegram, we will use the Koa library, a replacement for ExpressJS, to set up the integration with Telegraf.

Excited? Let's hit the Node.js road.

Meet RunKit

In this section, you will see how to create a RunKit account, run a first Node.js program, and then write and publish a simple Koa-based service. RunKit starts by being a Node.js playground in your browser. You can access the RunKit the home page at `https://runkit.com` (Figure 11-1).



Prototype and explore your ideas

RunKit notebooks completely remove the friction of trying new ideas. With one click you'll have a sandboxed JavaScript environment where you can instantly switch node versions, use every npm module without having to wait to install it, and even visualize your results. No more configuration, just straight to coding.

Data Visualizing

```
var url = "http://example.com";
```

press shift + return to run

require() any package from npm directly, without installing (search)

npm connected
Every version of every package on npm pre installed. Built in search to help you find it.

Visualize your data
From graphs and maps to low level hexadecimal inspectors, you can pick and choose the best way to look at your data after creating it.

Figure 11-1. *RunKit home page*

RunKit is used to write test code, fetch and display data, share code, and run server code directly in the cloud.

Creating an Account

To create an account, you can sign up on `runkit.com`, using your GitHub account, or a standard username password combination (Figure 11-2).

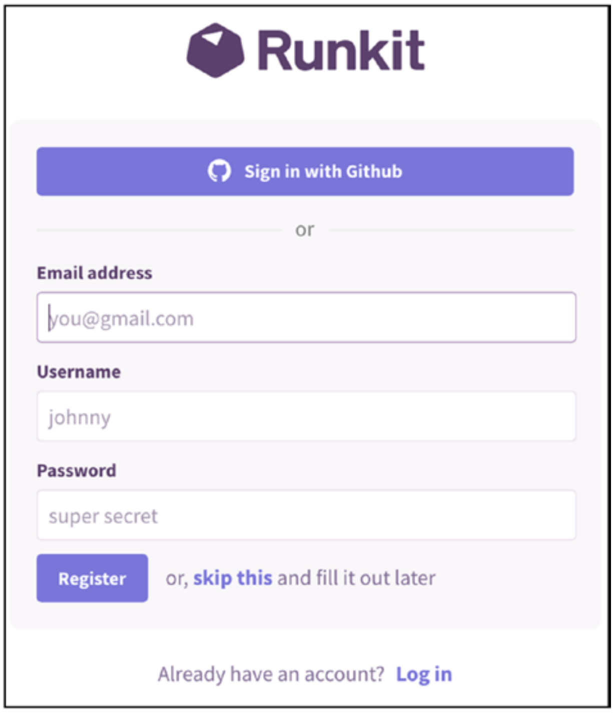
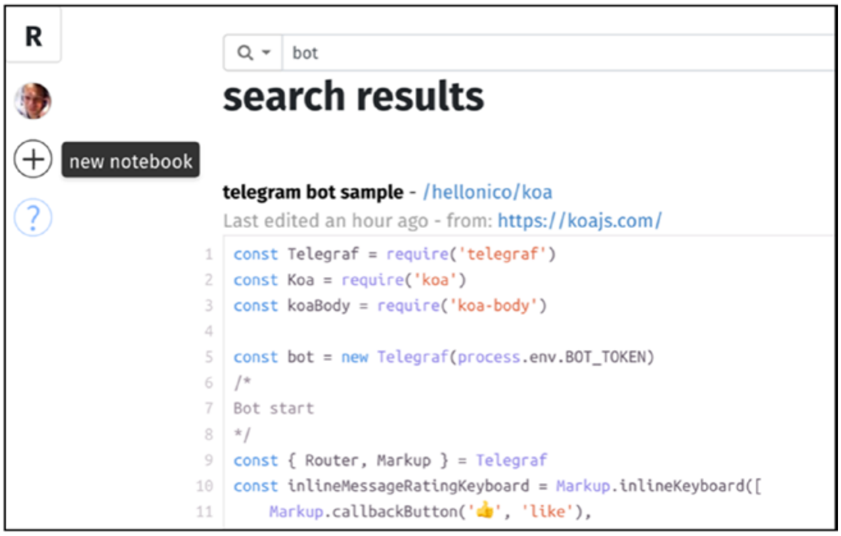


Figure 11-2. *Creating your RunKit account*

Once you are logged in, you can see a simple interface, with a menu on the left-hand side, mostly to create new playgrounds, and the list of playgrounds you have (will) created in the center of the page (Figure 11-3).



search results

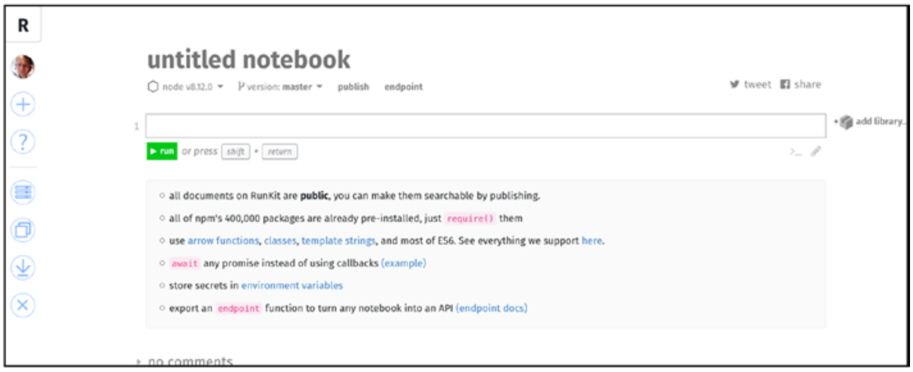
telegram bot sample - /hellonico/koa

Last edited an hour ago - from: https://koajs.com/

```
const Telegraf = require('telegraf')
const Koa = require('koa')
const koaBody = require('koa-body')

const bot = new Telegraf(process.env.BOT_TOKEN)
/*
Bot start
*/
const { Router, Markup } = Telegraf
const inlineMessageRatingKeyboard = Markup.inlineKeyboard([
    Markup.callbackButton('👍', 'like'),
```

Figure 11-3. *RunKit personal page*

If you press the + button on the left-hand side, you are directed to an empty playground page (Figure 11-4).

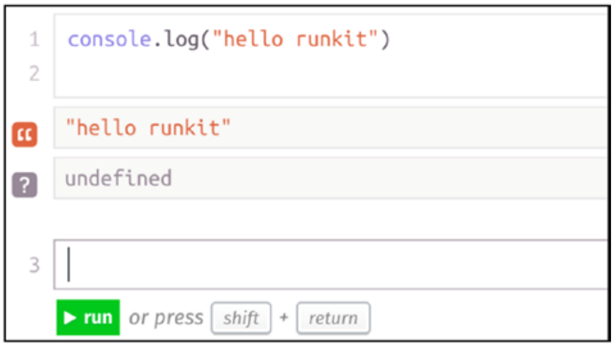


- all documents on RunKit are **public**, you can make them searchable by publishing.
- all of npm's 400,000 packages are already pre-installed, just `require()` them
- use arrow functions, classes, template strings, and most of ES6. See everything we support here.
- `await` any promise instead of using callbacks (example)
- store secrets in environment variables
- export an `endpoint` function to turn any notebook into an API (endpoint docs)

Figure 11-4. *RunKit empty playground page*

First Code on RunKit

From there, it won't be a surprise that you can just type in whatever JavaScript code you want to write. So, let's start by saying hello, as shown in Figure 11-5.



```
console.log("hello runkit")
```

```
"hello runkit"
undefined
```

Figure 11-5. *Say "hello" with RunKit*

Executing is done either by clicking the run button or, as indicated, with shift+return. Each resulting line of the execution is shown following. Say you want to compute quickly some Fibonacci numbers...You could either implement this yourself, with a possible implementation shown following.

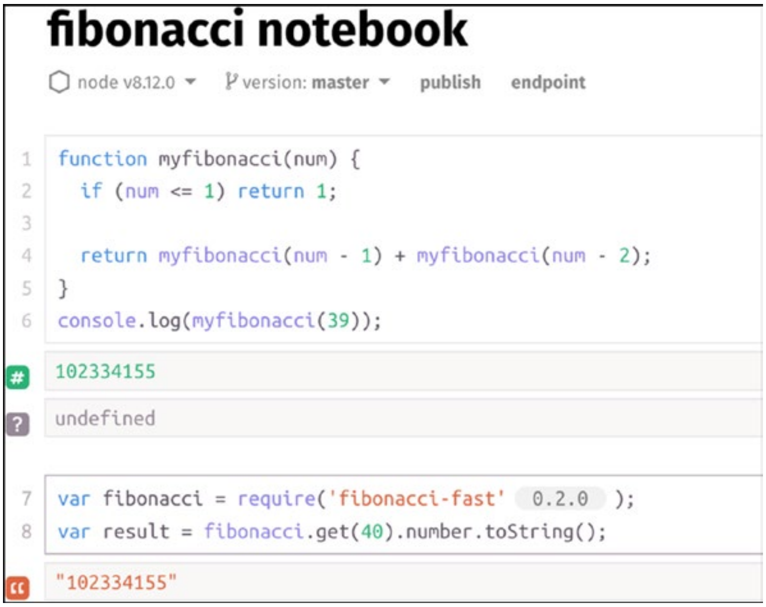
```
function myfibonacci(num) {
  if (num <= 1) return 1;

  return myfibonacci(num - 1) + myfibonacci(num - 2);
}
console.log(myfibonacci(39));
```

Or you could also require a Node.js library, available through RunKit (and which you can check at `https://npm.runkit.com/`).

So, for example, you could simply require a library, for example, `fibonacci-fast`, to compute those numbers directly from the playground.

```
var fibonacci = require('fibonacci-fast');
var result = fibonacci.get(39    ).number.toString();
console.log(result);
```

The playground will make that library available to your notebook, without you having to install or download anything. And with or without a library, it works all the same, as shown in Figure 11-6.



```
function myfibonacci(num) {
  if (num <= 1) return 1;

  return myfibonacci(num - 1) + myfibonacci(num - 2);
}
console.log(myfibonacci(39));
```

```
102334155
```

```
undefined
```

```
var fibonacci = require('fibonacci-fast' 0.2.0 );
var result = fibonacci.get(40).number.toString();
```

```
"102334155"
```

Figure 11-6. *Write it or require it*

Note how the version that was imported in the notebook is displayed right next to the `require` statement.

A Certain Je Ne Sais Koa

Koa is the next-generation web framework for Node.js. It is built with what was learned during the Express JS years and is a step easier to learn and maintain. Koa's home page can be found at `https://koajs.com/#application`.

With what you've seen of the RunKit playground, you may already feel that you can `require` Koa libraries and start a server.

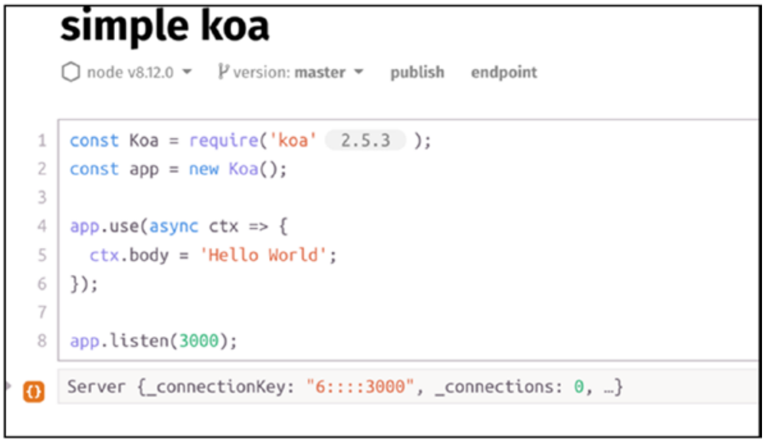
Following is a short snippet taken from the Koa samples:

```
const Koa = require('koa');
const app = new Koa();

app.use(async ctx => {
  ctx.body = 'Hello World';
});

app.listen(3000);
```

There are four main steps to creating a simple Koa application.

- Require koa
- Create a new Koa app
- Create an asynchronous handler
- Get the app to listen (on a port)

If you execute the code from the preceding snippet in a new notebook, you can instantiate a server directly from the browser (Figure 11-7).

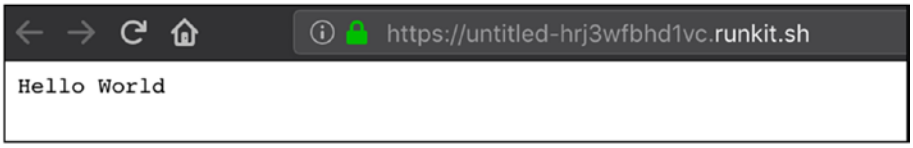

simple koa

```
const Koa = require('koa' 2.5.3 );
const app = new Koa();

app.use(async ctx => {
  ctx.body = 'Hello World';
});

app.listen(3000);
```

```
Server {_connectionKey: "6::::3000", _connections: 0, …}
```

Figure 11-7. *Running a server on RunKit*

And, yes, this server is already listening to requests. So, if you click the end point click available in the notebook, you will open a page, with a temporary URL assigned to your Koa application, with the expected Hello World message showing up here again (Figure 11-8).

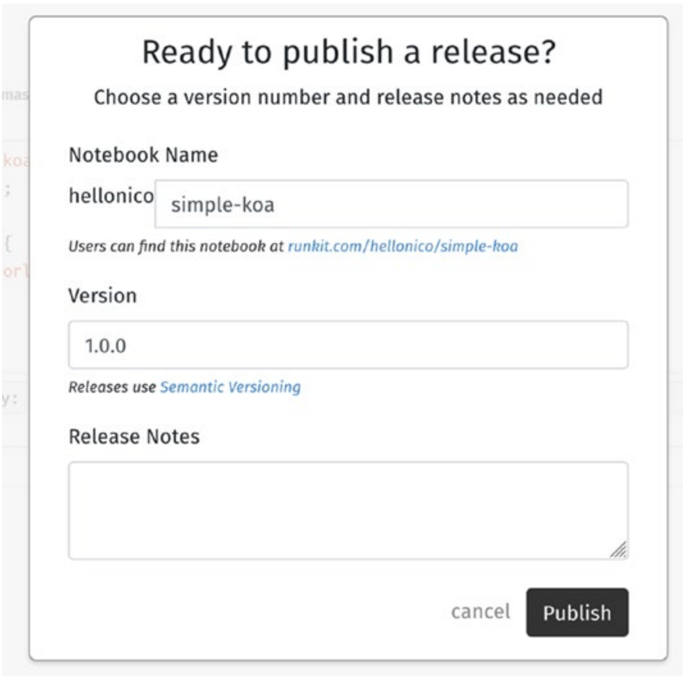


```
Hello World
```

Figure 11-8. *Koa running in the cloud*

Publishing Some Koa

Publishing to a temporary URL is fine, but to work with Telegram Bot, you must have a somewhat permanent and public URL to work with. This can be achieved in RunKit by using the Publish link. Clicking the link will show a pop-up dialog asking you for some semantic (!) version of your application (Figure 11-9).


Ready to publish a release?

Choose a version number and release notes as needed

Notebook Name

hellonico simple-koa

Users can find this notebook at runkit.com/hellonico/simple-koa

Version

1.0.0

Releases use Semantic Versioning

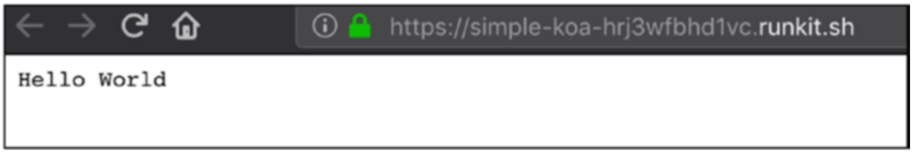
Release Notes

Figure 11-9. *Ready to publish, Koa?*

And now the Koa application is available at an easy-to-remember location, in the following form:

`https://runkit.io/hellonico/simple-koa/branches/master`

You can access it reliably from your browser. Note that you will actually get redirected to a URL mapped internally by RunKit (see Figure 11-10).


https://simple-koa-hrj3wfbhd1vc.runkit.sh

```
Hello World
```

Figure 11-10. *Published!*

Also, note that the URL is via the HTTPS protocol, which is quite important, because Telegram does not accept pure HTTP end points.

From here, you should practice some more with Koa and RunKit, and once you are ready, let's see how to write a first Telegram bot using RunKit, Koa, and that mysterious Telegram webhook.

Telegram Bot with Webhooks

So, first, webhooks...What are they? Webhooks work in the opposite direction as polling. Where polling is your client bot periodically asking the Telegram server if any new message has arrived, with webhooks, you ask the Telegram server to send you an update message whenever a new message that your bot should know about has been sent to a chat room.

The flow is summarized in Figure 11-11.

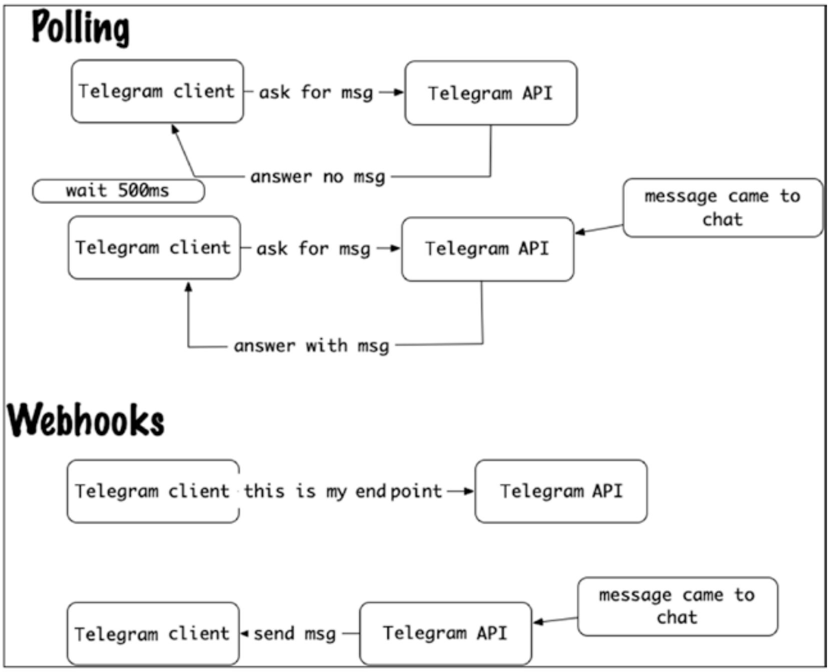


Figure 11-11. *Polling vs. webhooks*

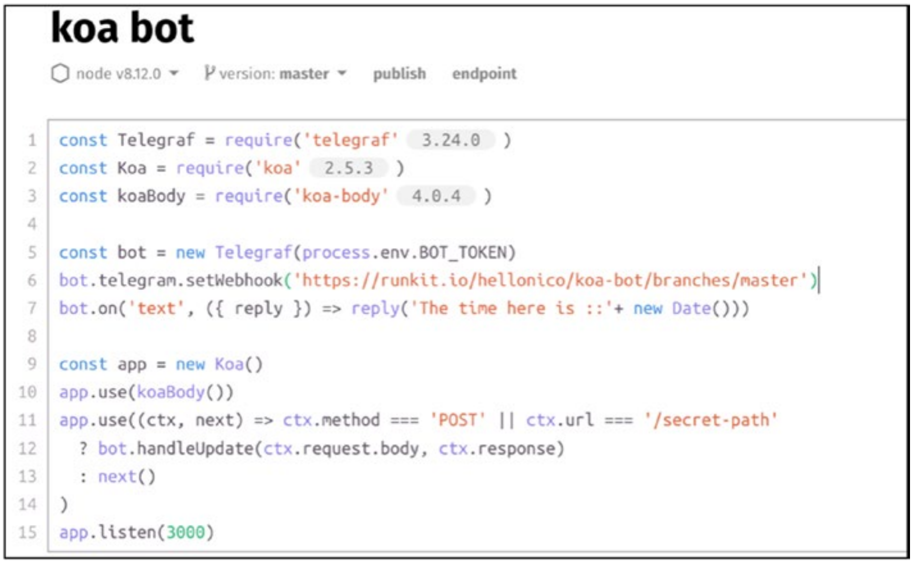
Knowing this, we just need to know if there is a Telegram Bot API method to tell about your application end point—and there is one here:

https://core.telegram.org/bots/api#setwebhook

In the following snippet, you can see how the `setWebhook` function is used to publicize the URL to the bot API.

```
const Telegraf = require('telegraf')
const Koa = require('koa')
const koaBody = require('koa-body')

const bot = new Telegraf(process.env.BOT_TOKEN)
bot.on('text', ({ reply }) => reply('The time here is ::'+ new
Date()))

bot.telegram.setWebhook('https://runkit.io/hellonico/koa-bot/
branches/master')

const app = new Koa()

app.use(koaBody())
app.use((ctx, next) => ctx.method === 'POST' || ctx.url === '/
secret-path'
  ? bot.handleUpdate(ctx.request.body, ctx.response)
  : next()
)
app.listen(3000)
```

It will show in Koa as in Figure 11-12.



```
const Telegraf = require('telegraf' 3.24.0 )
const Koa = require('koa' 2.5.3 )
const koaBody = require('koa-body' 4.0.4 )

const bot = new Telegraf(process.env.BOT_TOKEN)
bot.telegram.setWebhook('https://runkit.io/hellonico/koa-bot/branches/master')
bot.on('text', ({ reply }) => reply('The time here is ::'+ new Date()))

const app = new Koa()
app.use(koaBody())
app.use((ctx, next) => ctx.method === 'POST' || ctx.url === '/secret-path'
  ? bot.handleUpdate(ctx.request.body, ctx.response)
  : next()
)
app.listen(3000)
```

Figure 11-12. *First bot on RunKit*

Now, I can explain the two missing pieces of the code. The first is where we glue the HTTP `POST` request to the Telegraf bot, using `handleUpdate`, which does two things:

- Maps `ctx.request.body` to the input request for the bot
- Maps `ctx.response` to the output response from the bot

```
app.use(koaBody())
app.use((ctx, next) => ctx.method === 'POST' || ctx.url
=== '/secret-path'
  ? bot.handleUpdate(ctx.request.body, ctx.response)
  : next()
)
```

The second missing piece is similar to other APIs presented in this book.

```
bot.on('text', ({ reply }) => reply('The time here is ::'+ new
Date()))
```

Whenever some text arrives to the bot, we have a callback, with a destructured reply object (prepared by Telegraf), which we can use to send messages back to the chat. Before running this bot, you will have noticed that the code requires a token retrieved from the environment that started the Node.js process.

```
const bot = new Telegraf(process.env.BOT_TOKEN)
```

RunKit allows you to do that, by setting environment variables to your notebooks(yes!).

To access the settings page, navigate to your own RunKit settings page (Figure 11-13).

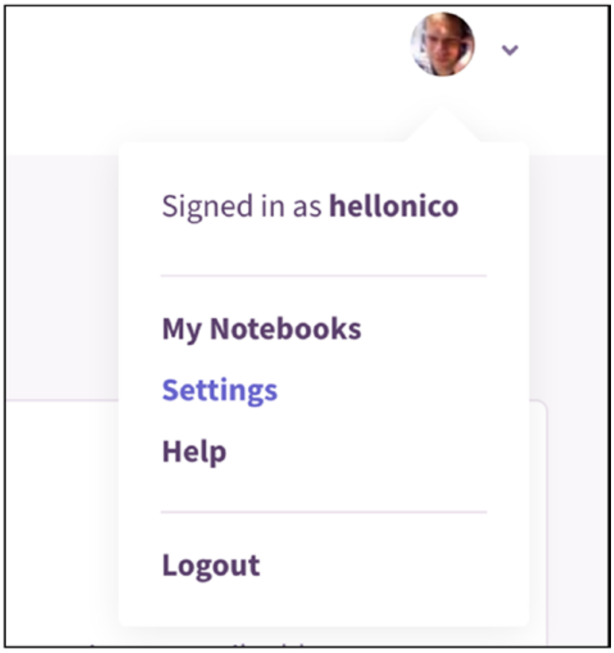
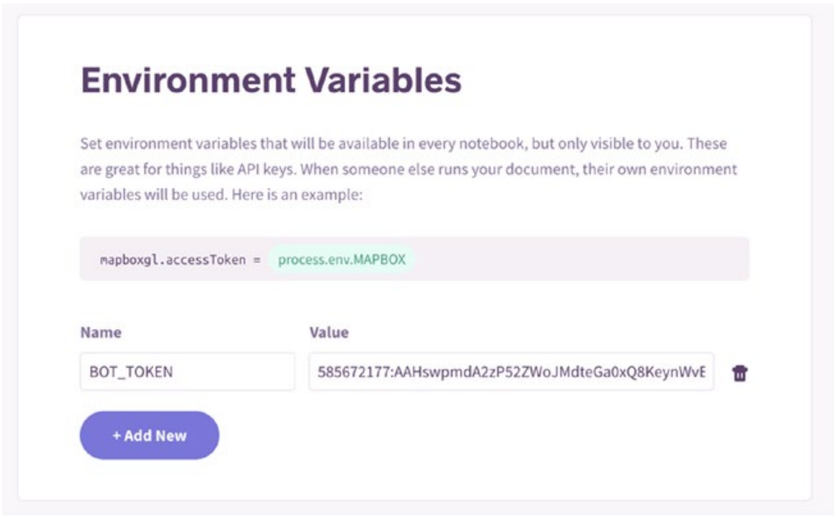


Figure 11-13. *Settings page*

On that page, there is a section with environment variables, with which you can set the needed BOT_TOKEN variable to instantiate the Telegraf bot (Figure 11-14).



Environment Variables

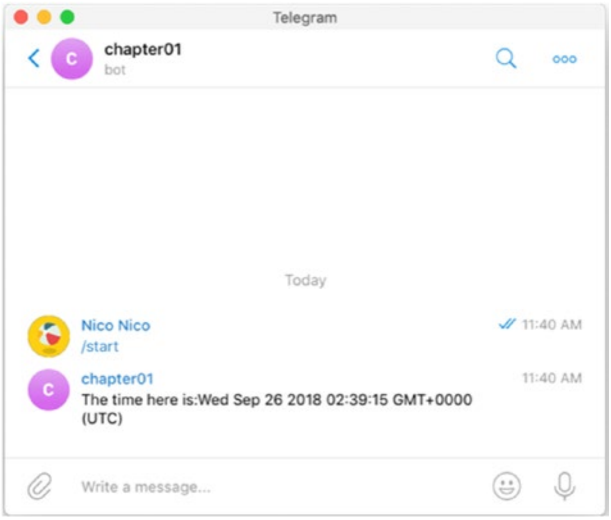
Set environment variables that will be available in every notebook, but only visible to you. These are great for things like API keys. When someone else runs your document, their own environment variables will be used. Here is an example:

```
mapboxgl.accessToken = process.env.MAPBOX
```

Name	Value
BOT_TOKEN	585672177:AAHswpmdA2zP52ZWoJMdteGa0xQ8KeynWvE

Figure 11-14. *Setting the BOT_TOKEN variable with your own token*

Now, you can start the RunKit/Koa/Telegram bot together and start chatting with your bot as usual (Figure 11-15).



Nico Nico
/start
11:40 AM

chapter01
The time here is:Wed Sep 26 2018 02:39:15 GMT+0000 (UTC)
11:40 AM

Figure 11-15. *Telegraf, with Koa on RunKit bot*

More on the Telegraf Library

I have not yet reviewed the Telegraf library in great detail. As a reminder, its GitHub URL is the one following:

https://github.com/telegraf/telegraf/

And you will find extensive examples on games and inline keyboards in its examples folder.

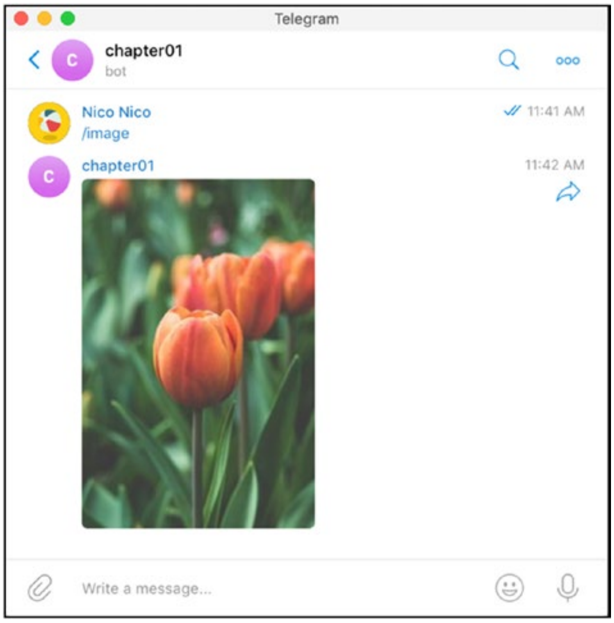
https://github.com/telegraf/telegraf/tree/develop/docs/examples

Image-to-Chat Example

The image command example is an instant self-gratification win. You can try this directly in the RunKit bot you have just defined.

```
const bot = new Telegraf(process.env.BOT_TOKEN)
bot.command('image',
(ctx) =>
ctx.replyWithPhoto({ url: 'https://picsum.
photos/200/300/?random' }))
```

Once the command is deployed, you can send the `/image` command to the bot and get a random picure from the Picsum web site. Note, too, how `replyWithPhoto` is used with the URL parameter, to send a picture to the chat (Figure 11-16).



Nico Nico
/image
11:41 AM
chapter01
11:42 AM

Figure 11-16. *Random photo*

RegExp, Inline Keyboards, and Embedded Emojis

Telegraf has this cool embedded feature that allows you to match messages on RegExp and perform actions depending on those matches. This is done using a regexp within either a `.hears` (for messages coming to a chat group) or `.on` (message directly sent to the bot) callback.

In the following, “like” is searched in group chat messages, and an inline keyboard shows up.

```
const { Markup } = Telegraf
const inlineMessageRatingKeyboard = Markup.inlineKeyboard([
    Markup.callbackButton('👍', 'like'),
    Markup.callbackButton('👎', 'dislike')
]).extra()
bot.hears(/like (.+)/, (ctx) => ctx.telegram.sendMessage(
    ctx.from.id,
    'Like?',
    inlineMessageRatingKeyboard)
)
```

Actions for callbacks themselves can be defined after. Here, we are editing the last message, the one with the inline keyboard in place, using the API function `editMessageText`.

```
bot.action('like', (ctx) => ctx.editMessageText('•• Awesome! ••'))
bot.action('dislike', (ctx) => ctx.editMessageText('okey'))
```

When the code is run, the bot will notify you whenever it finds a message starting with “like,” as seen in Figure 11-17.

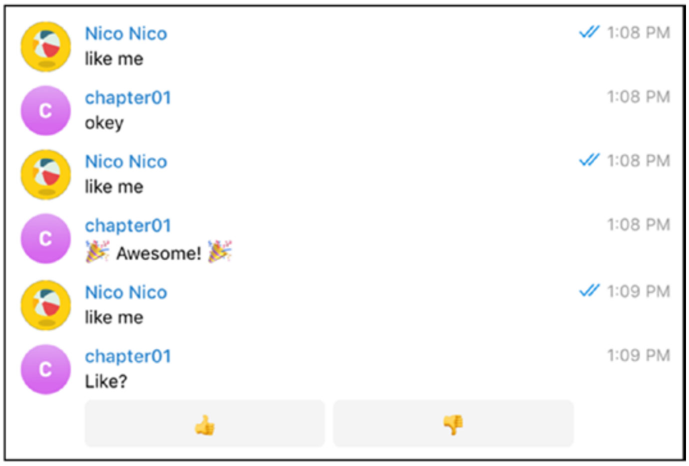

Nico Nico 1:08 PM
like me
chapter01 1:08 PM
okey
Nico Nico 1:08 PM
like me
chapter01 1:08 PM
🎉 Awesome! 🎉
Nico Nico 1:09 PM
like me
chapter01 1:09 PM
Like?

Figure 11-17. *Like me or not?*

Note that you can also use the matched pattern, by using match in the callback.

```
bot.hears(/reverse (.+)/,
({ match, reply }) => reply(match[1].split('').reverse().
join('')))
```

Finally, let's have a look on how to run this bot locally or our own server.

Running Node.js Locally

After running all the examples from within RunKit, you may indeed want to host this somewhere other than RunKit, for example, on your own machine. For this, we will have to install Node.js.

Setting Up Node.js

Installing Node.js is a no-brainer—from either the home page, which has the necessary packages,

https://nodejs.org/en/

or from your usual package manager.

Also, whereas working with NPM is good enough, these days, the yarn build tool for Node.js is all the rage, and you can find/install it from https://yarnpkg.com/en/docs/install#mac-stable.

Once you have it installed, you can start with a few version checks.

```
$ node -v
v10.4.0
$ yarn -v
1.7.0
$ npm -v
6.2.0
```

When the tooling is set up, you can download the notebook you were working on in RunKit, using the download this notebook button (Figure 11-18).

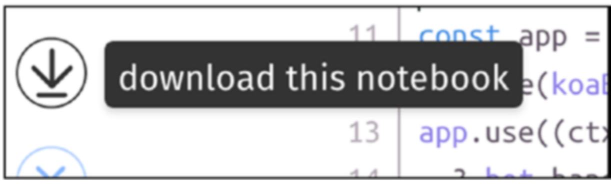


Figure 11-18. *Downloading the RunKit notebook to your machine*

Once you extract the content of the archive, you will see something similar to Figure 11-19.

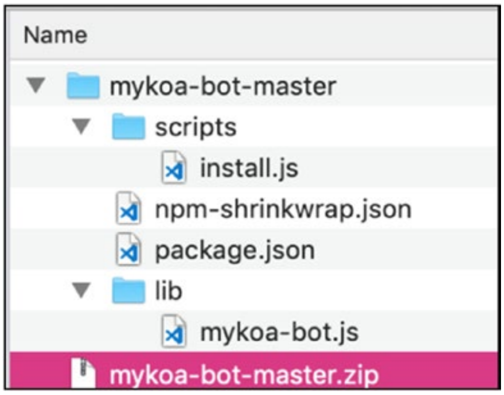

Name
mykoa-bot-master
scripts
install.js
npm-shrinkwrap.json
package.json
lib
mykoa-bot.js
mykoa-bot-master.zip

Figure 11-19. *Content of `mykoa-bot` zip file from RunKit*

Using Local Tunnel

To run this bot, you could use polling, but let's try something a bit more challenging. Whenever you start your Koa application, your application will begin to bind the listening host to `localhost` and (usually, by default) on port 3000.

Wouldn't it be great if something made this wonderful Koa site immediately available to the world? That's where LocalTunnel comes in. LocalTunnel creates a URL for you, and redirects all requests sent to it to your locally listening listener.

The installation with NPM is as follows:

```
npm install -g localtunnel
```

Then start it with

```
lt --port 3000
```

It will give you a temporary à la Heroku URL, such as the one following:

https://short-cougar-89.localtunnel.me

Then you can tell the Koa app to register this as a webhook.

```
const Telegraf = require('telegraf')
const Koa = require('koa')
const koaBody = require('koa-body')

const bot = new Telegraf(process.env.BOT_TOKEN)
bot.command('image', (ctx) => ctx.replyWithPhoto({ url: 
'https://picsum.photos/200/300/?random' }))

bot.telegram.setWebhook('https://short-cougar-89.localtunnel.me')

const app = new Koa()
app.use(koaBody())
app.use((ctx, next) => ctx.method === 'POST' || ctx.url === '/
secret-path'
  ? bot.handleUpdate(ctx.request.body, ctx.response)
  : next()
)
app.listen(3000)
```

In Figure 11-20, we're back to random images again!

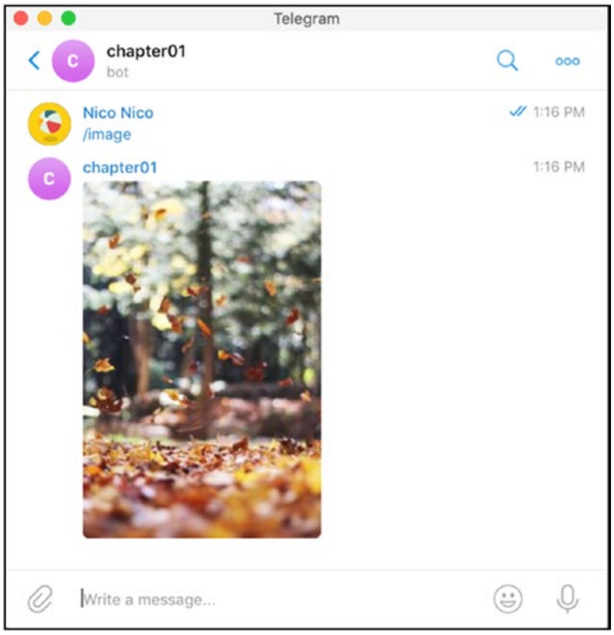


Figure 11-20. *Random images from the Telegram bot with the webhook setup, running via* `localtunnel`

CHAPTER 12

Week 12: Python

Always look on the bright side of life.

—Monty Python

Python is en route to becoming the most widely used programming language of the 21st century. Hobbyists love it, analysts love it, and even kids starting to code use Python these days.

With its simple syntax and zillions of available libraries, you can't go wrong with Python. Recently, many of these libraries have refocused on machine learning, AI, data science…so much so that Python, the language, does not require much of an introduction. That said, here's one (Figure 12-1).

Figure 12-1. *Hello, Python*

While I also like Python, a lot of the code is easy to write but harder to maintain. So, I usually switch to another language, but it's hard to match the number of libraries available with Python—OpenCV, TensorFlow…all come with a first-class Python wrapper.

Installation

3.6. What is it? 3.6 is the version of Python you want to install. Yes, the latest version is 3.7, but the TensorFlow library did not support version 3.7 at the time of writing, so you are better off using 3.6. If you really do not care about the TensorFlow samples, but I hope you do, you can stick to 3.7.

Python itself sometimes comes preinstalled and is already available. If not, or if the version does not match, or if you're a Windows lover, you can download the installer from the following Python download page:

https://www.python.org/downloads/windows/

The Python package manager, pip, will have to be installed as well. You can perform the installation for that by following the steps here.

https://pip.pypa.io/en/stable/installing/

Or, in short,

```
# download the get-pip.py file( manually if you don't have curl)
curl https://bootstrap.pypa.io/get-pip.py -o get-pip.py
# execute it with the python executable
python get-pip.py
```

An alternative but recommended method is to install mode for Python and use a tool named pyenv. pyenv is a small tool that allows you to switch from one Python tree to another, meaning you can switch from one version of Python and its libraries to another.

https://github.com/pyenv/pyenv#installation

With pyenv installed, you can now switch from one version of Python to another in a convenient manner. To check the versions installed, use `pyenv versions`.

```
$ pyenv versions
  system
* 3.6.0 (set by /Users/niko/.pyenv/version)
  3.7.0
  anaconda3-5.0.1
```

As shown in the preceding and following code snippets, we're supporting Python version 3.6 and pip version 18.0. Yes, 3.6, because, again, the TensorFlow packages were not available for Python 3.7 at the time of writing.

```
$ pip --version
pip 18.0 from /Users/niko/.pyenv/versions/3.7.0/lib/python3.7/
site-packages/pip (python 3.7)
```

But python2 is also perfectly usable, but not much tested in the scope of this book.

In a new folder for the forthcoming Python script, we can set up the `tasks.json` usable by Visual Studio Code.

```
{
    "version": "2.0.0",
    "tasks": [
        {
            "label": "echo",
            "type": "shell",
            "command": "python",
            "args": [
                "${file}"
            ],
            "group": {
                "kind": "build",
                "isDefault": true
            }
        }
    ]
}
```

The plug-in to work with Python in Visual Studio Code is shown in Figure 12-2.

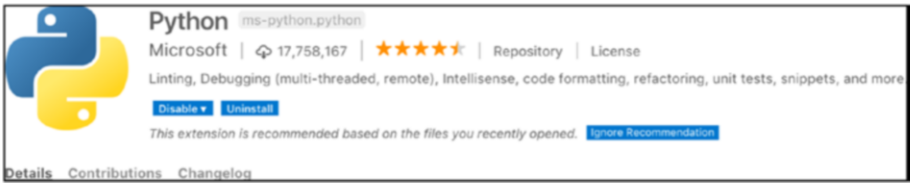

Python ms-python.python
Microsoft | 17,758,167 | ★★★★½ | Repository | License
Linting, Debugging (multi-threaded, remote), Intellisense, code formatting, refactoring, unit tests, snippets, and more
This extension is recommended based on the files you recently opened.

Figure 12-2. *Python plug-in for Visual Studio Code*

That's it for the setup. Let's move on to our first Python program.

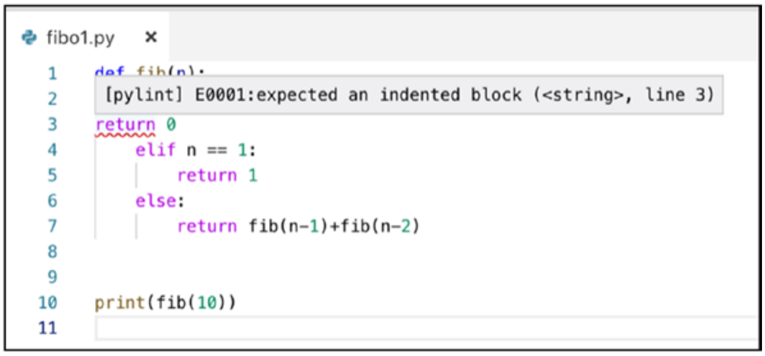
A Few Python Programs

You've probably guessed it already, so there's no need to resist too much. Let's work on Fibonacci numbers in Python. What's great is that we can go through the examples one by one and learn (new) things about the language.

Fibonacci 1

This first implementation goes the recursive way. We define a function `fib`, with `def`, that calls itself.

Note that the indentation of any Python program is important. So, the `if`, `elif`, and `else` are all one tab in from the previous indentation, and the `return` statements are an additional one tab in from these. If you don't respect the indentation, the linter or the syntax checker of Visual Studio Code will show an error (Figure 12-3).



fibo1.py ×

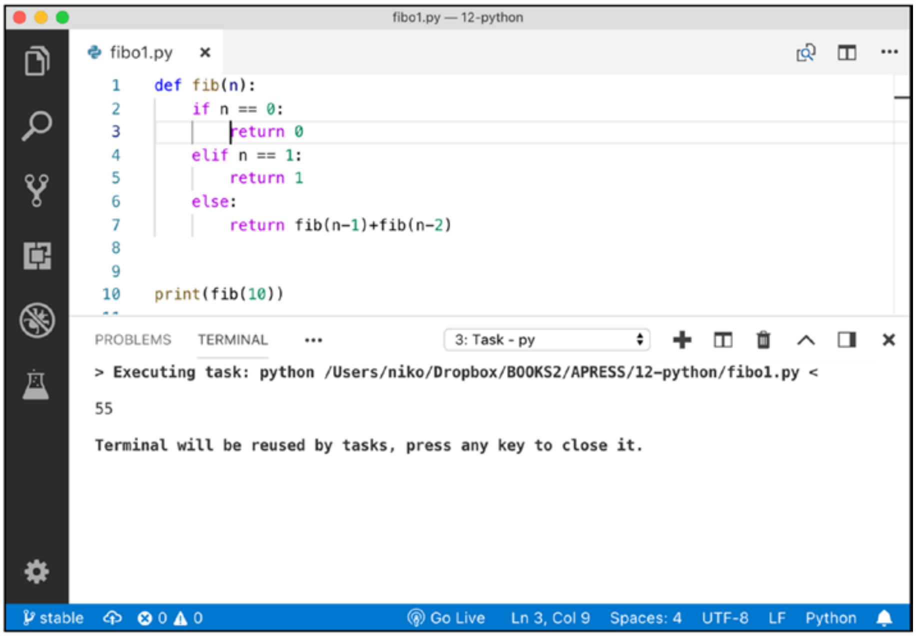
```
def fib(n):
[pylint] E0001:expected an indented block (<string>, line 3)
return 0
    elif n == 1:
        return 1
    else:
        return fib(n-1)+fib(n-2)


print(fib(10))

```

Figure 12-3. *Python is very strict with indentation*

With this in mind, here comes the first listing. The function is defined first, then the print statement, exactly two lines (!), after the function definition.

```
def fib(n):
    if n == 0:
        return 0
    elif n == 1:
        return 1
    else:
        return fib(n-1)+fib(n-2)

print(fib(10))
```

If you run this file with the usual Command/Ctrl+Shift+B build task of Visual Studio Code, you will see the output of the program in the console again (Figure 12-4).



```
def fib(n):
    if n == 0:
        return 0
    elif n == 1:
        return 1
    else:
        return fib(n-1)+fib(n-2)


print(fib(10))
```

```
> Executing task: python /Users/niko/Dropbox/BOOKS2/APRESS/12-python/fibo1.py <

55

Terminal will be reused by tasks, press any key to close it.
```

Figure 12-4. *Executing the Python code in Visual Studio Code*

Let's move on to the second implementation.

Fibonacci 2

This second implementation works with an internal, and simple, cache to compute the numbers. This time, we start by adding some documentation on the `fastFib` function, right after the `def` line.

Then we add a new parameter, `memo`, which will act as a cache. We add a default value to `memo`, the start of the Fibonacci sequence, in which `fib[0]=1` and `fib[1]=1`.

Next, we just past the `memo` around when calling `fastFib` recursively.

```
def fastFib(n, memo={0:1, 1:1}):
    memoized recursive function, returns a Fibonacci number"'
    print('>', n, memo)
    if not n in memo:
        memo[n] = fastFib(n-1, memo) + fastFib(n-2, memo)
    return memo[n]

print(fastFib(5))
```

Because we have the print statements, when you execute the program, you can see the cache being filled along the way.

```
> 5 {0: 1, 1: 1}
> 4 {0: 1, 1: 1}
> 3 {0: 1, 1: 1}
> 2 {0: 1, 1: 1}
> 1 {0: 1, 1: 1}
> 0 {0: 1, 1: 1}
> 1 {0: 1, 1: 1, 2: 2}
> 2 {0: 1, 1: 1, 2: 2, 3: 3}
> 3 {0: 1, 1: 1, 2: 2, 3: 3, 4: 5}
8
```

Fibonacci 3

This next implementation is fun enough to write in here. We also use a cache—this time, global—to avoid passing it around, and we just append element to the ever-growing array. This also shows how to use a `for` loop with a range and, finally, how to join all the values of the array using `join`.

```
x = [1, 1] # this is an array

for i in range(2, 40):
    x.append(x[-1] + x[-2])

print(', '.join(str(y) for y in x))
```

Fibonacci 4

This new implementation presents tuples, with the `zip` function. The `zip` function returns a list of tuples `zip(fn1(), fn2())` that finishes whenever one of fn1s or `fn2`s stops returning values. `range` returns a list of numbers from 0 to 9, included. This is not so important, but the `print` statement in the loop formats the variables to keep the indentation with padding.

The difficult part yields, pun intended, the usage of the keyword yields. While `fib()` looks like a function, it is actually a generator.

What is a generator? `range(n)` is a generator. It returns values from 0 to n. A generator works like looping over a list.

To implement a never-ending list, a generator of constant values, you could use the following definition, in which you can picture `constant` as (1,1,1,1 …).

```
def constant():
    a = 1
    while True:
        yield a
```

`range()` itself could be simply reimplemented, as in the following snippet, in which we start with the value `0` and return to a list of `n` elements, the list of incremented `a`'s.

```
def myrange(n):
    a = 0
    while a < n:
        a=a+1
        yield a
```

Thus, `yield` is like returning a list of elements.

So, here comes the implementation of `fib` using `yield`. Note that the list is never-ending, so the loop is never-ending.

```
def fib():
    a, b = 0, 1
    while True:
           a, b = b, a + b
           yield a

for index, fibonacci_number in zip(range(20), fib()):
    print('{i:3}: {f:3}'.format(i=index, f=fibonacci_number))
```

The result of the execution is as follows:

```
  0:   1
  1:   1
  2:   2
 ...
16: 1597
 17: 2584
 18: 4181
 19: 6765
```

Fibonacci 5

The last Fibonacci example in this chapter uses an implementation based on squared roots. `sqrt` is the function used to compute square roots, and it is located in the `Math` package. So, we're using `import` to make it available to our program.

```
from math import sqrt

def F(n):
    return ((1+sqrt(5))**n-(1-sqrt(5))**n)/(2**n*sqrt(5))

print(F(100))
```

Alright, enough Fibonaccis. We're done with the basics, so let's write some Telegram code with Python.

First Telegram with Python

To start playing with Telegram, we will use `telepot`, a Python wrapper for the Telegram API, which is located at https://github.com/nickoala/telepot.

To install a library for Python, we use `pip`, the Python package installer. To install any package, you use

```
pip install <packagename>
```

So, to install `telepot`, we will run the `pipinstall` with the `telepot` package name.

```
$ pip install telepot
```

```
Collecting telepot
...
Installing collected packages: telepot
```

You've now successfully installed telepot-12.7. You have seen it before, in Visual Studio Code, to pass a token to the process started by the build task. You can define the environment variable for the token in the integrated terminal of Visual Studio Code.

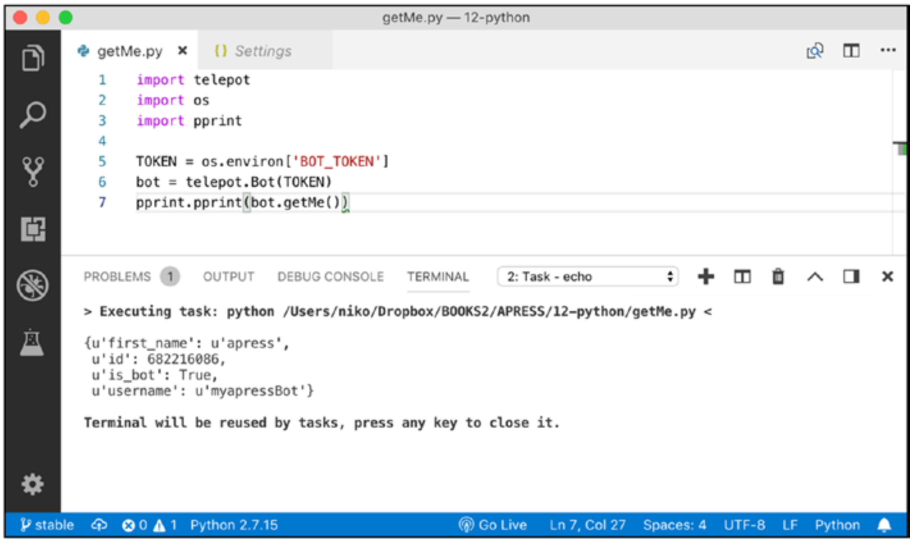
This can be done by setting up the `terminal.integrated.env.[youros]` key and adding the following into your user settings:

```
    "terminal.integrated.env.osx": {
        "BOT_TOKEN":
"682216086:AAGeNyQ4jf9sAKuOvWJzKs45i4ui1VgWulk"
}
```

More on this and the integrated terminal settings can be found in the following Visual Studio Code documentation:

https://code.visualstudio.com/docs/editor/integrated-terminal

The first example will use `telepot` to retrieve information on the bot, using the `getMe` method call of Telegram. Again, we will run everything from the Visual Studio Code, as shown in Figure 12-5.



```
import telepot
import os
import pprint

TOKEN = os.environ['BOT_TOKEN']
bot = telepot.Bot(TOKEN)
pprint.pprint(bot.getMe())
```

```
> Executing task: python /Users/niko/Dropbox/BOOKS2/APRESS/12-python/getMe.py <

{u'first_name': u'apress',
 u'id': 682216086,
 u'is_bot': True,
 u'username': u'myapressBot'}

Terminal will be reused by tasks, press any key to close it.
```

Figure 12-5. *Python bot from Visual Studio Code*

Alright, so to call the Telegram API, we need to

- Retrieve the token to use for the bot authentication from an environment variable
- Create an instance of the Telegram wrapper `telebot`, using that token
- Call `getMe`, to use the newly instantiated bot using the library

Note that we actually do not need to set up pooling or webhooks for this first program. Environment variables in Python can be retrieved using the `os` module. In the `os` module, there is a global array named `environ` that has all the variables passed to the process. We just saw how to define the `BOT_TOKEN` variable, so no surprise here.

A bot object can then be instantiated using `telepot.Bot` and the token. Finally, we can call any method of the API we want here, and because we are retrieving a Python data structure as return value, we use `pprint` from the `pprint` module, to display that as formatted data on the output of the console. This gives the first snippet, as follows:

```
import telepot
import os
import pprint

TOKEN = os.environ['BOT_TOKEN']
bot = telepot.Bot(TOKEN)
pprint.pprint(bot.getMe())
# empty line
```

And as you have seen in the screenshot, after executing the program, you'll get the info data related to the bot queried.

```
{u'first_name': u'apress',
 u'id': 682216086,
 u'is_bot': True,
 u'username': u'myapressBot'}
```

We're getting there, aren't we?

First Bot: Send a Random Photo

Taking on the image example from Chapter 11, we are now going to write some code to send a picture back to the chat, using the `sendPhoto` function from Python's `telepot`.

The bot object is instantiated in the same way, but now we will set it to listen to the messages using the `handle` callback function. At this point in the book, the `handle` function has few secrets. We retrieve the `chat_id` from the update and `msg`, going through a map object or, in Python terms, a dictionary.

```
import os
import random
import telepot
from telepot.loop import MessageLoop

def handle(msg):
    chat_id = msg['chat']['id']
    command = msg['text']

    if command == '/image':
        bot.sendPhoto(chat_id, 'https://picsum.
        photos/200/300/?random')

bot = telepot.Bot(os.environ["BOT_TOKEN"])
MessageLoop(bot, handle).run_forever()
```

Start the bot by calling execute, and now we can send the `/image` message to retrieve a random image, as was done with Node.js (Figure 12-6).

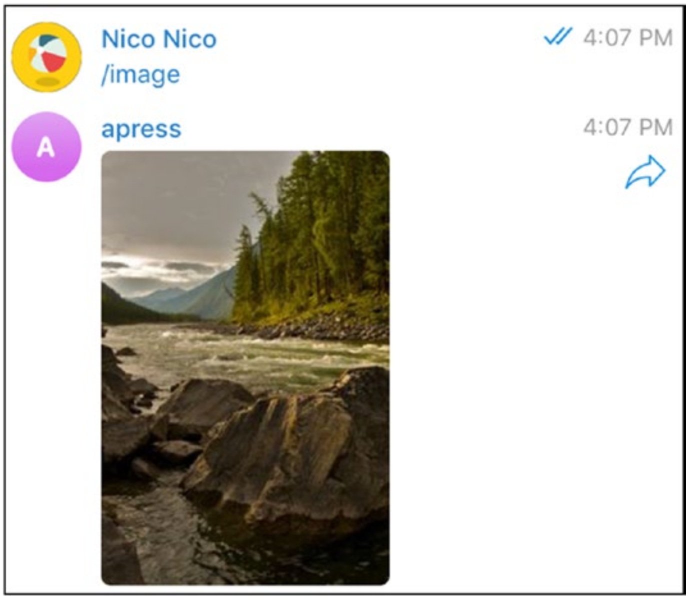

Nico Nico 4:07 PM
/image
apress 4:07 PM

***Figure 12-6.** Sending a message and getting a photo from the Python* `bot.` *check.*

First OpenCV Bot: Changing the Color Space of a Picture

OpenCV is one of the treats of coding with Python. Everything is ready for instant consumption, and in the 21st century, what could be better than instant consumption?

So, now, we will convert a picture from standard color to a black-and-white version. This is quite easy to do with `opencv`.

We'll start by installing the ready-to-use `opencv` and then move on to the code. The recommended means to install the library with Python is, of course, `pip`.

```
pip install opencv-python
```

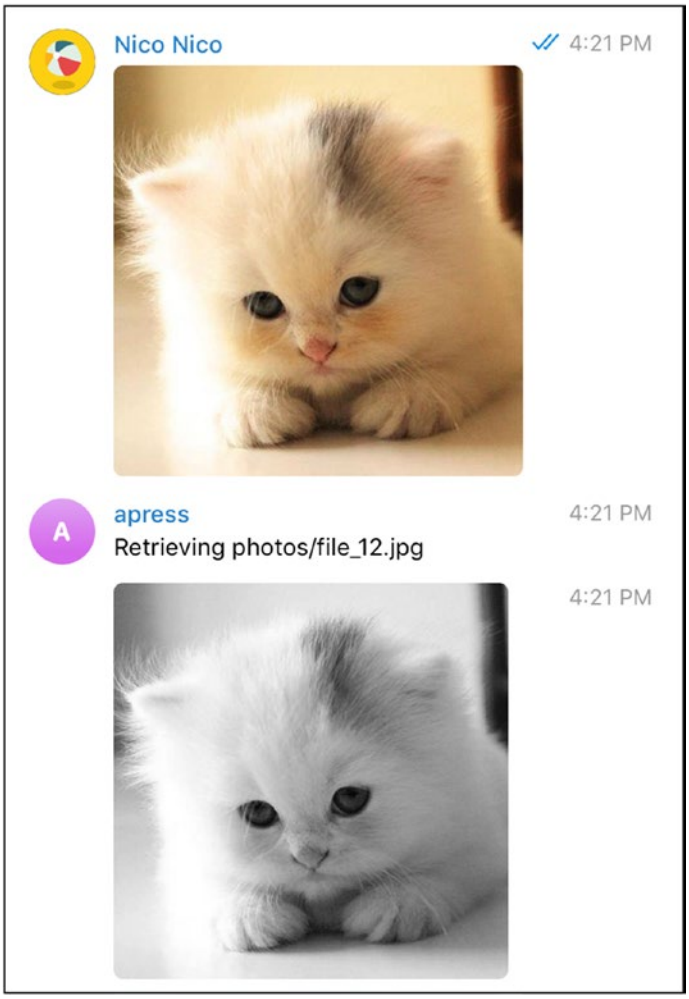
The code itself will

- Create a temporary file, using the function `NamedTemporaryFile` from the `tempfile` module
- Read the `file_id` from the photo object contained in the Telegram update
- Download the file to a temporary file
- Open the file using `opencv`'s `imread` function
- Convert the color of the file using the `cvtColor` function
- Write the file to disk again, using `opencv`'s `imwrite` function
- Send the photo, using `telepot`'s `sendPhoto` function again, but this time on a file

Note, along the way, how we rename the default module from cv2 to cv, to make it easier to understand that we are using version 3.

```
import os
import telepot
from telepot.loop import MessageLoop
import pprint
import cv2 as cv
import tempfile

def handle(msg):
    if msg["photo"]:
        chat_id = msg['chat']['id']
        f = tempfile.NamedTemporaryFile(delete=True).name+".png"
        photo = msg['photo'][-1]["file_id"]
        path = bot.getFile(photo)["file_path"]
        bot.sendMessage(chat_id, "Retrieving %s" % path)
        bot.download_file(photo, f)
        p = cv.imread(f)
gray = cv.cvtColor(p, cv.COLOR_BGR2GRAY)
        cv.imwrite(f, gray)
        bot.sendPhoto(chat_id, open(f, 'rb'))
    else:
        print("no photo")

bot = telepot.Bot(os.environ["BOT_TOKEN"])
MessageLoop(bot, handle).run_forever()
```

The looping part is the same as in the previous example, and so now, if you start the bot and send a picture, you'll get something similar to Figure 12-7.


Nico Nico

4:21 PM

apress

Retrieving photos/file_12.jpg

4:21 PM

4:21 PM

Figure 12-7. Colored cat turned gray

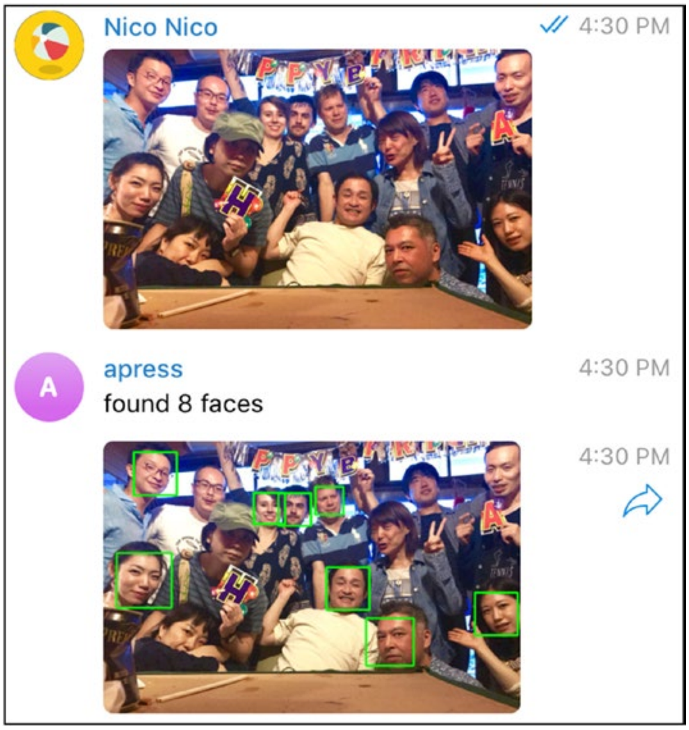
Second OpenCV Bot: Count Faces

Because we have opencv installed and ready to use, we can't really get away with not doing an example that picks up and counts the number of faces in a picture, the most recognizable of all opencv examples. The flow is quite similar to that in the previous example of changing colors with opencv. This time, we will use what opencv calls a classifier, and use it on a grayscale version of the sent picture. Then we will draw rectangles inside the picture, by looping over the faces found, using the opencv's rectangle function.

The detect function will do most of the opencv work, by detecting, counting, and drawing the faces. Note how the function returns two values simultaneously again, and how we are assigning them to two values in the main handle function.

```
import os
import telepot
from telepot.loop import MessageLoop
import pprint
import cv2 as cv
import tempfile

classifier = cv.CascadeClassifier(cv.data.haarcascades +
"haarcascade_frontalface_default.xml")

def detect(image):
    gray = cv.cvtColor(image, cv.COLOR_BGR2GRAY)
    faces = classifier.detectMultiScale(gray, 1.3, 5)
    count = 0
    for (x, y, w, h) in faces:
        count = count+1
        cv.rectangle(image, (x, y), (x+w, y+h), (0, 255, 0), 5)
    return image, count

def handle(msg):
    if msg["photo"]:
        chat_id = msg['chat']['id']
        f = tempfile.NamedTemporaryFile(delete=True).name+".png"
        photo = msg['photo'][-1]["file_id"]
        path = bot.getFile(photo)["file_path"]
        bot.download_file(photo, f)
        p = cv.imread(f)
        hsv, l = detect(p)
        cv.imwrite(f, hsv)
        bot.sendMessage(chat_id, "found %i faces" % l)
        bot.sendPhoto(chat_id, open(f, 'rb'))
    else:
        print("no photo")

bot = telepot.Bot(os.environ["BOT_TOKEN"])
MessageLoop(bot, handle).run_forever()
```

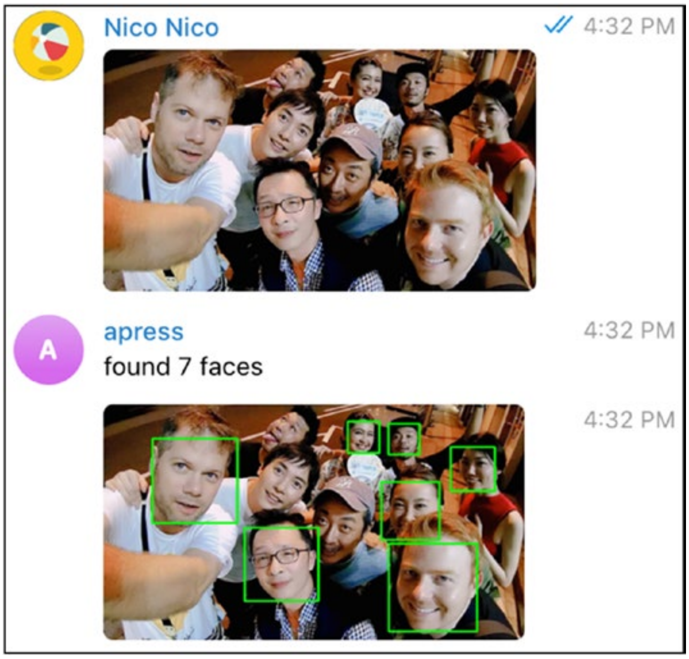
I've tried this bot twice, and while not perfect, it can find quite a few party people in pictures, as shown in Figures 12-8 and 12-9.


Nico Nico 4:30 PM

apress 4:30 PM
found 8 faces

4:30 PM

***Figure 12-8.** Eight party faces!*


Nico Nico 4:32 PM

apress 4:32 PM
found 7 faces

4:32 PM

Figure 12-9. *Seven party faces!*

TensorFlow to Close the Show

You have probably heard about TensorFlow, one of the most famous machine learning frameworks. Creating your own models and understanding all the mathematics behind the library is completely beyond the scope of this book. But because TensorFlow comes as a Python first, we are going to see a short example of a Telegram bot that uses TensorFlow to identify the content of pictures.

With TensorFlow, you can train models, using a list of layers (steps), for something that looks like a memory, a network. You tell this memory to recognize that this X in input gives this Y in output, or X,Y in input gives Z in output, and, eventually, that a list of pixels is a cat or a dog.

You train this memory with a large data set of inputs and outputs, in this case, images, and then you can reuse this network in the wild. There are already pretrained models for us, so the following bot will use an existing set of pictures to train a model and reuse that TensorFlow model.

TensorFlow itself is again installed using `pip`.

```
pip install tensorflow
```

The model and the image classification code is located at

https://github.com/tensorflow/models

And, more specifically,

https://github.com/tensorflow/models/tree/master/tutorials/image/imagenet

To use this, we are going to first copy the `classify_image` code and apply a few modifications to the code, mostly to

- Call it as a library instead of the command line
- Return the prediction—actually, the top best prediction

The `diff` is provided in the example and as follows:

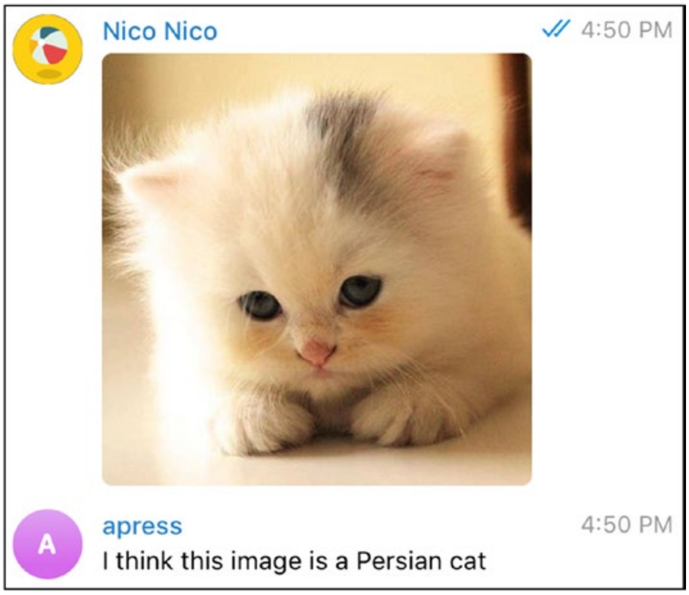
```
48c48,54
< FLAGS = None
---
> class ObjectDict(dict):
>       def __init__(self, *args, **kws):
>           super(ObjectDict, self).__init__(*args, **kws)
>           self.__dict__ = self
>
> FLAGS = ObjectDict({'model_dir':"/tmp/imagenet", 'num_top_
  predictions': 1})
>
```

```
164,167c171
<     for node_id in top_k:
<       human_string = node_lookup.id_to_string(node_id)
<       score = predictions[node_id]
<       print('%s (score = %.5f)' % (human_string, score))
---
>     return node_lookup.id_to_string(top_k[0])
```

The bot is following the opencv examples, in which we get a photo file and call the TensorFlow model on it, via the classify_image.run_inference_on_image function on the picture.

```
import os
import telepot
from telepot.loop import MessageLoop
import tempfile
import classify_image

def handle(msg):
    if msg["photo"]:
        chat_id = msg['chat']['id']
        f = tempfile.NamedTemporaryFile(delete=True).name+".png"
        photo = msg['photo'][-1]["file_id"]
        bot.download_file(photo, f)
        prediction = classify_image.run_inference_on_image(f)
        bot.sendMessage(chat_id, "I think this image is a %s" %
        prediction)
    else:
        print("no photo")

classify_image.maybe_download_and_extract()
bot = telepot.Bot(os.environ["BOT_TOKEN"])
MessageLoop(bot, handle).run_forever()
```

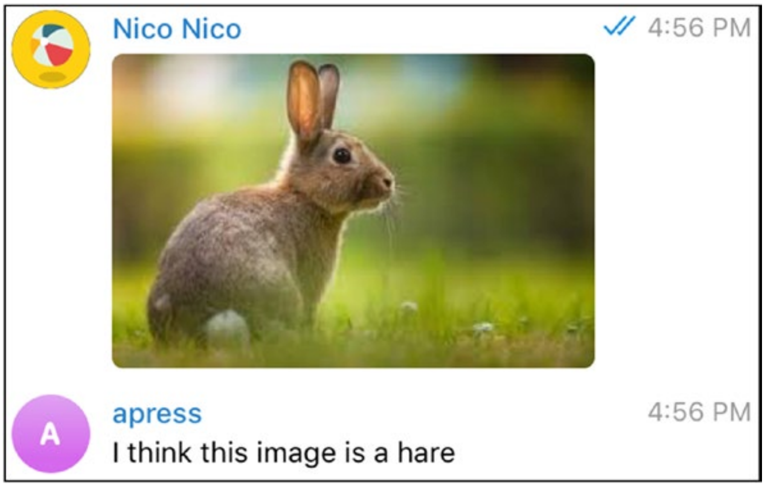
On running this bot, we can again send pictures and see what it is guessing. A cat is recognized (Figure 12-10).


Nico Nico 4:50 PM

apress 4:50 PM
I think this image is a Persian cat

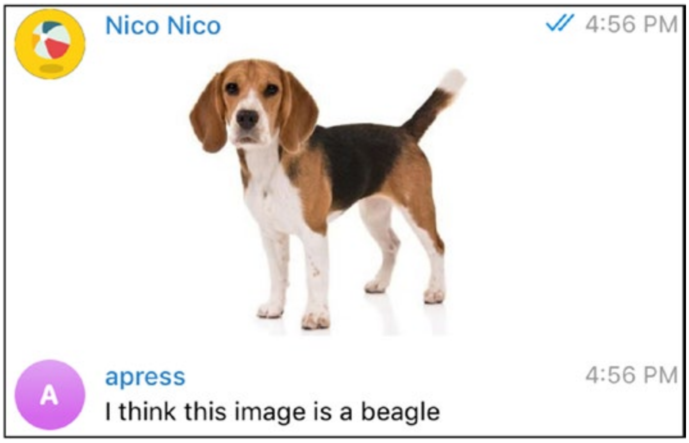
Figure 12-10. *The classification is even more detailed than "cat"; it's "Persian cat"!*

Figures 12-11, 12-12, and 12-13 show pretty good image classification, which you could put to use!


Nico Nico 4:56 PM

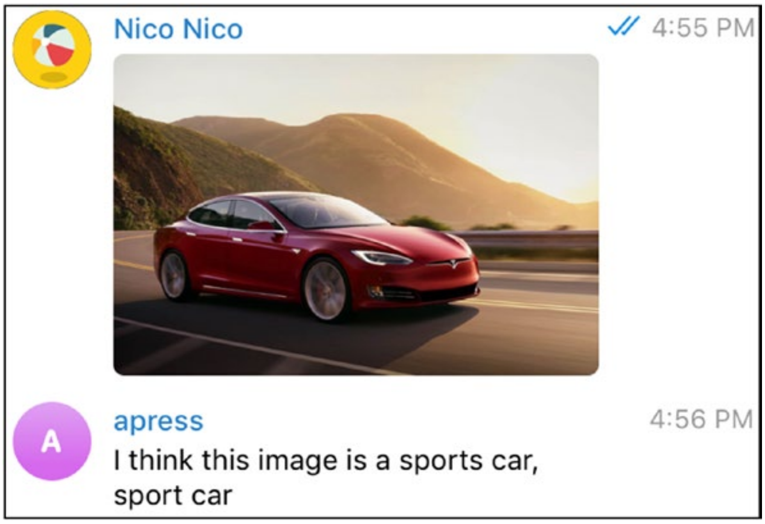
apress 4:56 PM
I think this image is a hare

Figure 12-11. *Rabbit?*


Nico Nico 4:56 PM

apress 4:56 PM
I think this image is a beagle

Figure 12-12. *A beagle! How did it guess that right?*



I think this image is a sports car, sport car

Figure 12-13. *Tesla!*

Now it's time to hit the road with that Tesla and lead the new bot army that you have created. The fun is all yours from now on.

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