

BY BOBBY ILIEV

Introduction to Bash Scripting

FOR DEVELOPERS



Table of Contents

About the book	6
About the author	7
Sponsors	8
Introduction to Bash scripting	10
Bash Structure	11
Bash Hello World	12
Bash Variables	14
Bash User Input	16
Bash Comments	18
Bash Arguments	19
Bash Arrays	22
Bash Conditional Expressions	24
File expressions	25
String expressions	27
Arithmetic operators	29
Bash Conditionals	31

Bash Loops	33
For loops	34
While loops	35
Until Loops	37
Continue and Break	38
 Bash Functions	 39
 Debugging and testing	 41
 Creating custom bash commands	 42
Example	43
Making the change persistent	45
Listing all of the available aliases	46
Conclusion	47
 Write your first Bash script	 48
Planning the script	49
Writing the script	50
Adding comments	51
Adding your first variable	52
Adding your first function	53
Adding more functions challenge	55
The sample script	56
Conclusion	58
 Creating an interactive menu in Bash	 59
Planning the functionality	60
Adding some colors	62

Adding the menu	63
Testing the script	65
Conclusion	69
Executing BASH scripts on Multiple Remote Servers	70
Prerequisites	71
The BASH Script	74
Running the Script on all Servers	76
Conclusion	78
Work with JSON in BASH using jq	79
Planning the script	80
Installing jq	81
Parsing JSON with jq	83
Getting the first element with jq	85
Getting a value only for specific key	86
Using jq in a BASH script	87
Conclusion	90
Working with Cloudflare API with Bash	91
Prerequisites	92
Challenge - Script requirements	93
Example script	94
Conclusion	96
BASH Script parser to Summarize Your NGINX and Apache Access Logs	97
Script requirements	98

Example script	99
Running the script	100
Understanding the output	101
Conclusion	103
Wrap Up	104

About the book

This is an open-source introduction to Bash scripting guide that will help you learn the basics of Bash scripting and start writing awesome Bash scripts that will help you automate your daily SysOps, DevOps, and Dev tasks. No matter if you are a DevOps/SysOps engineer, developer, or just a Linux enthusiast, you can use Bash scripts to combine different Linux commands and automate boring and repetitive daily tasks, so that you can focus on more productive and fun things.

The guide is suitable for anyone working as a developer, system administrator, or a DevOps engineer and wants to learn the basics of Bash scripting.

The first 13 chapters would be purely focused on getting some solid Bash scripting foundations then the rest of the chapters would give you some real life examples and scripts.

About the author

My name is Bobby Iliev, and I have been working as a Linux DevOps Engineer since 2014. I am an avid Linux lover and supporter of the open-source movement philosophy. I am always doing that which I cannot do in order that I may learn how to do it, and I believe in sharing knowledge.

I think it's essential always to keep professional and surround yourself with good people, work hard, and be nice to everyone. You have to perform at a consistently higher level than others. That's the mark of a true professional.

For more information, please visit my blog at <https://bobbyiliev.com>, follow me on Twitter [@bobbyiliev_](#) and [YouTube](#).

Sponsors

This book is made possible thanks to these fantastic companies!

DigitalOcean

DigitalOcean is a cloud services platform delivering the simplicity developers love and businesses trust to run production applications at scale.

It provides highly available, secure, and scalable compute, storage, and networking solutions that help developers build great software faster.

Founded in 2012 with offices in New York and Cambridge, MA, DigitalOcean offers transparent and affordable pricing, an elegant user interface, and one of the largest libraries of open source resources available.

For more information, please visit <https://www.digitalocean.com> or follow [@digitalocean](#) on Twitter.

If you are new to DigitalOcean, you can get a free \$100 credit and spin up your own servers via this referral link here:

[Free \\$100 Credit For DigitalOcean](#)

DevDojo

The DevDojo is a resource to learn all things web development and web design. Learn on your lunch break or wake up and enjoy a cup of coffee with us to learn something new.

Join this developer community, and we can all learn together, build together, and grow together.

Join DevDojo

For more information, please visit <https://www.devdojo.com> or follow [@thedeveloper](#) on Twitter.

Introduction to Bash scripting

Welcome to this Bash basics training guide! In this **bash crash course**, you will learn the **Bash basics** so you could start writing your own Bash scripts and automate your daily tasks.

Bash is a Unix shell and command language. It is widely available on various operating systems and it is also the default command interpreter on most Linux systems.

Bash stands for Bourne-Again SHell. As with other shells, you can use bash interactively directly in your terminal, and also you can use Bash like any other programming language to write scripts.

In order to write Bash scripts, you just need a UNIX terminal and a text editor like Sublime Text, VS Code, or terminal-based editor like vim or nano.

Bash Structure

Let's start by creating a new file with a `.sh` extension, as an example we could create a file called `devdojo.sh`.

To create that file, you can use the `touch` command:

```
touch devdojo.sh
```

Or you can use your text editor instead:

```
nano devdojo.sh
```

In order to execute/run a bash script file with the bash shell interpreter, the first line of a script file must indicate the absolute path to the bash executable:

```
#!/bin/bash
```

This is also called a Shebang. All that the shebang does is to instruct the operating system to run the script with the `/bin/bash` executable.

Bash Hello World

Once we have our `devdojo.sh` file created and we've specified the bash shebang on the very first line, we are ready to create our first `Hello World` bash script.

To do that, open the `devdojo.sh` file again and add the following after the `#!/bin/bash` line:

```
#!/bin/bash  
  
echo "Hello World!"
```

Save the file and exit.

After that make the script executable by running:

```
chmod +x devdojo.sh
```

After that execute the file:

```
./devdojo.sh
```

You will see a "Hello Wolrd" message on the screen.

Another way to run the script would be:

```
bash devdojo.sh
```

As bash can be used interactively, you could run the following command directly in your terminal and you would get the same result:

```
echo "Hello DevDojo!"
```

Putting a script together is useful once you have to combine multiple commands together.

Bash Variables

As with any other programming language, you can use variables in bash as well. However, there are no data types and a variable in bash can contain numbers and characters.

To assign a value to a variable all you need to do is use the `=` sign:

```
name="DevDojo"
```

Notice: Note: as an important note, you can not have spaces before and after the `=` sign.

After that to access the variable, you have to use the `$` and reference it like this:

```
echo $name
```

Wrapping the variable name between curly brackets is not required but is considered good practice:

```
echo ${name}
```

The above would output: `DevDojo` as this is the value of our variable.

Next, let's update our `devdojo.sh` script and include a variable.

Again, with your favorite text editor open the file:

```
nano devdojo.sh
```

And update the file so it looks like this:

```
#!/bin/bash  
  
name="DevDojo"  
  
echo "Hi there $name"
```

Save it and run it again:

```
./devdojo.sh
```

You would see the following output on your screen:

```
Hi there DevDojo
```

Here is a rundown of the script:

- `#!/bin/bash` - first we specified our shebang
- `name=DevDojo` - then we specified a variable called `name` and assigned a value to it
- `echo "Hi there $name"` - finally we output the content of the variable on the screen by using `echo``

Bash User Input

With the previous script, we defined a variable and we output the value of the variable on the screen with the `echo $name`.

Now let's go ahead and ask the user for input instead. To do that again open the file with your favorite text editor and update the script as follows:

```
#!/bin/bash

echo "What is your name?"
read name

echo "Hi there $name"
echo "Welcome to DevDojo!"
```

The above will prompt the user for input, and then store that input as a string/text in a variable.

We can then use the variable and print a message back to them.

The output of the above script would be:

- First run the script:

```
./devdojo.sh
```

- Then you would be prompted to enter your name:


```
What is your name?  
Bobby
```

- Once you've typed your name just hit enter:

```
Hi there Bobby  
Welcome to DevDojo!
```

To reduce the code, we could change the first `echo` statement with the `read -p`, the `read` command used with `-p` flag will print a message before prompting the user for their input:

```
#!/bin/bash  
  
read -p "What is your name? " name  
  
echo "Hi there $name"  
echo "Welcome to DevDojo!"
```

Bash Comments

As with any other programming language you can add comments to your script. Comments are used to leave yourself notes through your code.

To do that in bash you need to add the `#` symbol at the beginning of the line. Comments will never be rendered on the screen.

Here is an example of a comment:

```
# This is a comment and will not be rendered on the screen
```

Let's go ahead and add some comments to our script:

```
#!/bin/bash

# Ask the user for their name

read -p "What is your name? " name

# Greet the user
echo "Hi there $name"
echo "Welcome to DevDojo!"
```

Bash Arguments

You can pass arguments to your shell script when you execute it. To pass an argument you just need to write it right after the name of your script. For example:

```
./devdojo.com your_argument
```

In the script, we can then use `$1` in order to reference the first argument that we specified.

If we pass a second argument it would be available as `$2` and so on.

Let's create a short script called `arguments.sh` as an example:

```
#!/bin/bash  
  
echo "Argument one is $1"  
echo "Argument two is $2"  
echo "Argument three is $3"
```

Save the file and make it executable:

```
chmod +x arguments.sh
```

Then run the file and pass 3 arguments:

```
./arguments.sh dog catbird
```

The output that you would get would be:

```
Argument one is dog
Argument two is cat
Argument three is bird
```

To reference all arguments you can use `$@`:

```
#!/bin/bash

echo "All arguments: $@"
```

If you run the script again:

```
./arguments.sh dog cat bird
```

You will get the following output:

```
All arguments: dog cat bird
```

Another thing that you need to keep in mind is that `$0` is used to reference the script itself.

This is a good way to create self destruct the file if you need to or just get the name of the script.

For example, let's create a script that prints out the name of the file and deletes the file after that:

```
#!/bin/bash
```

```
echo "The name of the file is: $0 and it is going to be self-  
deleted"
```

```
rm -f $0
```

Bash Arrays

If you have ever done any programming you are probably already familiar with arrays.

But just in case that you are not a developer, unlike variables, arrays can hold several values under one name.

You can initialize an array by assigning values divided by space and enclosed in `()`. Example:

```
my_array=("value 1" "value 2" "value 3" "value 4")
```

To access the elements in the array, you need to reference them by their numeric index.

Notice: Note: keep in mind that you need to use curly brackets.

- Access a single element, this would output: `value 2`

```
echo ${my_array[1]}
```

- This would return the last element: `value 4`

```
echo ${my_array[-1]}
```

- This would output the total number of elements in the array, in our

case it is 4:

```
echo ${my_array[@]}
```

Bash Conditional Expressions

In computer science, conditional statements, conditional expressions and conditional constructs are features of a programming language, which perform different computations or actions depending on whether a programmer-specified boolean condition evaluates to true or false.

In bash conditional expressions are used by the `[[` compound command and the `[]` builtin commands to test file attributes and perform string and arithmetic comparisons.

Here is a list with the most popular bash conditional expressions, you do not have to memorize them by hard, you can simply bookmark this page and reference back to this list whenever you need it!

File expressions

- True if file exists.

```
[[ -a ${file} ]]
```

- True if file exists and is a block special file.

```
[[ -b ${file} ]]
```

*True if file exists and is a character special file.

```
[[ -c ${file} ]]
```

- True if file exists and is a directory.

```
[[ -d ${file} ]]
```

- True if file exists.

```
[[ -e ${file} ]]
```

- True if file exists and is a regular file.

```
[[ -f ${file} ]]
```

- True if file exists and is a symbolic link.

```
[[ -h ${file} ]]
```

- True if file exists and is readable.

```
[[ -r ${file} ]]
```

- True if file exists and has a size greater than zero.

```
[[ -s ${file} ]]
```

- True if file exists and is writable.

```
[[ -w ${file} ]]
```

- True if file exists and is executable.

```
[[ -x ${file} ]]
```

- True if file exists and is a symbolic link.

```
[[ -L ${file} ]]
```

String expressions

- True if the shell variable varname is set (has been assigned a value).

```
[[ -v ${varname} ]]
```

True if the length of the string is zero.

```
[[ -z ${string} ]]
```

True if the length of the string is non-zero.

```
[[ -n ${string} ]]
```

- True if the strings are equal. = should be used with the test command for POSIX conformance. When used with the [[command, this performs pattern matching as described above (Compound Commands).

```
[[ ${string1} == ${string2} ]]
```

- True if the strings are not equal.

```
[[ ${string1} != ${string2} ]]
```

- True if string1 sorts before string2 lexicographically.

```
[[ ${string1} < ${string2} ]]
```

- True if string1 sorts after string2 lexicographically.

```
[[ ${string1} > ${string2} ]]
```

Arithmetic operators

- Returns true if the numbers are **equal**

```
[[ ${arg1} -eq ${arg2} ]]
```

- Returns true if the numbers are **not equal**

```
[[ ${arg1} -ne ${arg2} ]]
```

- Returns true if arg1 is **less than** arg2

```
[[ ${arg1} -lt ${arg2} ]]
```

- Returns true if arg1 is **less than or equal** arg2

```
[[ ${arg1} -le ${arg2} ]]
```

- Returns true if arg1 is **greater than** arg2

```
[[ ${arg1} -gt ${arg2} ]]
```

- Returns true if arg1 is **greater than or equal** arg2

```
[[ ${arg1} -ge ${arg2} ]]
```

As a side note, arg1 and arg2 may be positive or negative integers.

As with other programming languages you can use **AND** & **OR** conditions:

```
[[ test_case_1 ]] && [[ test_case_2 ]] # And  
[[ test_case_1 ]] || [[ test_case_2 ]] # Or
```

Bash Conditionals

In the last section we covered some of the most popular conditional expressions, we can now use them with standard conditional statements like `if` and `if-else` statements.

The format of an `if` statement in bash is as follows:

```
if [[ some_test ]]
then
    <commands>
fi
```

We can then combine this with the conditional expressions from the previous section as follows:

```
#!/bin/bash

# Bash if statement example

read -p "What is your name? " name

if [[ -z ${name} ]]
then
    echo "Please enter your name!"
else
    echo "Hi there ${name}"
fi
```

You can use the above if statement with all of the conditional expressions from the previous section!

```
#!/bin/bash

admin="devdojo"

read -p "Enter your username? " username

# Check if the username provided is the admin

if [[ "${username}" == "${admin}" ]] ; then
    echo "You are the admin user!"
else
    echo "You are NOT the admin user!"
fi
```


Bash Loops

As with any other language, loops are very useful. With bash you can use `for` loops, `while` loops and `until` loops.

For loops

Here is the structure of a for loop:

```
for var in ${list}
do
    your_commands
done
```

Example:

```
#!/bin/bash

users="devdojo, bobby, tony"

for user in ${users}
do
    echo "${user}"
done
```

You can also use `for` to process a series of numbers, for example here is one way to loop through from 1 to 10:

```
#!/bin/bash

for num in {1..10}
do
    echo ${num}
done
```

While loops

The structure of a while loop is quite similar to the `for` loop:

```
while [ your_condition ]
do
    your_conditions
done
```

Example:

```
#!/bin/bash

counter=1
while [[ $counter -le 10 ]]
do
    echo $counter
    ((counter++))
done
```

Let's create a script that asks the user for their name and not allow an empty input:

```
#!/bin/bash

read -p "What is your name? " name

while [[ -z ${name} ]]
do
    echo "Your name can not be blank, please enter a valid name!"
    read -p "Enter your name again? " name
done

echo "Hi there ${name}"
```

Now if you run the above and just press enter without providing input, the loop would run again and ask you for your name again and again until you actually provide an input.

Until Loops

The difference between `until` and `while` loops is that the `until` loop will run the commands within the loop until the condition becomes true.

Structure:

```
until [ your_condition ]  
do  
    your_commands  
done
```

Example:

```
#!/bin/bash  
  
count=1  
until [ $count -gt 10 ]  
do  
    echo $count  
    ((count++))  
done
```

Continue and Break

As with other languages you can use `continue` and `break` with your bash scripts as well:

- `continue` tells your bash script to stop the current iteration of the loop and start the next iteration
- `break` tells your bash script to end the loop straight away

Bash Functions

Functions are a great way to reuse code. The structure of a function in bash is quite similar to most languages:

```
function function_name() {  
    your_commands  
}
```

You can also omit the `function` keyword in the beginning which would also work:

```
function_name() {  
    your_commands  
}
```

I prefer putting it there for better readability.

Example of a "Hello World!" function:

```
#!/bin/bash  
  
function hello(){  
    echo "Hello World Function!"  
}  
  
hello
```

One thing to keep in mind is that when you call the function, you should not add the parenthesis.

Passing arguments to a function works in the same way as passing arguments to a script:

```
#!/bin/bash

function hello(){
    echo "Hello $1!"
}

hello DevDojo
```


Debugging and testing

In order to debug your bash scripts, you can use `-x` when executing your scripts:

```
bash -x ./your_script.sh
```

Or you can add `set -x` before the specific line that you want to debug, `set -x` enables a mode of the shell where all executed commands are printed to the terminal.

Another way to test your scripts is to use this amazing tool here:

<https://www.shellcheck.net/>

Just copy and paste your script into the textbox and the tool will give you some suggestions on how you can improve your script.

You can also run the tool directly in your terminal:

<https://github.com/koalaman/shellcheck>

Creating custom bash commands

As a developer or system administrator, you might have to spend a lot of time in your terminal. I always try to look for ways to optimize any repetitive tasks.

One way to do that is to either write short bash scripts or create custom commands also known as aliases. For example, rather than typing a really long command every time you could just create a short cut for it.

Example

Let's start with the following scenario, as a system admin, you might have to check the connections to your web server quite often, so I will use the `netstat` command as an example.

What I would usually do when I access a server that is having issues with the connections to port 80 or 443 is to check if there are any services listening on those ports and the number of connections to the ports.

The following `netstat` command would show us how many TCP connections on port 80 and 443 we currently have:

```
netstat -plant | grep '80\|443' | grep -v LISTEN | wc -l
```

This is quite a lengthy command so typing it every time might be time-consuming in the long run especially when you want to get that information quickly.

To avoid that, we can create an alias, so rather than typing the whole command, we could just type a short command instead. For example, let's say that we wanted to be able to type `conn` (short for connections) and get the same information. All we need to do in this case is to run the following command:

```
alias conn="netstat -plant | grep '80\|443' | grep -v LISTEN | wc -l"
```

That way we are creating an alias called `conn` which would essentially be a 'short cut' for our long `netstat` command. Now if you run just `conn`:

```
conn
```

You would get the same output as the long `netstat` command. You can get even more creative and add some info messages like this one here:

```
alias conn="echo 'Total connections on port 80 and 443:' ;  
netstat -plant | grep '80\|443' | grep -v LISTEN | wc -l"
```

Now if you run `conn` you would get the following output:

```
Total connections on port 80 and 443:  
12
```

Now if you log out and log back in, your alias would be lost. In the next step you will see how to make this persistent.

Making the change persistent

In order to make the change persistent, we need to add the `alias` command in our shell profile file.

By default on Ubuntu this would be the `~/.bashrc` file, for other operating systems this might be the `~/.bash_profile`. With your favorite text editor open the file:

```
nano ~/.bashrc
```

Go to the bottom and add the following:

```
alias conn="echo 'Total connections on port 80 and 443:' ;  
netstat -plant | grep '80\|443' | grep -v LISTEN | wc -l"
```

Save and then exit.

That way now even if you log out and log back in again your change would be persisted and you would be able to run your custom bash command.

Listing all of the available aliases

To list all of the available aliases for your current shell, you have to just run the following command:

```
alias
```

This would be handy in case that you are seeing some weird behavior with some commands.

Conclusion

This is one way of creating custom bash commands or bash aliases.

Of course, you could actually write a bash script and add the script inside your `/usr/bin` folder, but this would not work if you don't have root or sudo access, whereas with aliases you can do it without the need of root access.

Notice: Note: This was initially posted on [DevDojo.com](https://devdojo.com)

Write your first Bash script

Let's try to put together what we've learned so far and create our first Bash script!

Planning the script

As an example, we will write a script that would gather some useful information about our server like:

- Current Disk usage
- Current CPU usage
- Current RAM usage
- Check the exact Kernel version

Feel free to adjust the script by adding or removing functionality so that it matches your needs.

Writing the script

The first thing that you need to do is to create a new file with a `.sh` extension. I will create a file called `status.sh` as the script that we will create would give us the status of our server.

Once you've created the file, open it with your favorite text editor.

As we've learned in chapter 1, on the very first line of our Bash script we need to specify the so-called Shebang:

```
#!/bin/bash
```

All that the shebang does is to instruct the operating system to run the script with the `/bin/bash` executable.

Adding comments

Next, as discussed in chapter 6, let's start by adding some comments so that people could easily figure out what the script is used for. To do that right after the shebang you can just add the following:

```
#!/bin/bash  
  
# Script that returns the current server status
```

Adding your first variable

Then let's go ahead and apply what we've learned in chapter 4 and add some variables which we might want to use throughout the script.

To assign a value to a variable in bash, you just have to use the `=` sign. For example, let's store the hostname of our server in a variable so that we could use it later:

```
server_name=$(hostname)
```

By using `$()` we tell bash to actually interpret the command and then assign the value to our variable.

Now if we were to echo out the variable we would see the current hostname:

```
echo $server_name
```

Adding your first function

As you already know after reading chapter 12, in order to create a function in bash you need to use the following structure:

```
function function_name() {  
    your_commands  
}
```

Let's create a function that returns the current memory usage on our server:

```
function memory_check() {  
    echo ""  
    echo "The current memory usage on ${server_name} is: "  
    free -h  
    echo ""  
}
```

Quick run down of the function:

- `function memory_check() {` - this is how we define the function
- `echo ""` - here we just print a new line
- `echo "The current memory usage on ${server_name} is: "` - here we print all a small message and the `$server_name` variable
- `}` - finally this is how we close the function

Then once the function has been defined, in order to call it, just use the name of the function:

```
# Define the function
function memory_check() {
    echo ""
    echo "The current memory usage on ${server_name} is: "
    free -h
    echo ""
}

# Call the function
memory_check
```

Adding more functions challenge

Before checking out the solution, I would challenge you to use the function from above and write a few functions by yourself.

The functions should do the following:

- Current Disk usage
- Current CPU usage
- Current RAM usage
- Check the exact Kernel version

Feel free to use google if you are not sure what commands you need to use in order to get that information.

Once you are ready, feel free to scroll down and check how we've done it and compare the results!

Note that there are multiple correct ways of doing it!

The sample script

Here's what the end result would look like:

```
#!/bin/bash

##
# BASH script that checks:
#   - Memory usage
#   - CPU load
#   - Number of TCP connections
#   - Kernel version
##

server_name=$(hostname)

function memory_check() {
    echo ""
    echo "Memory usage on ${server_name} is: "
    free -h
    echo ""
}

function cpu_check() {
    echo ""
    echo "CPU load on ${server_name} is: "
    echo ""
    uptime
    echo ""
}

function tcp_check() {
    echo ""
    echo "TCP connections on ${server_name}: "
    echo ""
    cat /proc/net/tcp | wc -l
    echo ""
}

function kernel_check() {
    echo ""
    echo "Kernel version on ${server_name} is: "
    echo ""
}
```



```
        uname -r
    echo ""
}

function all_checks() {
    memory_check
    cpu_check
    tcp_check
    kernel_check
}

all_checks
```

Conclusion

Bash scripting is awesome! No matter if you are a DevOps/SysOps engineer, developer, or just a Linux enthusiast, you can use Bash scripts to combine different Linux commands and automate boring and repetitive daily tasks, so that you can focus on more productive and fun things!

Notice: Note: This was initially posted on [DevDojo.com](https://devdojo.com)

Creating an interactive menu in Bash

In this tutorial, I will show you how to create a multiple-choice menu in Bash so that your users could choose between what action should be executed!

We would reuse some of the code from the previous chapter, so if you have not read it yet make sure to do so.

Planning the functionality

Let's start again by going over the main functionality of the script:

- Checks the current Disk usage
- Checks the current CPU usage
- Checks the current RAM usage
- Checks the check the exact Kernel version

In case that you don't have it on hand, here is the script itself:

```
#!/bin/bash

##
# BASH menu script that checks:
#   - Memory usage
#   - CPU load
#   - Number of TCP connections
#   - Kernel version
##

server_name=$(hostname)

function memory_check() {
    echo ""
    echo "Memory usage on ${server_name} is: "
    free -h
    echo ""
}

function cpu_check() {
    echo ""
    echo "CPU load on ${server_name} is: "
    echo ""
    uptime
    echo ""
}

function tcp_check() {
    echo ""
    echo "TCP connections on ${server_name}: "
```

```
    echo ""
    cat /proc/net/tcp | wc -l
    echo ""
}

function kernel_check() {
    echo ""
    echo "Kernel version on ${server_name} is: "
    echo ""
    uname -r
    echo ""
}

function all_checks() {
    memory_check
    cpu_check
    tcp_check
    kernel_check
}
```

We will then build a menu that allows the user to choose which function to be executed.

Of course, you can adjust the function or add new ones depending on your needs.

Adding some colors

In order to make the menu a bit more 'readable' and easy to grasp at first glance, we will add some color functions.

At the beginning of your script add the following color functions:

```
##  
# Color Variables  
##  
green='\e[32m'  
blue='\e[34m'  
clear='\e[0m'  
  
##  
# Color Functions  
##  
  
ColorGreen(){  
    echo -ne $green$1$clear  
}  
ColorBlue(){  
    echo -ne $blue$1$clear  
}
```

You can use the color functions as follows:

```
echo -ne $(ColorBlue 'Some text here')
```

The above would output the **Some text here** string and it would be blue!

Adding the menu

Finally, to add our menu, we will create a separate function with a case switch for our menu options:

```
menu(){
echo -ne "
My First Menu
$(ColorGreen '1') Memory usage
$(ColorGreen '2') CPU load
$(ColorGreen '3') Number of TCP connections
$(ColorGreen '4') Kernel version
$(ColorGreen '5') Check All
$(ColorGreen '0') Exit
$(ColorBlue 'Choose an option:') "
    read a
    case $a in
        1) memory_check ; menu ;;
        2) cpu_check ; menu ;;
        3) tcp_check ; menu ;;
        4) kernel_check ; menu ;;
        5) all_checks ; menu ;;
        0) exit 0 ;;
        *) echo -e $red"Wrong option."$clear;
WrongCommand;;
    esac
}
```

A quick rundown of the code

First we just echo out the menu options with some color:

```

echo -ne "
My First Menu
$(ColorGreen '1') Memory usage
$(ColorGreen '2') CPU load
$(ColorGreen '3') Number of TCP connections
$(ColorGreen '4') Kernel version
$(ColorGreen '5') Check All
$(ColorGreen '0') Exit
$(ColorBlue 'Choose an option:') "

```

Then we read the answer of the user and store it in a variable called `$a`:

```

read a

```

Finally, we have a switch case which triggers a different function depending on the value of `$a`:

```

    case $a in
        1) memory_check ; menu ;;
        2) cpu_check ; menu ;;
        3) tcp_check ; menu ;;
        4) kernel_check ; menu ;;
        5) all_checks ; menu ;;
        0) exit 0 ;;
        *) echo -e $red"Wrong option."$clear;
WrongCommand;;
    esac

```

At the end we need to call the menu function to actually print out the menu:

```

# Call the menu function
menu

```


Testing the script

In the end, your script will look like this:

```
#!/bin/bash

##
# BASH menu script that checks:
#   - Memory usage
#   - CPU load
#   - Number of TCP connections
#   - Kernel version
##

server_name=$(hostname)

function memory_check() {
    echo ""
    echo "Memory usage on ${server_name} is: "
    free -h
    echo ""
}

function cpu_check() {
    echo ""
    echo "CPU load on ${server_name} is: "
    echo ""
    uptime
    echo ""
}

function tcp_check() {
    echo ""
    echo "TCP connections on ${server_name}: "
    echo ""
    cat /proc/net/tcp | wc -l
    echo ""
}

function kernel_check() {
    echo ""
    echo "Kernel version on ${server_name} is: "
    echo ""
}
```

```

        uname -r
    echo ""
}

function all_checks() {
    memory_check
    cpu_check
    tcp_check
    kernel_check
}

##
# Color Variables
##
green='\e[32m'
blue='\e[34m'
clear='\e[0m'

##
# Color Functions
##

ColorGreen(){
    echo -ne $green$1$clear
}
ColorBlue(){
    echo -ne $blue$1$clear
}

menu(){
    echo -ne "
My First Menu
$(ColorGreen '1') Memory usage
$(ColorGreen '2') CPU load
$(ColorGreen '3') Number of TCP connections
$(ColorGreen '4') Kernel version
$(ColorGreen '5') Check All
$(ColorGreen '0') Exit
$(ColorBlue 'Choose an option:') "
    read a
    case $a in
        1) memory_check ; menu ;;
        2) cpu_check ; menu ;;
        3) tcp_check ; menu ;;
        4) kernel_check ; menu ;;
        5) all_checks ; menu ;;

```

```

        0) exit 0 ;;
        *) echo -e $red"Wrong option."$clear;
WrongCommand;;
        esac
    }

    # Call the menu function
    menu

```

To test the script, create a new file with a `.sh` extension, for example: `menu.sh` and then run it:

```
bash menu.sh
```

The output that you would get will look like this:

```

My First Menu
1) Memory usage
2) CPU load
3) Number of TCP connections
4) Kernel version
5) Check All
0) Exit
Choose an option:

```

You will be able to choose a different option from the list and each number will call a different function from the script:

```

My First Menu
1) Memory usage
2) CPU load
3) Number of TCP connections
4) Kernel version
5) Check All
0) Exit
Choose an option: 1

Memory usage on bobbyiliev is:
      total      used      free      shared  buff/cache   available
Mem:    983Mi    406Mi    85Mi       13Mi       491Mi       388Mi
Swap:   1.0Gi    336Mi    687Mi

My First Menu
1) Memory usage
2) CPU load
3) Number of TCP connections
4) Kernel version
5) Check All
0) Exit
Choose an option: 

```

Conclusion

You now know how to create a Bash menu and implement it in your scripts so that users could select different values!

Notice: Note: This content was initially posted on [DevDojo.com](https://devdojo.com)

Executing BASH scripts on Multiple Remote Servers

Any command that you can run from the command line can be used in a bash script. Scripts are used to run a series of commands. Bash is available by default on Linux and macOS operating systems.

Let's have a hypothetical scenario where you need to execute a BASH script on multiple remote servers, but you don't want to manually copy the script to each server, then again login to each server individually and only then execute the script.

Of course you could use a tool like Ansible but lets learn how to do that with Bash!

Prerequisites

For this example I will use 3 remote Ubuntu servers deployed on DigitalOcean. If you don't have a Digital Ocean account yet, you can sign up for DigitalOcean and get \$100 free credit via this referral link here:

<https://m.do.co/c/2a9bba940f39>

Once you have your Digital Ocean account ready go ahead and deploy 3 droplets.

I've gone ahead and created 3 Ubuntu servers:



Learning

Class project / Educational purposes

Resources

Activity

Settings

DROPLETS (3)

•  dev001

•  dev003

•  dev002

I'll put those servers IP's in a `servers.txt` file which I would use to loop through with our Bash script.

If you are new to DigitalOcean you can follow the steps on how to create a Droplet here:

- [How to Create a Droplet from the DigitalOcean Control Panel](#)

You can also follow the steps from this video here on how to do your initial server setup:

- [How to do your Initial Server Setup with Ubuntu](#)

Or even better, you can follow this article here on how to automate your initial server setup with Bash:

[Automating Initial Server Setup with Ubuntu 18.04 with Bash](#)

With the 3 new servers in place, we can go ahead and focus on running our Bash script on all of them with a single command!

The BASH Script

I will reuse the demo script from the previous chapter with some slight changes. It simply executes a few checks like the current memory usage, the current CPU usage, the number of TCP connections and the version of the kernel.

```
#!/bin/bash

##
# BASH script that checks the following:
#   - Memory usage
#   - CPU load
#   - Number of TCP connections
#   - Kernel version
##

##
# Memory check
##
server_name=$(hostname)

function memory_check() {
    echo "#####"
    echo "The current memory usage on ${server_name} is: "
    free -h
    echo "#####"
}

function cpu_check() {
    echo "#####"
    echo "The current CPU load on ${server_name} is: "
    echo ""
    uptime
    echo "#####"
}

function tcp_check() {
    echo "#####"
    echo "Total TCP connections on ${server_name}: "
    echo ""
}
```

```

        cat /proc/net/tcp | wc -l
    echo "#####"
}

function kernel_check() {
    echo "#####"
    echo "The exact Kernel version on ${server_name} is: "
    echo ""
    uname -r
    echo "#####"
}

function all_checks() {
    memory_check
    cpu_check
    tcp_check
    kernel_check
}

all_checks

```

Copy the code bellow and add this in a file called `remote_check.sh`. You can also get the script from [here](#).

Running the Script on all Servers

Now that we have the script and the servers ready and that we've added those servers in our servers.txt file we can run the following command to loop through all servers and execute the script remotely without having to copy the script to each server and individually connect to each server.

```
for server in $(cat servers.txt) ; do ssh your_user@${server}  
'bash -s' < ./remote_check.sh ; done
```

What this for loop does is, it goes through each server in the servers.txt file and then it runs the following command for each item in the list:

```
ssh your_user@the_server_ip 'bash -s' < ./remote_check.sh
```

You would get the following output:

```

biliev@bobby-mac:~/devdojo$ for server in $(cat servers.txt ; do ssh root@{server} 'bash -s' < ./remote_check.sh
#####
The current memory usage on dev001 is:
#####
#####
#####
The current CPU load on dev001 is:

  16:08:17 up 7 min,  0 users,  load average: 0.16, 0.04, 0.01
#####
#####
Total TCP connections on dev001:

4
#####
#####
The exact Kernel version on dev001 is:

4.15.0-52-generic
#####
#####
The current memory usage on dev003 is:
#####
#####
#####
The current CPU load on dev003 is:

  16:08:20 up 7 min,  0 users,  load average: 0.00, 0.05, 0.04
#####
#####
Total TCP connections on dev003:

4
#####
#####
The exact Kernel version on dev003 is:

4.15.0-52-generic
#####

```

Our Bash Script

List with server IPs

Conclusion

This is just a really simple example on how to execute a simple script on multiple servers without having to copy the script to each server and without having to access the servers individually.

Of course you could run a much more complex script and on many more servers.

If you are interested in automation, I would recommend checking out the Ansible resources page on the DigitalOcean website:

[Ansible Resources](#)

Notice: This content was initially posted on [DevDojo](#)

Work with JSON in BASH using jq

The **jq** command-line tool is a lightweight and flexible command-line **JSON** processor. It is great for parsing JSON output in BASH.

One of the great things about **jq** is that it is written in portable C, and it has zero runtime dependencies. All you need to do is to download a single binary or use a package manager like apt and install it with a single command.

Planning the script

For the demo in this tutorial, I would use an external REST API that returns a simple JSON output called the [QuizAPI](https://quizapi.io/):

<https://quizapi.io/>

If you want to follow along make sure to get a free API key here:

<https://quizapi.io/clientarea/settings/token>

The QuizAPI is free for developers.

Installing jq

There are many ways to install **jq** on your system. One of the most straight forward ways to do so is to use the package manager depending on your OS.

Here is a list of the commands that you would need to use depending on your OS:

- Install jq on Ubuntu/Debian:

```
sudo apt-get install jq
```

- Install jq on Fedora:

```
sudo dnf install jq
```

- Install jq on openSUSE:

```
sudo zypper install jq
```

- Install jq on Arch:

```
sudo pacman -S jq
```

- Installing on Mac with Homebrew:

```
brew install jq
```

- Install on Mac with MacPort:

```
port install jq
```

If you are using other OS, I would recommend taking a look at the official documentation here for more information:

<https://stedolan.github.io/jq/download/>

Once you have jq installed you can check your current version by running this command:

```
jq --version
```

Parsing JSON with jq

Once you have `jq` installed and your QuizAPI API Key, you can parse the JSON output of the QuizAPI directly in your terminal.

First, create a variable that stores your API Key:

API_KEY=YOUR_API_KEY_HERE

In order to get some output from one of the endpoints of the QuizAPI you can use the curl command:

```
curl
"https://quizapi.io/api/v1/questions?apiKey=${API_KEY}&limit=1
0"
```

For a more specific output, you can use the QuizAPI URL Generator [here](#):

<https://quizapi.io/api-config>

After running the curl command, the output which you would get would look like this:

[illegible]

This could be quite hard to read, but thanks to the `jq` command-line tool, all we need to do is pipe the `curl` command to `jq` and we would see

a nice formatted JSON output:

```
curl
"https://quizapi.io/api/v1/questions?apiKey=${API_KEY}&limit=1
0" | jq
```

Note the `| jq` at the end.

In this case the output that you would get would look something like this:

```
[
  {
    "id": 475,
    "question": "How can you make A bulleted list with numbers?",
    "description": null,
    "answers": {
      "answer_a": "<dl>",
      "answer_b": "<ul>",
      "answer_c": "<ol>",
      "answer_d": "<list>",
      "answer_e": null,
      "answer_f": null
    },
    "multiple_correct_answers": "false",
    "correct_answers": {
      "answer_a_correct": "false",
      "answer_b_correct": "false",
      "answer_c_correct": "true",
      "answer_d_correct": "false",
      "answer_e_correct": "false",
      "answer_f_correct": "false"
    },
    "correct_answer": "answer_a",
    "explanation": null,
    "tip": null,
    "tags": [
      {
        "name": "HTML"
      }
    ],
    "category": "Code",
    "difficulty": "Easy"
  },
  {
    "id": 804,
    "question": "Suppose you have 3 containers running and out of these, you wish to access one of them. How do you access a running container?",
    "description": null,
    "answers": {
      "answer_a": "$ docker exec it <container id> bash",
      "answer_b": "$ docker exec --it <container id>",
      "answer_c": "$ docker exec -it <container id> bash",
      "answer_d": null,
      "answer_e": null,
      "answer_f": null
    },
    "multiple_correct_answers": "false",
    "correct_answers": {
      "answer_a_correct": "false",
      "answer_b_correct": "false",
      "answer_c_correct": "true",

```

Now, this looks much nicer! The `jq` command-line tool formatted the output for us and added some nice coloring!

Getting the first element with jq

Let's say that we only wanted to get the first element from the JSON output, in order to do that we have to just specify the index that we want to see with the following syntax:

```
jq .[0]
```

Now, if we run the curl command again and pipe the output to jq .[0] like this:

```
curl
"https://quizapi.io/api/v1/questions?apiKey=${API_KEY}&limit=1
0" | jq.[0]
```

You will only get the first element and the output will look like this:

```
{
  "id": 792,
  "question": "What is Hypervisor?",
  "description": null,
  "answers": {
    "answer_a": "A hypervisor is a software that makes virtualization possible. It is also called Virtual Machine Monitor.",
    "answer_b": "A hypervisor is a hardware that makes optimization possible. It is also called Virtual Machine Monitor.",
    "answer_c": "A hypervisor is a software that makes optimization possible. It is also called Virtual Machine Monitor.",
    "answer_d": null,
    "answer_e": null,
    "answer_f": null
  },
  "multiple_correct_answers": "false",
  "correct_answers": {
    "answer_a_correct": "true",
    "answer_b_correct": "false",
    "answer_c_correct": "false",
    "answer_d_correct": "false",
    "answer_e_correct": "false",
    "answer_f_correct": "false"
  },
  "correct_answer": "answer_a",
  "explanation": null,
  "tip": null,
  "tags": [
    {
      "name": "Docker"
    }
  ],
  "category": "Docker",
  "difficulty": "Easy"
}
```

Getting a value only for specific key

Sometimes you might want to get only the value of a specific key only, let's say in our example the QuizAPI returns a list of questions along with the answers, description and etc. but what if you wanted to get the Questions only without the additional information?

This is going to be quite straight forward with `jq`, all you need to do is add the key after `jq` command, so it would look something like this:

```
jq .[].question
```

We have to add the `.[]` as the QuizAPI returns an array and by specifying `.[]` we tell `jq` that we want to get the `.question` value for all of the elements in the array.

The output that you would get would look like this:

```
"To use 'mysqldbcopy' which privileges are required on the source server?"  
"Each virtual machine includes the application, the necessary binaries and  
"The GROUP BY command cannot be used with aggregate functions together"  
"Which command can be used to make variables of shell to be made available  
"To program additional authentication logic besides available authenticator  
"Tags and test that are not directly displayed on the page are written in  
"What is Solaris?"  
"Kubernetes cluster data is stored in which of the following?"  
"Which command can you use to re-execute a previous command?"  
"You can add a row using SQL in a database with which of the following?"
```

As you can see we now only get the questions without the rest of the values.

Using jq in a BASH script

Let's go ahead and create a small bash script which should output the following information for us:

- Get only the first question from the output
- Get all of the answers for that question
- Assign the answers to variables
- Print the question and the answers
- To do that I've put together the following script:

Notice: Note: make sure to change the API_KEY part with your actual QuizAPI key:

```
#!/bin/bash

##
# Make an API call to QuizAPI and store the output in a
variable
##
output=$(curl
'https://quizapi.io/api/v1/questions?apiKey=API_KEY&limit=10'
2>/dev/null)

##
# Get only the first question
##
output=$(echo $output | jq .[0])

##
# Get the question
##
question=$(echo $output | jq .question)

##
# Get the answers
##

answer_a=$(echo $output | jq .answers.answer_a)
answer_b=$(echo $output | jq .answers.answer_b)
answer_c=$(echo $output | jq .answers.answer_c)
answer_d=$(echo $output | jq .answers.answer_d)

##
# Output the question
##

echo "
Question: ${question}

A) ${answer_a}
B) ${answer_b}
C) ${answer_c}
D) ${answer_d}

"
```

If you run the script you would get the following output:


```
Question: "Which of the answers listed below refers to a package management system most often used on Debian"
A) "kde"
B) "apt"
C) "yum"
D) "rpm"
```

We can even go further by making this interactive so that we could actually choose the answer directly in our terminal.

There is already a bash script that does this by using the QuizAPI and `jq`:

You can take a look at that script here:

- <https://github.com/QuizApi/QuizAPI-BASH/blob/master/quiz.sh>

Conclusion

The **jq** command-line tool is an amazing tool that gives you the power to work with JSON directly in your BASH terminal.

That way you can easily interact with all kinds of different REST APIs with BASH.

For more information, you could take a look at the official documentation here:

- <https://stedolan.github.io/jq/manual/>

And for more information on the **QuizAPI**, you could take a look at the official documentation here:

- <https://quizapi.io/docs/1.0/overview>

Notice: Note: This content was initially posted on [DevDojo.com](https://devdojo.com)

Working with Cloudflare API with Bash

I host all of my websites on **DigitalOcean** Droplets and I also use Cloudflare as my CDN provider. One of the benefits of using Cloudflare is that it reduces the overall traffic to your user and also hides your actual server IP address behind their CDN.

My personal favorite Cloudflare feature is their free DDoS protection. It has saved my servers multiple times from different DDoS attacks. They have a cool API that you could use to enable and disable their DDoS protection easily.

This chapter is going to be an exercise! I challenge you to go ahead and write a short bash script that would enable and disable the Cloudflare DDoS protection for your server automatically if needed!

Prerequisites

Before following this guide here, please set up your Cloudflare account and get your website ready. If you are not sure how to do that you can follow these steps here: [Create a Cloudflare account and add a website](#).

Once you have your Cloudflare account, make sure to obtain the following information:

- A Cloudflare account
- Cloudflare API key
- Cloudflare Zone ID

Also, Make sure curl is installed on your server:

```
curl --version
```

If curl is not installed you need to run the following:

- For RedHat/CentOs:

```
yum install curl
```

- For Debian/Ubuntu

```
apt-get install curl
```

Challenge - Script requirements

The script needs to monitor the CPU usage on your server and if the CPU usage gets high based on the number vCPU it would enable the Cloudflare DDoS protection automatically via the Cloudflare API.

The main features of the script should be:

- Checks the script CPU load on the server
- In case of a CPU spike the script triggers an API call to Cloudflare and enables the DDoS protection feature for the specified zone
- After the CPU load is back to normal the script would disable the "I'm under attack" option and set it back to normal

Example script

I already have prepared a demo script which you could use as a reference. But I encourage you to try and write the script yourself first and only then take a look at my script!

To download the script just run the following command:

```
wget
https://raw.githubusercontent.com/bobbyiliev/cloudflare-ddos-p
rotection/main/protection.sh
```

Open the script with your favorite text editor:

```
nano protection.sh
```

And update the following details with your Cloudflare details:

```
CF_ZONE_ID=YOUR_CF_ZONE_ID
CF_EMAIL_ADDRESS=YOUR_CF_EMAIL_ADDRESS
CF_API_KEY=YOUR_CF_API_KEY
```

After that make the script executable:

```
chmod +x ~/protection.sh
```

Finally, set up 2 Cron jobs to run every 30 seconds. To edit your crontab run:

```
crontab -e
```

And add the following content:

```
* * * * * /path-to-the-script/cloudflare/protection.sh  
* * * * * ( sleep 30 ; /path-to-the-  
script/cloudflare/protection.sh )
```

Note that you need to change the path to the script with the actual path where you've stored the script at.

Conclusion

This is quite straight forward and budget solution, one of the downsides of the script is that if your server gets unresponsive due to an attack, the script might not be triggered at all.

Of course, a better approach would be to use a monitoring system like Nagios and based on the statistics from the monitoring system then you can trigger the script, but this script challenge could be a good learning experience!

Notice: This content was initially posted on [DevDojo](#)

BASH Script parser to Summarize Your NGINX and Apache Access Logs

One of the first things that I would usually do in case I notice a high CPU usage on some of my Linux servers would be to check the process list with either top or htop and in case that I notice a lot of Apache or Nginx process I would quickly check my access logs to determine what has caused or is causing the CPU spike on my server or to figure out if anything malicious is going on.

Sometimes reading the logs could be quite intimidating as the log might be huge and going through it manually could take a lot of time. Also, the raw log format could be confusing for people with less experience.

Just like the previous chapter, this chapter is going to be a challenge! You need to write a short bash script that would summarize the whole access log for you without the need of installing any additional software.

Script requirements

This BASH script needs to parse and summarize your access logs and provide you with very useful information like:

- The 20 top pages with the most POST requests
- The 20 top pages with the most GET requests
- Top 20 IP addresses and their geo-location

Example script

I already have prepared a demo script which you could use as a reference. But I encourage you to try and write the script yourself first and only then take a look at my script!

In order to download the script, you can either clone the repository with the following command:

```
git clone  
https://github.com/bobbyiliev/quick_access_logs_summary.git
```

Or run the following command which would download the script in your current directory:

```
wget  
https://raw.githubusercontent.com/bobbyiliev/quick_access_logs_summary/master/spike_check
```

The script does not make any changes to your system, it only reads the content of your access log and summarizes it for you, however, once you've downloaded the file, make sure to review the content yourself.

Running the script

All that you have to do once the script has been downloaded is to make it executable and run it.

To do that run the following command to make the script executable:

```
chmod +x spike_check
```

Then run the script:

```
./spike_check /path/to/your/access_log
```

Make sure to change the path to the file with the actual path to your access log. For example if you are using Apache on an Ubuntu server, the exact command would look like this:

```
./spike_check /var/log/apache2/access.log
```

If you are using Nginx the exact command would be almost the same, but with the path to the Nginx access log:

```
./spike_check /var/log/nginx/access.log
```

Understanding the output

Once you run the script, it might take a while depending on the size of the log.

The output that you would see should look like this:

```
[root@bobby quick_access_logs_summary]# ./spike_check bobby.log
Summarizing log..
This might take a while depending on the size of the log

Top 20 GET requests:
16 GET /blog/feed
16 GET /robots.txt
16 GET /roots.php
16 GET /wp-content/themes/nervaq/js/jquery.flexslider.min.js
96 GET /6avision/wp-content/themes/Lucid/images/widget-grey-bullet.png

Most Recent top 20 GET requests:
16 GET /blog/feed
16 GET /robots.txt
16 GET /roots.php
16 GET /wp-content/themes/nervaq/js/jquery.flexslider.min.js
96 GET /6avision/wp-content/themes/Lucid/images/widget-grey-bullet.png

Top 20 POST requests for:
16 POST /wp-cron.php
16 POST /xmlrpc.php

Most Recent top 20 POST requests:
16 POST /wp-cron.php
16 POST /xmlrpc.php

Top 20 IP addresses that have been accessing your site:
Do you want geo location check for the IPs? [yes/no]
yes
64 - 5.255.253.7 - Russian Federation
32 - 5.255.253.6 - Russian Federation
```

Essentially what we can tell in this case is that we've received 16 POST requests to our xmlrpc.php file which is often used by attackers to try and exploit WordPress websites by using various username and password combinations.

In this specific case, this was not a huge brute force attack, but it gives us an early indication and we can take action to prevent a larger attack in the future.

We can also see that there were a couple of Russian IP addresses

accessing our site, so in case that you do not expect any traffic from Russia, you might want to block those IP addresses as well.

Conclusion

This is an example of a simple BASH script that allows you to quickly summarize your access logs and determine if anything malicious is going on.

Of course, you might want to also manually go through the logs as well but it is a good challenge to try and automate this with Bash!

Notice: This content was initially posted on [DevDojo](#)

Wrap Up

Congratulations! You have just completed the Bash basics book!

Be sure to bookmark this guide anytime you need to reference any Bash topic in the future.

In this tutorial, we just covered the basics, but you still have enough under your belt to start wringing some awesome scripts and automating daily tasks!

As a next step try writing your own script and share it with the world! This is the best way to learn any new programming or scripting language!

Make sure to tweet about it and tag [@bobbyiliev_](#) so that we could check it out!

Congrats again on completing this tutorial!