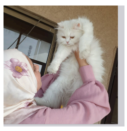
MARCH 20, 2023 / #BASH

Bash Scripting Tutorial – Linux Shell Script and Command Line for Beginners



Zaira Hira

In Linux, process automation relies heavily on shell scripting. This involves creating a file containing a series of commands that can be executed together.

In this article, we'll start with the basics of bash scripting which includes variables, commands, inputs/ outputs, and debugging. We'll

Table of Contents

Pre-requisites

To follow along with this tutorial, you should have the following accesses:

- A running version of Linux with access to the command line.

If you do not have Linux installed or you are just starting out, you can easily access the Linux command line through Replit. Replit is a browser-based IDE where you can access the bash shell in a few minutes.

You can also install Linux on top of your Windows system using WSL (Windows Subsystem for Linux). Here is a tutorial for that.

Introduction

Definition of Bash scripting

A bash script is a file containing a sequence of commands that are executed by the bash program line by line. It allows you to perform a series of actions, such as navigating to a specific directory, creating a folder, and launching a process using the command line.

By saving these commands in a script, you can repeat the same sequence of steps multiple times and execute them by running the script.

Advantages of Bash scripting

Bash scripting is a powerful and versatile tool for automating system administration tasks, managing system resources, and

- **Automation**: Shell scripts allow you to automate repetitive tasks and processes, saving time and reducing the risk of errors that can occur with manual execution.
- **Portability**: Shell scripts can be run on various platforms and operating systems, including Unix, Linux, macOS, and even Windows through the use of emulators or virtual machines.
- **Flexibility**: Shell scripts are highly customizable and can be easily modified to suit specific requirements. They can also be combined with other programming languages or utilities to create more powerful scripts.
- **Accessibility**: Shell scripts are easy to write and don't require any special tools or software. They can be edited using any text editor, and most operating systems have a built-in shell interpreter.
- **Integration**: Shell scripts can be integrated with other tools and applications, such as databases, web servers, and cloud services, allowing for more complex automation and system management tasks.
- **Debugging**: Shell scripts are easy to debug, and most shells have built-in debugging and error-reporting tools that can help identify and fix issues quickly.

Overview of Bash shell and command line interface

The terms "shell" and "bash" are used interchangeably. But there is a subtle difference between the two.

The term "shell" refers to a program that provides a command-line interface for interacting with an operating system. Bash (Bourne-

A shell or command-line interface looks like this:

zaira@Zaira: ~

```
zaira@Zaira:~$
```

The shell accepts commands from the user and displays the output

In the above output, `zaira@Zaira` is the shell prompt. When a shell is used interactively, it displays a `$` when it is waiting for a command from the user.

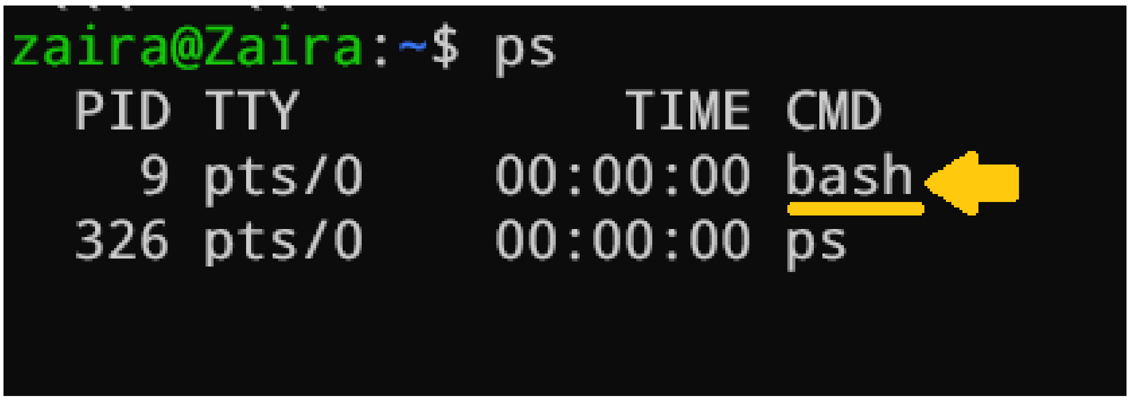
If the shell is running as root (a user with administrative rights), the prompt is changed to `#`. The superuser shell prompt looks like this:

```
[root@host ~]#
```

Although Bash is a type of shell, there are other shells available as well, such as Korn shell (ksh), C shell (csh), and Z shell (zsh). Each shell has its own syntax and set of features, but they all share the common purpose of providing a command-line interface for interacting with the operating system.

```
ps
```

Here is the output for me:



```
zaira@Zaira:~$ ps
  PID TTY          TIME CMD
    9 pts/0    00:00:00 bash
  326 pts/0    00:00:00 ps
```

Checking the shell type. I'm using bash shell

In summary, while "shell" is a broad term that refers to any program that provides a command-line interface, "Bash" is a specific type of shell that is widely used in Unix/Linux systems.

Note: In this tutorial, we will be using the "bash" shell.

How to Get Started with Bash Scripting

Running Bash commands from the command line

As mentioned earlier, the shell prompt looks something like this:

You can enter any command after the `$` sign and see the output on the terminal.

Generally, commands follow this syntax:

```
command [OPTIONS] arguments
```

Let's discuss a few basic bash commands and see their outputs. Make sure to follow along :)

- `date` : Displays the current date

```
zaira@Zaira:~/shell-tutorial$ date
Tue Mar 14 13:08:57 PKT 2023
```

- `pwd` : Displays the present working directory.

```
zaira@Zaira:~/shell-tutorial$ pwd
/home/zaira/shell-tutorial
```

- `ls` : Lists the contents of the current directory.

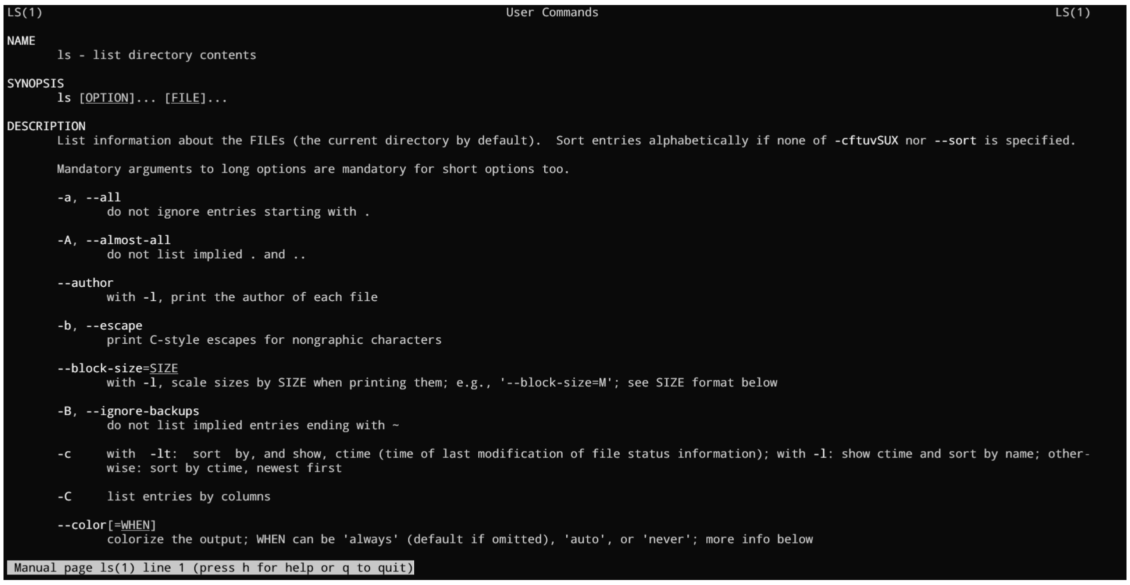
```
zaira@Zaira:~/shell-tutorial$ ls
```

- `echo`: Prints a string of text, or value of a variable to the terminal.

```
zaira@Zaira:~/shell-tutorial$ echo "Hello bash"
Hello bash
```

You can always refer to a commands manual with the `man` command.

For example, the manual for `ls` looks something like this:



```
LS(1)                                   User Commands                                   LS(1)

NAME
       ls - list directory contents

SYNOPSIS
       ls [OPTION]... [FILE]...

DESCRIPTION
       List information about the FILEs (the current directory by default).  Sort entries alphabetically if none of -cftuvSUX nor --sort is specified.

       Mandatory arguments to long options are mandatory for short options too.

       -a, --all
              do not ignore entries starting with .

       -A, --almost-all
              do not list implied . and ..

       --author
              with -l, print the author of each file

       -b, --escape
              print C-style escapes for nongraphic characters

       --block-size=SIZE
              with -l, scale sizes by SIZE when printing them; e.g., '--block-size=M'; see SIZE format below

       -B, --ignore-backups
              do not list implied entries ending with ~

       -c     with  -lt:  sort  by, and show, ctime (time of last modification of file status information); with -l: show ctime and sort by name; other-
              wise: sort by ctime, newest first

       -C     list entries by columns

       --color[=WHEN]
              colorize the output; WHEN can be 'always' (default if omitted), 'auto', or 'never'; more info below

 Manual page ls(1) line 1 (press h for help or q to quit)
```

You can see options for a command in detail using `man`

How to Create and Execute Bash scripts

Script naming conventions

By naming convention, bash scripts end with `.sh`. However, bash scripts can run perfectly fine without the `sh` extension.

Bash scripts start with a `shebang`. Shebang is a combination of `bash #` and `bang !` followed by the bash shell path. This is the first line of the script. Shebang tells the shell to execute it via bash shell. Shebang is simply an absolute path to the bash interpreter.

Below is an example of the shebang statement.

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

You can find your bash shell path (which may vary from the above) using the command:

```
which bash
```

Creating our first bash script

Our first script prompts the user to enter a path. In return, its contents will be listed.

Create a file named `run_all.sh` using the `vi` command. You can use any editor of your choice.

```
vi run_all.sh
```

Add the following commands in your file and save it:

```
echo -e "\nenter the path to directory"
read the_path

echo -e "\n you path has the following files and folders: "
ls $the_path
```

Let's take a deeper look at the script line by line. I am displaying the same script again, but this time with line numbers.

```
1 #!/bin/bash
2 echo "Today is " `date`
3
4 echo -e "\nenter the path to directory"
5 read the_path
6
7 echo -e "\n you path has the following files and folders: "
8 ls $the_path
```

- Line #1: The shebang (`#!/bin/bash`) points toward the bash shell path.
- Line #2: The `echo` command is displaying the current date and time on the terminal. Note that the `date` is in backticks.
- Line #4: We want the user to enter a valid path.
- Line #5: The `read` command reads the input and stores it in the variable `the_path`.
- line #8: The `ls` command takes the variable with the stored path and displays the current files and folders.

Executing the bash script

```
chmod u+x run_all.sh
```

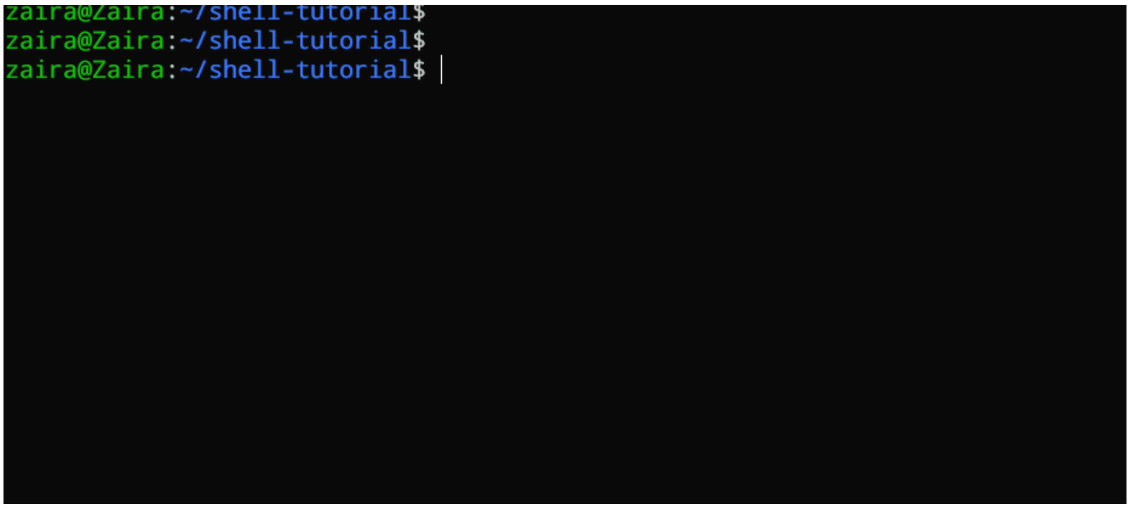
Here,

- `chmod` modifies the ownership of a file for the current user : `u`.
- `+x` adds the execution rights to the current user. This means that the user who is the owner can now run the script.
- `run_all.sh` is the file we wish to run.

You can run the script using any of the mentioned methods:

- `sh run_all.sh`
- `bash run_all.sh`
- `./run_all.sh`

Let's see it running in action 🚀



```
zaira@Zaira:~/shell-tutorial$
zaira@Zaira:~/shell-tutorial$
zaira@Zaira:~/shell-tutorial$
```

Comments in bash scripting

Comments start with a `#` in bash scripting. This means that any line that begins with a `#` is a comment and will be ignored by the interpreter.

Comments are very helpful in documenting the code, and it is a good practice to add them to help others understand the code.

These are examples of comments:

```
# This is an example comment
# Both of these lines will be ignored by the interpreter
```

Variables and data types in Bash

Variables let you store data. You can use variables to read, access, and manipulate data throughout your script.

There are no data types in Bash. In Bash, a variable is capable of storing numeric values, individual characters, or strings of characters.

In Bash, you can use and set the variable values in the following ways:

1. Assign the value directly:

2. Assign the value based on the output obtained from a program or command, using command substitution. Note that `$` is required to access an existing variable's value.

```
same_country=$country
```

To access the variable value, append `$` to the variable name.

```
zaira@Zaira:~$ country=Pakistan
zaira@Zaira:~$ echo $country
Pakistan
zaira@Zaira:~$ new_country=$country
zaira@Zaira:~$ echo $new_country
Pakistan
```

Variable naming conventions

In Bash scripting, the following are the variable naming conventions:

1. Variable names should start with a letter or an underscore (`_`).
2. Variable names can contain letters, numbers, and underscores (`_`).
3. Variable names are case-sensitive.
4. Variable names should not contain spaces or special characters.

6. Avoid using reserved keywords, such as `if`, `then`, `else`, `fi`, and so on as variable names.

Here are some examples of valid variable names in Bash:

```
name
count
_var
myVar
MY_VAR
```

And here are some examples of invalid variable names:

```
2ndvar (variable name starts with a number)
my var (variable name contains a space)
my-var (variable name contains a hyphen)
```

Following these naming conventions helps make Bash scripts more readable and easier to maintain.

Input and output in Bash scripts

Gathering input

In this section, we'll discuss some methods to provide input to our scripts.

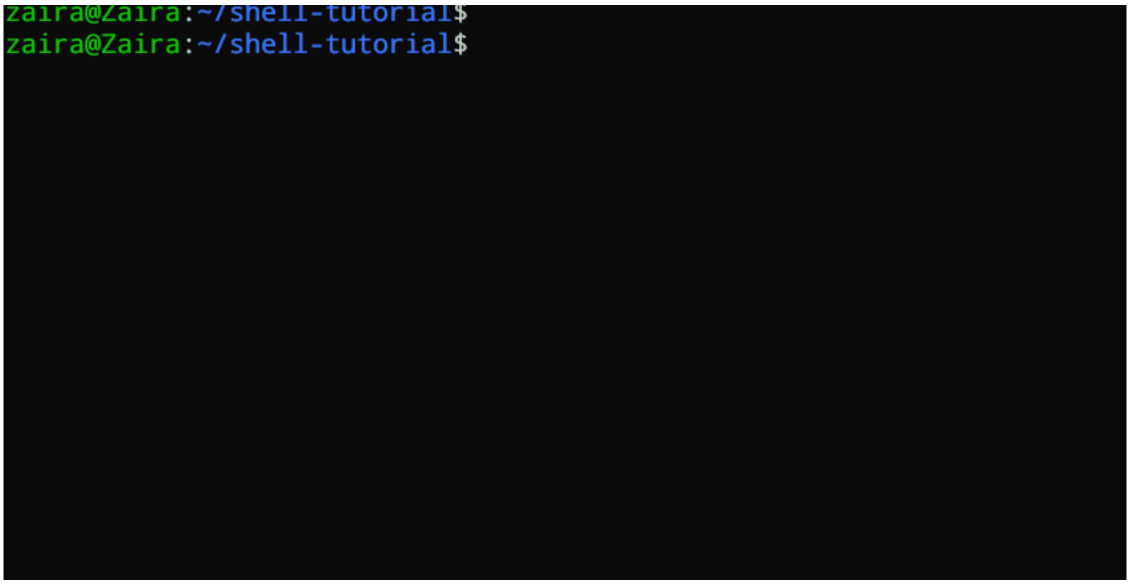
1. Reading the user input and storing it in a variable

We can read the user input using the `read` command.

```
echo "What's your name?"

read entered_name

echo -e "\nWelcome to bash tutorial" $entered_name
```



```
zaira@Zaira:~/shell-tutorial$
zaira@Zaira:~/shell-tutorial$
```

2. Reading from a file

This code reads each line from a file named `input.txt` and prints it to the terminal. We'll study while loops later in this article.

```
while read line
do
  echo $line
done < input.txt
```

3. Command line arguments

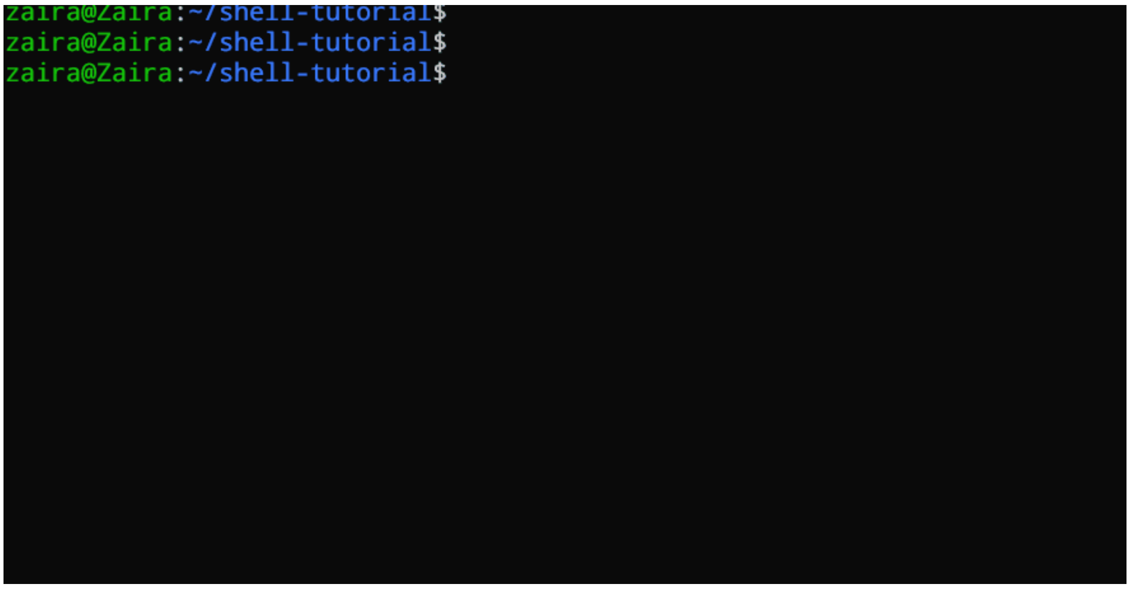
This script takes a name as a command-line argument and prints a personalized greeting.

```
echo "Hello, $1!"
```

We have supplied `Zaira` as our argument to the script.

```
#!/bin/bash
echo "Hello, $1!"
```

Output:



```
zaira@Zaira:~/shell-tutorial$
zaira@Zaira:~/shell-tutorial$
zaira@Zaira:~/shell-tutorial$
```

Displaying output

Here we'll discuss some methods to receive output from the scripts.

```
echo "Hello, World!"
```

This prints the text "Hello, World!" to the terminal.

2. Writing to a file:

```
echo "This is some text." > output.txt
```

This writes the text "This is some text." to a file named `output.txt`. Note that the `>` operator overwrites a file if it already has some content.

3. Appending to a file:

```
echo "More text." >> output.txt
```

This appends the text "More text." to the end of the file `output.txt`.

4. Redirecting output:

```
ls > files.txt
```

Basic Bash commands (echo, read, etc.)

Here is a list of some of the most commonly used bash commands:

1. `cd` : Change the directory to a different location.
2. `ls` : List the contents of the current directory.
3. `mkdir` : Create a new directory.
4. `touch` : Create a new file.
5. `rm` : Remove a file or directory.
6. `cp` : Copy a file or directory.
7. `mv` : Move or rename a file or directory.
8. `echo` : Print text to the terminal.
9. `cat` : Concatenate and print the contents of a file.
10. `grep` : Search for a pattern in a file.
11. `chmod` : Change the permissions of a file or directory.
12. `sudo` : Run a command with administrative privileges.
13. `df` : Display the amount of disk space available.
14. `history` : Show a list of previously executed commands.
15. `ps` : Display information about running processes.

Conditional statements (if/else)

Expressions that produce a boolean result, either true or false, are called conditions. There are several ways to evaluate conditions, including `if` , `if-else` , `if-elif-else` , and nested conditionals.

```
if [[ condition ]];
then
    statement
elif [[ condition ]]; then
    statement
else
    do this by default
fi
```

We can use logical operators such as AND `-a` and OR `-o` to make comparisons that have more significance.

```
if [ $a -gt 60 -a $b -lt 100 ]
```

Let's see an example of a Bash script that uses `if`, `if-else`, and `if-elif-else` statements to determine if a user-inputted number is positive, negative, or zero:

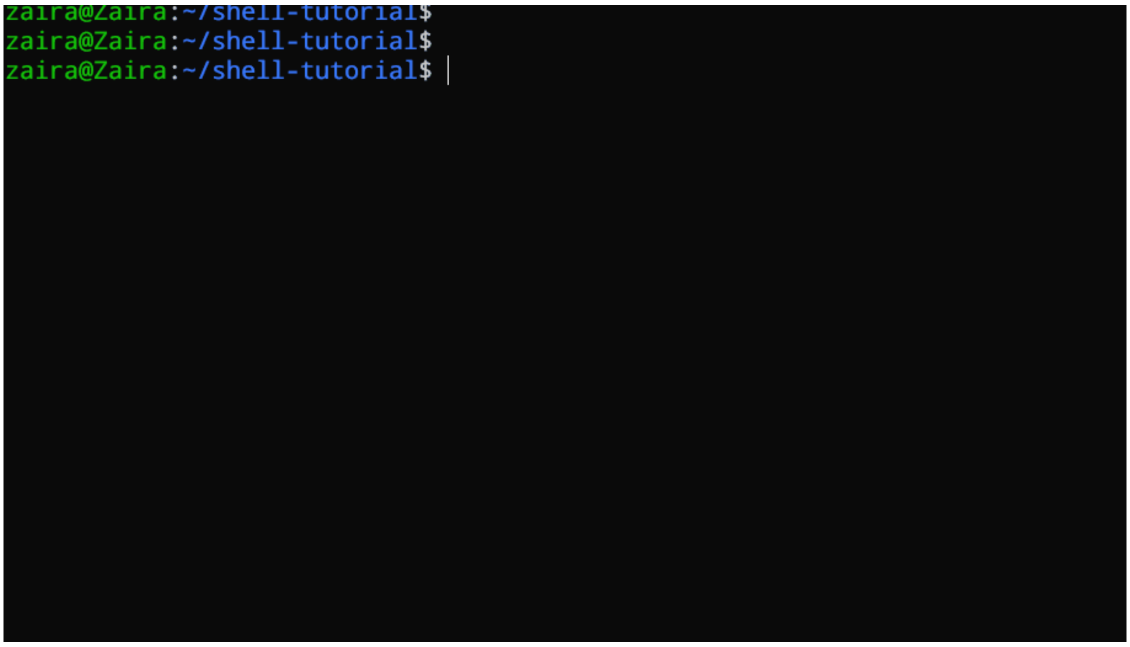
```
#!/bin/bash

echo "Please enter a number: "
read num

if [ $num -gt 0 ]; then
  echo "$num is positive"
elif [ $num -lt 0 ]; then
  echo "$num is negative"
else
  echo "$num is zero"
fi
```

greater than 0, the script moves on to the next statement, which is an `if-elif` statement. Here, the script checks if the number is less than 0. If it is, the script outputs that the number is negative. Finally, if the number is neither greater than 0 nor less than 0, the script uses an `else` statement to output that the number is zero.

Seeing it in action 🚀



```
zaira@Zaira:~/shell-tutorial$
zaira@Zaira:~/shell-tutorial$
zaira@Zaira:~/shell-tutorial$ |
```

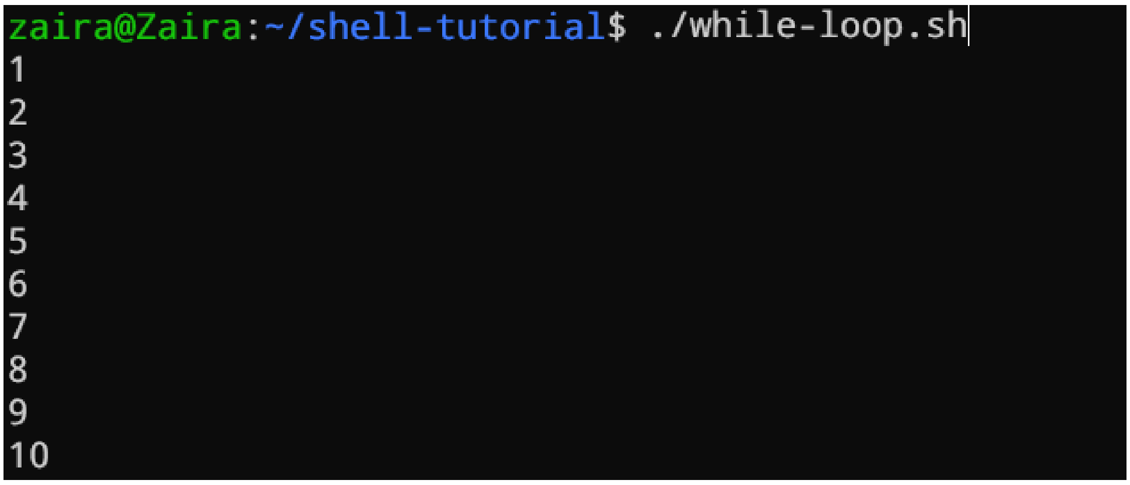
Looping and Branching in Bash

While loop

While loops check for a condition and loop until the condition remains `true`. We need to provide a counter statement that increments the counter to control loop execution.

In the example below, `(( i += 1 ))` is the counter statement that increments the value of `i`. The loop will run exactly 10 times.

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



```
zaira@Zaira:~/shell-tutorial$ ./while-loop.sh
1
2
3
4
5
6
7
8
9
10
```

For loop

The `for` loop, just like the `while` loop, allows you to execute statements a specific number of times. Each loop differs in its syntax and usage.

In the example below, the loop will iterate 5 times.

```
#!/bin/bash

for i in {1..5}
do
    echo $i
done
```

Case statements

In Bash, case statements are used to compare a given value against a list of patterns and execute a block of code based on the first pattern that matches. The syntax for a case statement in Bash is as follows:

```
case expression in
    pattern1)
        # code to execute if expression matches pattern1
        ;;
    pattern2)
        # code to execute if expression matches pattern2
        ;;
    pattern3)
        # code to execute if expression matches pattern3
        ;;
    *)
        # code to execute if none of the above patterns match express
        ;;
esac
```

Here, "expression" is the value that we want to compare, and "pattern1", "pattern2", "pattern3", and so on are the patterns that we want to compare it against.

The double semicolon ";;" separates each block of code to execute for each pattern. The asterisk "*" represents the default case, which

```
fruit="apple"

case $fruit in
    "apple")
        echo "This is a red fruit."
        ;;
    "banana")
        echo "This is a yellow fruit."
        ;;
    "orange")
        echo "This is an orange fruit."
        ;;
    *)
        echo "Unknown fruit."
        ;;
esac
```

In this example, since the value of "fruit" is "apple", the first pattern matches, and the block of code that echoes "This is a red fruit." is executed. If the value of "fruit" were instead "banana", the second pattern would match and the block of code that echoes "This is a yellow fruit." would execute, and so on. If the value of "fruit" does not match any of the specified patterns, the default case is executed, which echoes "Unknown fruit."

How to Schedule Scripts using cron

Cron is a powerful utility for job scheduling that is available in Unix-like operating systems. By configuring cron, you can set up automated jobs to run on a daily, weekly, monthly, or specific time

Below is the syntax to schedule crons:

```
# Cron job example
* * * * * sh /path/to/script.sh
```

Here, the `*` s represent minute(s) hour(s) day(s) month(s) weekday(s), respectively.

Below are some examples of scheduling cron jobs.

SCHEDULE	DESCRIPTION	EXAMPLE
`0 0`	Run a script at midnight every day	`0 0 /pat`
`/5`	Run a script every 5 minutes	`/5 /path`
`0 6 1-5`	Run a script at 6 am from Monday to Friday	`0 6 1-5`
`0 0 1-7`	Run a script on the first 7 days of every month	`0 0 1-7`
`0 12 1`	Run a script on the first day of every month at noon	`0 12 1 /`

Using crontab

The `crontab` utility is used to add and edit the cron jobs.

`crontab -l` lists the already scheduled scripts for a particular user.

You can add and edit the cron through `crontab -e`.

You can read more about corn jobs in my other article here.

Bash Scripts

Debugging and troubleshooting are essential skills for any Bash scripter. While Bash scripts can be incredibly powerful, they can also be prone to errors and unexpected behavior. In this section, we will discuss some tips and techniques for debugging and troubleshooting Bash scripts.

Set the `set -x` option

One of the most useful techniques for debugging Bash scripts is to set the `set -x` option at the beginning of the script. This option enables debugging mode, which causes Bash to print each command that it executes to the terminal, preceded by a `+` sign. This can be incredibly helpful in identifying where errors are occurring in your script.

```
#!/bin/bash

set -x

# Your script goes here
```

Check the exit code

When Bash encounters an error, it sets an exit code that indicates the nature of the error. You can check the exit code of the most recent command using the `$?` variable. A value of `0` indicates success, while any other value indicates an error.

```
if [ $? -ne 0 ]; then
    echo "Error occurred."
fi
```

Use `echo` statements

Another useful technique for debugging Bash scripts is to insert `echo` statements throughout your code. This can help you identify where errors are occurring and what values are being passed to variables.

```
#!/bin/bash

# Your script goes here

echo "Value of variable x is: $x"

# More code goes here
```

Use the `set -e` option

If you want your script to exit immediately when any command in the script fails, you can use the `set -e` option. This option will cause Bash to exit with an error if any command in the script fails, making it easier to identify and fix errors in your script.

```
#!/bin/bash

set -e
```

Troubleshooting crons by verifying logs

We can troubleshoot crons using the log files. Logs are maintained for all the scheduled jobs. You can check and verify in logs if a specific job ran as intended or not.

For Ubuntu/Debian, you can find `cron` logs at:

```
/var/log/syslog
```

The location varies for other distributions.

A cron job log file can look like this:

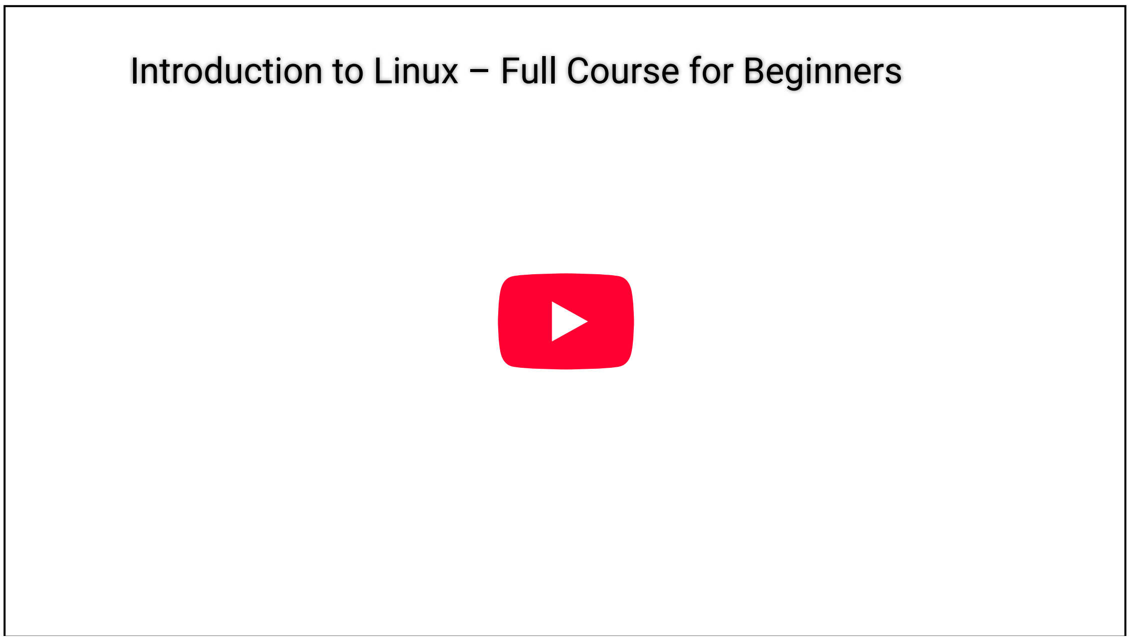
```
2022-03-11 00:00:01 Task started
2022-03-11 00:00:02 Running script /path/to/script.sh
2022-03-11 00:00:03 Script completed successfully
2022-03-11 00:05:01 Task started
2022-03-11 00:05:02 Running script /path/to/script.sh
2022-03-11 00:05:03 Error: unable to connect to database
2022-03-11 00:05:03 Script exited with error code 1
2022-03-11 00:10:01 Task started
2022-03-11 00:10:02 Running script /path/to/script.sh
2022-03-11 00:10:03 Script completed successfully
```

Conclusion

In this article, we started with how to access the terminal and then ran some basic bash commands. We also studied what a bash shell is. We briefly looked at branching the code using loops and

Resources for learning more about Bash scripting

If you want to dig deeper into the world of bash scripting, I would suggest you have a look at this 6-hour course on Linux at freeCodeCamp.



What's your favorite thing you learned from this tutorial? You can also connect with me on any of these platforms. 📧�

See you in the next tutorial, happy coding 😁

Banner image credits: Image by Freepik

Zaira Hira

Making complex topics easy for you to understand.