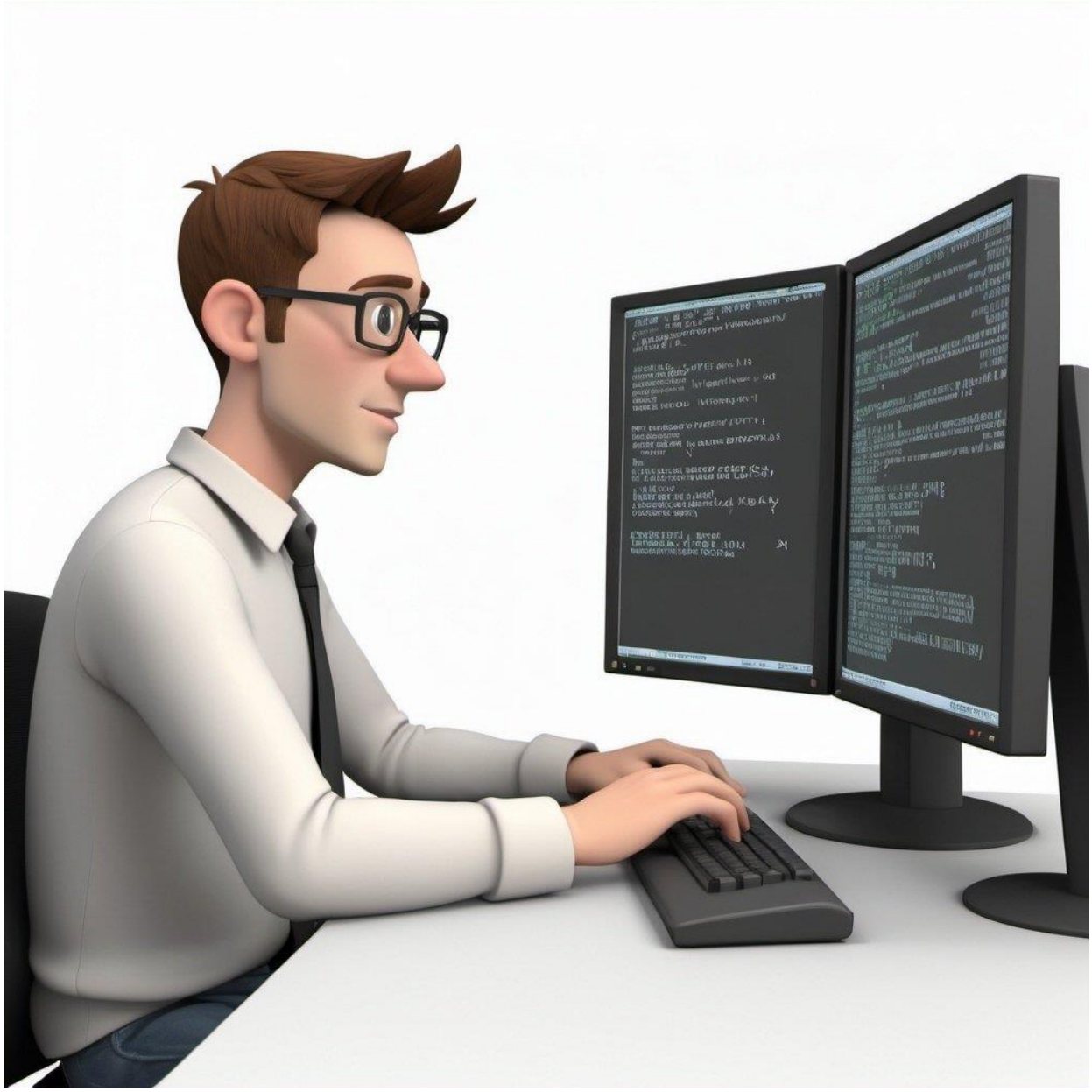
Chapter 9

Shell Scripts

What is in This Chapter ?

This chapter discusses shell scripting. **Shell scripts** are small interpreted programs that allow you to examine, manipulate and calculate things at the Linux command level within a Linux shell. There are many basic examples here that make use of the **sh shell scripting language**.



9.1 Scripting

What is a scripting language? It is a very high-level programming language. Some are general-purpose, some are domain-specific. The languages are limited in that most do not have data types or functions. Most are interpreted, not compiled … which means that they run slower. There are a few different scripting languages out there:

- shell scripting (bash, csh, sh)
- PHP, Perl
- Javascript
- Python
- Ruby
- Lua

Scripting languages are used to do different things, but mainly they are used for:

- performing some kind of one-time task
- automating the execution of other more complex programs
- rapid prototyping

We can use scripting languages to write code that runs in a Linux shell. These are called ***shell scripts***. Typical operations performed by **shell scripts** include:

- system administration tasks
- file manipulation and management
- application configuration and setup
- program execution
- printing text
- testing

A script which sets up the environment, runs the program, and does any necessary cleanup, logging, etc. is called a ***wrapper***.

A shell script is really just a set of commands saved in a file as a program. The commands will depend on the type of shell used, although they are all similar to one another. Here are some shell types:

- Bourne shell (**sh**)
- Bourne-again shell (**bash**)
- C shell (**csh**)
- Korn shell (**ksh**)

We will discuss the Bourne shell (**sh**), which is a subset of **bash**. So, all **sh** commands are valid in **bash**. When we write our script files, they will have a **.sh** file extension.

Here is the Hello World of shell scripting. You can use a text editor to write this script and save it into a file called **helloWorld.sh**:

```
#!/bin/sh
#This is a comment
echo Hello World
```

Indicates that we should always run this script using **sh** rather than **bash** or some other shell.

The # symbol is used to indicate that the text on that line is a comment (single line only). The **echo** command is used to tell the interpreter to print out the text that follows to the terminal. You run the script by using the **sh** command, followed by the file name:

```
student@COMPBase:~$ sh helloWorld.sh
Hello World
student@COMPBase:~$
```

You can get user input (in the form of a string) by using the **read** command, followed by a name for the variable that you'd like to store the string in. We can then refer to the value of that variable anywhere in the script by using the variable name with a **$** character in front. Here is a script that gets the user's name and then displays it:

```
#!/bin/sh
#This script asks for the user's name
echo What is your name?
read NAME
echo $NAME is a cool name
```

```
student@COMPBase:~$ sh getName.sh
What is your name?
Mark
Mark is a cool name
student@COMPBase:~$
```

It is interesting that shell script variables do not need to be declared. Space is allocated the first time the shell sees a new variable. Notice as well that no data types are specified since all variables are stored as strings. The variable should be in uppercase letters with underscores when needed.

We can even hardcode constants, which are treated as variables. However, we need to make sure that there is no space before the equal sign. Also, the value can be anything, but if we want to use the values in a numerical expression, they can only be integers (i.e., no floats).

```
COUNT=5          #no spaces before or after =
COUNT = 5        #this won't work!!
```

To calculate a math expression, we need to use the **expr** command, which is a little cumbersome to work with. It is actually an external program that we will run. First of all, the math expression must be encapsulated with a single backquote character ` … which is not the usual single straight quote character '. The backquote character may be hard to find. It is under the ESC key on my keyboard.

The **expr** command can take in some variables (use the **$** in front of the name) as well as some math operators. You should precede the math operators with a **** character. Here is an example of how to use it. This script asks for the number of bags of milk and cartons of eggs to buy and then calculates the integer-based price:

```
#!/bin/sh
#Calculate price for buying X bags of milk and Y cartons of eggs
MILK=4      #Notice no spaces before or after the = sign
EGGS=2
echo How many bags of milk do you want?
read NUM_MILK
echo How many cartons of eggs do you want?
read NUM_EGGS
PRICE=`expr $NUM_MILK \* $MILK \+ $NUM_EGGS \* $EGGS`
echo The total price for $NUM_MILK bag\(s\) of milk and $NUM_EGGS
carton\(s\) of eggs is \$$PRICE
```

```
student@COMPBase:~$ sh prices.sh
How many bags of milk do you want?
1
How many cartons of eggs do you want?
1
The total price for 1 bag(s) of milk and 1 carton(s) of eggs is $6
student@COMPBase:~$ sh prices.sh
How many bags of milk do you want?
3
How many cartons of eggs do you want?
5
The total price for 3 bag(s) of milk and 5 carton(s) of eggs is $22
student@COMPBase:~$
```

Notice the use the backslash character in the last echo command line. It is used to display a special character, which is the parenthesis or dollar sign in this case. We can even supply values to the script from the command line. We access the command line arguments by using **$1**, **$2**, **$3**, etc. You can use **$0** to get the command itself (i.e., the name of the script file), **$#** to get the number of arguments and **$$** to get the process ID. Here is a modified program that uses command line arguments instead of asking the user for the numbers:

```
#!/bin/sh
#Calculate price for buying X bags of milk and Y cartons of eggs
# X and Y are supplied as command line arguments
echo The command is $0
echo There are $# command line arguments
echo The process ID is $$

MILK=4
EGGS=2
PRICE=`expr $1 \* $MILK \+ $2 \* $EGGS`

echo The total price for $1 bag\(s\) of milk and $2 carton\(s\) of eggs is
\$$PRICE
```

```
student@COMPBase:~$ sh cmdLine.sh 1 1
The command is cmdLine.sh
There are 2 command line arguments
The process ID is 3467
The total price for 1 bag(s) of milk and 1 carton(s) of eggs is $6
student@COMPBase:~$ sh cmdLine.sh 3 5
The command is cmdLine.sh
There are 2 command line arguments
The process ID is 3469
The total price for 1 bag(s) of milk and 1 carton(s) of eggs is $22
student@COMPBase:~$
```

We can also do a **FOR** loop in which we need to specify a set of strings to loop through:

```
#!/bin/sh
#This example just shows that we can loop through strings
for i in 1 2 5 A Z temp output
do
  echo file$i.txt   #or can use file${i}.txt
done
```

Notice how we just list all strings here.

```
student@COMPBase:~$ sh forLoop.sh
file1.txt
file2.txt
file5.txt
fileA.txt
fileZ.txt
filetemp.txt
fileoutput.txt
student@COMPBase:~$
```

Here is an example of a **WHILE** loop that repeats until the user enters a string other than **yes**:

```
#!/bin/sh
#Example showing how to use a while loop
RESPONSE=yes
while [ $RESPONSE = yes ]
do
  echo Do you want to loop again?
  read RESPONSE
done
echo Goodbye!
```

The spacing is required here!!

```
student@COMPBase:~$ sh whileLoop.sh
Do you want to loop again?
yes
Do you want to loop again?
yes
Do you want to loop again?
no
Goodbye!
student@COMPBase:~$
```

Of course, sooner or later we will need the ability to make decisions. There are **if**/**then**/**fi** and **if**/**then**/**else**/**fi** control structures for doing this.

```
#!/bin/sh
#This script tests out the IF statement based on a command line name
if [ $1 = Mark ]; then
    echo Hello Mark
else if [ $1 = Christie ]; then
       echo Hello Christie
     else
       echo I do not know you
     fi
fi
```

The spacing is very important here!!

Semicolon required!!

Backwards "if" to end it all

```
student@COMPBase:~$ sh if.sh Mark
Hello Mark
student@COMPBase:~$ sh if.sh Christie
Hello Christie
student@COMPBase:~$ sh if.sh Bob
I do not know you
student@COMPBase:~$
```

Within the square brackets, we can do various types of testing of conditionals:

- **-z** tests if string is empty
- **-n** tests if string is not empty
- **-lt**, **-le** tests whether LHS operand is < or <= RHS operand
- **-gt**, **-ge** tests whether LHS operand is > or >= RHS operand

Here is an example showing some nested **IF** statements that make use of the **-n** and **-lt** conditions by taking in three command-line integers and displaying the smallest one:

```
#!/bin/sh
#This script tests out conditionals based on 3 command line integers
if [ -z $3 ]; then
    echo ERROR I need three numbers
else
    if [ $1 -lt $2 ]; then
      if [ $1 -lt $3 ]; then
          echo $1 is the smallest number
      else
          echo $3 is the smallest number
      fi

    else
      if [ $2 -lt $3 ]; then
          echo $2 is the smallest number
      else
          echo $3 is the smallest number
      fi
    fi
fi
```

```
student@COMPBase:~$ sh tests.sh 2 4 6
2 is the smallest number
student@COMPBase:~$ sh tests.sh 7 3 9
3 is the smallest number
student@COMPBase:~$ sh tests.sh 8 5 1
1 is the smallest number
student@COMPBase:~$ sh tests.sh 34 64
ERROR I need three numbers
student@COMPBase:~$ sh tests.sh 34
ERROR I need three numbers
student@COMPBase:~$
```

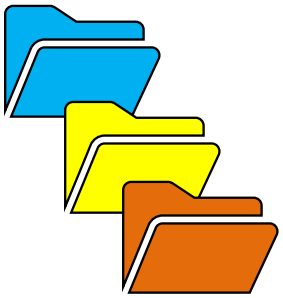
Here are some more options for the conditional statements, which are file-related. These are very handy as many shell scripts are written to manipulate and examine files:

- **-f** tests whether a file with the given name exists
- **-d** tests whether a given operand is a directory
- **-r**, **-w**, **-x** tests whether the given file has read/write/execute permissions

Here is a script that looks for a particular file or directory (specified in the command line) and then indicates whether the file was found and displays its read/write/execute permissions.

```
#!/bin/sh
#This script checks if a file or directory exists (specified as command
#line argument).  It also checks the permissions
if [ $# = 0 ]; then
    echo Error\: Missing Filename
    echo USAGE\: sh fileCheck.sh \<fileName\>
    exit
fi
if [ -f $1 ]; then
    echo FILE \"$1\" exists
    if [ -r $1 ]; then echo FILE is readable
    fi
    if [ -w $1 ]; then echo FILE is writeable
    fi
    if [ -x $1 ]; then echo FILE is executable
    fi
else
    if [ -d $1 ]; then
        echo DIRECTORY \"$1\" exists
        if [ -r $1 ]; then echo DIRECTORY is readable
        fi
        if [ -w $1 ]; then echo DIRECTORY is writeable
        fi
        if [ -x $1 ]; then echo DIRECTORY is executable
        fi
    else
        echo File/Directory \"$1\" not found
    fi
fi
```

Quit the script



```
student@COMPBase:~$ ls
aDirectory  fileCheck.sh  getName.sh  helloWorld.sh  prices.sh  whileLoop.sh
cmdLine.sh  forLoop.sh    hello       if.sh          tests.sh
student@COMPBase:~$ sh fileCheck.sh getName.sh
FILE "getName.sh" exists
FILE is readable
FILE is writeable
student@COMPBase:~$ sh fileCheck.sh hello
FILE "hello" exists
FILE is readable
FILE is writeable
FILE is executable
student@COMPBase:~$ sh fileCheck.sh aDirectory
DIRECTORY "aDirectory" exists
DIRECTORY is readable
DIRECTORY is writeable
DIRECTORY is executable
student@COMPBase:~$ sh fileCheck.sh missing
File/Directory "missing" not found
student@COMPBase:~$ sh fileCheck.sh
Error: Missing Filename
USAGE: sh fileCheck.sh <fileName>
student@COMPBase:~$
```

We have covered the basics of the SH scripting language but there are external shell programs that we can also invoke. That is, we can use any Unix commands or executable user programs from within our script. This is where the power really lies in scripting. We have seen one use of this already with the **expr** command, which is actually an external program being run. As with the **expr** command, all external program calls must be encapsulated with a single backquote character `.

Here is an example of a script that uses the **ls** Unix command to get the files in the current directory and then shows them in two ways:

```
#!/bin/sh
#This script lists all files in two ways

echo Here is the result of executing the \"ls\" command\:
echo
FILES=`ls`
echo $FILES
echo
echo Here are the files one at a time\:
echo
for i in $FILES
do
  echo Filename $i
done
```

Stores result of “ls” command in string called FILES.

```
student@COMPBase:~$ sh listFiles.sh
Here is the result of executing the "ls" command:

aDirectory cmdLine.sh fileCheck.sh forLoop.sh getName.sh hello helloWorld.sh
if.sh listFiles.sh listFiles.sh~ prices.sh tests.sh whileLoop.sh

Here are the files one at a time:

Filename aDirectory
Filename cmdLine.sh
Filename fileCheck.sh
Filename forLoop.sh
Filename getName.sh
Filename hello
Filename helloWorld.sh
Filename if.sh
Filename listFiles.sh
Filename listFiles.sh~
Filename prices.sh
Filename tests.sh
Filename whileLoop.sh
student@COMPBase:~$
```

This script counts files and directories:

```
#!/bin/sh
#This script counts the files and directories

FILES=`ls`
FILE_COUNT=0
DIR_COUNT=0

for file in $FILES
do
    if [ -f $file ]; then
      FILE_COUNT=`expr $FILE_COUNT + 1`
    fi
    if [ -d $file ]; then
      DIR_COUNT=`expr $DIR_COUNT + 1`
    fi
done
echo There are $FILE_COUNT files and $DIR_COUNT directories
```

```
student@COMPBase:~$ ls
aDirectory      fileCheck.sh  hello          listFiles.sh  whileLoop.sh
cmdLine.sh      forLoop.sh    helloWorld.sh  prices.sh
countFiles.sh   getName.sh    if.sh          tests.sh
student@COMPBase:~$ sh countFiles.sh
There are 12 files and 1 directories
student@COMPBase:~$
```

The **tr** program allows us to replace characters in a string with other characters. We supply two parameters … the string to look for and the string to replace it with. It takes data from **stdin** and outputs to **stdout**. We can use a pipeline to do the conversion. Here is a simple example:

```
#!/bin/sh
#This script does a search and replace for a string

STR="This sentence is about to be modified."
OUT=`echo $STR | tr e o`
echo $OUT
```

Pipe the string as input to the **tr** program

```
student@COMPBase:~$ sh replace.sh
This sontonco is about to bo modifiod.
student@COMPBase:~$
```

This can be powerful when we combine it with file searches to rename a bunch of files. Here is an example of a program that renames all the files in the current directory to uppercase:

```
#!/bin/sh
#This script renames all files to uppercase

FILES=`ls`
for NAME in $FILES
do
  NEW_NAME=`echo $NAME | tr [:lower:] [:upper:]`
  if [ $NEW_NAME != $NAME ]; then
    mv $NAME $NEW_NAME
  fi
done
```

Can use [:upper:] or [:lower:] to indicate an uppercase or lowercase character


```
student@COMPBase:~$ ls
rename.sh   test01.dat  test03.dat  test05.dat  test07.dat
rename.sh~  test02.dat  test04.dat  test06.dat  test08.dat
student@COMPBase:~$ sh rename.sh
student@COMPBase:~$ ls
RENAME.SH   TEST01.DAT  TEST03.DAT  TEST05.DAT  TEST07.DAT
RENAME.SH~  TEST02.DAT  TEST04.DAT  TEST06.DAT  TEST08.DAT
student@COMPBase:~$
```

The **cut** program allows us to remove portions of a line of input. We can use the **-d** option to indicate a delimiter in the string. This indicates the character (or string) that separates the tokens (e.g., words) of the string. We may often use **" "** as the delimiter string.

We can use the **-f n** option (where **n** is a number starting at 1) to indicate that the **n**th token (i.e., word) of each line should be retained. We can list some tokens by using a comma between the token numbers that we want like this **-f n1,n2,n3**.

Here is an example that keeps the 2nd and 5th word from each sentence:

```
#!/bin/sh
#This script maintains the 2nd and 5th word from each sentence
STR="The cat climbed the tree\nThe dog chased the stick\nThe turtle took a
nap"
OUT=`echo $STR | cut -d " " -f 2,5`
echo $OUT
```

```
student@COMPBase:~$ sh cut.sh
cat tree dog stick turtle nap
student@COMPBase:~$
```

Another useful option is the **-b** option. It allows you to extract a range of characters from a string based on the number of the character in the string. So, we could use this, for example, along with the `ls -l` Unix command to get the total of all file sizes in a directory:

```
#!/bin/sh
#This script uses ls -l and the examines the
#output to calculate the total files sizes
SIZES=`ls -l | cut -b 30-34`
TOTAL=0
for SIZE in $SIZES
do
  TOTAL=`expr $TOTAL + $SIZE`
done
echo Total of all file sizes = $TOTAL bytes
```

```
student@COMPBase:~$ ls -l
total 72
drwxrwxr-x 2 student student 4096 Jul 26 12:50 aDirectory
-rw-rw-r-- 1 student student  354 Jul 24 15:18 cmdLine.sh
-rw-rw-r-- 1 student student  318 Jul 26 11:50 countFiles.sh
-rw-rw-r-- 1 student student  198 Jul 26 13:01 cut.sh
-rw-rw-r-- 1 student student  234 Jul 26 13:08 cutSizes.sh
-rw-rw-r-- 1 student student  740 Jul 26 11:13 fileCheck.sh
-rw-rw-r-- 1 student student  163 Jul 24 15:36 forLoop.sh
-rw-rw-r-- 1 student student  110 Jul 24 15:18 getName.sh
-rwxrwxr-x 1 student student 7348 Jul 26 11:18 hello
-rw-rw-r-- 1 student student   52 Jul 24 15:19 helloWorld.sh
-rw-rw-r-- 1 student student  223 Jul 24 16:27 if.sh
-rw-rw-r-- 1 student student  232 Jul 26 11:42 listFiles.sh
-rw-rw-r-- 1 student student  404 Jul 24 15:19 prices.sh
-rw-rw-r-- 1 student student  213 Jul 26 12:52 rename.sh
-rw-rw-r-- 1 student student  147 Jul 26 12:00 replace.sh
-rw-rw-r-- 1 student student  413 Jul 24 16:57 tests.sh
-rw-rw-r-- 1 student student  164 Jul 24 15:39 whileLoop.sh
student@COMPBase:~$ sh cutSizes.sh
Total of all file sizes = 15409 bytes
student@COMPBase:~$
```

You can use `cut --help` in the shell window to see all the options.

There are even more sophisticated string processing programs and Linux utilities:

- **`awk`** – provides powerful formatting capabilities similar to **printf()**.
- **`basename`** – strips the directory and (optionally) suffix from a filename.
- **`find`** – finds files in and below directories according to their name, age, size, etc..
- **`grep`** – searches text for matching lines based on regular expressions.
- **`sed`** – an advanced version of **tr** which can be used for search and replace.
- **`sort`** – can be used to sort strings in various ways.
- **`test`** – check existence of a file and its permissions; or compare numbers and strings.
- **`wc`** – counts words, lines and characters.

Check out the **man** pages on these. You can do some really amazing things. Remember … through pipelining, you can join/merge many programs together to produce a very sophisticated shell script.