OSL640: INTRODUCTION TO OPEN SOURCE SYSTEMS

WEEK 10 LESSON 1

INTRODUCTION TO SHELL SCRIPTING / CREATING SHELL SCRIPTS / SHELL VARIABLES

LESSON 1 TOPICS

Shell Scripts

- Definition / Purpose
- Considerations When Creating Shell Scripts /
- Comments / She-bang line / **echo** command
- Creating Shell Scripts / Running Shell Scripts / Demonstration

Shell Variables

- Definition / Purpose
- Environment Variables / User Defined Variables / **read** command
- Demonstration

Perform Week 10 Tutorial

- Investigation 1
- Review Questions (Questions Part A **1 – 3 ,** Part B **Walk-Thru #1**)

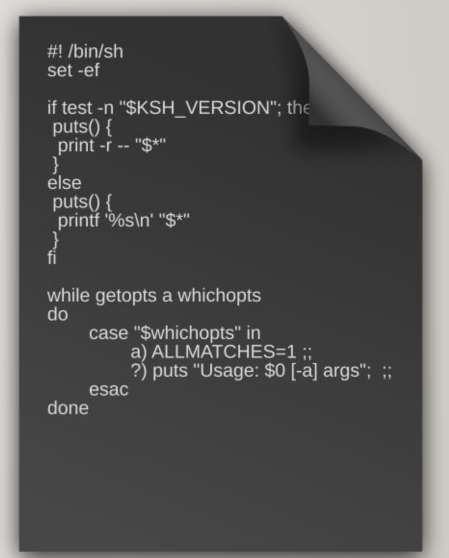
CREATING SHELL SCRIPTS

Definition

*A **shell script** is a computer **program** designed to be run by the Unix **shell,** a **command-line interpreter**.*

Typical operations performed by shell scripts include
***file manipulation**, **program execution**, and **printing text**.*

Reference: https://en.wikipedia.org/wiki/Shell_script



CREATING SHELL SCRIPTS

Considerations When Creating Shell Scripts

The reason to create shell scripts is to **automate** the execution of commonly issued **Linux commands**, **shell operations**, **math calculations** as well as **Logic / Loop** operations.

Prior to the creation of the shell script file, you should **plan** the shell script and **list steps** that you want to accomplish.

Those **sequence** of steps can then be used to create your shell script.

CREATING SHELL SCRIPTS

Considerations When Creating Shell Scripts

Once you have **planned** your shell script you need to **create** a **shell script file** via a **text editor** that will contain Linux commands.

When creating a shell script, avoid using filenames of **existing** Linux commands. You can use the **which** command to see if the filename is recognized as a Unix/Linux command: (e.g. **`which shell-script-name`**)

Adding an **extension** to your shell script filename will help to **identify** the type of shell that the shell script was designed to run.

Examples:

```
clean-directory.bash
copy-directory-structure.csh
```

CREATING SHELL SCRIPTS

The Shebang Line

The **#** symbol makes the shell ignores running text after this symbol so that text can be used to provide information of how the shell script works.

```
# This is a comment
```

The **she-bang** line is a **special comment** at top of your shell script to run a shell script within a specific shell.

Example:

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

The shebang line <u>must</u> appear on the **<u>first</u>** line and at the **<u>beginning</u>** of the line, otherwise, it will be treated as a **regular comment** and **ignored**.

CREATING SHELL SCRIPTS

#!

The Shebang Line

Since Linux shells have evolved over a period of time, using a **she-bang line** **<u>forces</u>** the shell script to run in **a specific shell**, which could **prevent errors** in case an <u>older</u> shell does not recognize newer features from recent shells.

You can use the **`which`** command to determine the **full pathname** of the shell.

```
which bash
/bin/bash
```

CREATING SHELL SCRIPTS

Displaying Text with the echo Command

When creating shell scripts, it is useful to **display text** to prompt the user for data, display results or notify the user of incorrect usage of the shell script.

The `echo` command is used to display text.

To prevent problems with special characters, it is recommended to use **double-quotes** which will allow the values of variables to be displayed.

Example:

```
echo "My username is: $USER"
```

```
echo hello
hello

echo 'hello'
hello

echo 'My username is: $USER'
My username is: $USER

echo "My username is: $USER"
My username is: murray.saul
```

RUNNING A SHELL SCRIPT

Running Shell Scripts

In order to run your shell script by name, you need to first assign **execute permissions** for the user.

To run your shell script, you can issue the shell script's pathname using a ***relative***, ***absolute***, or ***relative-to-home*** pathname

Examples:

```
chmod u+x myscript.bash

./myscript.bash
/home/username/myscript.bash
~/myscript.bash
```

FYI: You can **run** a shell script without **execute permissions** by issuing the **shell command** followed by the shell script's pathname.

Example:

```
bash ~murray.saul/scripts/week10-check-1
```

You can add the **current directory** that contains the shell script so it can be issued only by **filename** (not pathname).

Example:

```
PATH=$PATH:.
```

To be **persistent** on new shell instances, setting the PATH environment variable would need to be added in your **profile** (start-up) file (discussed in a later lesson).

INSTRUCTOR DEMONSTRATION

Task:

Create a Bash Shell script to clear the screen and then display all users that are currently logged onto the system.

SHELL SCRIPTING

Variables

Variables *are used to* ***store information*** *to be referenced and manipulated in a computer program. They also provide a way of labeling data with a descriptive name, so our programs can be understood more clearly by the reader and ourselves…*

…It is helpful to think of variables as ***containers*** *that hold information. Their sole purpose is to label and store data in memory. This data can then be used throughout your program.*

Reference: https://launchschool.com/books/ruby/read/variables

SHELL SCRIPTING

Using Variables

Shell variables are classified into **two groups**:

System (shell) variables:

Describes the OS system's **working environment** which can be used in a shell script.

User-created variables:

Customized variables **created by the programme**r for use in a shell script.

The name of a variable can be any sequence of **letters** and **numbers**,
but it must **NOT begin with a number**!

SHELL SCRIPTING

Environment Variables

Shell **environment** variables define the **working environment** while in your shell. Some of these variables are displayed in the table below and its value can be viewed by issuing the following pipeline command: `set | more`

Variable Name	Purpose
PS1	Primary shell prompt
PWD	Absolute path of present working directory
HOME	Absolute path to user's home
PATH	List of directories where commands / programs are located
HOST	Host name of the computer
USER	Name of the user logged in
SHELL	Name (type) of current shell used

SHELL SCRIPTING

Environment Variables

Placing a dollar sign **$** before a **variable name** will cause the variable to **expand** to the value contained in the variable.

Examples:

```
echo "My current location is: $PWD"
who | grep $USER
echo $HOST
```

```
echo "My current location is: $PWD"
My current location is: /home/murray.saul

who | grep $USER
murray.saul pts/0        Jun 14 08:38 (99.236.168.165)

echo $HOST
matrix
```

SHELL SCRIPTING

User Defined (Created) Variables

User-defined variables *are* ***variables*** *which can be* ***created*** *by the* ***user*** *and exist in the session.*
Reference: https://mariadb.com/kb/en/user-defined-variables/

You assign a value by using the **equal** sign (without spaces)

```
name=value
```

If a variable's value contain spaces or tabs,
it should be surrounded by **quotes**

```
fullName="David G Ward"
```

SHELL SCRIPTING

User Defined Variables

There are a few methods to remove a variable's value:

```
variableName=
```

or

```
unset variableName
```

Examples:

```
customerName=
unset userAge
```

```
customerName=ACME
echo $customerName
ACME

customerName=
echo $customerName


userAge=57
echo $userAge
57
unset userAge
echo $userAge
```

CREATING SHELL SCRIPTS

Prompting User for Input to Store in a Variable:

The `echo` command with the `-n` option will display text <u>without</u> the **newline** character.

The `read` command pauses and waits for a user to enter data and then stores the enter data into a **variable** when the user presses the **ENTER** key.

Example:

```
echo -n "Enter your age: "
read age
echo "Your age is $age"
```

For **Bash shell scripts**, the `read` command with the `-p` option prompts the user for data <u>without</u> requiring the **echo** command.

Example:

```
read -p "Enter your age: " age
echo "Your age is $age"
```

```
echo -n "Enter your age: " ; read age
Enter your age: 57

echo "Your age is $age"
Your age is 57

read -p "Enter your age: " age
Enter your age: 57
echo "Your age is $age"
Your age is 57
```

SHELL SCRIPTING

User Defined (Created) Variables

Issuing the `readonly` command after setting the variable's value **prevents** the user from changing the value of the variable while the shell script is running or during the duration of your shell session.

Examples:

```
readonly name
readonly phone="123-4567"
```

```
name="Evan Weaver"
echo $name
Evan Weaver
name="Murray Saul"
echo $name
Murray Saul
readonly name
name="Mark Fernandes"
-bash: name: readonly variable

readonly phone="123-4567"
phone=456-7891
-bash: phone: readonly variable
```

INSTRUCTOR DEMONSTRATION

Task1:

Write a Bash shell script to display the following message using an **environment variable** so it will work in any user's terminal if the shell script was issued:

```
My username is: (your-username)
```

Task2:

Write a Bash shell script to prompt the user for their **full name** and prompt the user for their **age** to be stored in **user-defined** variables. Display the following output using the values of those variables:

```
Enter your Full Name: (your full name)
Enter your Age: (your age)
Hello, my name is (your full name), and I am (your age) years old.
```

SHELL SCRIPTING

Getting Practice

To get practice perform **Week 10 Tutorial:**

- INVESTIGATION 1: CREATING A SHELL SCRIPT
- INVESTIGATION 2: USING VARIABLES IN SHELL SCRIPTS
- LINUX PRACTICE QUESTIONS (Part A **1 – 3 ,** Part B **Walk-Thru #1**)

OSL640: INTRODUCTION TO OPEN SOURCE SYSTEMS

WEEK 10: LESSON 2

POSITIONAL PARAMETERS / COMMAND SUBSTITUTION / MATH OPERATIONS TESTING CONDITIONS / CONTROL FLOW STATEMENTS (LOGIC / LOOPS)

LESSON 2 TOPICS

Positional Parameters

- Definition / Purpose / Usage / Demonstration

Command Substitution / Math Operations

- Definition / Purpose / Usage / Demonstration

Control Flow Statements

- Definition / Purpose
- Exit Status **$?** / Testing Conditions (**test**) / Demonstration
- Control Flow Statements (**if**, **if-else**, **for**) / Demonstration

Perform Week 10 Tutorial

- Investigation 2
- Review Questions (Questions Part A **#4** , Part B **Walk-Thru #2**)

POSITIONAL PARAMETERS

arg1 arg2 arg3 … argN

*A positional parameter is a variable within a shell program; its value is set from an **argument** specified on the command line that invokes the program.*

*Positional parameters are numbered and are referred to with a preceding "**$**": **$1**, **$2**, **$3**, and so on.*

Reference: http://osr600doc.xinuos.com/en/SDK_tools/_Positional_Parameters.html

POSITIONAL PARAMETERS

arg1   arg2   arg3 … argN

Assigning Values as Positional Parameters

There are **two methods** to **assign values** as positional parameters:

- Use the `set` command inside a shell script with values as **arguments**
- Run a shell script with **arguments** (i.e. like a command)

POSITIONAL PARAMETERS

arg1 arg2 arg3 … argN

Using the set command:

```
set   apples   oranges   bananas
```

You place a dollar sign ($) prior to the number corresponding to the position of the argument

Examples:

```
echo $1
echo $2
echo $3
```

```
set apples oranges bananas
echo $1
apples
echo $2
oranges
echo $3
bananas
echo $4
```

POSITIONAL PARAMETERS

arg1 arg2 arg3 … argN

Running a Shell Script with Arguments:

You would use **positional parameters** in your shell script that would **expand** the positional parameters with its stored value.

Here are the contents of the shell script called **`myScript.bash`**:

```
#!/bin/bash

echo "First argument is $1"
echo "Second argument is $2"
```

You would then issue the **myScript.bash** shell script with **arguments** that would be used within the shell script. For Example:

```
./mySript.bash apples oranges
```

```
cat myScript.bash
#!/bin/bash

echo "First argument is $1"
echo "Second argument is $2"

chmod u+x myScript.bash
./myScript.bash
First argument is
Second argument is

./myScript.bash apples oranges
First argument is apples
Second argument is oranges
```

POSITIONAL PARAMETERS

arg1 arg2 arg3 … argN

The positional parameter `$0` refers to either the **name of shell** where command was issued, or **name of shell script file** being executed.

If using positional parameters greater than 9,
you need to include number within **braces** `{ }`

Examples:

```
echo $0
echo ${10}
```

```
cat positional.bash
#!/bin/bash

set 10 9 8 7 6 5 4 3 2 1

echo
echo "\$0 is: $0"
echo
echo "\$10 is: $10"
echo
echo "\${10} is: ${10}"

./positional.bash

$0 is: ./positional.bash

$10 is: 100

${10} is: 1
```

POSITIONAL PARAMETERS

arg1 arg2 arg3 … argN

The **shift** command can be used with positional parameters to move positional parameters to the **left** by one or more positions.

Examples:

```
shift
shift 2
```

```
set canoe tent food water
echo $1
canoe

shift
echo $1
tent

shift 2
echo $1
water
```

SPECIAL PARAMETERS

$* $# $?

There are a group of **special parameters** that can be used for shell scripting.

A few of these special parameters and their purpose are displayed in the table below.

Parameter	Purpose
`$*`	Display all positional parameters.
`"$*"`	Containing values of all arguments separated by a single space
`"$@"`	Multiple double-quoted strings, each containing the value of one argument
`$#`	Represents the number of parameters (not including the script name)
`$?`	Exit Status of previous command (discussed in next lesson)

```
set 1 2 3 4 5

echo $#
5
echo $*
1 2 3 4 5

pwd
/home/murray.saul
echo $?
0   # zero is true in Unix/Linux

PWD
-bash: PWD: command not found
echo $?
127  # non-zero is false in Unix/Linux
```

POSITIONAL AND SPECIAL PARAMETERS

Task:

Write a **Bash shell script** that accepts arguments from the shell script filename when executed (i.e., just like a regular Linux command).

The *Bash Shell* script will clear the screen and then display the following text (using **special parameters**):

```
Number of arguments are: (number of positional parameters)

The arguments are: (displays of all positional parameters)
```

COMMAND SUBSTITUTION

Command substitution *is a facility that allows a command to be run and its* ***output*** *to be pasted back on the command line as* ***arguments*** *to another command.*

Reference: https://en.wikipedia.org/wiki/Command_substitution

Usage:

`command1 $(command2)` or `command1 `command2``

Examples:

```
file $(ls)

mail –s “message” $(cat email-list.txt) < message.txt

echo "The current directory is $(pwd)"

echo "The current hostname is $(hostname)"

echo "The date is: $(date +'%A %B %d, %Y')"
```

```
echo "The current directory is $(pwd)"
The current directory is /home/murray.saul

echo "The current hostname is $(hostname)"
The current hostname is mtrx-node06pd.dcm.senecacollege.ca

echo "The date is: $(date +'%A %B %d, %Y')"
The date is: Tuesday March 02, 2021
```

COMMAND SUBSTITUTION

Task:

Write a **Bash** shell script that **sets** all files in your current directory as **positional parameters.**
Use **command substitution** to store all files in your current directory as **positional parameters.**

The *Bash Shell* script will clear the screen and then display the following text
(using special parameters):

```
Number of files in current directory are:
(number of positional parameters)

Here are the filenames:
(displays of all positional parameters)
```

MATH OPERATIONS

Performing **math** calculations can be an important element in shell scripting.

A problem you may experience in shell scripting (as opposed to other programming languages) is that in shell scripting, all characters (including numbers) are stored as **text**.

This can create **problems** when performing math operations.

Demonstration:

```
num1=5;num2=10
echo "$num1+$num2"
5+10
echo "$num1-$num2"
5-10
echo "$num1*$num2"
5*10
```

MATH OPERATIONS

In order to make math operations work in a Linux shell or shell script, you need to **convert** numbers stored as **text** into **binary numbers**.

We can do this by using using a **math construct** consisting two pairs of round brackets `(( ))`

Examples:

```
num1=5;num2=10
echo "$(( $num1 + $num2))"
15

echo "$((num1-num2))"
-5

((product=num1*num2))
echo "$product"
50
```

MATH OPERATIONS

Additional math operators are shown below.

Examples:

```
num1=2;num2=3
echo $((num1/num2))
0
echo $((num1%num2))
3
echo $((num1**num2))
8
echo $((num2++))
4
echo $((num1--))
1
```

Operator	Description
+	Addition
-	Subtraction
*	Multiplication
/	Division
%	Remainder
**	Exponentiation
++	Increment (increase by 1)
--	Decrement (decrease by 1)

MATH OPERATIONS

Task 1:

Write a **Bash** shell script that prompts the user for the sale **price** of an item and the **number** of items purchased.

The shell script will display the **total amount** (eg. **price** x **number** of items**)** of the sale.

For simplicity, you can assume prices are just **integers**.

Task 2:

Write a **Bash** shell script that prompts the user prompts the user for **two numbers**.

The shell script will then show the results from **addition**, **subtraction**, **multiplication** and **division** of those numbers.

CONTROL FLOW STATEMENTS

So far, we have created Bash Shell Scripts that execute Linux commands in a **fixed sequence**.

Although those type of scripts can be useful, we can use **control flow statements** that will **control the sequence** of the running script based on various situations or conditions.

Control Flow Statements are used to make your shell scripts more **flexible** and allow them to **adapt** to *changing situations*.

CONTROL FLOW STATEMENTS

The $? (exit status) Special Parameter

The special parameter `$?` is used to determine the **exit status** of the previously issued **Linux command** or **Linux pipeline command**.

The exit status will either display a **zero** (representing **TRUE**) or a **non-zero number** (representing **FALSE**).

This method can be used with control-flow statements to **change the sequence** of your shell script execution. We will apply this when we discuss advanced shell scripting in two weeks.

Examples:

```
PWD
echo $?
pwd
echo $?
```

```
PWD
-bash: PWD: command not found
echo $?
127

pwd
/home/murray.saul
echo $?
0

echo "Hi there" | grep Hi
Hi there
echo $?
0

echo "Hi there" | grep Goodbye
echo $?
1
```

CONTROL FLOW STATEMENTS

The `test` Linux Command

The **test** Linux command is used to test conditions to see if they are **TRUE** (i.e. value **zero**) or **FALSE** (i.e. value **non-zero**).

This method can also be used with control-flow statements to **change the sequence** of your shell script execution.

Examples:

```
name="Murray"
test $name = "Murray"
echo $?
test $name = "David"
echo $?
```

```
name="Murray"
test $name = "Murray"
echo $?
0

test $name = "David"
echo $?
1

test $name != "David"
echo $?
0
```

CONTROL FLOW STATEMENTS

Numerical Comparisons with test Command

You **CANNOT** use the **>** or **<** symbols when using the **test** command since those are **redirection** symbols.

You need to use **options** when performing numerical comparisons. Refer to the table below for test options and their purposes.

Option	Purpose
`-eq`	Equal to
`-ne`	Not equal to
`-lt , -le`	Less than, Less than or equal to
`-gt, -ge`	Greater than, greater than or equal to

```
num1=5
num2=10
test $num1 –eq $num2
echo $?
1

test $num1 –lt $num2
echo $?
0

test $num1 –ne $num2
echo $?
0

test $num1 –ge $num2
echo $?
1
```

CONTROL FLOW STATEMENTS

The `test` Linux Command: Additional Options

There are other **comparison options** that can be used with the **test** command such as testing to see if a **regular file** or if **directory pathname exists**, or if the regular file pathname is **non-empty**.

Refer to the table below for some of those additional options.

Option	Purpose
`-f file_pathname`	Regular filename exists
`-d file_pathname`	Directory filename exists
`-s file_pathname`	Regular filename is non-empty
`-w file_pathname`	file exists / write permission is granted

```
mkdir mydir
test -d mydir
echo $?
0

touch myfile.txt
test -f myfile.txt
echo $?
0

test ! -f myfile.txt
echo $?
1

test -s myfile.txt
echo $?
1

test ! -s myfile.txt
echo $?
0
```

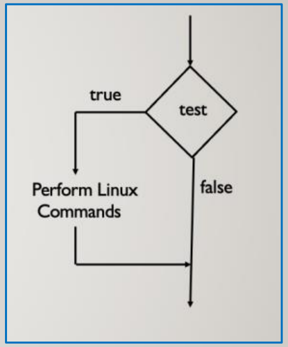
CONTROL FLOW STATEMENTS - LOGIC

Logic Statements

A **logic statement** is used to determine which Linux commands to be executed based on the result of a **test condition** or **command** (i.e. **TRUE** if zero value) or **FALSE** (if non-zero value).

There are **several logic statements**, but we will just concentrate on **if** statement and the **if-else** statements.

CONTROL FLOW STATEMENTS - LOGIC



if Control Flow Statement

If the **test** command returns a **TRUE** value,
then the Linux Commands between ***then*** and ***fi*** statements are executed.

If the **test** command returns a **FALSE** value,
the ***if*** statement is **by-passed**.

Usage:

```
if test condition
 then
     command(s)
fi
```

```
cat if.bash
#!/bin/bash

read -p "Enter First Number: " num1
read -p "Enter Second Number: " num2

if test $num1 -lt $num2
then
  echo "Less Than"
fi

./if.bash
Enter First Number: 5
Enter Second Number: 10
Less Than

./if.bash
Enter First Number: 10
Enter Second Number: 5
```

CONTROL FLOW STATEMENTS - LOGIC

Using [ ] to Represent test Command

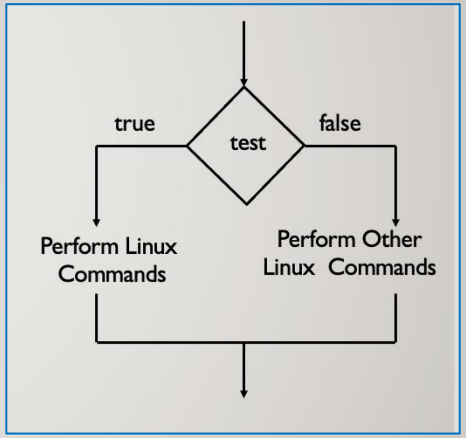
A set of square brackets **[ ]** can be used to represent the **test** command.

NOTE: There must be **spaces** between the **square brackets** and the **test** condition.

Example:

```
num1=5
num2=10
if [ $num1 -lt $num2 ]
 then
    echo "Less Than"
fi
```

CONTROL FLOW STATEMENTS - LOGIC



if-else Control Flow Statement

If the test condition returns a **TRUE** value, then the Linux Commands between the **then** and **else** statements are executed.

If the test returns a **FALSE** value, then the the Linux Commands between the **else** and **fi** statements are executed.

Usage:

```
if test condition
 then
     command(s)
 else
     command(s)
fi
```

```
cat if-else.bash
#!/bin/bash

read -p "Enter First Number: " num1
read -p "Enter Second Number: " num2

if [ $num1 -lt $num2 ]
then
   echo "Less Than"
else
   echo "Greater Than or Equal To"
fi

./if-else.bash
Enter First Number: 3
Enter Second Number: 5
Less Than

./if-else.bash
Enter First Number: 5
Enter Second Number: 3
Greater Than or Equal To
```

CONTROL FLOW STATEMENTS - LOGIC

Instructor Demonstration

Task1:

Write a **Bash** shell script that will first set a variable called **course** to the value **uli101** (lowercase). Then the shell script will clear the screen and prompt the user for the current course code. Use **logic** that if the user's entry does match the value contained in the variable **course**, the following text is displayed:

```
You are correct
```

Task2:

Modify the previous Bash Shell script to display the alternative message if the user's entry does NOT match the value (stored in the variable called **course**)
then the following alternative text is displayed:

```
You are incorrect
```

CONTROL FLOW STATEMENTS - LOOPS

Loop Statements (iteration)

*A **loop** statement is a series of steps or sequence of statements **executed repeatedly** zero or more times satisfying the given condition.*

Reference:
https://www.chegg.com/homework-help/definitions/loop-statement-3

CONTROL FLOW STATEMENTS - LOOPS

The `for` Loop

There are several loops, but we will look at the **for** loop using a **list**.

Usage:

```
for item in list
do
    command(s)
done
```

The variable **item** will hold one item from the list every time the loop iterates (repeats) the commands between the **do** and **done** reserved words.

A **list** can consist of a series of arguments (separated by spaces) or supplied by command substitution

CONTROL FLOW STATEMENTS - LOOPS

The **for** Loop

Example:

```
for x in apples oranges bananas
do
    echo "The item is: $x"
done
```

```
cat for.bash
#!/bin/bash

for x in apples oranges bananas
do
    echo "The item is: $x"
done

./for.bash
The item is: apples
The item is: oranges
The item is: bananas
```

CONTROL FLOW STATEMENTS - LOOPS

Task:

Write a **Bash shell script** that **sets** all files in your current directory as **positional parameters.** Use **command substitution** to store all files in your current directory as **positional parameters.**

The *Bash Shell* script will clear the screen and then display the following text (using special parameters). Use a for loop to display each filename on a SEPARATE line using a **for** loop:

```
Number of files in current directory are:
(number of positional parameters)

Here are the filenames:
(displays each positional parameters on a SEPARATE line)
```

HOMEWORK

Getting Practice

To get practice perform **Week 10 Tutorial:**

- INVESTIGATION 3: COMMAND SUBSTITUTION / MATH OPERATIONS
- INVESTIGATION 4: USING CONTROL FLOW STATEMENTS IN SHELL SCRIPTS
- LINUX PRACTICE QUESTIONS (Part A **4** , Part B **Walk-Thru #2)**