Introduction to Linux (Part 3) -- Shell Scripting

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Linux Virtual Machine

- Get a temporary account (or use your own CHPC account)
- Virtual Machine FastX portal: https://linuxclass.chpc.utah.edu:3300
- Open a XFCE Terminal
  - Adjust Font size: Edit → Preferences → Appearance → Click on Font → adjust Font Size
- Use Bash shell (quick check: echo $SHELL)
- Copy and Paste issue on Mac

Getting the exercise files

```
cd ~
mkdir LinuxClass
cd LinuxClass
wget https://home.chpc.utah.edu/~u6047586/LinuxScripting2.tar.gz
tar -xvzf LinuxScripting2.tar.gz
cd LinuxScripting2
```

What is a shell script?

- A script is a series of shell commands stored in a file
- A script can be executed in several ways:
  - bash scriptname.sh (python xxxx.py)
  - ./scriptname.sh (if the script file executable, rwx r-x r-x)
  - scriptname.sh (if the script is on your **$PATH environment variable**)
- commands are separated by:
  - new line
  - semi colon “;”
- Commands executed sequentially until
  - the end of the file has been reached
  - an error happens
  - the “exit” command is executed

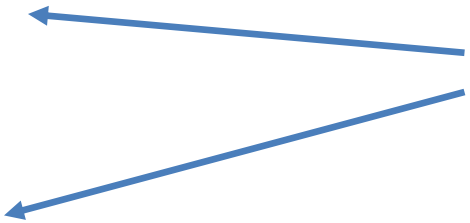
Scenarios for scripting

- Using the batch system at CHPC (discussed in the talk on Slurm Basics)
- Automating pre- and post- processing of datasets
- Performing lots of menial, soul draining tasks efficiently and quickly
- Preserve/share operations

Exercise 1: Write a first script

Create a file named **my_ex1.sh** using nano.
First line always contains '**#!**' followed by the language interpreter. ("shebang")

```
#!/bin/bash
echo "My first script:"
echo "My user name is:"
whoami
echo “My HOME dir is at”
echo $HOME
MSG1="I am in the directory:"
echo $MSG1
pwd
MSG2="Today's date:"
echo $MSG2
date
echo "End of my first script."
```



User-defined Variables

Run the script:

bash **my_ex1.sh**

Or, make the script executable first:

chmod +x **my_ex1.sh**

Then run your script:

./**my_ex1.sh**

Script Arguments

Command line arguments to a script are available in the script as **$1**, **$2**, and so on.
For example, if a script is named “myscript.sh” and the script is executed with “./myscript.sh value1 value2 value3”:

- the pre-defined internal variable **$1** has the value “value1”
- the variable **$2** has the value “value2”
- the variable **$3** has the value “value3”
- **$0** contains the name of the script
- **$#** contains the # arguments
- **$*** contains all arguments

Try it out

1) Create a new script “test_args.sh”
2) chmod +x test_args.sh
3) ./test_args.sh a b c

```
#!/bin/bash
echo "script name: $0"
echo "how many arguments: $#"
echo "list all arguments: $*"
echo "arg1: $1"
echo "arg2: $2"
echo "arg3: $3"
echo "done"
```

Re-cap: Different Variables

Environmental Variables:
eg $HOME, $PATH

Internal Variables in Bash Script:
eg $0, $1, $2, $*, $#

User-defined Variables:
MY_VAR=“this is my first var!”
echo $MY_VAR

Saving **results** of a command to a user-defined Variable

- The **result** of a command can be put directly into a variable with the **backtick**: `
- The backtick is not the same as a single quote:

  Backtick: ` Single quote: ‘

- For example: (no spaces around = sign)

```
VAR=`wc -l $FILENAME`
```

- You can also do this:

```
VAR=$(wc -l $FILENAME)
```

String replacement

A neat trick for changing the name of your output file is to use string replacement to mangle the filename.

```
#!/bin/bash
IN=“myfile.in”
#changes myfile.in to myfile.out
OUT=${IN/.in/.out}
./my_program $IN > $OUT
```

- In bash, ${VAR/search/replace} is all that is needed.
- You can use the sed, awk, or tr commands for more powerful manipulations.

Exercise 2.0

Write a script (my_ex2.sh) that takes a file name as an argument, searches that file for exclamation points with **grep**, puts all the lines with exclamation marks "!" into a new file named "outfile", and then counts the number of lines in outfile. Use "histan-qe.out" (output file of a Materials Science software) as your test file.

Don't forget **#!/bin/bash**

Variables - Bash style: **VAR="string"** (no spaces!)

Arguments - **$1 $2 $3 . . .**

Grep - **grep 'string' filename**

Counting Lines - **wc –l filename**

Solution to Exercise 2.0

Script my_ex2.sh

```
#!/bin/bash
INPUT=$1
grep "!" $INPUT > outfile
cat outfile | wc -l
```

The output from your script should have been “34”.

Dates and Times

- Date strings are easy to generate in Linux
  - "date" command gives the date,

    Fri Sep 8 09:59:02 MDT 2023

    but not nicely formatted for filenames
  - "date --help" will give format options (use +)
- date +"Today is: %D" "Today is 05/31/18"
- date +%r "10:51:17 AM"
- date +%Y-%m-%d_%H-%M-%S_%N

  "2014-09-15_17-27-32_864468693"

Exercise 2.1

Modify your previous script so that instead of writing to an output file with a fixed name, the output filename is derived from the input file (e.g., ‘XXXX.out” becomes “XXXX.todays_date”). Don’t forget to copy your script in case you make a mistake!

Command execution to string - **VAR=`command`** (use the backtick) or **VAR=$(command)**

Bash replacement – **${VAR/search/replace}**

Dates - **date +%Y-%m-%d_%H-%M-%S_%N** (or pick your own format)

Solution to Exercise 2.1

```
#!/bin/bash
INPUT=$1
DATE=`date +%Y-%m-%d_%H-%M-%S_%N`
OUT=${INPUT/out/$DATE}
grep "!" $INPUT > $OUT
wc -l $OUT
```

Every time you run the script, a new unique output file should have been generated.

Conditionals (If statements)

```
#!/bin/bash
VAR1="name"
VAR2="notname"
if [ "$VAR1" == "$VAR2" ]
then
        echo "VAR1 and VAR2 have the same value."
else
        echo "VAR1 and VAR2 have different values."
fi
if [ -d "$VAR1" ] then
        echo "$VAR1 is a directory!"
else
        echo "$VAR1 is not a directory!"
fi
```

- The operators ==, !=, <, >, &&, || and a few others work.
- The “else” clause is optional.
- You can test variable values and file properties.
- See the manual page with “man test” for all the options.

Conditionals (File properties)

Test	bash
Is a directory	- d
If file exists	- a , - e
Is a regular file (like .txt)	- f
Readable	- r
Writeable	- w
Executable	- x
Is owned by user	- O
Is owned by group	- G
Is a symbolic link	- h , - L
If the string given is zero length	- z
If the string is length is non-zero	- n

-The last two flags are useful for determining if an environment variable exists.
-The rwx flags only apply to the user who is running the test.

Loops (for statements)

```
#!/bin/bash
for i in 1 2 3 4 5
do
  echo $i
done
for i in *.in
do
  touch ${i/.in/.out}
done
for i in `cat files`
do
  grep "string" $i >> list
done
```

- Loops can be executed in a script --or-- on the command line.
- All loops respond to the wildcard operators *,?,[a-z], and {1,2}
- The output of a command can be used as a for loop input.
- There are also while and until loops.

Exercise 2.2

Run the script called ex2.sh. This will generate a directory "ex2" with 100 directories and files with different permissions. Write a script (my_ex22.sh) that examines all the directories and files in "ex2" using conditionals and for loops. For each iteration of the loop:

1. Test if the item is a directory. If it is, delete it.
2. If the file is not a directory, check to see if it is executable.
   A. If it is, then change the permissions so the file is not executable.
   B. If the file is not executable, change it so that it is executable and rename it so that it has a ".script" extension.
3. After all the files have been modified, execute all the scripts in the directory.

For loops : **for VAR in *; do ... done**

If statements : **if [condition]; then ... else ... fi** Useful

property flags - **-x** for executable, **-d** for directory

-You can reset the directory by re-running the script ex2.sh

-Make sure that you do not write your script in the ex2 directory, or it will be deleted!

Solution to Exercise 2.2 (my_ex22.sh)

```
#!/bin/bash

for i in ex2/*
do
  if [ -d $i ]
  then
    rm -rf $i
  else
    if [ -x $i ]
    then
      chmod -x $i
    else
      chmod +x $i
      mv $i $i.script
    fi
  fi
done
for i in ex2/*.script
do
 ./$i
done
```

Basic Math

```
#!/bin/bash
#initialization
i=1
#increment
i=$(( i++ ))
#addition, subtraction
i=$(( i + 2 - 1 ))
#multiplication, division
i=$(( i * 10 / 3 ))
#modulus
i=$(( i %10 ))
#not math, echo returns "i+1"
i=i+1
```

- Bash uses **$(( ))** for arithmetic operations.
- Important! This only works for integer math. If you need more, use Python, R, etc.

Bash “Strict” Mode

- Some bash settings simplify debugging:

```
set -e          #Exit immediately on any command returns errors
set -u          #Error if referencing undefined variable
set –o fail     #Error on any pipe command

    # Example: this code should fail:
    pattern=“somestring $some_undefined_variable”
    grep $pattern non_existent_file | wc -l
```

- You can do this all at once (put after shebang):

  set -euo pipefail

- See Aaron Maxwell’s blog:
  - http://redsymbol.net/articles/unofficial-bash-strict-mode/
- Also helpful is ”bash –x yourscript.sh” or “set –x”: prints each line before execution

More on scripting techniques

- Create functions

```
my_func() {
    echo “Today is $1”
}
my_func “Friday”
my_func “a big day!”
```

- Single quotes ‘ ’ V.S. Double quotes “ ”

```
MY_VAR=1
echo "The value is $MY_VAR"   #Expand variable into value: The value is 1
echo ‘The value is $MY_VAR’   #Preserve literal string: The value is $MY_VAR
```

- Redirect the standard error

```
command   # Output (stdout) and Error (stderr) printed on Screen
command > out.txt  # Save Output to a file; Error printed on Screen
command 2> error.txt  # Save Error to a file; Output printed on Screen
command > out.txt 2>error.txt  # Save output and Error to different files
command &> logs.txt (or command > logs.txt 2>&1) # Save both to same file
```

Thank You

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