Introduction to Linux Basics

Part-II Shell Scripting

Georgia Advanced Computing Resource Center
University of Georgia
Zhuofei Hou, HPC Trainer
zhuofei@uga.edu

Outline

- What is GACRC?
- What are Linux Shell and Shell Scripting?
- Shell Scripting Syntax Basics
- Real Shell Scripting Examples

What is GACRC?

Who Are We?

- **G**eorgia **A**dvanced **C**omputing **R**esource **C**enter
- Collaboration between the Office of Vice President for Research (**OVPR**) and the Office of the Vice President for Information Technology (**OVPIT**)
- Guided by a faculty advisory committee (GACRC-AC)

Why Are We Here?

- To provide computing hardware and network infrastructure in support of high-performance computing (**HPC**) at UGA

Where Are We?

- http://gacrc.uga.edu (Web) http://wiki.gacrc.uga.edu (Wiki)
- http://gacrc.uga.edu/help/ (Web Help)
- https://wiki.gacrc.uga.edu/wiki/Getting_Help (Wiki Help)

GACRC Users September 2015

Colleges & Schools	Depts	PIs	Users
Franklin College of Arts and Sciences	14	117	661
College of Agricultural & Environmental Sciences	9	29	128
College of Engineering	1	12	33
School of Forestry & Natural Resources	1	12	31
College of Veterinary Medicine	4	12	29
College of Public Health	2	8	28
College of Education	2	5	20
Terry College of Business	3	5	10
School of Ecology	1	8	22
School of Public and International Affairs	1	3	3
College of Pharmacy	2	3	5
	40	214	970
Centers & Institutes	9	19	59
TOTALS:	**49**	**233**	**1029**

GACRC Users September 2015

Centers & Institutes	PIs	Users
Center for Applied Isotope Study	1	1
Center for Computational Quantum Chemistry	3	10
Complex Carbohydrate Research Center	6	28
Georgia Genomics Facility	1	5
Institute of Bioinformatics	1	1
Savannah River Ecology Laboratory	3	9
Skidaway Institute of Oceanography	2	2
Center for Family Research	1	1
Carl Vinson Institute of Government	1	2
	19	**59**

What are Linux Shell and Shell Scripting?

- Linux: A full-fledged operating system with 4 major parts

  I. Kernel: Low-level OS, handling files, disks, RAM, networking, etc.

  II. Supplied Programs: Web browsing, Audio, Video, DVD burning……

  III. Shell: A command-line user interface for a user to type and execute commands:

    - ✓ Bourne Shell (sh)
    - ✓ Korn Shell (ksh)
    - ✓ C Shell (csh)

    } UNIX standard shells

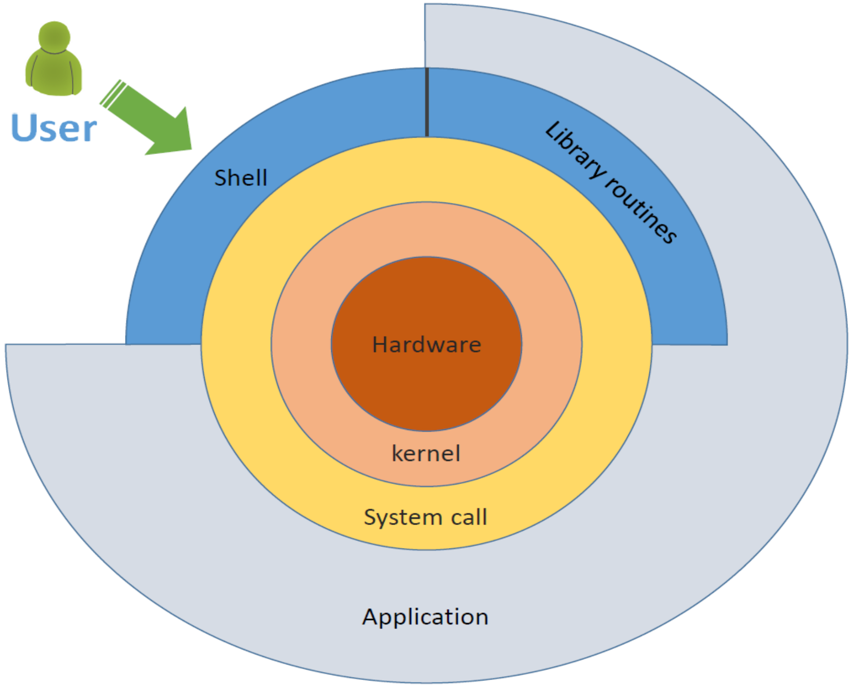
    - ✓ Bourne-Again Shell (bash) → Linux default shell

  IV. X: A graphical system providing graphical user interface(GUI)

What are Linux Shell and Shell Scripting?

- Linux Shell: A place to type and run commands on Linux
  - ✓ Command-line user interface for typing commands
  - ✓ Command interpreter to interpret & run commands
  - ✓ Programming environment for scripting
- Linux default: Bourne-Again Shell (bash)
- To open a shell on:

Local Linux/Mac	shell window	Terminal
Local windows	shell window	SSH Secure Shell Client
Remote Linux machine	a shell will run immediately when log in	



What are Linux Shell and Shell Scripting?

- Linux Shell Script: A text file running as a program to accomplish tasks on Linux that a single command cannot run
  - ✓ Variables
  - ✓ Expansion (~, $, ` `, $(( )))
  - ✓ Quoting (‘ ’, “ ”)
  - ✓ Commands (|, ;)
  - ✓ Redirection (>, >>, 2>, 2>&1, >&, <)
  - ✓ Flow Control (if-then-else)
  - ✓ Loops (for, while)
- Linux Shell Scripting: Programming with shell scripts in Linux shell

Shell Scripting Syntax Basics – Variables

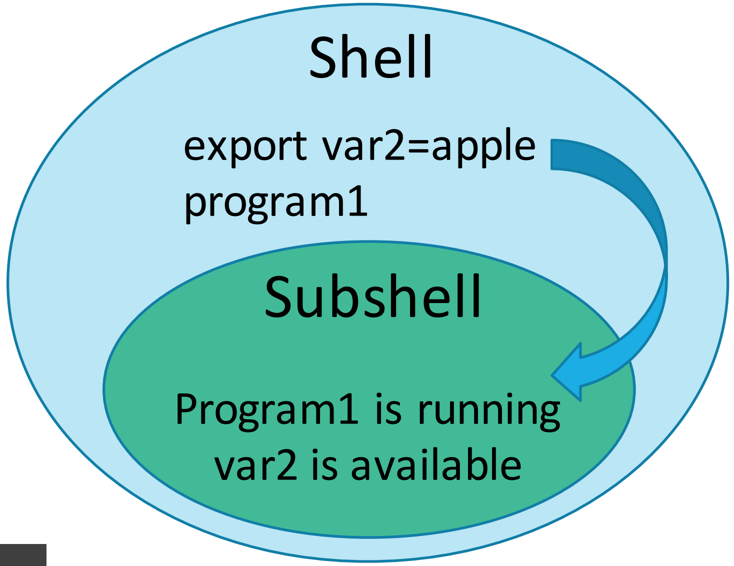
- Variable assignment: name=value (NO space! e.g., name =value is wrong!)

```
$ var1=kiwi       # all values held in variables are strings! var1=“kiwi”
$ echo $var1      # echo prints the value of variable to screen
$ kiwi

$ var2=7          # same as var2=“7”
$ echo $var2
$ 7

$ var3=$var1+7    # same as var3=“kiwi+7”
$ echo $var3
$ kiwi+7

$ var4=10         # same as var4=“10”
$ echo $var2+$var4
$ 7+10
```

Shell Scripting Syntax Basics – Variables

- Exporting variables as global ***environment variables*** for use in a shell's child processes running in subshells ➔ export

```
$ var1=kiwi
$ export var2=apple # var2=apple; export var2
$ printenv var1     # printenv prints env variables
$
$ printenv var2
$ apple
```



- Numeric expression to be evaluated? ➔ expr or $((…))

```
$ var1=10
$ var2=20
$ expr $var1 + $var2    # space and $ are required!
$ 30
$ echo $((var1+var2))   # space and $ are not required!
$ 30
```

Shell Scripting Syntax Basics – Variables

- bash automatically sets several ***shell variables*** at startup time (Note: Some shell variables may be environment variables* whereas others are local variables.)

Shell Variables	Definition
HOME*	Home directory of the current user
PATH*	Search path for commands (colon-separated dirs in which shell looks for commands)
PWD*	Current working directory
SHELL*	Default shell currently being used
USER*	Current user's name
UID	Numeric user ID of the current user
LD_LIBRARY_PATH*	Shared library search path for C program (PERLLIb, PYTHONPATH)

Shell Scripting Syntax Basics – Variables

- Why we have those ***shell variables***? ➔ Configure user working environment!

- Example: .bash_profile for interactive login shell

```
if [ -f ~/.bashrc ]; then  # if .bashrc exists and is a regular file, then
        . ~/.bashrc        # run/source it in current shell to
fi                         # make interactive login and non-login shell
                           # have the same environment

# User specific environment and startup programs
export PATH=$PATH:$HOME/bin   # append and export command searching path

# Zhuofei 2015-05-29
export PATH=$PATH:$HOME/scripts
```

Shell Scripting Syntax Basics – Variables

- Suggestion 1: “$var” to prevent runtime errors in script

```
$ var=“My Document”              # “My Document” is a subdirectory
$ cd $var                        # same as cd My Document, 2 args
$ -bash: cd: My: No such file or directory
$ cd “$var”                      # same as cd “My Document”, 1 args
My Document$
```

- Suggestion 2: ${var} to prevent unexpected behavior

```
$ var=“apple”
$ echo “Mary has 3 $vars”        # variable vars is empty!
$ Mary has 3
$ echo “Mary has 3 {$var}s”      # {$var} is not working!
$ Mary has 3 {apple}s
$ echo “Mary has 3 ${var}s”      # ${var} is working!
$ Mary has 3 apples
```

Shell Scripting Syntax Basics – Expansion

- Tilde Expansion: ~

```
$ cd ~username   # home directory associated username
$ cd ~           # replaced by $HOME
$ cd ~/          # same as above
```

- Variable Expansion: $

```
$ var=24
$ echo ${var}th  # outputs 24th; ${var} to prevent unexpected behavior!
```

- Command Substitution: `command` (back quota)

```
$ cd `pwd`       # same as cd /home/abclab/jsmith/workingDir
```

- Arithmetic Expansion: $((expression))

```
$ echo $(( ((5+3*2)-1)/2 ))    # outputs 5; space is not required!
$ var1=24 ; var2=10            # ; for a sequence of commands
$ echo $((var1+var2))          # outputs 34
```

Shell Scripting Syntax Basics – Quoting

- Linux special characters

` ~ ! # % ^ & * ( ) - + / \ | ; ‘ “ , . < > ? {

- Quoting rules in bash

1. All special characters are disabled by enclosing single quotes **‘ ’**
2. All special characters are disabled by enclosing double quotes **“ ”** except for **!**, **$**, `, \, and **{**
3. All special characters are disabled by a preceding backslash \

Shell Scripting Syntax Basics – Quoting

- Quoting Examples

```
$ FRUIT=apples
$ echo ‘I like $FRUIT’                # $ is disabled by ‘ ’
$ I like $FRUIT
$ echo “I like $FRUIT”                # $ is not disabled by “ ”
$ I like apples
$ echo “I like \$FRUIT”               # $ is disabled by preceding \
$ I like $FRUIT
$ echo ‘`pwd`’                        # ` is disabled by ‘ ’
$ `pwd`
$ echo “`pwd`”                        # ` is not disabled by “ ”
$ /home/abclab/jsmith
```

Shell Scripting Syntax Basics – Commands

- Pipeline command1 | command2 | … connects std output of *command1* to the std input of *command2*, and so on (Demonstration)

```
$ ls -l | more
$ ls -l | grep ".sh"
$ ps aux | awk '{if($1=="zhuofei") print $0}' | more
$ qstat -u "*" | awk '{print $4}' | sort | less
$ qstat -u "*" | grep ‘qw' | awk 'BEGIN{n=0} {n++} END{printf "%d jobs waiting on queue\n", n}'
```

- List command1 ; command2 ; … ; simply runs commands in sequence on a single command line

```
$ pwd ; ls
$ cd .. ; ls
$ mkdir ./subdir ; cd ./subdir ; touch file1 ; ls
```

Shell Scripting Syntax Basics – Redirection

- Standard output redirection: > and >>

```
$ ls > outfile              # std output of a command is written to outfile
$ ls >> outfile             # std output of a command is appended to outfile
$ ./myprog > outfile        # std output of a program is written to outfile
```

- Standard error redirection: 2>, 2>&1 and >&

```
$ ./myprog > outfile 2> errorfile     # std output and error ➔ separate files
$ ./myprog > outfile 2>&1             # std output and error ➔ single file
$ ./myprog >& outfile                 # same as above
```

- Standard input redirection: <

```
$ ./myprog < infile                   # std input is from infile
```

- General usage

```
$ ./myprog < infile > outfile 2>&1
```

Shell Scripting Syntax Basics – Flow Control

- if-fi Block

```
if [ expression ]   : if expression is evaluated to be true
then
    body1
else
    body2
fi
```

- Example (Demonstration)

```
echo “Please enter you name:”
read name                                   # read a line from standard input
if [ “$name” == “zhuofei” ]                 # true if strings are equal
then
    echo “Hello, ${name}!”
else
    echo “Hi, ${name}, you are not zhuofei!”
fi
```

Shell Scripting Syntax Basics – Flow Control

	Test Expression	Description
File testing	-e file	True if file exists
	-d or -f file	True if file exists and is a directory or a regular file
	-r or -w or -x file	True if file exists and is readable or writable or executable
	-s file	True if file exists and has a nonzero size
	file1 -nt or -ot file2	True if file1 is newer or older than file2
String testing	-z or -n string	True if the length of string is zero or nonzero
	str1 == str2	True if the strings are equal
	str1 != str2	True if the strings are not equal
ARITH testing	arg1 OP arg2	OP is one of -eq, -ne, -lt, -le, -gt, or -ge. Arg1 and arg2 may be +/- integers
Logical testing	! expr	True if expr is false
	expr1 -a expr2	True if both expr1 AND expr2 are true
	expr1 -o expr2	True if either expr1 OR expr2 is true

Shell Scripting Syntax Basics – Loops

- for Loop

```
for variable in list
do
    body
done
```

while Loop

```
while [ expression ]
do
    body
done
```

- Example (Demonstration)

```
for file in *.doc *.docx
do
    echo "$file is a MS word file!"
done
```

```
i=1
while [ $i -le 10 ]
do
    echo $i
    i=`expr $i + 1`
done
```

Real Shell Scripting Examples

- To create a shell script, simply put bash commands into a text file

- To run the script:

1. Prepend #!/bin/bash to the very top of the script (1st line and left-justified)

2. Make the script executable: `chmod 700 script.sh`

3. Run the script:`./script.sh or script.sh`

Real Shell Scripting Examples

- Example 1: A script to submit all job submission scripts in current working dir

```
#!/bin/bash

SUBDIR=`pwd`
CTR=1

for sub in ${SUBDIR}/*.sh ; do
    if [ "`basename ${sub}`" != "`basename $0`" ] ; then

        qsub -q rcc-30d ${sub} > ${SUBDIR}/outfile_${CTR}

        echo "`basename ${sub}` submitted!”
        CTR=$(($CTR+1))
    fi
Done
printf "\nTotally %d jobs submitted!\n\n" $(($CTR-1))
qstat -u `id -un`
```

Real Shell Scripting Examples

- Example 2: A serial job submission script on zcluster

```
#!/bin/bash
cd `pwd`
time ./myprog < myin > myout
```

- Example 3: A MPI job submission script on zcluster *(default MPICH2 and PGI compilers)*

```
#!/bin/bash
cd `pwd`
export LD_LIBRARY_PATH=/usr/local/mpich2/1.4.1p1/pgi123/lib:${LD_LIBRARY_PATH}
mpirun -np $NSLOTS ./myprog
```

https://wiki.gacrc.uga.edu/wiki/Running_Jobs_on_zcluster

Thank You!