Basic Shell Scripting

Feng Chen
HPC User Services
LSU HPC & LONI
sys-help@loni.org

Louisiana State University
Baton Rouge
February 21, 2024

What have we learned so far?

- **Introduction to Linux**
  - OS used on HPC clusters

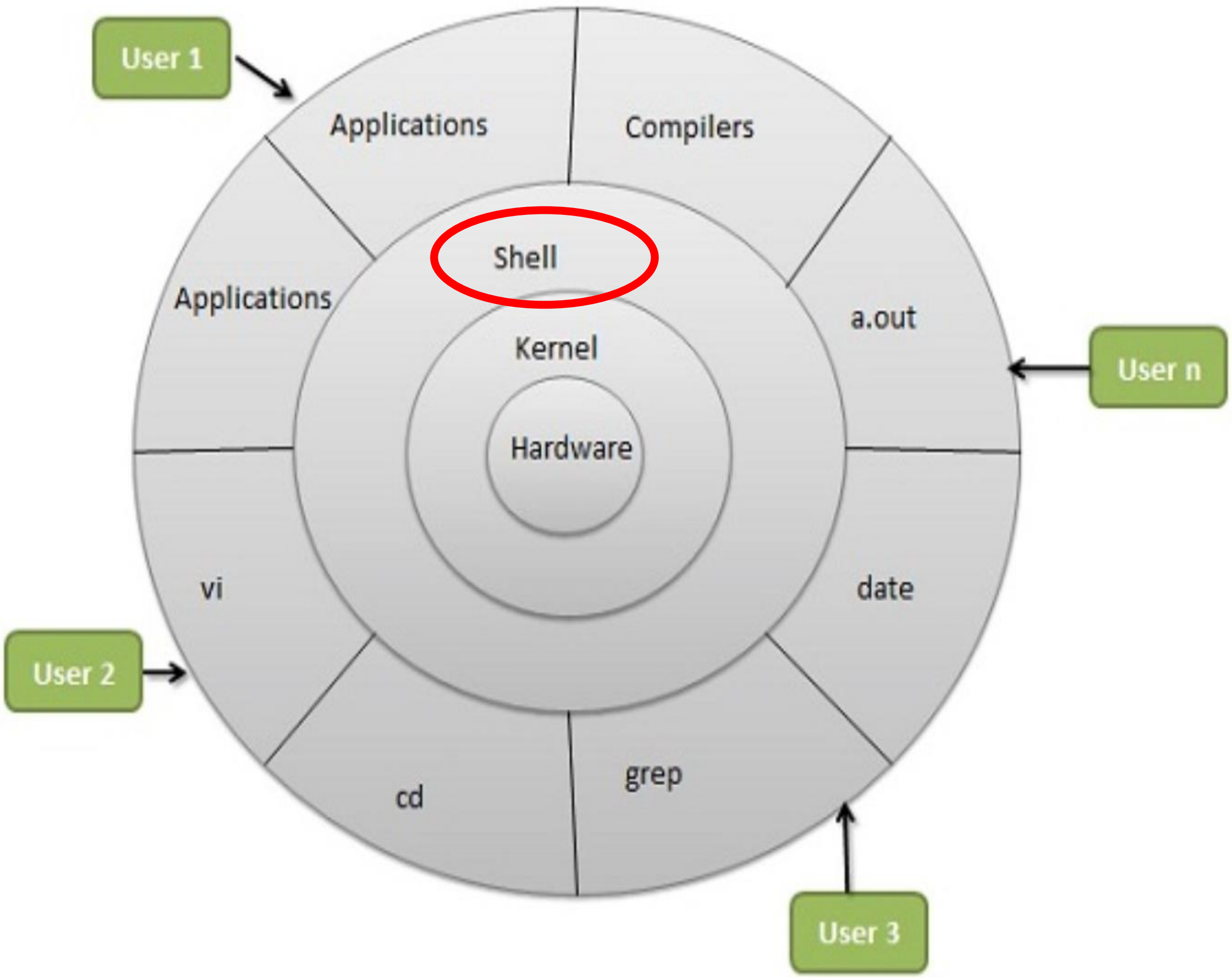
- **HPC User Environment 1**
  - LSU and LONI HPC policy
  - Connect to our cluster
  - Use software on HPC

- **HPC User Environment 2**
  - How to submit jobs (PBS/Slurm)
    - Interactive jobs
    - Batch jobs

Outline

- Introduction to Linux Shell
- Shell Scripting Basics
  - Variables/Special Characters
  - Arithmetic Operations
  - Arrays
- Beyond Basic Shell Scripting
  - – Flow Control
  - – Functions
- Advanced Text Processing Commands (grep, sed, awk)

Linux System Architecture



What is a Linux Shell

- An application running on top of the kernel and provides a command line interface to the system
  - Process user's commands, gather input from user and execute programs
- Types of shell with varied features
  - `sh`
    - the original Bourne shell.
  - `ksh`
    - one of the three: Public domain ksh (pdksh), AT&T ksh or mksh
  - `bash`
    - the GNU Bourne-again shell. It is mostly Bourne-compatible, mostly POSIX-compatible, and has other useful extensions. It is the default on most Linux systems.
  - `csh`
    - BSD introduced the C shell, which sometimes resembles slightly the C programming language.
  - `tcsh`
    - csh with more features. csh and tcsh shells are NOT Bourne-compatible.

Shell Comparison

Software	sh	csh	ksh	bash	tcsh
Programming language	y	y	y	**y**	y
Shell variables	y	y	y	**y**	y
Command alias	n	y	y	**y**	y
Command history	n	y	y	**y**	y
Filename autocompletion	n	y*	y*	**y**	y
Command line editing	n	n	y*	**y**	y
Job control	n	y	y	**y**	y

*: not by default

http://www.cis.rit.edu/class/simg211/unixintro/Shell.html

What can you do with a shell?

- Check the current shell you are using
  - `echo $0`
- List available shells on the system
  - `cat /etc/shells`
- Change to another shell
  - `csh`
- Date
  - `date`
- wget: get online files
  - wget https://ftp.gnu.org/gnu/gcc/gcc-7.1.0/gcc-7.1.0.tar.gz
- Compile and run applications
  - `gcc hello.c -o hello`
  - `./hello`
- What we need to learn today?
  - Automation of an entire script of commands!
  - Use the shell script to run jobs – Write job scripts

Shell Scripting

- Script: a program written for a software environment to automate execution of tasks
  - A series of shell commands put together in a file
  - When the script is executed, those commands will be executed one line at a time automatically
  - Shell script is interpreted, not compiled.

- The majority of script programs are “quick and dirty”, where the main goal is to get the program written quickly
  - May not be as efficient as programs written in C and Fortran

When NOT to use Shell Scripting…

- Selected situations:
  - Resource-intensive tasks, especially where speed is a factor (sorting, hashing, recursion [2] ...)
  - Procedures involving heavy-duty math operations, especially floating point arithmetic, arbitrary precision calculations, or complex numbers (use C++ or FORTRAN instead)
  - Complex applications, where structured programming is a necessity (type-checking of variables, function prototypes, etc.)
  - Extensive file operations required (Bash is limited to serial file access, and that only in a particularly clumsy and inefficient line-by-line fashion.)
  - Need native support for multi-dimensional arrays, data structures, such as linked lists or trees
  - Need to use libraries or interface with legacy code

Script Example (~/.bashrc)

```
# .bashrc

# Source global definitions
if [ -f /etc/bashrc ]; then
   . /etc/bashrc
fi

# User specific aliases and functions
export PATH=$HOME/packages/bin:$PATH
export LD_LIBRARY_PATH=$HOME/packages/lib:$LD_LIBRARY_PATH
alias qsubI="qsub -I -X -l nodes=1:ppn=20 -l walltime=01:00:00 –A my_allocation"
alias lh="ls -altrh"
```

Hello World

```
#!/bin/bash
# A script example
echo 'Hello World!' # print something
```

1. `#!`: "Shebang" line to instruct which interpreter to use. In the current example, bash. For tcsh, it would be: `#!/bin/tcsh`
2. All comments begin with "#".
3. Print "Hello World!" to the screen.

```
[fchen14@mike1 shelltut]$ ./hello_world.sh # using default /bin/bash
Hello World!
[fchen14@mike1 shelltut]$ bash hello_world.sh # using bash to run the script
Hello World!
```

Interactive and non-interactive shells

- An interactive shell is one started without non-option arguments, unless -s is specified, without specifying the -c option, and whose input and error output are both connected to terminals or one started with the -i option.
  - *The user can interact with the shell from the terminal.*
  - e.g., open an interactive shell by typing bash or ssh from the terminal
- A shell running a script is always a non-interactive shell.
  - All the same, the script can still access its tty. It is even possible to emulate an interactive shell in a script.

- Test whether you are using an interactive shell using `$-` (prints The current set of options in your current shell.)

```
[fchen14@mike1 shelltut]$ echo $-
himBH
[fchen14@mike1 shelltut]$ cat checkshell.sh
#!/bin/bash
# read value # you can still interact with the script
echo $-
[fchen14@mike1 shelltut]$ ./checkshell.sh
hB
```

Subshell

- Definition:
  - A subshell is a child process launched by a shell (or shell script).
  - Just as your commands are interpreted at the command-line prompt, similarly does a script batch-process a list of commands.
  - Each shell script running is, in effect, a subprocess (child process) of the parent shell.
- Two typical examples of starting subshell:
  - Running a shell script launches a new process, a *subshell*.
  - Type "`bash`" from an interactive shell

Outline

- Introduction to Linux Shell
- Shell Scripting Basics
    - Variables/Special Characters
    - Arithmetic Operations
    - Arrays
- Beyond Basic Shell Scripting
    - Control flow
    - Functions
- Advanced Text Processing Commands (grep, sed, awk)

Variables

- Variable names
  - Must start with a letter or underscore
  - Number can be used anywhere else
  - Do not use special characters such as `@,#,%,$`
  - Case sensitive
  - Allowed: `VARIABLE, VAR1234able, var_name, _VAR`
  - Not allowed: `1var, %name, $myvar, var@NAME, myvar-1`
- To reference a variable, prepend **`$`** to the name of the variable
- Example: `$PATH, $LD_LIBRARY_PATH, $myvar` etc.
- When assigning a variable, no space allowed before or after the equal sign. (bash)

Global and Local Variables

- Two types of variables:
  - Global (Environmental) variables
    - Inherited by subshells (child process, see next slide)
    - provide a simple way to share configuration settings between multiple applications and processes in Linux
    - Using all uppercase letters by convention
    - Example: `PATH, LD_LIBRARY_PATH, DISPLAY` etc.
    - `printenv/env` list the current environmental variables in your system.
  - Local (shell) variables
    - Only visible to the current shell
    - Not inherited by subshells

Editing Variables

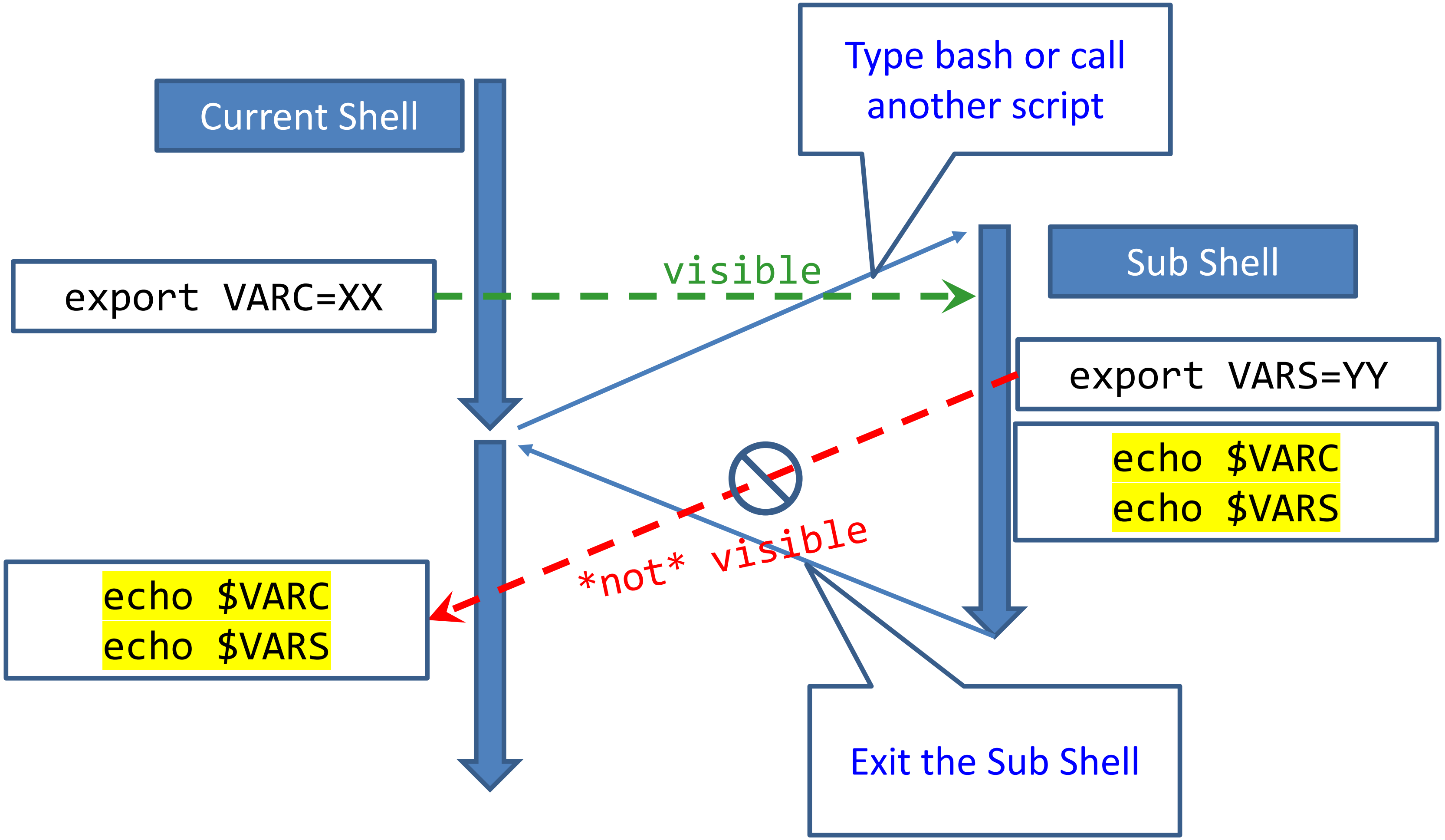
- Assign values to variables

Type	sh/ksh/bash	csh/tcsh
Shell (local)	`name=value`	`set name=value`
Environment (global)	`export name=value`	`setenv name value`

- Local (Shell) variables is only valid within the current shell, while environment variables are valid for all subsequently opened shells.
- Example: useful when running a script, where exported variables (global) at the terminal can be inherited within the script.

With export	Without export
`$ export v1=one`	`$ v1=one`
`$ bash`	`$ bash`
`$ echo $v1`	`$ echo $v1`
→one	→

Global and Local Variables - current shell and subshell



How to inherit the variables in the script?

- Using the *source* command, it has a synonym in dot "`.`" (period)
  - Syntax:
    ```
    . filename [arguments]
    source filename [arguments]
    ```
  - The script does not need execute permission in this case. Commands are executed *in the current shell process*, so any changes made to your environment will be visible when the script finishes execution.
  - Executing will run the commands in a new shell process (subshell).

```
[fchen14@mike1 shelltut]$ cat source_var.sh
#!/bin/bash
export myvar="newvalue"
[fchen14@mike1 shelltut]$ bash source_var.sh
[fchen14@mike1 shelltut]$ echo $myvar

[fchen14@mike1 shelltut]$ source source_var.sh
[fchen14@mike1 shelltut]$ echo $myvar
newvalue
```

List of Some Environment Variables

PATH	A list of directory paths which will be searched when a command is issued
LD_LIBRARY_PATH	colon-separated set of directories where libraries should be searched for first
HOME	indicate where a user's home directory is located in the file system.
PWD	contains path to current working directory.
USER	Current logged in user's name
OLDPWD	contains path to previous working directory.
TERM	specifies the type of computer terminal or terminal emulator being used
SHELL	contains name of the running, interactive shell.
PS1	default command prompt
PS2	Secondary command prompt
HOSTNAME	The systems host name
DISPLAY	Network name of the X11 display to connect to, if available.

Quotations

- Single quotation
  - Enclosing characters in single quotes `(')` preserves the literal value of each character within the quotes. A single quote may not occur between single quotes, even when preceded by a backslash.
- Double quotation
  - Enclosing characters in double quotes `(")` preserves the literal value of all characters within the quotes, with the exception of `‘$’, ‘`’, ‘\’`
- Back “quotation?”
  - Command substitution ``(``)`` allows the output of a command to replace the command itself, enclosed string is executed as a command, almost the same as `$()`

Quotation - Examples

```
[fchen14@mike1 ~]$ str1='echo $USER'
[fchen14@mike1 ~]$ echo "$str1"
echo $USER
[fchen14@mike1 ~]$ str2="echo $USER"
[fchen14@mike1 ~]$ echo "$str2"
echo fchen14
[fchen14@mike1 ~]$ str3=`echo $USER`
[fchen14@mike1 ~]$ echo $str3
fchen14
[fchen14@mike1 ~]$ str3=$(echo $USER)
[fchen14@mike1 ~]$ echo "$str3"
fchen14
```

Always use double quotes around variable substitutions and command substitutions: `"$foo"`, `"${foo}"`

Special Characters (1)

`#`	Start a comment line.
`$`	Indicate the name of a variable.
`\`	Escape character to display next character literally; line continuation
`{}`	Enclose name of variable
`;`	Command separator. Permits putting two or more commands on the same line.
`;;`	Terminator in a case option
`.`	“dot” command, equivalent to `source` (for bash only)
`|`	Pipe: use the output of a command as the input of another one
`>` `<`	Redirections (`0<:` standard input; `1>:` standard out; `2>:` standard error)

Special Characters (2)

`$?`	Exit status for the last command, 0 is success, failure otherwise
`$$`	Process ID variable.
`[ ]`	Test expression, eg. if condition
`[[ ]]`	Extended test expression, more flexible than [ ]
`$[], $(( ))`	Integer expansion
`||, &&, !`	Logical OR, AND and NOT

Outline

- Introduction to Linux Shell
- Shell Scripting Basics
  - Variables/Special Characters
  - Arithmetic Operations
  - Arrays
- Beyond Basic Shell Scripting
  - Arrays
  - Flow Control
  - Functions
- Advanced Text Processing Commands (grep, sed, awk)

Integer Arithmetic Operations

Operation	Operator
Addition	`+`
Subtraction	`-`
Multiplication	`*`
Division	`/`
Exponentiation	`** (bash only)`
Modulo	`%`

Integer Arithmetic Operations

- `$((...))` or `$[...]` commands
  - `x=$((1+2))     # Addition, suggested`
  - `echo $[$x*$x] # Multiplication, deprecated`
- `let` command:
  - `let c=$x+$x     # no space`
  - `let c=x+x       # you can omit the $ sign`
  - `let c="x + x"   # can have space`
  - `let c+=1 or let --c # C-style increment operator`
- `expr` command:
  - `expr 10 / 2 # division, space required`
  - `expr  5 \* 4 # multiplication, space required`

Note: Bash is picky about spaces!

Floating-Point Arithmetic Operations

GNU basic calculator (bc) external calculator

- Add two numbers
  ```
  echo "3.8 + 4.2" | bc
  ```
- Divide two numbers and print result with a precision of 5 digits:
  ```
  echo "scale=5; 2/5" | bc
  ```
- Convert between decimal and binary numbers
  ```
  echo "ibase=10; obase=2; 10" |bc
  ```
- Call bc directly:
  ```
  bc <<< "scale=5; sqrt(2)"
  ```

Outline

- Introduction to Linux Shell
- Shell Scripting Basics
  - Variables
  - Quotations
  - Arithmetic Operations
  - Arrays
- Beyond Basic Shell Scripting
  - Flow Control
  - Command Line Arguments
  - Functions
- Advanced Text Processing Commands (grep, sed, awk)

Arrays Operations (1)

- Initialization

```
my_array=("Alice" "Bill" "Cox" "David")
my_array[0]="Alice";
my_array[1]="Bill”
```

- Bash supports one-dimensional arrays
  - Index starts at 0
  - No space around “=“
- Reference an element

```
${my_array[i]} # must include curly braces {}
```

- Print the whole array

```
${my_array[@]}
```

- Length of array

```
${#my_array[@]}
```

Array Operations (2)

- Add an element to an existing array
  - `my_array=(first ${my_array[@]})`
  - `my_array=("${my_array[@]}" last)`
  - `my_array[4]=(“Nason”)`
- Copy the current array to a new array
  - `new_array=(${my_array[@]})`
- Concatenate two arrays
  - `two_arrays=(${my_array[@]} ${new_array[@]})`

Array Operations (3)

- Delete the entire array
  - `unset my_array`
- Delete an element to an existing array
  - `unset my_array[0]`

Outline

- Introduction to Linux Shell
- Shell Scripting Basics
  - Arrays
  - Arithmetic Operations
- Beyond Basic Shell Scripting
  - Flow Control
  - Functions
- Advanced Text Processing Commands (grep, sed, awk)

Flow Control

- Shell scripting languages execute commands in sequence similar to programming languages such as C and Fortran
  - Control constructs can change the order of command execution
- Control constructs in bash
  - Conditionals:
    - if-then-else
    - Switches: case
  - Loops: for, while, until

if statement

- if/then construct test whether the exit status of a list of commands is **0**, and if so, execute one or more commands

```
if [ condition ]; then
   Do something
elif [ condition 2 ] ; then
   Do something
else
   Do something else
fi
```

- Strict spaces between condition and the brackets (bash)
- `[[ condition ]] extended test` construct is the more versatile Bash version of `[ condition ]`, generally safer to use.

File Operations

Operation	bash
File exists	`if [ -e test ]`
File is a regular file	`if [ -f test]`
File is a directory	`if [ -d /home ]`
File is not zero size	`if [ -s test ]`
File has read permission	`if [ -r test ]`
File has write permission	`if [ -w test ]`
File has execute permission	`if [ -x test ]`

Integer Comparisons

Operation	bash
Equal to	`if [ 1 -eq 2 ]`
Not equal to	`if [ $a -ne $b ]`
Greater than	`if [ $a -gt $b ]`
Greater than or equal to	`if [ 1 -ge $b ]`
Less than	`if [ $a -lt 2 ]`
Less than or equal to	`if [ $a -le $b ]`

String Comparisons

Operation	bash
Equal to	`if [ $a == $b ]`
Not equal to	`if [ $a != $b ]`
Zero length or null	`if [ -z $a ]`
Non zero length	`if [ -n $a ]`

Logical Operators

Operation	Example
! (NOT)	if [! –e test]
&& (AND)	if [-f test] && [-s test] if [[-f test && -s test]] if (-e test && ! –z test)
|| (OR)	if [-f test1] || [-f test2] if [[-f test1 || -f test2]]

if condition examples

Example 1:

```
read input
if [ $input == "hello" ]; then
   echo hello;
else echo wrong ;
fi
```

Example 2

```
touch test.txt
if [ -e test.txt ]; then
   echo “file exist”
elif [ ! -s test.txt ]; then
   echo “file empty”;
fi
```

What happens after

```
echo “hello world” >> test.txt
```

Loop Constructs

- A loop is a block of code that iterates a list of commands as long as the loop control condition stays true
- Loop constructs

  `for`, `while` and `until`

for loop examples

Exmaple1:

```
for arg in `seq 1 4`
do
   echo $arg;
   touch test.$arg
done
```

How to delete test files using a loop?

```
rm test.[1-4]
```

Example 2:

```
for file in `ls /home/$USER`
do
   cat $file
done
```

While Loop

- The `while` construct test for a condition at the top of a loop and keeps going as long as that condition is true.
- In contrast to a `for` loop, a `while` is used when loop repetitions is not known beforehand.

```
read counter
while [ $counter -ge 0 ]
do let counter--
   echo $counter
done
```

Until Loop

- The `until` construct test a condition at the top of a loop, and stops looping when the condition is met (opposite of `while` loop)

```
read counter
until [ $counter -lt 0 ]
do let counter--
   echo $counter
done
```

Switching Constructs - bash

- The `case` constructs are technically not loops since they do not iterate the execution of a code block

```
#!/bin/sh
echo "Please talk to me ..."
while :
do
  read INPUT_STRING
  case $INPUT_STRING in
    hello)
        echo "Hello yourself!"
        ;;
    bye)
        echo "See you again!"
        break
        ;;
    *)
        echo "Sorry, I don't understand"
        ;;
  esac
Done
echo "That's all folks!"
```

Outline

- Introduction to Linux Shell
- Shell Scripting Basics
- Beyond Basic Shell Scripting
  - Arithmetic Operations
  - Arrays
  - Flow Control
  - Functions
- Advanced Text Processing Commands (grep, sed, awk)

Functions

- A function is a code block that implements a set of operations. Code reuse by passing parameters,
  - Syntax:

```
function_name () {
   command...
}
```

- By default all variables are global.
- Modifying a variable in a function changes it in the whole script.
- Create a local variables using the local command, which is invisible outside the function

```
local var=value
local varName
```

Pass Arguments to Bash Scripts

- Note the difference between the arguments passed to the script and the function.
- All parameters can be passed at runtime and accessed via `$1, $2, $3…, add {} when >=10`
- `$0:` the shell script name
- Array variable called `FUNCNAME` contains the names of all shell functions currently in the execution call stack.
- `$* or $@:` all parameters passed to a function
- `$#:` number of positional parameters passed to the function
- $?: exist code of last command
- $$: PID of current process

Function example

```
#!/bin/bash

func_add () # define a simple function
{
    local x=$1    # 1st argument to the function
    local y=$2    # 2nd argument to the function
    result=$(( x + y ))
    # echo "result is: " $result
}

a=3;b=4
echo "a= $a, b= $b"
result="nothing"
echo "result before calling the function is: " $result
func_add $a $b # note this is arguments to the function
echo "result by passing function arguments is: " $result
func_add $1 $2 # note this is command line arguments
echo "result by passing command line arguments is: " $result
```

Outline

- Introduction to Linux Shell
- Shell Scripting Basics
  - Variables/Special Characters
  - Arithmetic Operations
  - Arrays
- Beyond Basic Shell Scripting
  - Flow Control
  - Functions
- Advanced Text Processing Commands (grep, sed, awk)

Advanced Text Processing Commands

- `grep`
- `sed`
- `awk`

One slide about Regular Expression

- What are Regular Expressions (regex)?
  - They describe patterns in strings
  - These patterns can be used to modify strings
  - Invented by Stephen Cole Kleene
  - Idea of RegEx dates back to the 1950s
- Today, they come in different “flavors”
- PCRE, POSIX Basic & Extended RegEx, ECMA RegEx and loads more!
- Examples:

Regex examples

- Anchors - `^ and $`
  - `^The` matches any string that starts with The
  - `end$` matches a string that ends with end
  - `^The end$` exact string match (starts and ends with The end)
  - `roar` matches any string that has the text roar in it
- Quantifiers - `* + ? and {}`
  - `abc*` matches a string that has ab followed by zero or more c
  - `abc+` matches a string that has ab followed by one or more c
  - `abc?` matches a string that has ab followed by zero or one c
  - `abc{2}` matches a string that has ab followed by 2 c
  - `abc{2,}` matches a string that has ab followed by 2 or more c
  - `abc{2,5}` matches a string that has ab followed by 2 up to 5 c
- OR operator - `| or []`
  - `a(b|c)` matches a string that has a followed by b or c
  - `a[bc]` same as previous

grep & egrep

- **`grep:`** Unix utility that searches a pattern through either information piped to it or files.
- **`egrep:`** extended grep, same as `grep -E`
- **`zgrep:`** compressed files.

- Usage: `grep <options> <search pattern> <files>`
- Options:

`-i`	ignore case during search
`-r,-R`	search recursively
`-v`	invert match i.e. match everything except *`pattern`*
`-l`	list files that match *`pattern`*
`-L`	list files that do not match *`pattern`*
`-n`	prefix each line of output with the line number within its input file.
`-A num`	print `num` lines of trailing context after matching lines.
`-B num`	print `num` lines of leading context before matching lines.

grep Examples

- Search files containing the word `bash` in current directory

```
grep bash *
```

- Search files NOT containing the word `bash` in current directory

```
grep -v bash *
```

- Repeat above search using a case insensitive pattern match and print line number that matches the search pattern

```
grep -in bash *
```

- Search files not matching certain name pattern

```
ls | grep –vi fun
```

grep Examples

```
100  Thomas  Manager    Sales         $5,000
200  Jason     Developer  Technology  $5,500
300  Raj        Sysadmin   Technology  $7,000
500  Randy     Manager    Sales          $6,000
```

- grep OR

```
grep 'Man\|Sales' employee.txt
-> 100  Thomas  Manager    Sales      $5,000
   300  Raj     Sysadmin   Technology  $7,000
   500  Randy   Manager    Sales      $6,000
```

- grep AND

```
grep -i 'sys.*Tech' employee.txt
-> 100300  Raj    Sysadmin   Technology  $7,000
```

sed

- "stream editor" to parse and transform information
  - information piped to it or from files
- line-oriented, operate one line at a time and allow regular expression matching and substitution.
- `s` substitution command

sed commands and flags

Flags	Operation	Command	Operation
-e	combine multiple commands	s	substitution
-f	read commands from file	g	global replacement
-h	print help info	p	print
-n	disable print	i	ignore case
-V	print version info	d	delete
-r	use extended regex	G	add newline
		w	write to file
		x	exchange pattern with hold buffer
		h	copy pattern to hold buffer
		;	separate commands

sed Examples

```
#!/bin/bash

# My First Script

echo "Hello World!”
```

sed Examples (2)

- Delete blank lines from a file

```
sed '/^$/d' hello.sh

#!/bin/bash
# My First Script
echo "Hello World!"
```

- Delete line `n` through `m` in a file

```
sed '2,4d' hello.sh

#!/bin/bash
echo "Hello World!"
```

sed Examples (1)

- Add flag -e to carry out multiple matches.

```
cat hello.sh | sed -e 's/bash/tcsh/g' -e 's/First/Second/g'
#!/bin/tcsh
# My Second Script
echo "Hello World!"
```

- Alternate form

```
sed 's/bash/tcsh/g; s/First/Second/g' hello.sh

#!/bin/tcsh
# My Second Script
echo "Hello World!"
```

- The default delimiter is slash (/), can be changed

```
sed 's:/bin/bash:/bin/tcsh:g' hello.sh

#!/bin/tcsh
# My First Script
echo "Hello World!"
```

sed Examples (4)

- Replace-in-place with a backup file

```
sed –i.bak '/First/Second/i' hello.sh
```

- echo with sed

```
$ echo "shell scripting" | sed "s/[si]/?/g"
$ ?hell ?cr?pt?ng

$ echo "shell scripting 101" | sed "s/[0-9]/#/g"
$  shell scripting ###
```

awk

- The `awk` text-processing language is useful for tasks such as:
  - Tallying information from text files and creating reports from the results.
  - Adding additional functions to text editors like "vi".
  - Translating files from one format to another.
  - Creating small databases.
  - Performing mathematical operations on files of numeric data.
- `awk` has two faces:
  - It is a utility for performing simple text-processing tasks, and
  - It is a programming language for performing complex text-processing tasks.

How Does awk Work

- `awk` reads the file being processed line by line.
- The entire content of each line is split into columns with space or tab as the delimiter.
- `$0` Print the entire line
- `$1, $2, $3, ...` for each column (if exists)
- `NR` number of records (lines)
- `NF` number of fields or columns in the current line.
- By default the field delimiter is space or tab. To change the field delimiter use the `-F<delimiter>` command.

awk Syntax

`awk pattern {action}`

`pattern` decides when `action` is performed

`Actions:`

- Most common action: `print`
- Print file dosum.sh:

```
awk '{print $0}' dosum.sh
```

- Print line matching files in all `.sh` files in current directory:

```
awk '/bash/{print $0}' *.sh
```

```
uptime
11:18am up 14 days 0:40, 5 users, load average: 0.15, 0.11, 0.17

uptime | awk '{print $0}'
11:18am up 14 days 0:40, 5 users, load average: 0.15, 0.11, 0.17

uptime | awk '{print $1,NF}'
11:18am 12

uptime | awk '{print NR}'
1

uptime | awk -F, '{print $1}'
11:18am up 14 days 0:40

for i in $(seq 1 3); do touch file${i}.dat ; done
for i in file* ; do
> prefix=$(echo $i | awk -F. '{print $1}')
> suffix=$(echo $i | awk -F. '{print $NF}')
> echo $prefix $suffix $i; done

file1 dat file1.dat
file2 dat file2.dat
file3 dat file3.dat
```

Awk Examples

- Print list of files that are bash script files

```
awk '/^#\!\/bin\/bash/{print $0, FILENAME}' *
→  #!/bin/bash Fun1.sh
   #!/bin/bash fun_pam.sh
   #!/bin/bash hello.sh
   #!/bin/bash parm.sh
```

- Print extra lines below patterns

```
awk '/sh/{print;getline;print}' <hello.sh
#!/bin/bash
```

More about grep, sed and awk

- **grep:**
  - http://www.panix.com/~elflord/unix/grep.html
- **sed:**
  - http://www.panix.com/~elflord/unix/sed.html
- **awk:**
  - https://www.grymoire.com/Unix/Awk.html

What have we learned so far?

Introduction to Linux

OS used on HPC clusters

HPC User Environment 1

LSU and LONI HPC policy

Connect to our cluster

Use Software on HPC

HPC User Environment 2

How to submit jobs (PBS/Slurm)

Interactive jobs

Batch jobs

Getting Help

- User Guides
  - LSU HPC: http://www.hpc.lsu.edu/docs/guides.php#hpc
  - LONI: http://www.hpc.lsu.edu/docs/guides.php#loni
- Documentation: http://www.hpc.lsu.edu/docs
- Archived tutorials: http://www.hpc.lsu.edu/training/archive/tutorials.php
- Contact us
  - Email ticket system: sys-help@loni.org
  - Telephone Help Desk: 225-578-0900