Basic Shell Scripting

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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

Diagram showing the layers of a Linux system architecture:

- **User 1**
  - Applications
- **Shell**
- **Kernel**
- **Hardware**
  - **cd**
  - **grep**
- **Compiler**
- **User 2**
  - vi
- **User 3**
  - date
- **User n**
  - a.out
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

<table>
<thead>
<tr>
<th>Software</th>
<th>sh</th>
<th>csh</th>
<th>ksh</th>
<th>bash</th>
<th>tcsh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming language</td>
<td>y</td>
<td>y</td>
<td>y</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Shell variables</td>
<td>y</td>
<td>y</td>
<td>y</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Command alias</td>
<td>n</td>
<td>y</td>
<td>y</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Command history</td>
<td>n</td>
<td>y</td>
<td>y</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Filename autocompletion</td>
<td>n</td>
<td>y*</td>
<td>y*</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Command line editing</td>
<td>n</td>
<td>n</td>
<td>y*</td>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>Job control</td>
<td>n</td>
<td>y</td>
<td>y</td>
<td>y</td>
<td>y</td>
</tr>
</tbody>
</table>

*: 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 \(\text{tty}\). 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
Edit Variables

- Assign values to variables

<table>
<thead>
<tr>
<th>Type</th>
<th>sh/ksh/bash</th>
<th>csh/tcsh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell (local)</td>
<td>name=value</td>
<td>set name=value</td>
</tr>
<tr>
<td>Environment (global)</td>
<td>export name=value</td>
<td>setenv name value</td>
</tr>
</tbody>
</table>

- 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.

<table>
<thead>
<tr>
<th>With export</th>
<th>Without export</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ export v1=one</td>
<td>$ v1=one</td>
</tr>
<tr>
<td>$ bash</td>
<td>$ bash</td>
</tr>
<tr>
<td>$ echo $v1</td>
<td>$ echo $v1</td>
</tr>
<tr>
<td>→one</td>
<td>→</td>
</tr>
</tbody>
</table>
Global and Local Variables - current shell and subshell

Current Shell

- `export VARC=XX`
- `echo $VARC`
- `echo $VARS`

Sub Shell

- `export VARS=YY`
- `echo $VARC`
- `echo $VARS`
- `type bash or call another script`
- `exit the Sub Shell`

visible

*not* visible
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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATH</td>
<td>A list of directory paths which will be searched when a command is issued.</td>
</tr>
<tr>
<td>LD_LIBRARY_PATH</td>
<td>Colon-separated set of directories where libraries should be searched for first.</td>
</tr>
<tr>
<td>HOME</td>
<td>Indicate where a user's home directory is located in the file system.</td>
</tr>
<tr>
<td>PWD</td>
<td>Contains path to current working directory.</td>
</tr>
<tr>
<td>USER</td>
<td>Current logged in user's name.</td>
</tr>
<tr>
<td>OLDPWD</td>
<td>Contains path to previous working directory.</td>
</tr>
<tr>
<td>TERM</td>
<td>Specifies the type of computer terminal or terminal emulator being used.</td>
</tr>
<tr>
<td>SHELL</td>
<td>Contains name of the running, interactive shell.</td>
</tr>
<tr>
<td>PS1</td>
<td>Default command prompt</td>
</tr>
<tr>
<td>PS2</td>
<td>Secondary command prompt</td>
</tr>
<tr>
<td>HOSTNAME</td>
<td>The systems host name</td>
</tr>
<tr>
<td>DISPLAY</td>
<td>Network name of the X11 display to connect to, if available.</td>
</tr>
</tbody>
</table>
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

Always use double quotes around variable substitutions and command substitutions: "$foo", "${foo}"
# 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 (\texttt{0<:} standard input; \texttt{1>:} standard out; \texttt{2>:} standard error)
## Special Characters (2)

<table>
<thead>
<tr>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>$?</code></td>
<td>Exit status for the last command, 0 is success, failure otherwise</td>
</tr>
<tr>
<td><code>$$</code></td>
<td>Process ID variable.</td>
</tr>
<tr>
<td><code>[]</code></td>
<td>Test expression, eg. if condition</td>
</tr>
<tr>
<td><code>[[ ]]</code></td>
<td>Extended test expression, more flexible than <code>[ ]</code></td>
</tr>
<tr>
<td><code>$[ ]$, </code>$(( ))`</td>
<td>Integer expansion</td>
</tr>
<tr>
<td>`</td>
<td></td>
</tr>
</tbody>
</table>
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• Beyond Basic Shell Scripting
  – Arrays
  – Flow Control
  – Functions
• Advanced Text Processing Commands (grep, sed, awk)
## Integer Arithmetic Operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>+</td>
</tr>
<tr>
<td>Subtraction</td>
<td>-</td>
</tr>
<tr>
<td>Multiplication</td>
<td>*</td>
</tr>
<tr>
<td>Division</td>
<td>/</td>
</tr>
<tr>
<td>Exponentiation</td>
<td>** (bash only)</td>
</tr>
<tr>
<td>Modulo</td>
<td>%</td>
</tr>
</tbody>
</table>
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

• 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]`
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  (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

```bash
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

<table>
<thead>
<tr>
<th>Operation</th>
<th>bash</th>
</tr>
</thead>
<tbody>
<tr>
<td>File exists</td>
<td>if [ -e test ]</td>
</tr>
<tr>
<td>File is a regular file</td>
<td>if [ -f test ]</td>
</tr>
<tr>
<td>File is a directory</td>
<td>if [ -d /home ]</td>
</tr>
<tr>
<td>File is not zero size</td>
<td>if [ -s test ]</td>
</tr>
<tr>
<td>File has read permission</td>
<td>if [ -r test ]</td>
</tr>
<tr>
<td>File has write permission</td>
<td>if [ -w test ]</td>
</tr>
<tr>
<td>File has execute permission</td>
<td>if [ -x test ]</td>
</tr>
</tbody>
</table>
## Integer Comparisons

<table>
<thead>
<tr>
<th>Operation</th>
<th>bash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal to</td>
<td><code>if [ 1 -eq 2 ]</code></td>
</tr>
<tr>
<td>Not equal to</td>
<td><code>if [ $a -ne $b ]</code></td>
</tr>
<tr>
<td>Greater than</td>
<td><code>if [ $a -gt $b ]</code></td>
</tr>
<tr>
<td>Greater than or equal to</td>
<td><code>if [ 1 -ge $b ]</code></td>
</tr>
<tr>
<td>Less than</td>
<td><code>if [ $a -lt 2 ]</code></td>
</tr>
<tr>
<td>Less than or equal to</td>
<td><code>if [ $a -le $b ]</code></td>
</tr>
</tbody>
</table>
## String Comparisons

<table>
<thead>
<tr>
<th>Operation</th>
<th>bash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal to</td>
<td>if [ $a == $b ]</td>
</tr>
<tr>
<td>Not equal to</td>
<td>if [ $a != $b ]</td>
</tr>
<tr>
<td>Zero length or null</td>
<td>if [ -z $a ]</td>
</tr>
<tr>
<td>Non zero length</td>
<td>if [ -n $a ]</td>
</tr>
</tbody>
</table>
## Logical Operators

<table>
<thead>
<tr>
<th>Operation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>! (NOT)</td>
<td><code>if [ ! -e test ]</code></td>
</tr>
</tbody>
</table>
| && (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

Example 1:
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.

```bash
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)

```sh
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

```bash
#!/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!"
```
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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 \texttt{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
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Advanced Text Processing Commands

- grep
- sed
- awk
One slide about Regular Expression

• What are Regular Expressions (regex)?
  o They describe patterns in strings
  o These patterns can be used to modify strings
  o Invented by Stephen Cole Kleene
  o 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  
  end$  
  ^The end$  
  roar  
  matches any string that starts with The  
  matches a string that ends with end  
  exact string match (starts and ends with The end)  
  matches any string that has the text roar in it

- **Quantifiers** - *, +, ?, and {}

  abc*  
  abc+  
  abc?  
  abc{2}  
  abc{2,}  
  abc{2,5}  
  matches a string that has ab followed by zero or more c  
  matches a string that has ab followed by one or more c  
  matches a string that has ab followed by zero or one c  
  matches a string that has ab followed by 2 c  
  matches a string that has ab followed by 2 or more c  
  matches a string that has ab followed by 2 up to 5 c

- **OR operator** - | or []

  a(b|c)  
  a[bc]  
  matches a string that has a followed by b or c  
  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

  ```bash
grep bash *
  ```

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

  ```bash
grep -v bash *
  ```

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

  ```bash
grep -in bash *
  ```

• Search files not matching certain name pattern

  ```bash
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

-> 100 300  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.
- substitution command
# sed commands and flags

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

#!/bin/bash

# My First Script

echo "Hello World!"
sed Examples (2)

- Delete blank lines from a file
  ```bash
  sed '/^$/d' hello.sh
  
  #!/bin/bash
  # My First Script
  echo "Hello World!"
  ```

- Delete line \(n\) through \(m\) in a file
  ```bash
  sed '2,4d' hello.sh
  
  #!/bin/bash
  echo "Hello World!"
  ```
sed Examples (1)

• Add flag -e to carry out multiple matches.

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

• Alternate form

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

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

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

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

```bash
#!/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"

$ 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`

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

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

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

```bash
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

```bash
awk '/sh/ {print; getline; print}' <hello.sh
#!/bin/bash
```
More about grep, sed and awk

➢ grep:

➢ sed:

➢ awk:
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