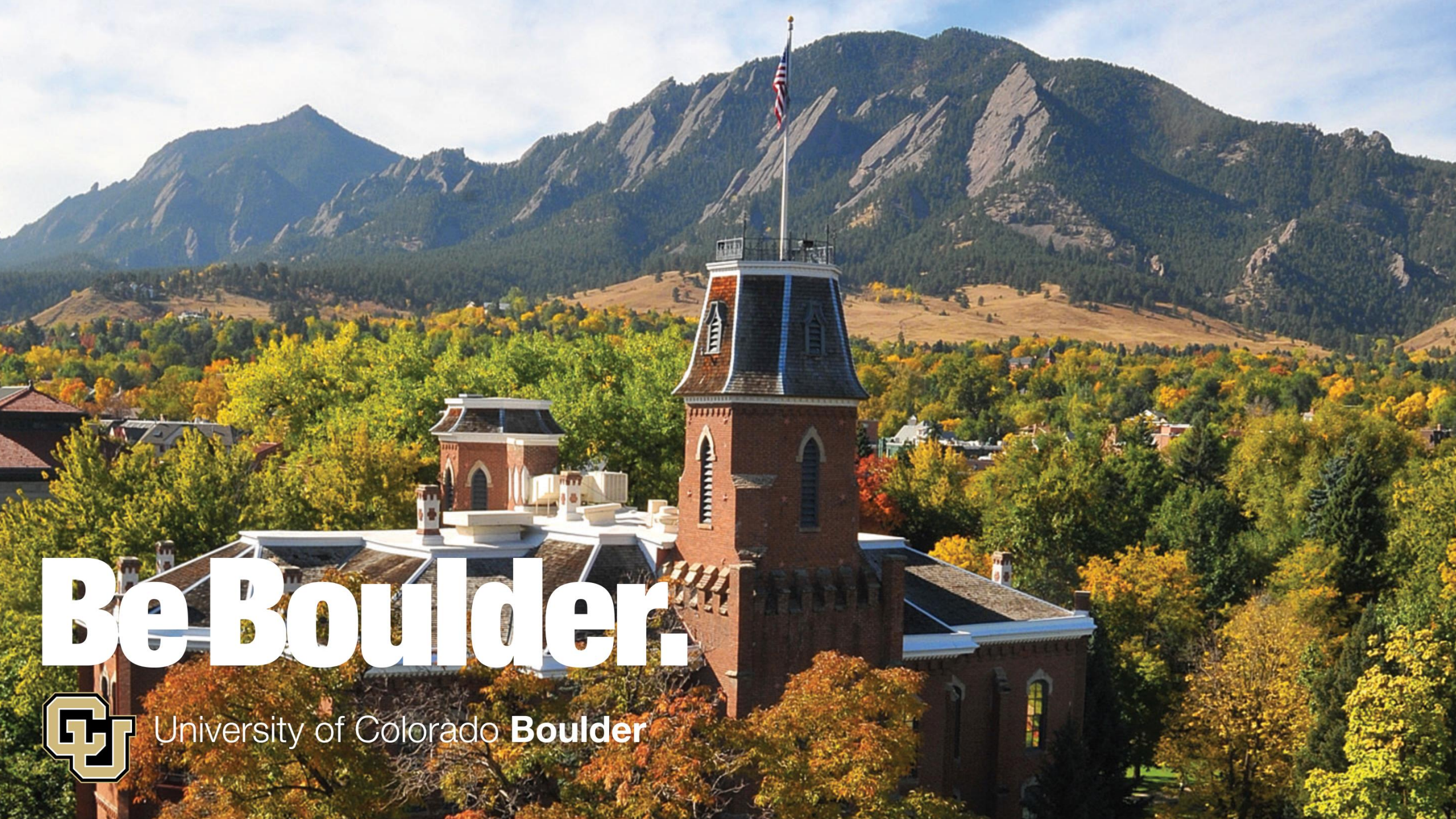
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- Introduction to Bash Shell Scripting

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Slides and other files available for download and viewing:
https://github.com/ResearchComputing/Fundamentals_HPC_Spring_2019
https://tinyurl.com/rc-hpc-19

Adapted from a presentation by Tim Brown, RC , 12 Feb 2015

Intro Demonstration

- A quick intro to demonstrate how you might use shell scripts
- Demo: Making a tool to manage the output from “squeue”
  - Often 1000 lines on Summit
  - Hard to manage
  - Harder to make meaningful

Let's log in to RC

- (If you are not using your local system)
- To connect to a remote system, use Secure Shell (SSH)
- From Windows – GUI SSH app such as PuTTY
- From Linux or Mac OS X terminal, or Windows GUI such as PuTTY or Gitbash, ssh on the command line:

```
ssh <username>@login.rc.colorado.edu
```

Guest account users (`user00XX`):

```
ssh <username>@tlogin1.rc.colorado.edu
```

- Once you are logged on, make a directory and cd to it:

```
mkdir bash_tutorial
cd bash_tutorial
```

Access the slides and examples

- https://github.com/ResearchComputing/Fundamentals_HPC_Spring_2019
- Easier: Browse to github.com/ResearchComputing
- Click into Fundamentals_HPC_Spring_2019 and then BASH…
- Or use the short URL: tinyurl.com/rc-hpc-19
- Cone the repo:
- `$ git clone https://tinyurl.com/rc-hpc-19`
- Or open files in a browser and copy/paste

Overview

- Introduction
- Variables
- Quoting
- Command Substitution
- Arithmetic Expansion
- Tests
- Decisions (if)
- Loops (for, while)
- Arguments
- Functions
- Alternatives

Introduction

A *shell* is the environment in which commands are interpreted in Linux.

GNU/Linux provides various numerous shells; the most common one is the Bourne Again shell (bash).

Other common shells available on Linux systems include:
1) sh ; 2) csh ; 3) tcsh ; 4) ksh

Shell scripts are files containing collections of commands for Linux systems that can be executed as programs.

Shell scripts are powerful tools for performing many types of tasks.

- Can be programmed interactively, directly on the terminal.
- It can also be programmed by script files. The first line of the file must contain #!/bin/bash.
- The program loader reconizes the #! and will interpret the rest of the line (/bin/bash) as the interpreter program.
- If a line starts with #, it is a comment and is not run.

```
#!/bin/bash
# the files in /tmp.
cd /tmp
ls | tail -n15
# cd - # not needed,why?
```

Shell to run

Comments

Change directories

Directory listing, last 15

Return to previous

Example

test.sh

- note: you can use “nano” to edit files in this tutorial.
- Just type “nano <filename>” at the prompt.
- You can edit text as you would in, e.g., MS Word.
- When you are finished, type ctrl-C and follow the prompts to save (type “Y”) and hit enter to keep the filename and exit.

Variables

- There are no data types.
- A variable can contain a number, a character, a string of characters.
- Shell variables are local.
- Environment variables are global.

```
$ PI=3.14159
$ name=(Joel Frahm)
$ echo ${name[0]}
$ Joel
$ echo $USER
$ frahm
```

Example

Local_vs_global.sh

Quoting

Quoting is used to remove the special meaning of certain characters or words to the shell.

Quotation	*Description*
`'string'`	Literally treat as string
`"$var"`	Treat as string but interpret variables
`{ }`	Disambiguation

Creating a file with my username in it's name.

```
$ touch "output_${USER}.txt"
```

Command Substitution

Command substitution allows the output of a command to be substituted in place of the command name itself.

- By enclosing the command with `$()`.
- Legacy syntax is using backticks ``` ``.

```
$ NOW=$(date +%Y-%m-%d)
$ echo $NOW
2018-10-09
```

Example

hello.sh and hello_world.txt

Arithmetic Expansion

Arithmetic expansion provides a mechanism for evaluating an arithmetic expression and substituting its value by enclosing the command with:
$(())

```
$ sqr_two=$(( 2 * 2 ))
$ echo ${sqr_two}
$ 4
```

Note that Bash only does integer math by default, however it is easy to do floating point math with the Bash calculator tool, 'bc'….

```
$ echo "5.6/9.4" | bc -l
$ .59574468085106382978
```

Tests I

Conditions are evaluated between [] or after the `test` word.

- File comparisons
  - Exists `[ -f file ]`
  - Executable `[ -x file ]`
  - Newer than `[ file1 -nt file2 ]`
  - Older than `[ file1 -ot file2 ]`
- Integer comparisons
  - Equal `[ num1 -eq num2 ]`
  - Not Equal `[ num1 -ne num2 ]`
  - Less than `[ num1 -lt num2 ]`
  - Less or equal `[ num1 -le num2 ]`
  - Greater than `[ num1 -ge num2 ]`

Tests II

- String comparisons
  - Equal `[ string1 = string2 ]`
  - Not equal `[ string1 != string2 ]`
  - Contains `[ string1 =~ string2 ]`
  - Non zero `[ -n string1 ]`
  - Zero `[ -z string1 ]`

- Combining tests
  - And `[ exp1 -a exp2 ]`
  - Or `[ exp1 -o exp2 ]`

A full list is in the `test` manual page (`man test`).

Decisions I

The `if` command executes a compound-list.

- Consisting of `if`, `elif`, `else` and `fi`.

```
x=$(date +%M)
if [ $x -gt 30 ] ; then
        echo "last half of the hour"
elif [ $x -lt 15 ] ; then
        echo "first quarter of the hour"
else
        echo "we're at ${x}"
fi
```

Example

test_for_file.sh

Decisions II

The `case` command executes a compound-list too.

- Consisting of `case` and `esac`.

```
x=10
case ${x} in
  1)  echo "one"     ;;
  5)  echo "five"    ;;
  10) echo "ten"     ;;
  *)  echo "unknown" ;;
esac
```

Example

case_example.sh

Loops

There are two types of loops:

```
x=0
while [ $x -lt 10 ] ; do
   echo $x
   x=$(( $x + 1 ))  done
```

```
list=(a b c)
for v in ${list} ; do
   echo $v
done
```

- `continue` will start the next iteration.
- `break` will exit the loop.

Example

while_example.sh

for_example.sh

dateloop_allbash.sh

Arguments I

It is often useful to pass arguments to a shell script.

- $0 denotes the script name.
- $1 denotes the first argument, $2 the second, up to ${99}.
- $# the total number of arguments.
- $* all arguments as a single word
- $@ all arguments as individual words.

Arguments II

```
#!/bin/bash
# Calculate the sine of the argument.

if [ $# -eq 1 ] ; then
  sine=$(echo "s($1)" | bc -l )
  echo "The sine of $1 is ${sine}"
else
  echo "Usage: $0 <number in radians>" 2>&1
  exit 1
fi
```

Example

calcsine.sh

Functions I

A function is a user-defined name that is used as a simple command to call a compound command with new positional parameters.

```
function_name () {
  commands
}
```

It is good practice to check the exit status of commands. I do this repeatedly in scripts, so a function is best to define it.

Functions II

```
#/bin/bash

# function e
e () {
  echo $1;
}

#now test e
e Hello
e World
```

Example

function.sh

Additional Examples (if time allows)

cd to the ”more” directory:

case_example_w_arg.sh

for_example_from_command.sh

for_example_list.sh

for_example_w_multiple_args.sh

Alternatives for Scripting

- `csh/tcsh` C-shell (tcsh: updated version of csh).
- `ksh` Korn shell; related to sh/bash
- `perl` exceptional text manipulation and parsing.
- `python` excellent for scientific and numerical work.
- `ruby` general scripting.
- `make` building executables from source code

Thank you!

Please fill out the survey:
http://tinyurl.com/curc-survey18

Additional Bash learning resources:
http://tldp.org/HOWTO/Bash-Prog-Intro-HOWTO.html *(general)*
https://www.shell-tips.com/2010/06/14/performing-math-calculation-in-bash/ *(math)*

Bash kernel for jupyter notebooks *(install anaconda first)*:
https://github.com/takluyver/bash_kernel