Bash Shell Scripting

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Shell Scripting

- All of the commands that are accessible from the shell can be placed into a shell “script”

- Shell scripts are executed line by line, as if they were being typed in line by line

Shell Script – High Level

- High level programming language
  - Variables, conditionals, loops, etc.
- Interpreted
  - No compiling, no variable declaration, no memory management
- Powerful/efficient
  - Do lots with little code
  - Can interface with any UNIX program that uses stdin, stdout, stderr
- String and file oriented

When to Use Shell Scripts?

- Automating frequent UNIX tasks
- Simplify complex commands
- For small programs that:
  - … you need to create quickly
  - … will change frequently
  - … need to be very portable
  - … you want others to see and understand easily
- As a glue to connect together other programs

Hello World!

Note special “shebang” magic characters #!

The first line tells UNIX the path to the shell with which to interpret the script

Lines beginning with # are comments

```
#!/bin/bash
# Obligatory programming example
echo Hello World!
```

Lines to execute begin here

Variables

- Create a variable by simply assigning to it:

```
myint=1
mystr=Ben
mystr=123
```

Note: (very) weakly typed!

- Get the value back out by using the $ operator in front of the variable:

```
myint=1
echo $myint
```

Quote Marks – Protecting Your Text

- Quotation marks allow you to control the expansion of variables within strings of text, and group text into a single argument.

- Single Quotes (' '): No variable expansion

```
$ printf 'all your base $abtu'
all your base $abtu
```

- Double Quotes (""): Variables are expanded

```
$ printf "all your base $abtu"
all your base are belong to us
```

Note how these quoted strings are interpreted as one argument

- Backslash character (\) means evaluate literally, instead of interpret:

```
$ printf "\$\n\t"
$nt
```

Printing Example - Demonstration

```
$ echo -e "cat\ndoge\nkat\ndoug" | sort
cat
doge
doug
kat
```

Somewhat complicated

Versus:

```
$ cAd
cat
doge
doug
kat
```

Easier to type! How do we built this script?

Printing Example - Built From Scratch

```
$ echo "#!/bin/bash"
-bash: !/bin/bash": event not found
```

This occurs because the history feature engages when ! Is the first character

```
$ echo "#\x21/bin/bash"
#\x21/bin/bash
```

Without the -e argument, the hexadecimal ASCII code (21) for ! won't be expanded

```
$ echo -e "#\x21/bin/bash" > cAd
$ echo -e "echo \"cat\"\necho \"doge\"\necho \"kat\"\necho \"doug\"" | sort >> cAd
$ chmod +x cAd
$ cAd
cat
doge
doug
kat
```

Make this file be executable - more on `chmod` later

Editors and Word Processors

- Instead of using “echo >>” to build up a file, we typically use word processing programs like:
  - emacs
  - vi
  - pico

Upcoming lecture on vi

- You can write UNIX files on other operating systems, but the differences in line endings in file formats is a challenge
  - `dos2unix` converts windows line endings to those used by UNIX

Shell Keywords

- Keywords are commands in bash that are interpreted by the shell as delimiters, branching constructs, and loops, among others.

- `compgen` generates possible completion matches for various categories of keywords.
  - -k is all reserved keywords

- Can’t use keywords as variable names

```
$ compgen -k
if
then
else
elif
fi
case
esac
for
select
while
until
do
done
in
function
time
{
}
!
[[
]]
coproc
```

Environment Variables

- A set of variables that are always available in your shell
- These environment variables control options that change the operation of the shell
- Here are a few common ones:
  - PATH - the set of directories bash will search through to find a command
  - HOME - a shortcut back to your home directory (equivalent to ~)
  - SHELL - the full path to the default shell
  - HOSTNAME - the name of the computer you're currently using

There's about a billion more of these: you can get a complete list of all of them plus their current contents like so:

```
$ printenv
```

Environment Variables - PATH and HOME

```
$ echo $PATH
/bin:/sbin:/usr/local/bin:/usr/bin:/usr/local/apps/bin:/usr/bin/X11
:/nfs/stak/faculty/b/brewsteb/bin:.
$ echo HOME
HOME
$ echo $HOME
/nfs/stak/faculty/b/brewsteb
$ echo ~
/nfs/stak/faculty/b/brewsteb
$ echo $~
$~
```

Oops

~ is not a variable, it controls the bash feature called *tilde expansion*

Special Parameters

- A set of variables that are always available in a script
- Here are a few common ones:
  - $ - the process ID of the script itself (every running process has a unique PID)
  - ? - the return value of the previously terminated command or script
  - # - the number of arguments (positional parameters) given when a script is executed
  - 1 - the first argument (positional parameter) as of when the script was ran
  - 2 - the second argument (positional parameter) as of when the script was ran
  - 3, 4, etc.

These and more are all explained on the page: Built-In Shell Variables

Return Values Examined

- The `exit` bash shell command and C `exit()` function return their results to the `?` variable.
- 0 is interpreted to mean no errors (normal execution), anything else is a result with specific meaning (usually an error)

```
$ cat exittest
#!/bin/bash
ls
printf "result of ls: $?\n"
exit 5
$ exittest
exittest      testloop      prog1
result of ls: 0
$ echo $?
5
```

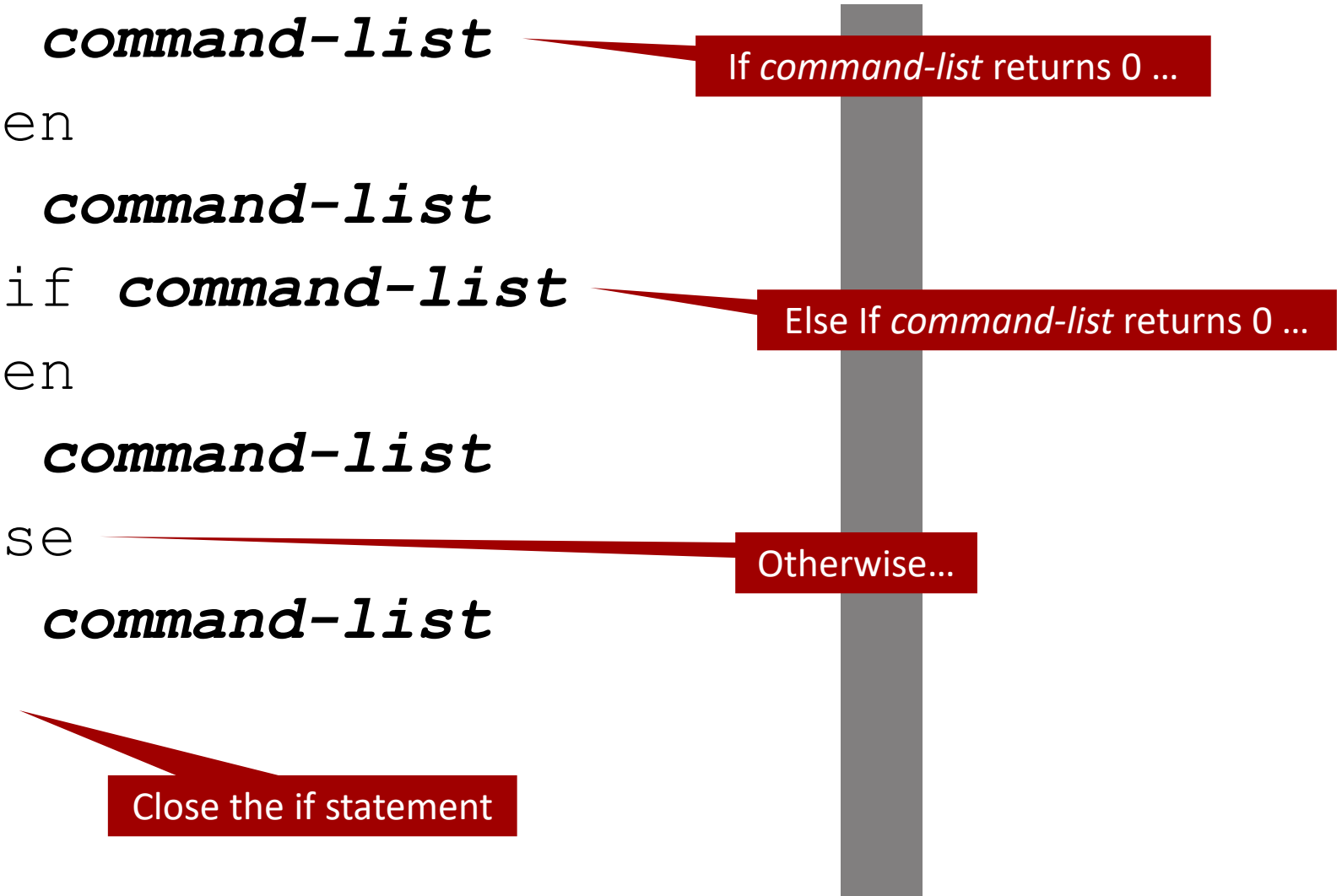
Return Values Examined

- The `exit` bash shell command and C `exit()` function return their results to the `?` variable.
- 0 means no errors (normal execution), anything else is a result with specific meaning (usually an error)

```
$ echo hello world
hello world
$ echo $?
0
$ cd %=^2%21
=^2%21: No such file or directory.
$ echo $?
1
```

The bash `if` Statement - Return Value Enabled

```
if command-list
then
    command-list
elif command-list
then
    command-list
else
    command-list
fi
```



Error Handling

- The shell will keep executing even if commands have the wrong syntax, delete files, break things, and in general cause havoc

- If you want the shell to exit if any commands have a problem (i.e. return a non-zero value after executing, with some exceptions):
  - Use -e with /bin/bash

- Most *signals* will kill script immediately
  - E.g.: CTRL-C

Error Handling - Cry Havoc!

```
$ cat havoc
#!/bin/bash
cd qwcein
ceiqim
eqo eo
$ chmod +x havoc
$ havoc
./havoc: line 2: cd: qwcein: No such file or directory
./havoc: line 3: ceiqim: command not found
./havoc: line 4: eqo: command not found
```

Protecting Your Thesis - Disastrous results

```
#!/bin/bash
cp thesis.docx thesis_current.docx
rm -f thesis.docx
```

Protecting Your Thesis - One Fix

```
#!/bin/bash -e
cp thesis.docx thesis_current.docx
rm -f thesis.doc
```

Will only be executed if the result of the previous command was 0

Protecting Your Thesis - Another Fix

```
#!/bin/bash
if cp thesis.docx thesis_current.docx
then
   rm -f thesis.docx
else
   echo "copy failed” 1>&2
   exit 1
fi
```

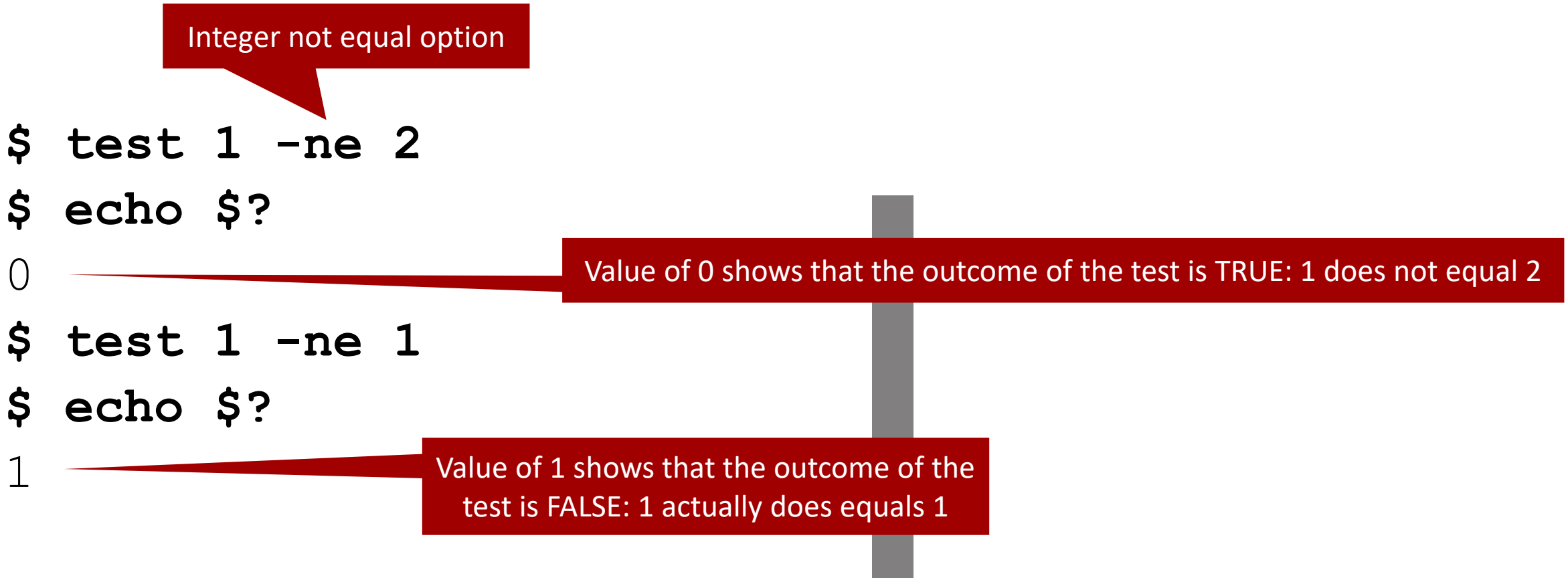
Protecting Your Thesis - Another Fix

```
#!/bin/bash
if cp thesis.docx thesis_current.docx
then
    rm -f thesis.docx
else
    echo "copy failed” 1>&2
    exit 1
fi
```

Bash command meaning: Take anything going to file descriptor 1 (stdout) and redirect it to file descriptor 2 (stderr) for the duration of this command

Protecting Your Thesis - Yet Another Fix with `test`

- You can test for file existence, equality of strings, length, permissions, number equality, etc.



Protecting Your Thesis - Yet Another Fix with `test`

```
#!/bin/bash
cp thesis.docx thesis_current.docx
if test $? -ne 0
then
   echo "copy failed" 1>&2
   exit 1
fi
rm -f thesis.docx
```

Again: bash command meaning: Take anything going to file descriptor 1 (stdout) and redirect it to file descriptor 2 (stderr) for the duration of this command

`for` Loop Syntax

```
$ cat forloop
#!/bin/bash
for i in a b c d
do
    printf "<%s>" $i
done
printf "\n"
$ forloop
<a><b><c><d>
$
```

`while` Loop Syntax

```
$ cat whileloop
#!/bin/bash
i=0
while test $i -ne 2
do
     printf "i = $i, not stopping yet\n"
     i=$(expr $i + 1)
done
printf "Stopping, i = $i\n"
$ whileloop
i = 0, not stopping yet
i = 1, not stopping yet
Stopping, i = 2
$
```

Test can also be written as square brackets:
`while [ $i -ne 2 ]`

Huh?

Subshells

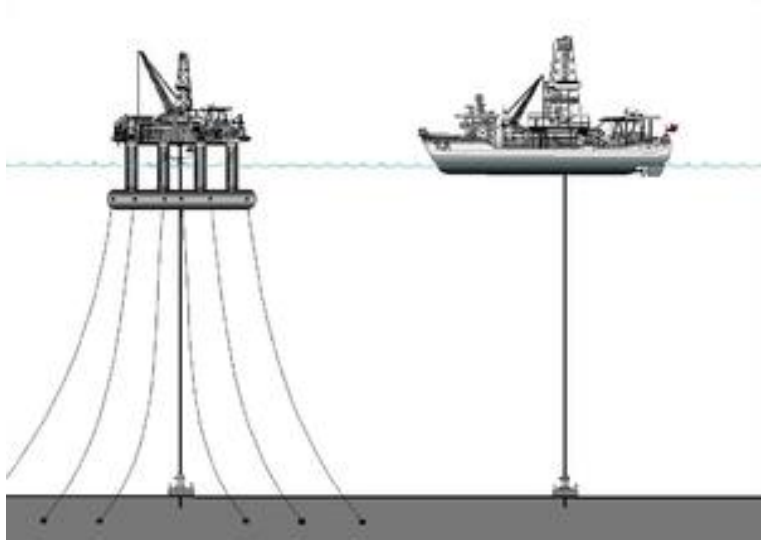
- Some operators (like =) and commands require strings or numbers to operate on, not other commands:

```
$ cat sumtest
#!/bin/bash
num1=9
num2=3 + $num1
echo "num2: $num2"
$ sumtest
./sumtest: line 3: +: command not found
num2:
$
```

Subshells

- If we want to increment, or set to an arbitrary value, we first have to calculate that value and return it *as text* to the script, then the script can continue.

- These are executed as entirely separate shells (called subshells) in their own processes that run and return.



Subshells

- Two ways to do command substitution with subshells:

```
i=`expr $i + 1`
i=$(expr $i + 1)
```

Backticks! Original method

Preferred method: POSIX compliant, doesn't need escaping when nested

- Both methods evaluate the expression and grab the results from stdout of the subshell
- Double parenthesis construct does arithmetic expansion and evaluation directly, no `expr` command needed:

```
i=$(( 9 + 9 ))
(( i++ ))
```

Common UNIX Commands - Trapping Signals

- Use the **`trap`** command to catch *signals* (like SIGINT generated by hitting CTRL+C) and clean up yer mess.

- Usage:

  `trap <code to execute> list of signals`

- Example:

Lots more about these later

```
#!/bin/sh
TMP="myCoolFilename$$"
trap "rm -f $TMP; echo 'CTRL+C received, exiting'; exit 1" INT HUP TERM
echo "lotsa text" > TMP
while [ 1 -ne 2 ]
do
        echo "Never ending loop - hit CTRL+C to exit!"
done
```

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Error!

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echo "lotsa text" > TMP
while [ 1 -ne 2 ]
do
        echo "Never ending loop
done
```

Error! Should be $TMP, otherwise the echo goes to a file called “TMP”, instead of a file with name stored in the TMP variable initialized above!