

# CS 241: Systems Programming

## Lecture 6. Shell Scripting 1

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# Wed Review - Version Control

- Creating git repositories
- Git commits
- Pulling from remote repositories

# Permissions

Every user has an id (uid), a group id (gid) and belongs to a set of groups

Every file has an **owner**, a **group**, and a set of **permissions**

```
steve@clyde:~$ id
uid=1425750506(steve) gid=1425750506(steve) groups=1425750506(steve),1425700508(faculty)
steve@clyde:~$ ls -ld /home
drwxr-xr-x 4 root root 4096 Aug 13 2013 /home
steve@clyde:~$ ls -ld ~
drwxr-x--x 30 steve faculty 50 Sep 2 11:31 /usr/users/noquota/faculty/steve
steve@clyde:~$ ls -l hello.py
-rwx----- 1 steve steve 100 Aug 31 14:31 hello.py
```

First letter of permissions says what type of file it is: – is file, d is directory

# Permissions

The next 9 letters `rwxrwxrwx` control who has what type of access

- ▶ owner
- ▶ group
- ▶ other (everyone else)

Each group of 3 determines what access the corresponding users have

- ▶ Files
  - ▶ r — the owner/group/other can read the file
  - ▶ w — the owner/group/other can write the file
  - ▶ x — the owner/group/other can execute the file (run it as a program)
- ▶ Directories
  - ▶ r — the owner/group/other can see which files are in the directory
  - ▶ w — the owner/group/other can add/delete files in the directory
  - ▶ x — the owner/group/other can access files in the directory

# Permissions example

```
-rw-r--r-- 1 mhogan mhogan 0 Sep  3 14:25 foo
```

The owner (mhogan) can read and write foo, everyone else can read it

```
-rwx----- 1 mhogan mhogan 100 Aug 31 14:31 hello.py
```

The owner can read, write, or execute, everyone else can do nothing

```
drwxr-x--x 33 mhogan faculty 54 Sep  3 14:25 .
```

```
drwxrwxr-x 2 mhogan faculty 4 Sep  2 11:45 books/
```

mhogan and all faculty have full access to ./books, everyone else can see the directory contents

# Changing owner/group/perms

## Handy shell commands

- `chown` — Change owner (and group) of files/directories
- `chgrp` — Change group of files/directories
- `chmod` — Change permissions for files/directories

Permissions are often specified numerically in octal (base 8)

- 0 = ---      4 = `r--`
- 1 = `--x`      5 = `r-x`
- 2 = `-w-`      6 = `rw-`
- 3 = `-wx`      7 = `rwx`

Common values 755 (`rwxr-xr-x`) and 644 (`rw-r--r--`)

After running `ls -l` we see the line  
`drwxr-x--- 6 mhogan faculty 14 Dec 18 15:59 hw6-solutions`

What of the following statements is **false**?

- A. `hw6-solutions` is a directory
- B. User `mhogan` is the only one who can read files in `hw6-solutions`
- C. User `mhogan` is the only one who can create/delete files in `hw6-solutions`
- D. Users (other than `mhogan`) who are not in the `faculty` group cannot see a directory listing for `hw6-solutions`

# Shell script basics

The shell executes lines one after another

Here's a file named space (helpfully colored by vim)

```
echo "Hello ${USER}."
disk_usage="$(du --summarize --human-readable "${HOME}" | cut -f 1)"
echo "Your home directory uses ${disk_usage}."
```

I can run this on mcnulty

```
mhogan@mcnulty:~$ bash space
```

```
Hello mhogan.
```

```
Your home directory uses 353M.
```



# Making the script executable

Provide a "shebang" line

- For bash: `#!/bin/bash`
- This will cause the OS to run `/bin/bash` with the script path as its argument

```
#!/bin/bash

echo "Hello ${USER}."
disk_usage="$(du --summarize --human-readable "${HOME}" | cut -f 1)"
echo "Your home directory uses ${disk_usage}."
```

Make the script executable and run it

```
mhogan@mcnulty:~$ chmod +x space
```

```
mhogan@mcnulty:~$ ./space
```

```
Hello mhogan.
```

```
Your home directory uses 353M.
```

# For loops

```
for var in word...; do  
    commands  
done
```

The words undergo expansion

```
for file in *.*; do  
    # Expand file and replace everything up to and including the first  
    # period with a single period.  
    echo "${file/#*./}"  
done
```

Prints out the file extension of each file in the current directory

# For loop example

```
for num in {1..10}; do  
    echo "${num}"  
done
```

Brace expansion makes this identical to

```
for num in 1 2 3 4 5 6 7 8 9 10; do  
    echo "${num}"  
done
```

# C-style for loop

```
for ( ( num = 1; num <= 10; ++num ) ); do  
    echo "${num}"  
done
```

Which for loop should we use to loop over all files with extension .txt?

A. `for file *.txt; do`  
    `cmds`  
    `done`

D. `for (( file; *.txt; ++file )); do`  
    `cmds`  
    `done`

B. `for file in *.txt; do`  
    `cmds`  
    `done`

E. `for (( file; ++file; *.txt )); do`  
    `cmds`  
    `done`

C. `for file in "*.txt"; do`  
    `cmds`  
    `done`

# Exit values

Every command returns an integer in the range {0, 1, ..., 255}

- 0 means success
- Everything else means failure

After each command, bash sets the variable `$?` to the exit value of the command

```
$ echo hi; echo "$?"
```

```
hi
```

```
0
```

```
$ ls nonexistent; echo "$?"
```

```
ls: cannot access 'nonexistent': No such file or directory
```

```
2
```

# Conditionals

```
if cmd; then
    more_cmds
fi
```

If cmd returns 0 (success), then run more\_cmds

```
if cmd1; then
    then_cmds
elif cmd2; then
    then_cmds2
else
    else_cmds
fi
```

```
if true; then  
  echo 'Our intuition works!'  
fi
```

When run, this code will print out "Our intuition works!"

Given that, what value must `true` return?

A. 0

B. 1

C. true

D. false

E. Some other integer



# Other loops

while loop

- execute cmds as long as cmd returns 0

until loop

- execute cmds until cmd returns 0

```
while cmd; do  
    cmds  
done
```

```
until cmd; do  
    cmds  
done
```

# Conditional expressions

`[ [ expr ] ]`

- Evaluates `expr` and returns 0 if it is true and 1 if it is false

## String comparisons

- `str1 OP str2` — `OP` is one of `=`, `!=`, `<`, or `>`
- `-z str` — true if `str` is an empty string (**z**ero length)
- `-n str` — true if `str` is not an empty string (**n**onzero length)

## Integer comparisons

- `arg1 OP arg2` — `OP` is one of `-eq`, `-ne`, `-lt`, `-le`, `-gt`, or `-ge`

# Examples

```
if [[ "${mode}" = debug ]]; then  
    echo 'the mode variable has the value debug'  
fi
```

```
if [[ -z "${var}" ]]; then  
    echo 'the var variable is the empty string'  
fi
```

```
if [[ $# -gt 0 ]]; then  
    echo "the first script/function argument is $1"  
fi
```

# Complete example

```
#!/bin/bash

# Play a guessing game.

num=$(( RANDOM % 10 + 1 ))

IFS= read -p 'Guess a number between 1 and 10: ' -e -r guess
if [[ "${num}" -eq "${guess}" ]]; then
    echo 'Good guess!'
else
    echo "Sorry. You guessed ${guess} but the number was ${num}."
fi
```

\$ ./guess

Guess a number between 1 and 10: 3

Sorry. You guessed 3 but the number was 6.

# Conditional expressions

## File tests

- ▶ `-e file` — true if `file` exists
- ▶ `-f file` — true if `file` exists and is a regular file
- ▶ `-d file` — true if `file` exists and is a directory
- ▶ There are a whole bunch more, read `bash(1)` under `CONDITIONAL EXPRESSIONS`

## Other operators

- ▶ `( expr )` — grouping
- ▶ `! expr` — true if `expr` is false
- ▶ `expr1 && expr2` — logical AND
- ▶ `expr1 || expr2` — logical OR

# Example script

```
#!/bin/bash

ret=0
for path in "$@"; do
    if [[ -f "${path}" ]]; then
        echo "${path}: file"
    elif [[ -d "${path}" ]]; then
        echo "${path}: directory"
    else
        echo "${path}: No such file or directory" >&2
        ret=1
    fi
done
exit ${ret}
```

# Mon Preview - More shell scripting

- Arguments
- Functions
- Arrays