03 – UNIX Permissions and find

CS 2043: Unix Tools and Scripting, Spring 2019 [2]

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As always: Everybody! ssh to wash.cs.cornell.edu

You and 188 of your closest friends

- Welcome back to WASH!
- Wash is a *multi-user* machine
    - there are multiple users on here
    - how to solve conflicts?
- You're going to be working on wash..
- Security is *kinda* important

Users. Users EVERYWHERE

- There are **217** users on wash.
- Even on a personal Linux computer, there are usually *at least* 30 different user account
- why so many users?
  - security
  - separation of concerns
  - principle of least privilege
- **EXAMPLE**: The `lp` user owns printing-related files

So, the security model is...?

- *NIX security model is *access control*-based
- Define who is *allowed* to use what resources
- What do users control?
    - file ownership and permissions
    - processes
- Most things are [represented by] a file
- **EXAMPLE**: The file `/dev/ttyS0` represents the serial port
    - early USB predecessor
    - ...what, I'm not **that** old.

So, if a special user owns printing stuff and serial ports... How to I print?

Groups

- Users can belong to [lots of] *groups*

List groups to which a user belongs

```
groups [user name]
```

- Lists groups to which [argument] belongs.
- With no argument, lists your groups

- All files are owned by *both* a `user` and a `group`
- Groups grant *permissions* on certain files and actions
  - **Example**: the `lp` *group* allows printing
  - **Example**: the `uucp` *group* allows serial port access

Let's see what groups we're in!

Groups with groups

```
$ groups
mpm288 cs2043student student_only
```

- the `netID` group is just for you (you're the only one in it)
- the `cs2043student` group is for the entire class — everyone is in it!
- the `student_only` group is for security; defines "student" as your *maximum privilege*
    - not getting into what that means this lecture `;)`

File Ownership

- You can discern who owns a file many ways, the most immediate being `ls -l`

Permissions with ls

```
$ ls -l README
-rwxrw---- 1 milano cs2043tas 20 Jan 26 15:48 README
#            milano             <-- the user
#                   cs2043tas   <-- the group
```

- Third column is the *user*, fourth column is the *group*.
- Other columns are the *link count* and *size*
  - we'll talk about like count in .... 5 lectures?

What is this RWX Nonsense?

- `r` = read, `w` = write, `x` = execute.

`-rwx------`	**User** permissions
`----rwx---`	**Group** permissions
`-------rwx`	**Other** permissions

  - Directory permissions begin with a `d` instead of a `-`
  - *Other*: “neither the owner, nor a member of the group”.

An example

- What would the permissions `-rwxr-----` mean?
  - It is a file.
  - User can read and write to the file, as well as execute it.
  - Group members can read the file
  - Group members **cannot** write to or execute the file.
  - Other cannot do *anything* with it.

Hold on... *execute* the file?

- Programs are just files!
- Most programs contain a special format of *binary data*, called ELF
- Some programs are *scripts*, which means they're just text!
- try to `cat` out the `handin` command, for example
    - (the path to it is: `/course/cs2043/bin/handin`)

Ok but... execute the *directory*?

- This one is a bit counter-intuitive
- **Reading** a directory means listing its contents
- **Writing** a directory means removing or creating
- **Executing** a directory means *interacting* with its contents
  - editing, printing, etc.
  - `drw-------` means you can create, remove, and list contents, but *cannot* print, edit, or execute anything *inside* the directory
  - `d-wx------` means you can create, remove, and use contents, but *cannot* list them.
- Execute without read means you have to know the name of the contents in order to access them!
  - no other way to discover the contents.
  - kinda like a password...

Changing Permissions

Change Mode

`chmod <mode> <file>`

- Changes file or directory permissions to **`<mode>`**.
- The format of **`<mode>`** is a combination of three fields:
  - Who is affected: a combination of **`u`**, **`g`**, **`o`**, or **`a`** (all).
  - Use a **`+`** to add permissions, and a **`-`** to remove.
  - Specify type of permission: any combination of **`r`**, **`w`**, **`x`**.

```
# Add read, write, & execute for user, group, & other
$ chmod ugo+rwx <file> # or chmod a+rwx <file>
# Remove read and write for other
$ chmod o-rw <file>
```

- Can specify mode in octal: user, then group, then other.
  - E.g., `750` means **`user`**`=7`, **`group`**`=5`, **`other`**`=0` permissions.

The Octal Version of **chmod**

- For the formula hungry, you can represent `r`, `w`, and `x` as binary variables (where 0 is off, and 1 is on). Then the formula for the modes is

Octal Ownership Permissions

$$r \cdot 2^2 + w \cdot 2^1 + x \cdot 2^0$$

- Examples
  - `chmod 755`: `rwxr-xr-x`
  - `chmod 777`: `rwxrwxrwx`
  - `chmod 600`: `rw-----`
- If that makes less sense to you, feel free to ignore it.
  - Just use the `stat` command to help you convert :)
- The octal version can be confusing, but will save you time. Excellent resource in [1].

Changing Ownership

- Changing the *group* of a file / directory

Change Group

```
chgrp group <file>
```

- Changes the group ownership of `<file>` to `group`.
- The `-R` flag will recursively change permissions of a directory.

- Changing the *owner* of a file / directory

Change Owner *and* Group

```
chown user:group <file>
```

- Changes the ownership of `<file>`.
- The `group` is optional (`chown user <file>`).
- The `-R` flag will recursively change permissions of a directory.

The root user

- The special user `root` is the ultimate administrator on the system
- Gets the permissions of *any* user on the system
    - if anyone can read/write/exec it, `root` can too
- can change permissions any way it wants
    - can even set an owner/group combo where the owner's not in the group!
- can become root with the `su` or `sudo` comamnds
    - we won't be using these in this class...
    - you should **never** use `su` or `sudo` on wash!

File Ownership, Alternate

- You will likely forget which column is which in `ls -l`...

Status of a File or Filesystem

`stat [opts] <filename>`

- Gives you a wealth of useful information.
- **`Uid`** (**`%U`**) is the user, **`Gid`** (**`%G`**) is the group.
  - BSD/OSX: **`stat -x <filename>`** for “standard” behavior.
- Can be useful to mimic file permissions you don’t know.
  - Human readable: **`--format=%A`**, e.g. **`-rw-rw-r--`**
    - BSD/OSX: **`-f %Sp`** is used instead.
  - Octal: **`--format=%a`** (great for **`chmod`**), e.g. 664
    - BSD/OSX: **`-f %A`** is used instead.

Types of Files and Usages

Plain Files

- Plain text files are human-readable, used for things such as:
  - Documentation,
  - Application settings,
  - Source code,
  - Logs, and
  - Anything you may want to read via the terminal
    - README
    - INSTALL
    - etc.

Binary Files

- Binary files are not human-readable. They are written in the language your computer prefers.
  - Executables,
  - Libraries,
  - Media files,
  - Archives (.zip, etc), and many more.

Special Files

- Special Files represent things which ought not be files!
  - Sockets (connections)
  - Devices (hard disk, keyboard, etc)
  - Raw Memory (RAM)
  - The (software-emulated) terminal you're using now!
  - A lot of really random other stuff
- The UNIX philosophy: represent *everything you possibly can* as a file

Default Permissions on Creation

User Mask

`umask <mode>`

- *Remove* `mode` from the file's permissions.
- Similar syntax to `chmod`:
  - `umask 077`: `+rwx` for *owner*, `-` for all others.
  - `umask g+w`: enables group write permissions.
- `umask -S`: display the current mask.
- Just a bit mask with `0o777` and your *mode*.

Full permissions	`0o777`
Sample User Mask	`0o002`
Logical `&` Gives	`0o002`

- Changing `umask` only applies for the remainder of the session.
  - Permanent if put in your `~/.bashrc` or `~/.bash_profile`.

Reading Files Without Opening

- Using your terminal to examine a file is very convenient!

File Perusal Filter for (crt) Viewing

`more <filename>`

- Scroll through one page at a time.
- Program **exits** when end is reached.

As the saying goes...

`less <filename>`

- Scroll pages or lines (mouse wheel, space bar, and arrows).
- Program does **not** exit when end is reached.

Beginning and End

- Long files can be a pain with the previous tools.

Print the Beginning (head) or End (tail) of a File

```
head -[numlines] <filename>
tail -[numlines] <filename>
```

- Prints the first / last **numlines** of the file.
- First 5 lines: **head -5 file.txt** *or* **head -n5 file.txt**
- Last 5 lines: **tail -5 file.txt** *or* **tail -n5 file.txt**
- Default is 10 lines.

Not Really a File...YET

- You can talk to yourself in the terminal too!

Display a Line of Text

```
echo <text>
```

- Prints the input string to the standard output (the terminal).
- We will soon learn how to use **echo** to put things into files, append to files, etc.
- Show off to your friends how cool you are:

```
$ echo 'I can have a conversation with my computer!'
$ echo 'But it always copies me.  RUDE.'
```

Flags & Command Clarification

Flags and Options

- Most commands take flags and optional arguments.
- These come in two general forms:
  - Switches (no argument required), and
  - Argument specifiers (for lack of a better name).
- When specifying flags for a given command, keep in mind:
  - Flags modify the behavior of the command / how it executes.
  - Some flags take precedence over others, and some flags you specify can implicitly pass additional flags to the command.
- There is no absolute rule here: research the command.

Flags and Options: Formats

- A flag that is
  - One letter is specified with a single dash (`-a`).
  - More than one letter is specified with two dashes (`--all`).
  - The reason is because of how switches can be combined.
- We generally use “flag” and “switch” interchangeably:
  - “flag” the command, telling it that “action X” should occur
  - specify to the command to “switch on/off action X”

Flags and Options: Switches

- *Switches* take no arguments, and can be specified in a couple of different ways.
- Switches are usually one letter, and multiple letter switches usually have a one letter alias.
- One option:
  - `ls -a`
  - `ls --all`
- Two options:
  - `ls -l -Q`
  - `ls -lQ`
- *Usually* applied from left to right in terms of operator precedence, but not always:
  - This is up to the developer of the tool.
  - Prompts: `rm -fi <file>`
  - Does **not** prompt: `rm -if <file>`

Flags and Options: Argument Specifiers

- The `--argument="value"` format, where the `=` and quotes are needed if `value` is more than one word.
  - Yes: `ls --hide="Desktop" ~/`
  - Yes: `ls --hide=Desktop ~/`
    - One word, no quotes necessary
  - No: `ls --hide = "Desktop" ~/`
    - Spaces by the `=` will be misinterpreted
    - It used `=` as the argument to `hide`
- The `--argument value` format (space after the `argument`).
  - Quote rules same as above.
  - `ls --hide "Desktop" ~/`
  - `ls --hide Desktop ~/`
- Usually, `--argument value` and `--argument=value` are interchangeable.
  - Not always!

Flags and Options: Conventions, Warnings

- Generally, always specify the flags before the arguments.
- `ls -l ~/Desktop/` and `ls ~/Desktop/ -l` both work.
  - Sometimes flags after arguments **get ignored**.
  - Depends both on the command, and the flag(s).
- The special sequence `--` signals the end of the options.
  - Executes as expected: `ls -l -a ~/Desktop/`
  - Only uses `-l`: `ls -l -- -a ~/Desktop/`
    - `"ls: cannot access -a: No such file or directory`
    - The `-a` was treated as an **argument**, and there is no `-a` directory (for me)
- In this example:
  - `-l` and `-a` are the **flags**.
  - `~/Desktop/` is the **argument**.

Flags and Options: Conventions, Warnings (cont)

- The special sequence `--` that signals the end of the options is often most useful if you need to do something special.
- Suppose I *wanted* to make the folder `-a` on my `Desktop`.

```
$ cd ~/Desktop # for demonstration purpose
$ mkdir -a     # fails: invalid option -- 'a'
$ mkdir -- -a  # success! (ls to confirm)
$ rmdir -a     # fails: invalid option -- 'a'
$ rmdir -- -a  # success! (ls to confirm)
```

- This trick can be useful in **many** scenarios, and generally arises when you need to work with special characters of some sort.

Your new best friend

- How do I know what the flags / options for all of these commands are?

The Manual Command

`man command_name`

- Loads the manual (manpage) for the specified command.
- Unlike google, manpages are `system-specific`.
- Usually very comprehensive. Sometimes *too* comprehensive.
- Type `/keyword` to search for `keyword`, and hit `<enter>`.
- The `n` key jumps to the next search result.

- Search example on next page if that was confusing. Intended for side-by-side follow-along.

Man oh man

- The `man` command is really useful!

```
$ man man #  you now have the manual loaded
$ /useful #  type /useful, then hit enter
########### [[[ first result highlighted ]]]
$ n       #  followed by enter
########### [[[ next result highlighted ]]]
# The default 'pager' is `less`, type `q`
# without backticks to exit.
```

- Subtle differences depending on distribution, e.g. `ls -B`
- BSD/OSX: Force printing of non-printable characters in file names as `\xxx`.
  - `xxx` is the numeric value of the character in **octal**.
- GNU (Fedora, Ubuntu): don't list implied entries ending with `~`
  - Files ending with `~` are *temporary* backup files that certain programs generate (e.g. some text-editors, your OS).

References

[1] Computer Hope. *Linux and Unix chmod command help and examples*. 2016. URL: http://www.computerhope.com/unix/uchmod.htm.

[2] Stephen McDowell, Bruno Abrahao, Hussam Abu-Libdeh, Nicolas Savva, David Slater, and others over the years. "Previous Cornell CS 2043 Course Slides".