

# 02 - The Unix File System

CS 2043: Unix Tools and Scripting, Spring 2017 [1]

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## Some Logistics

- Virtual Machines are *almost* ready, need to update the videos.
  - Assuming minimal errors recording, afternoon - dinner time.
- Still on the fence about taking the class?
  - Moral obligation: decide now, many others want to enroll.

# Notation

- Commands will be shown on slides using **teletype text**.

## Introducing new commands

```
some-command [opt1] [opt2]
```

New commands will be introduced in block boxes like this one, sometimes including common flags or warnings.

- To execute **some-command**, just type its name into the shell and press return / enter.
- **\$** in code-blocks indicate a new command being entered.

```
$ first-command  
output of first-command (where applicable)  
$ second-command  
output of second-command (where applicable)
```

# Unix Filesystem Overview

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# The Unix Filesystem

- Unlike Windows, UNIX has a single global "root" directory (instead of a root directory for each disk or volume).
  - The root directory is just /
- All files and directories are case sensitive.
  - `hello.txt`  $\neq$  `HELLO.TXT`
- Directories are separated by / instead of \ in Unix.
  - UNIX: `/home/sven/lemurs`
  - Windows: `E:\Documents\lemurs`
- Hidden files and folders begin with a "."
  - e.g. `.git/` (a hidden directory).
- Example: my home directory.

# What's Where?

- `/dev`: Hardware devices, like your hard drive, USB devices.
- `/lib`: Stores libraries, along with `/usr/lib`, `/usr/local/lib`, etc.
- `/mnt`: Frequently used to mount disk drives.
- `/usr`: Mostly user-installed programs and amenities.
- `/etc`: System-wide settings.

# What's Where: Programs Edition

Programs are usually installed in one of the "binaries" directories:

- `/bin`: System programs.
- `/usr/bin`: Most user programs.
- `/usr/local/bin`: A few other user programs.



# Personal Files

- Your personal files are in your home directory (and its subdirectories), which is *usually*\* located at

Linux	Mac
<code>/home/username</code>	<code>/Users/username</code>

- There is also a built-in alias for it: `~`
- For example, the Desktop for the user **sven** is located at

Linux	Mac
<code>/home/sven/Desktop</code>	<code>/Users/sven/Desktop</code>
<code>~/Desktop</code>	<code>~/Desktop</code>

# Basic Navigational Commands

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## Where am I?

- Most shells default to using the current path in their prompt. If not, you can find out where you are with

### Print working directory

`pwd`

- Prints the "full" path of the current directory.
  - Handy on minimalist systems when you get lost.
  - Can be used in scripts.
- Note that if you have a path with *symbolic* links, you need to use the **-P** flag.

# What's here?

- Knowing where you are is useful, but understanding what else is there is too...

## The `ls` command

`ls`

- Lists directory contents (including subdirectories).
- Works like the `dir` command in Windows.
- The `-l` flag lists detailed file / directory information (we'll learn more about flags later).
- Use `-a` to list hidden files.

# Ok lets go!

- Moving around is as easy as

## Changing directories

```
cd [directory name]
```

- Changes directory to [directory name].
- If not given a destination defaults to the user's home directory.
- You can specify both absolute and relative paths.
- If you do not specify a **directory**, the ~ (home) **directory** is assumed.

- Absolute paths start at / (the global root).
  - e.g. `cd /home/sven/Desktop`
- Relative paths start at the current directory.
  - e.g. `cd Desktop`, if you were already at `/home/sven`

# Relative Path Shortcuts

- Shortcuts

~	current user's home directory
.	the current directory (this is actually useful...)
..	the parent directory of the current directory
-	for <code>cd</code> command, return to previous working directory

- An example: starting in `/usr/local/src`

```
$ cd      # now at /home/sven
$ cd -    # now at /usr/local/src
$ cd ..   # now at /usr/local
```

# File and Folder Manipulation

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## Creating a new File

- The easiest way to create an empty file is using

### **touch**

```
touch [flags] <file>
```

- Adjusts the timestamp of the specified file.
  - With no flags uses the current date and time.
  - If the file does not exist, **touch** creates it.
- File extensions (**.txt**, **.c**, **.py**, etc) often **don't** matter in Unix. Using **touch** to create a file results in a blank plain-text file (so you don't necessarily have to add **.txt** to it).



# Creating a new Directory

- No magic here...

## Make directory

```
mkdir [flags] <dir1> <dir2> <...> <dirN>
```

- Can use relative or absolute paths.
  - a.k.a. you are not restricted to making directories in the current directory only.
- Need to specify at least one directory name.
- Can specify multiple, separated by spaces.
- The **-p** flag is commonly used in scripts:
  - Makes all parent directories if they do not exist.
  - Convenient because if the directory exists, **mkdir** will not fail.

# File Deletion

- Warning: once you delete a file (from the command line) there is no easy way to recover the file.

## Remove File

```
rm [flags] <filename>
```

- Removes the file `<filename>`.
- Remove multiple files with wildcards (more on this later).
  - Remove every file in the current directory: `rm *`
  - Remove every `.jpg` file in the current directory: `rm *.jpg`
- Prompt before deletion: `rm -i <filename>`

# Deleting Directories

- By default, `rm` cannot remove directories. Instead we use...

## Remove directory

```
rmdir [flags] <directory>
```

- Removes an **empty** directory.
  - Throws an error if the directory is not empty.
  - You are encouraged to use this command: failing on non-empty can and will save you!
- To delete a directory and all its subdirectories, we pass `rm` the flag `-r` (for recursive), e.g. `rm -r /home/sven/oldstuff`

## Copy

```
cp [flags] <file> <destination>
```

- Copies from one location to another.
- To copy multiple files, use wildcards (such as \*).
- To copy a complete directory: `cp -r <src> <dest>`

# Move it!

- Unlike the `cp` command, the `move` command automatically recurses for directories.
  - Think of the implication of if it did not...

## Move

```
mv [flags] <source> <destination>
```

- Moves a file or directory from one place to another.
- Also used for renaming, just move from `<oldname>` to `<newname>`.
- E.g. `mv badFolderName correctName`

## Recap

<code>ls</code>	list directory contents
<code>cd</code>	change directory
<code>pwd</code>	print working directory
<code>rm</code>	remove file
<code>rmdir</code>	remove directory
<code>cp</code>	copy file
<code>mv</code>	move file

# Flags & Command Clarifaction

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# 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.



## Flags and Options: A bad Analogy

- If you think of a command as a computer, you could think of the flags as the different hardware components installed. Let's say that in this case a hard drive is a flag.
- The computer shipped to you with a CPU, motherboard, hard drive, etc and installed on that hard drive was the original operating system (say Windows). When you start it, the computer was executed with the Windows flag.
- Now, you remove the original hard drive and insert another hard drive that has a different OS installed (say Fedora). Then you boot your computer, only this time you ended up passing the Fedora flag.
- Nothing about the other components of the computer changed (it's just a bunch of electricity being routed around), but the behavior changed because of the flag you passed.

# 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 (next page).

# 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 (the `ls` command has `--all` aliased to `-a`).

- One option:
  - `ls -a`
  - `ls --all`
- Two options:
  - `ls -l -Q`
- Two options:
  - `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.
  - `rm -fi <file>` ⇒ prompts
  - `rm -if <file>` ⇒ does *not* prompt

## Flags and Options: Argument Specifiers

- These flags expect an input, and you will encounter two general kinds.
- 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 `hide` value...)
- The `--argument value` format, with a space after the `argument`. Quote rules same as above.
  - `ls --hide "Desktop" ~/`
  - `ls --hide Desktop ~/`
- Note: The example I gave you was using the same `--hide` in both formats, but not *all* commands will accept both.

Advise `--argument="value"` format for higher success rates.

## Flags and Options: Conventions, Warnings

Generally, you should always specify the flags before the arguments. In this example, the flag is `-l` and `~/Desktop/` is the argument.

- `ls -l ~/Desktop/` and `ls ~/Desktop/ -l` both work
- there exist scenarios in which flags after arguments do **not** get processed

There is a special sequence `--` that signals the end of the options. I will use another flag to demonstrate:

- `ls -l -a ~/Desktop/`  $\Rightarrow$  executes as expected
- `ls -l -- -a ~/Desktop/`  $\Rightarrow$  only used `-l`
  - "ls: cannot access -a: No such file or directory"
  - `-a` was treated as an *argument*, and there is no `-a` directory (for me)

## 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 **man** 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.
- The **n** key jumps through the search results.

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

# Man oh man

```
$ man man # you now have the manual loaded
$ /useful # type /useful, then hit enter
##### [first result highlighted]
$ n      # followed by enter
##### [next result highlighted]
```

Note that there are subtle differences between options on different systems. For example, **ls -B**:

- BSD/OSX: Force printing of non-printable characters in file names as `\xxx`, where `xxx` is the numeric value of the character in *octal*.
- Fedora, Ubuntu: do not list implied entries ending with `~`
  - In these OS's, files ending with `~` are *temporary* backup files that certain programs (e.g. some text-editors) generate.



## References I

[1] B. Abrahao, H. Abu-Libdeh, N. Savva, D. Slater, and others over the years.

**Previous cornell cs 2043 course slides.**