The Linux Terminal

see https://www.digitalocean.com/community/tutorials/an-introduction-to-the-linux-terminal

terminal
    allows using a terminal in a GUI environment

shell
    a command line interface that interprets a user's commands and script files
        we use the Bourne-Again shell (bash)

command prompt

```
user_name@host_name:current_directory$
jgourd@latech:~$
```

    we run commands at the prompt

root
    the superuser account

process
    an instance of a running command
    a process must finish before we can run another one

frequently used commands

```
ls
cd
man
```

    note that everything in Linux is case sensitive!

arguments
    parameters that can affect the behavior of a command

```
ls /etc
cd /
```

options
    flags or switches that modify the behavior of a command

```
ls -lh /etc
```

environment variables
    named values that are used to change how commands and processes are executed

```
env
echo $HOME
echo $PATH
x=5
y="Hello World"
echo $x
echo $y
```

    new variables are created; existing variables are overwritten
    we can export variables so that child processes can use them (e.g., in scripts)

```
          export PATH=$PATH:~
```

useful keys

- `tab` (and `tab tab`)
- `!` and `!!` (more later)
- `.` and `..`
- `Shift+PgUp` and `Shift+PgDn`

Basic Linux Navigation

see https://www.digitalocean.com/community/tutorials/basic-linux-navigation-and-file-management

where am I?
```
pwd
```

how do I go to the root directory?
```
cd /
```

how do I go to my home directory?
```
cd ~
```

how do I list files in the current directory?
```
ls
```

what about a more detailed listing?
```
ls -l
```

but the file sizes are not easy to read...
```
ls -lh
```

can I see hidden files?
```
ls -alh
```

where is my history (i.e., when I type history)?
```
~/.bash_history
```

when I start up a terminal, is there a script that auto runs?
```
~/.bashrc
```
`rc` means run commands

how do I “see” a file?
```
cat ~/.bashrc
more ~/.bashrc
head -n 20 ~/.bashrc
tail -n 20 ~/.bashrc
vim ~/.bashrc
nano ~/.bashrc
```

how do I create directories?

```
cd ~
ls -lh
mkdir tmp
ls -lh
mkdir "tmp/another directory"
ls -lh tmp
mkdir -p "tmp/yet another directory/and another one inside"
ls -lh tmp
rm tmp
```

how do I copy files?

```
cd ~
touch 1 2 3 4 5
mkdir tmp
cp 1 tmp
ls -lh
ls -lh tmp
cp 2 3 4 tmp
ls -lh
ls -lh tmp
rm 1 2 3 4 5 tmp
```

what about copying recursively?

```
cd ~
mkdir -p tmp/a tmp/b
touch tmp/file1 tmp/a/file2 tmp/b/file3
ls -lh tmp/*
cp -r tmp tmp2
ls -lh tmp2/*
rm tmp tmp2
```

how do I move files?

```
cd ~
touch 1 2 3 4 5
ls -lh
mkdir tmp
mv 1 tmp
ls -lh
ls -lh tmp
mv 2 3 4 tmp
ls -lh
ls -lh tmp
rm 5 tmp
```

a few final useful things

to clear the screen: `clear`

but Ctrl+L also works (without clearing the command line!)

to clear the command line before the cursor: Ctrl+U (also copies what it cleared to the clipboard)

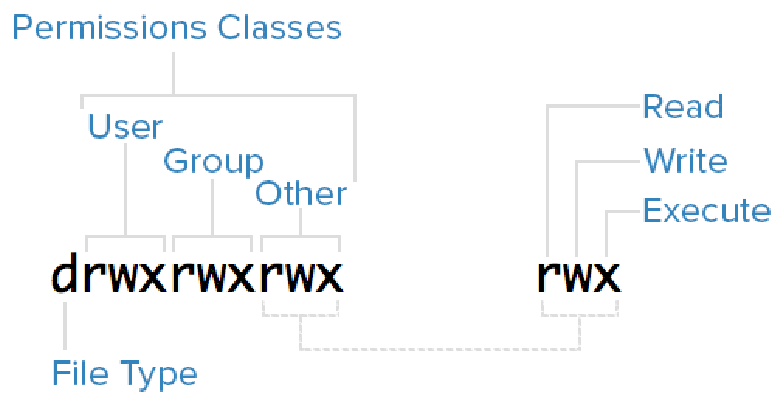
Linux File Permissions

see https://www.digitalocean.com/community/tutorials/an-introduction-to-linux-permissions

```
cd ~
ls -alh
```

```
     mode           owner  group  size last_mod     filename
     drwxr-xr-x 20 jgourd jgourd 4.0K Sep 13 14:02 .
     drwxr-xr-x  4 root   root   4.0K Sep 12 08:45 ..
     -rw-------  1 jgourd jgourd 2.6K Sep 13 14:20 .bash_history
     -rw-r--r--  1 jgourd jgourd  220 Sep 12 08:45 .bash_logout
     drwx------ 11 jgourd jgourd 4.0K Sep 13 14:12 .cache
     drwxr-xr-x 15 jgourd jgourd 4.0K Sep 12 09:04 .config
     drwx------  3 root   root   4.0K Sep 13 14:02 .dbus
     drwxr-xr-x  2 jgourd jgourd 4.0K Sep 12 08:47 Desktop
     -rw-------  1 jgourd jgourd   25 Sep 13 14:01 .dmrc
     drwxr-xr-x  2 jgourd jgourd 4.0K Sep 12 08:47 Documents
     drwxr-xr-x  2 jgourd jgourd 4.0K Sep 12 09:06 Downloads
```

mode/permissions



file types
- `-`: a normal file
- `d`: a directory
- `l`: a link

permission classes
- user: the owner of a file belongs to this class
- group: the members of a file's group belong to this class
- other: any users that are not part of the user or group classes belong to this class

permissions
- `r`: read
- `w`: write

`x`: execute (must be enabled for directory entry)
`-`: permission is not available

read
- can view the contents of a file
- can view the names of files in a directory

write
- can modify a file and delete it
- can delete a directory, modify its contents (create, delete, and rename files in it)
- can modify the contents of files in a directory (that have the read permission)

execute
- can execute a file (must also have the read permission)
- can access (traverse into) a directory
- can access metadata about files in the directory

common modes

```
-rw-------
-rw-r--r--
-rwxr-xr-x
drwxr-xr-x
drwx------
```

modifying permissions

```
chmod
```

```
cd ~
touch test
ls -l test
chmod u+x-w test
ls -l test
chmod g-r+wx,o-r+w test
ls -l test
chmod 777 test
ls -l test
chmod 644 test
ls -l test
rm test
```

recursive: `chmod -R`

numeric modes (binary!)

0: `---`
1: `--x`
2: `-w-`
3: `-wx`
4: `r--`
5: `r-x`
6: `rw-`

7: `rwx`

changing ownership

```
chown

chown jgourd:jgourd file
```

<u>Linux I/O Redirection</u>

see https://www.digitalocean.com/community/tutorials/an-introduction-to-linux-i-o-redirection

streams

- standard input: `stdin` (also numbered 0)
    - usually means the user's keyboard
- standard output: `stdout` (also numbered 1)
    - usually means the user's monitor
- standard error: `stderr` (also numbered 2)

stdin

```
cat
```

type:

```
1
2
3
Ctrl+D
```

stdout

```
echo "Sent to the terminal through stdout"
```

stderr

```
ls %
```

redirection

```
>: redirect stdout
<: redirect stdin
2>: redirect stderr
```

can also append

```
>>: redirect stdout
<<: redirect stdin
2>>: redirect stderr
```

e.g.,

```
cd ~
cat > file.txt
```

type stuff, then Ctrl+D

```
cat file.txt
cat > file.txt
```
type different stuff, then Ctrl+D
```
cat file.txt

cat >> file.txt
```
type different stuff, then Ctrl+D
```
cat file.txt

rm file.txt
```

pipes

used to redirect one stream to another; e.g.,
```
ls -lh /usr/bin
ls -lh /usr/bin | more
```

/dev/null

a special file that is used to trash anything that's redirected to it
```
ls -lh /usr/bin > /dev/null
```

redirecting stderr
```
cd ~
```
`mkdir ''` (this is two single quotes, side by side)
```
mkdir '' 2>> errors.txt
find / -maxdepth 2 2>> errors.txt
cat errors.txt
rm errors.txt
find / -maxdepth 2 > files.txt 2>> errors.txt
cat files.txt
cat errors.txt
rm files.txt errors.txt
```

filters

grep (print lines matching a pattern)
```
find /usr/bin
find /usr/bin | grep wc
```
wc (print newline, word, and byte counts)
```
find /usr/bin | wc
find /usr/bin | wc -l
```
tee (read from stdin and write to stdout/files)
```
cd ~
wc /etc/magic
wc /etc/magic | tee magic_file.txt
cat magic_file.txt
rm magic_file.txt
```
tr (translate or delete characters)
```
tail -n +10 ~/.bashrc | tr a A | tr -d s
```

multiple pipes

```
     find /etc | grep conf
     find /etc | grep conf | tr l 1 | tr e 3 | tr a 4 | tr s 5 | tr b
8 | tr o 0
```

Regular Expressions

see https://www.digitalocean.com/community/tutorials/an-introduction-to-regular-expressions

all about pattern matching
    usually because we want to find things in a lot of things

regular expression == regex
consists of **literal** characters and **meta** characters
    meta == power

e.g., with a large dictionary file

```
     cat dictionary.txt | wc -l
     tail -n 20 dictionary.txt
```

anchor meta characters
    `^`: matches the **start** of a pattern
    `$`: matches the **end** of a pattern

```
     grep -E '^a' dictionary.txt
     grep -E 'a$' dictionary.txt
```

the dot (.) meta character
    matches a single character

```
     grep -E '^a.....b$' dictionary.txt
```

character groups
    uses square brackets

```
     grep -E '^[aeiou]......[aeiou]$' dictionary.txt
```

groupings
    uses parentheses

```
     grep -E '^[a](si|fric)a$' dictionary.txt
```

quantifiers
    instead of

```
          grep -E '^a.....b$' dictionary.txt
```

    we can

```
          grep -E '^a.{5}b$' dictionary.txt
```

    we can also provide a range

```
          grep -E '^a.{4,5}b$' dictionary.txt
```

the quantifier {0,1} can be shortened to ?

```
grep -E '^a.{0,1}b$' dictionary.txt
grep -E '^a.?b$' dictionary.txt
grep -E '^af?r' dictionary.txt
```

the quantifier {0,} can be shortened to *

```
grep -E '^a.{0,}b$' dictionary.txt
grep -E '^a.*b$' dictionary.txt
grep -E '^af*r' dictionary.txt
```

the quantifier {1,} can be shortened to +

```
grep -E '^a.{1,}b$' dictionary.txt
grep -E '^a.+b$' dictionary.txt
grep -E '^af+r' dictionary.txt
```

e.g.,

matching a US ZIP code

```
grep -E '^[0-9]{5}(-[0-9]{4})?$'
```

matching all valid times in a 24 hour clock

```
grep -E '^([01][0-9]|2[0-3]):[0-5][0-9]:[0-5][0-9]'
```

word boundaries

```
grep -E '\bpour' dictionary.txt
grep -E 'pour\b' dictionary.txt
grep -E '\bpour\b' dictionary.txt
```

back references

```
grep -E '(au).*\1' dictionary.txt
grep -E '^([a-zA-Z]+)([a-zA-Z]+)\1\2\1' dictionary.txt
```

to list files in /usr/bin that begin with >=1 digit followed by >=0 lowercase letters, followed by 1 digit

```
ls /usr/bin | grep -E '^[0-9]+[a-z]*[0-9]'
```

we can use sed to replace!

```
grep tio dictionary.txt
grep tio dictionary.txt | sed 's/tio/sh/'
grep tio dictionary.txt | sed 's/tio/sh/i'
grep tio dictionary.txt | sed 's/tio/sh/g'
grep tio dictionary.txt | sed 's/tio/sh/ig'
```

<u>Working with Bash History</u>

see https://www.digitalocean.com/community/tutorials/how-to-use-bash-history-commands-and-expansions-on-a-linux-vps

also see `man history`

history defaults can be set in ~/.bashrc

```
HISTSIZE=5000
```

load the last 5,000 lines in memory

```
HISTFILESIZE=10000
```
save the last 10,000 lines to disk

```
HISTCONTROL=ignoredups:ignorespace
```
don't store duplicate commands

don't store commands that begin with a space

by default, history is saved for the last opened terminal

this sucks if you have multiple terminals open

we can save history for all opened terminals via

```
shopt -s histappend
```

how do we see our history?

```
history
history 10
history | grep sudo
```

executing commands from history

`!n`: execute the command associated with history #n

`!-n`: execute n commands ago; e.g.,

`!-2`: execute two commands ago (i.e., the one before the most recent)

!!: execute the last command

useful when you forget to use sudo; e.g.,

```
touch /root/file.txt
sudo !!
ls -Alh /root
sudo !!
rm /root/file.txt
sudo !!
```

`!blah`: execute the last command that **began** with **blah**

```
!grep
```

`!?blah?`: execute the last command that **contained blah**

```
!?tio?
```

`!?blah`: execute the last command that **ended** with **blah**

```
!?txt
```

made a mistake typing something?

```
cat /etc/hosst
^hosst^hosts^
```

from the command line, use the **up arrow key** to scroll backward through history

and use the **down arrow key** to scroll forward through history

...there's a lot more...

but it's way beyond this lesson!

Useful Linux Commands

see http://ss64.com/bash/

alias	ifconfig	ssh
apt-get	kill	su
apt-cache	killall	sudo
bc	ln	tail
cat	locate	tar
cd	logout	tee
chmod	ls	time
chown	man	timeout
clear	mkdir	touch
cp	more	top
cut	mv	traceroute
curl	netstat	tr
date	passwd	unalias
df	ping	uname
diff	ps	uniq
du	pwd	uptime
echo	rm	useradd
exit	rmdir	userdel
export	rsync	usermod
fg	screen	vim
find	scp	wc
grep	sed	whereis
head	sort	who
history	split	wget