# How to interact with OS

Unix,

Terminal commands

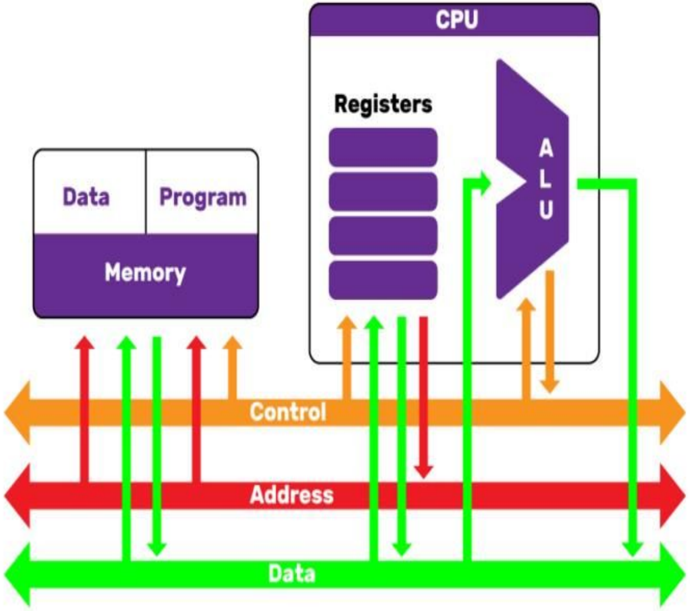
# Last week: Process

Program: a binary file in hard disk

When we run a program,

- We need to load its data, instructions into memory
- And run on CPU

Process: The program that is loaded into memory



https://www.icdrex.com/the-brain-behind-the-machine-transistors-in-cpu-architecture/

# Last week: Running one program vs running multiple program

Multi-tasking

- Computers can run many program at the same time
- Many programs use the same memory, CPU, I/O devices

Problems

- One program can affect another
- One program can steal another’s data
- There may be more than one user

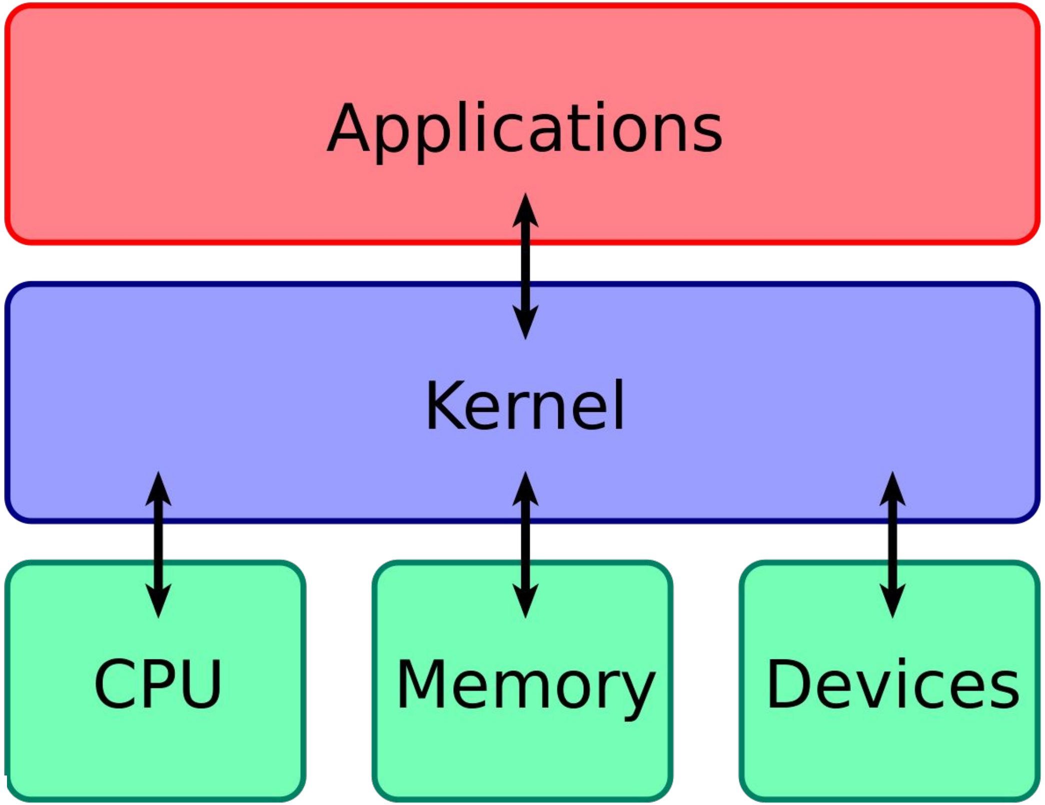
Protection

- How to protect system resources (hardware)?
- How to prevent one program affecting another?
- ..

# Last week:

## Operating system

Kernel: the core of os that controls system resources



https://en.wikipedia.org/wiki/Kernel_(operating_system)

# This week

How to interact with os

The rest of the semester:

User apps and their needs

- Apps for writing code
  - Version control
- Apps for documentation
- Data storage
- networking

# Unix OS

Some history

- 3rd time sharing system (2nd CTSS)
- Dev. started in 1969 at Bell Labs by Ken Thompson, Dennis Ritchie, Brian Kernighan, and others
  - Run on PDP-7 - Wikipedia  and -9 computers
  - Originally written in assembly, later written in C
- Outside bell labs- 1973
- Late 1970s distributed, licensed to academic and commercial institutions
-

Origins and History of Unix, 1969-1995

https://en.wikipedia.org/wiki/Unix

# Unix OS

The original spelling was “UNICS” (UNiplexed Information and Computing Service)

Ritchie observes:

- “What we wanted to preserve was not just a good environment in which to do programming, but a system around which a fellowship could form.
- We knew from experience that the essence of communal computing, as supplied by remote-access, time-shared machines, is not just to type programs into a terminal instead of a keypunch, but to encourage close communication”.

1969 was also the year the ARPANET (the direct ancestor of today's Internet) was invented.

Ken (seated) and Dennis (standing) at a PDP-11 in 1972.

Content copied from Origins and History of Unix, 1969-1995

John Lions's 1976 A COMMENTARY ON THE SIXTH EDITION UNIX OPERATING SYSTEM on the Version 6 source code became the first serious documentation of the Unix kernel internals.

Ken Arnold “...back then you couldn't be a kernel hacker without a Lions.”

Origins and History of Unix, 1969-1995

first public report in 1974- 600 installations.

AT&T (the parent organization of Bell Labs) had been forbidden from entering the computer business.

- Unix couldn’t turn into commercial product

Unix was very popular in academia 1970s and 1980s

Douglas Comer: “Many universities contributed to UNIX.

At the University of Toronto, the department acquired a 200-dot-per-inch printer/plotter and built software that used the printer to simulate a phototypesetter.

At Yale University, students and computer scientists modified the UNIX shell.

At Purdue University, the Electrical Engineering Department made major improvements in performance, producing a version of UNIX that supported a larger number of users. Purdue also developed one of the first UNIX computer networks.

At the University of California at Berkeley, students developed a new shell and dozens of smaller utilities.

By the late 1970s, when Bell Labs released Version 7 UNIX, it was clear that the system solved the computing problems of many departments, and that it incorporated many of the ideas that had arisen in universities.

The end result was a strengthened system. A tide of ideas had started a new cycle, flowing from academia to an industrial laboratory, back to academia, and finally moving on to a growing number of commercial sites”

Origins and History of Unix, 1969-1995

1977-BSD released  (Berkeley version of Unix)

1980-DARPA chose BSD as platform to implement TCP/IP

- TCP/IP implementation released with Berkeley 4.2 in 1983

1981-Microsoft made deal with IBM to market MS-DOS separately

- Mostly for PCs-cheaper machines instead of workstations

1983 System V Unix (AT&T try to commercialize but failed.

1983 Richard Stallman start writing GNU, completely a free clone of Unix

1985 GNU manifesto-(GNU Manifesto - Wikipedia )

The GNU Manifesto - GNU Project - Free Software Foundation

# Standardization

System V and BSD

1985 -POSIX standards backed by IEEE

- Described intersection set of between System V and BSD calls

1988-IBM, HP, etc formed open software foundation against AT&T/Sun

The UNIX® Standard | www.opengroup.org

Origins and History of Unix, 1969-1995

# Linux

1991-Linus Torvalds announced Linux project

By late 1993 Linux has

- X and internet capability
- GNU toolkits that provides high quality dev tools

# Open source movement

1998 source code release for Netscape

That leads more into Linux

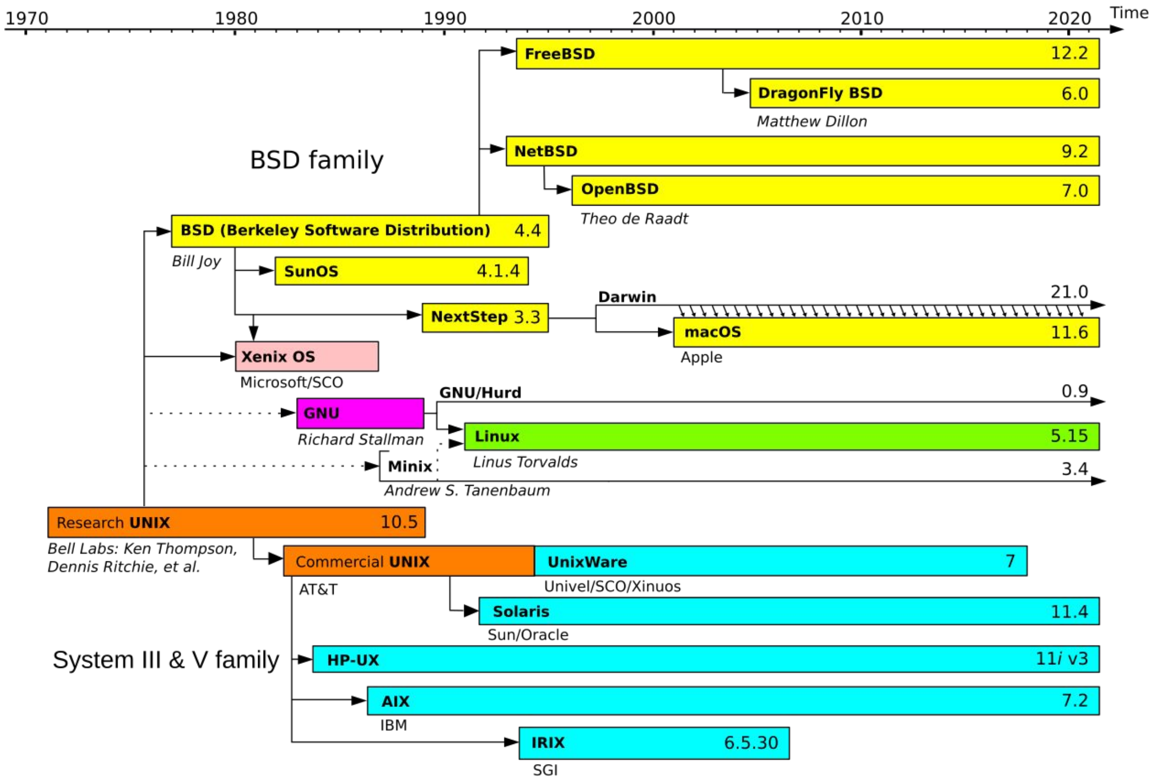
https://en.wikipedia.org/wiki/Open-source-software_movement

The Open-Source Movement: 1998 and Onward

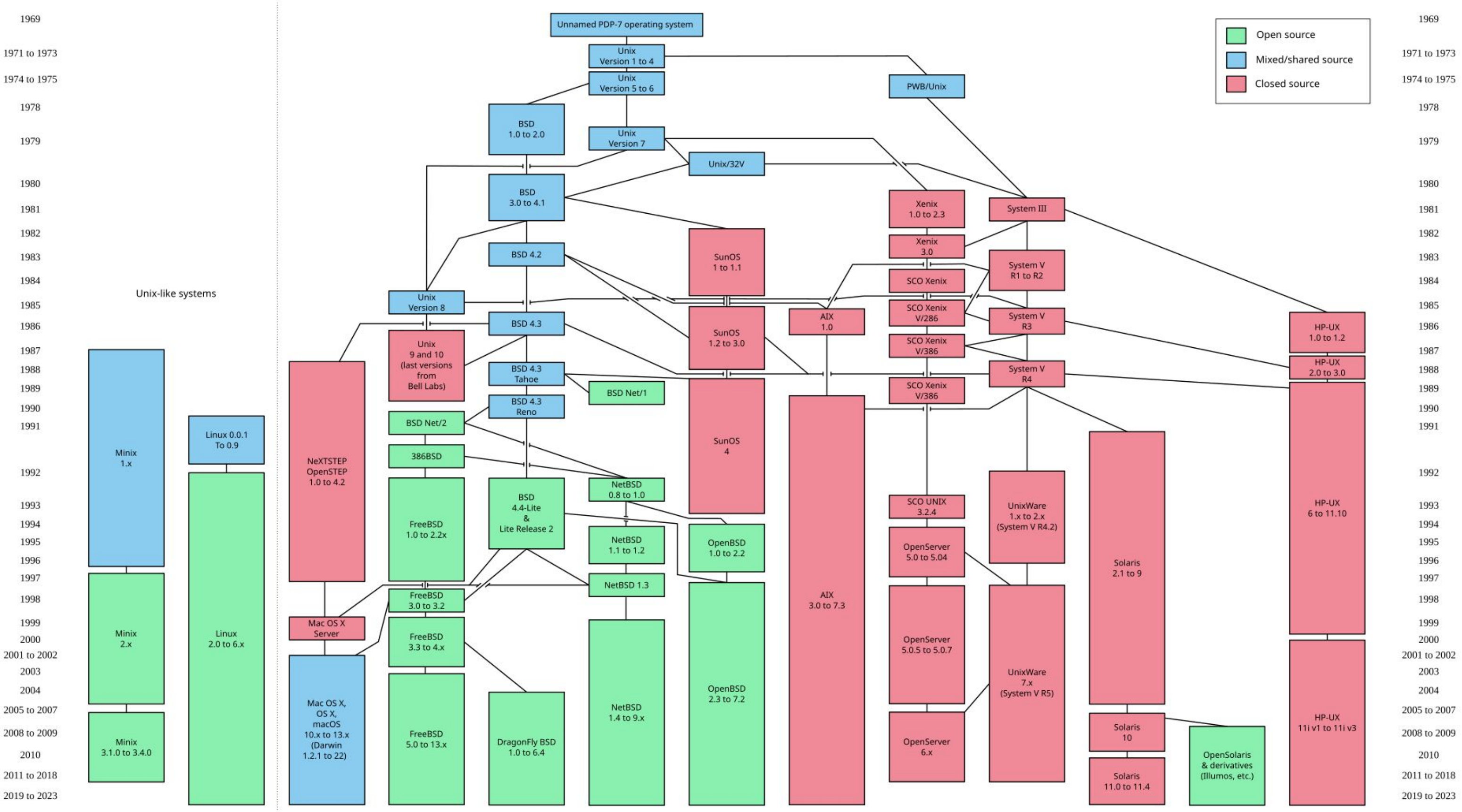
# Unix-like OSes (*Nix)

An OS behaves similar to Unix

- Amoeba
- BSD
- Coherent
- Darwin
- DEMOS
- DNIX
- Domain/OS
- DYNIX
- GNU Hurd
- Linux
- LynxOS
- MINIX
- MNOS
- MOS
- NeXTSTEP
- QNX
- Redox
- RISC iX
- SOX
- SunOS
- SerenityOS
- Ultrix
- uNETix



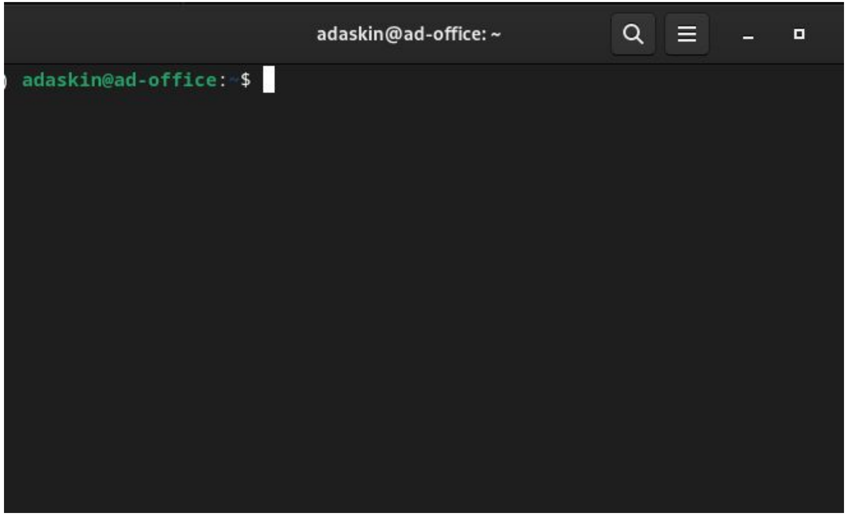
https://en.wikipedia.org/wiki/Unix-like



https://en.wikipedia.org/wiki/List_of_Unix_systems

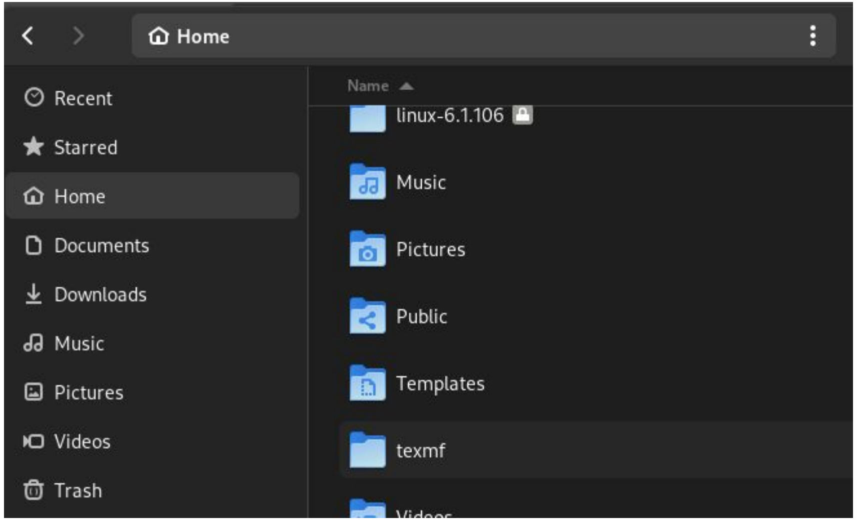
# OS user interface

Command Line (terminal, cmd)



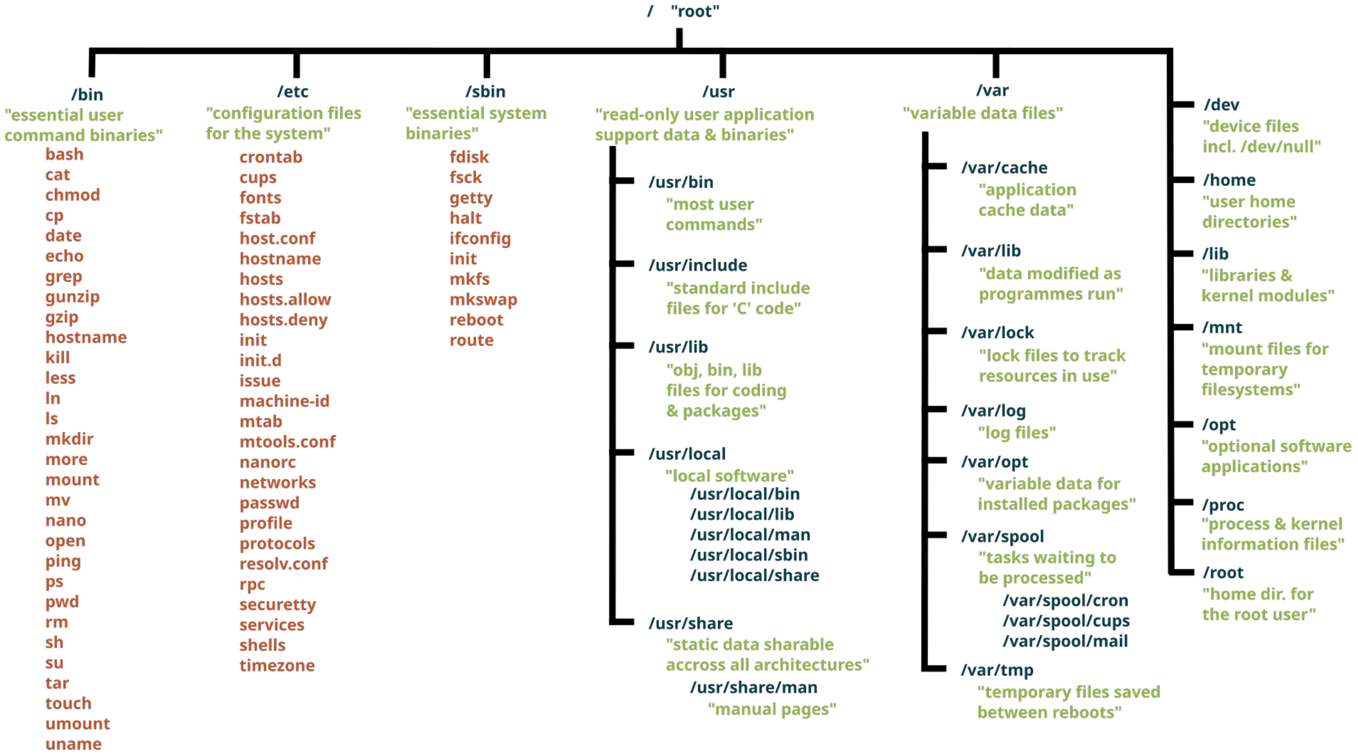
```
adaskin@ad-office:~$ 
```

GUI



Other examples?

# Unix-like OS file systems



/ "root"

/bin
"essential user command binaries"
bash
cat
chmod
cp
date
echo
grep
gunzip
gzip
hostname
kill
less
ln
ls
mkdir
more
mount
mv
nano
open
ping
ps
pwd
rm
sh
su
tar
touch
umount
uname

/etc
"configuration files for the system"
crontab
cups
fonts
fstab
host.conf
hostname
hosts
hosts.allow
hosts.deny
init
init.d
issue
machine-id
mtab
mtools.conf
nanorc
networks
passwd
profile
protocols
resolv.conf
rpc
securetty
services
shells
timezone

/sbin
"essential system binaries"
fdisk
fsck
getty
halt
ifconfig
init
mkfs
mkswap
reboot
route

/usr
"read-only user application support data & binaries"

/usr/bin
"most user commands"

/usr/include
"standard include files for 'C' code"

/usr/lib
"obj, bin, lib files for coding & packages"

/usr/local
"local software"
/usr/local/bin
/usr/local/lib
/usr/local/man
/usr/local/sbin
/usr/local/share

/usr/share
"static data sharable accross all architectures"
/usr/share/man
"manual pages"

/var
"variable data files"

/var/cache
"application cache data"

/var/lib
"data modified as programmes run"

/var/lock
"lock files to track resources in use"

/var/log
"log files"

/var/opt
"variable data for installed packages"

/var/spool
"tasks waiting to be processed"
/var/spool/cron
/var/spool/cups
/var/spool/mail

/var/tmp
"temporary files saved between reboots"

/dev
"device files incl. /dev/null"

/home
"user home directories"

/lib
"libraries & kernel modules"

/mnt
"mount files for temporary filesystems"

/opt
"optional software applications"

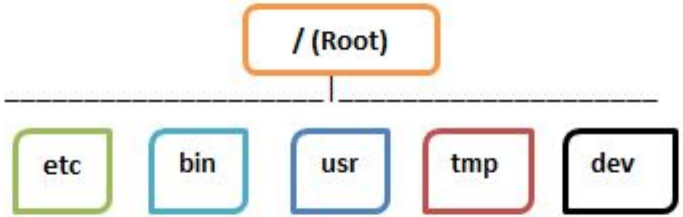
/proc
"process & kernel information files"

/root
"home dir. for the root user"

Generic Files

Device files

Directory files



# Users

Root user

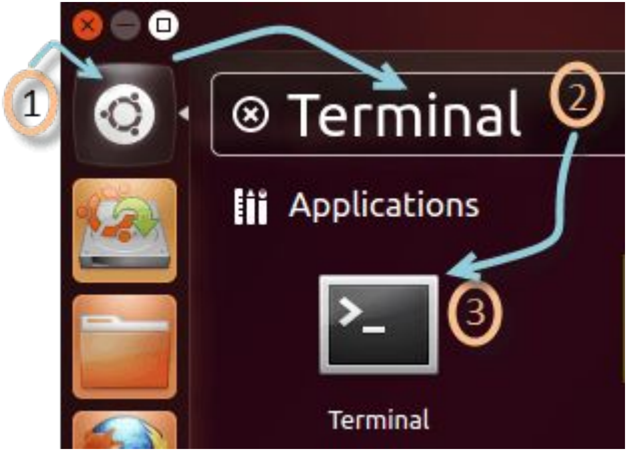
Regular user

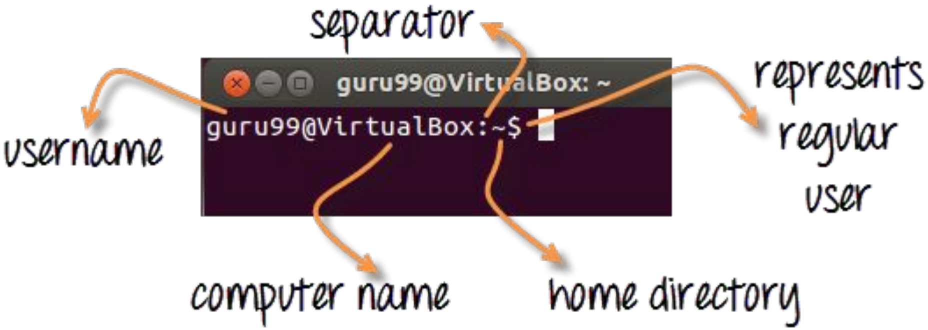
Service user

# Terminal

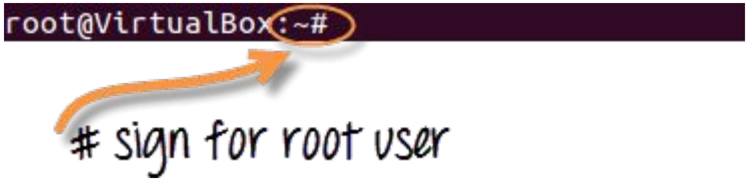
See also [The Linux command line for beginners | Ubuntu]

**CTRL + Alt + T** to launch the Terminal





```
guru99@VirtualBox:~$
```



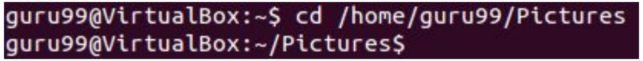
```
root@VirtualBox:~#
```

https://www.guru99.com/terminal-file-manager.html

# Commands

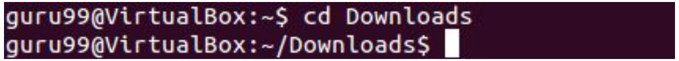
- ls
  - Listing files
- pwd
  - Present working directory
- cd
  - Changing directory
- man
  - Manual
  - Man ls
  - ls –help

Absolute path



```
guru99@VirtualBox:~$ cd /home/guru99/Pictures
guru99@VirtualBox:~/Pictures$
```

Relative path



```
guru99@VirtualBox:~$ cd Downloads
guru99@VirtualBox:~/Downloads$ █
```

https://www.guru99.com/terminal-file-manager.html

- cat
    - concatenate files and print on the standard output
    - cat f1 f2 f3
- Touch
    - Change access time
    - Touch afile
- rm
    - Remove
    - Non-recoverable
    - rm -r directory
        - Remove directory
- Mv
    - Move
    - mv a ../b

- Head
    - Output the first part
    - Head -n 9
        - Print the first 9 lines
- Tail
    - Output the last lines
    - Tail -n 9
        - Print the last 9 lines
- Less or more
    - One screenfull at a time view for files

https://www.guru99.com/must-know-linux-commands.html

# File ownerships

### User

A user is the owner of the file.

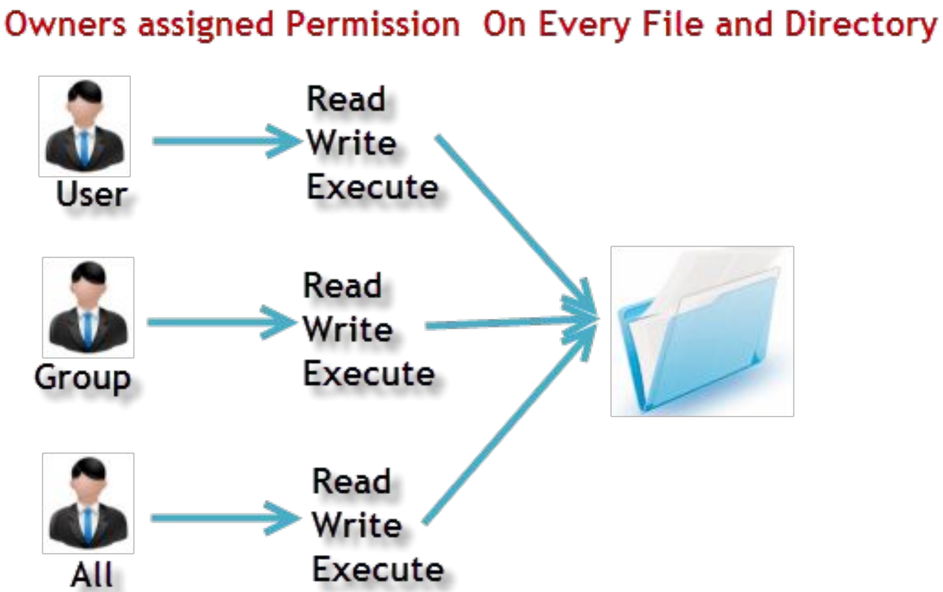
- By default, the person who created a file becomes its owner.

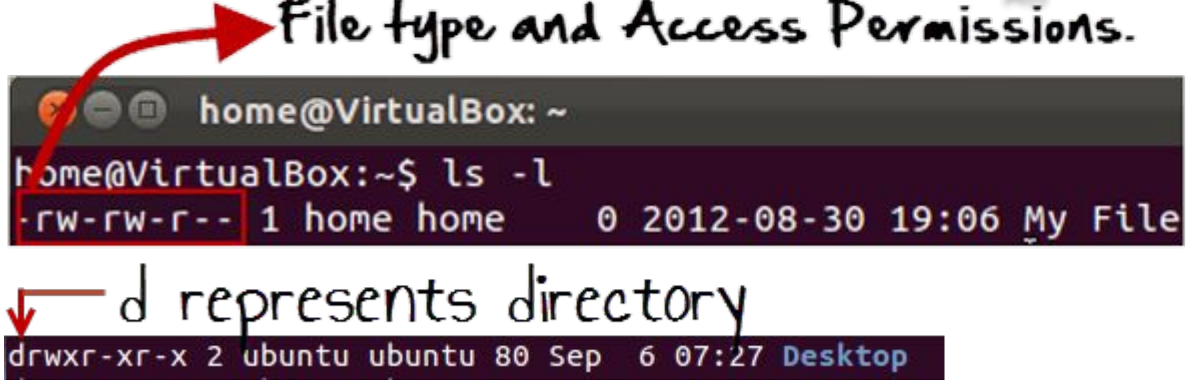
### Group

A user- group can contain multiple users.

### Other

Any other user who has access to a file.



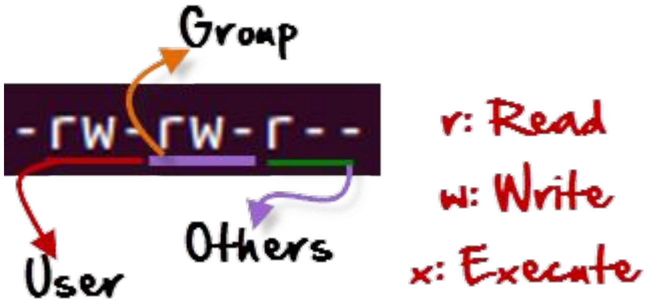


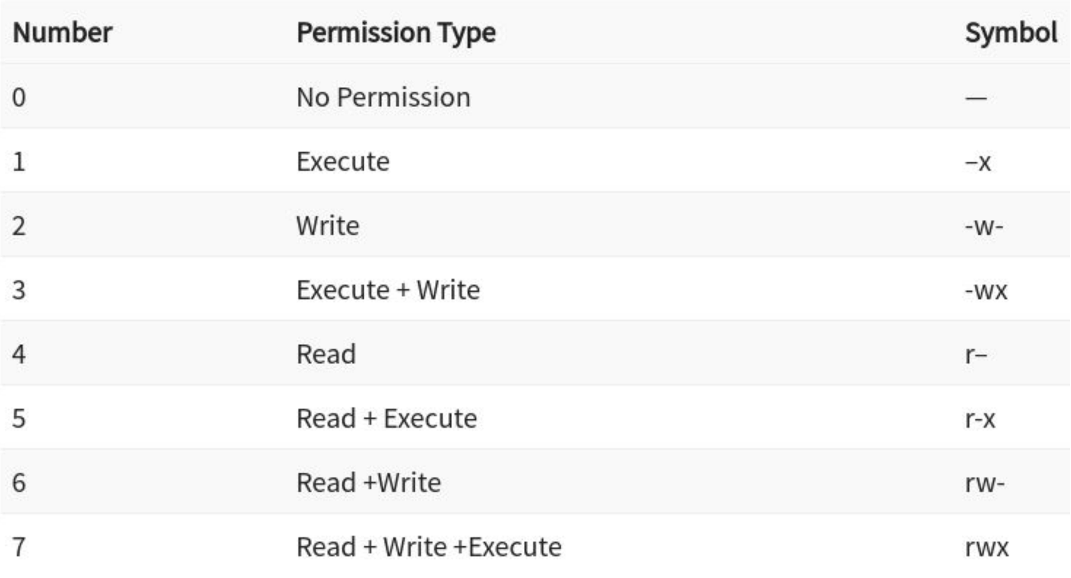
```
home@VirtualBox:~$ ls -l
-rw-rw-r-- 1 home home     0 2012-08-30 19:06 My File
```

```
drwxr-xr-x 2 ubuntu ubuntu 80 Sep  6 07:27 Desktop
```

https://www.guru99.com/file-permissions.html

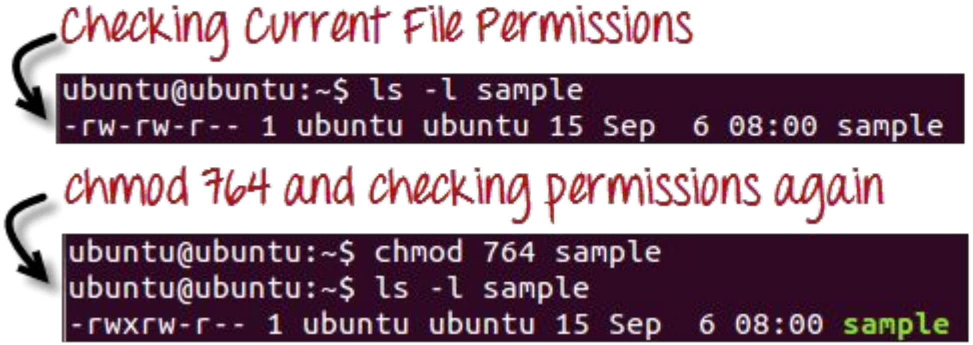
# Changing file permissions





| Number | Permission Type | Symbol |
|---|---|---|
| 0 | No Permission | — |
| 1 | Execute | –x |
| 2 | Write | -w- |
| 3 | Execute + Write | -wx |
| 4 | Read | r– |
| 5 | Read + Execute | r-x |
| 6 | Read +Write | rw- |
| 7 | Read + Write +Execute | rwx |

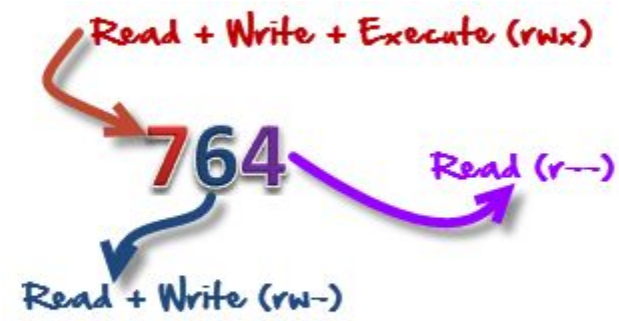
chmod permission filename


Checking Current File Permissions

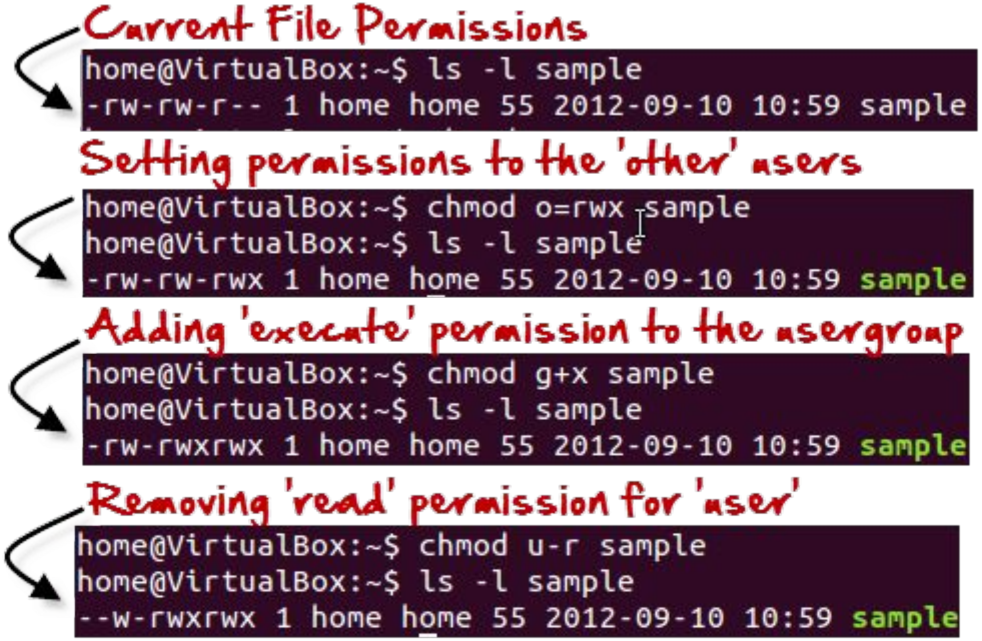
```
ubuntu@ubuntu:~$ ls -l sample
-rw-rw-r-- 1 ubuntu ubuntu 15 Sep  6 08:00 sample
```

chmod 764 and checking permissions again

```
ubuntu@ubuntu:~$ chmod 764 sample
ubuntu@ubuntu:~$ ls -l sample
-rwxrw-r-- 1 ubuntu ubuntu 15 Sep  6 08:00 sample
```



https://www.guru99.com/file-permissions.html



Current File Permissions

```
home@VirtualBox:~$ ls -l sample
-rw-rw-r-- 1 home home 55 2012-09-10 10:59 sample
```

Setting permissions to the 'other' users

```
home@VirtualBox:~$ chmod o=rwx sample
home@VirtualBox:~$ ls -l sample
-rw-rw-rwx 1 home home 55 2012-09-10 10:59 sample
```

Adding 'execute' permission to the usergroup

```
home@VirtualBox:~$ chmod g+x sample
home@VirtualBox:~$ ls -l sample
-rw-rwxrwx 1 home home 55 2012-09-10 10:59 sample
```

Removing 'read' permission for 'user'

```
home@VirtualBox:~$ chmod u-r sample
home@VirtualBox:~$ ls -l sample
--w-rwxrwx 1 home home 55 2012-09-10 10:59 sample
```

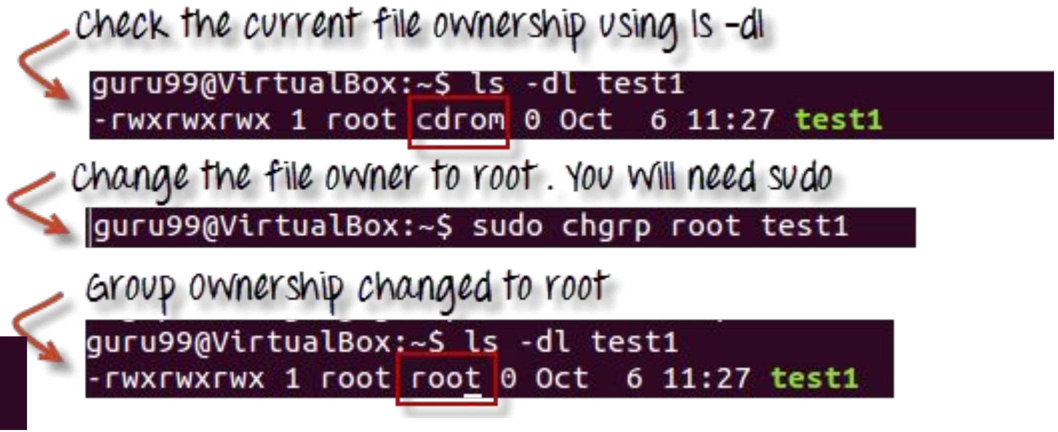
https://www.guru99.com/file-permissions.html

# Changing ownership

```
chown user filename

chown user:group filename

chgrp group_name filename
```



Check the current file ownership using ls -dl

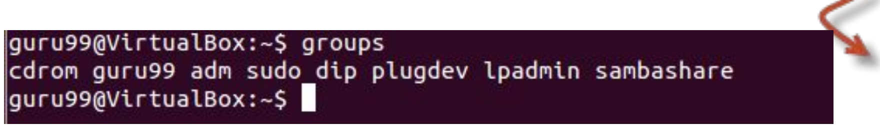
```
guru99@VirtualBox:~$ ls -dl test1
-rwxrwxrwx 1 root cdrom 0 Oct  6 11:27 test1
```

Change the file owner to root. You will need sudo

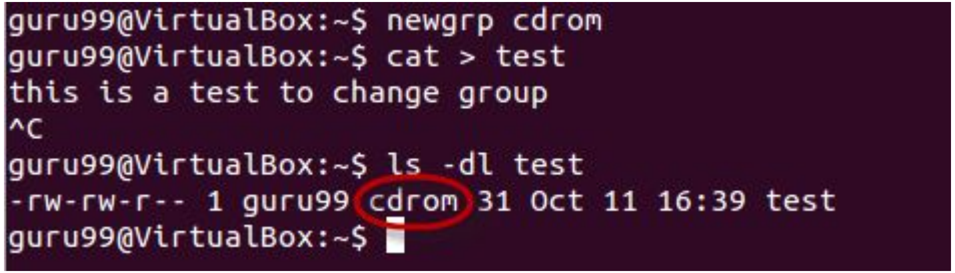
```
guru99@VirtualBox:~$ sudo chgrp root test1
```

Group ownership changed to root

```
guru99@VirtualBox:~$ ls -dl test1
-rwxrwxrwx 1 root root 0 Oct  6 11:27 test1
```



```
guru99@VirtualBox:~$ groups
cdrom guru99 adm sudo dip plugdev lpadmin sambashare
guru99@VirtualBox:~$
```



```
guru99@VirtualBox:~$ newgrp cdrom
guru99@VirtualBox:~$ cat > test
this is a test to change group
^C
guru99@VirtualBox:~$ ls -dl test
-rw-rw-r-- 1 guru99 cdrom 31 Oct 11 16:39 test
guru99@VirtualBox:~$
```

https://www.guru99.com/file-permissions.html

# Running commands with substitute user

- su
  - Defaults to root
- su username
-

- sudo
  - Defaults to super-user(root)
  - Execute commands as another user
- sudo rm afile
- sudo ls afile
-

# Adding user

Adduser, addgroup

Or useradd, groupadd

Usermod: modify a user account

- Change home, name, password, group etc.

```
sudo useradd ayse

sudo id ayse

sudo passwd ayse

sudo useradd -m ayse
```

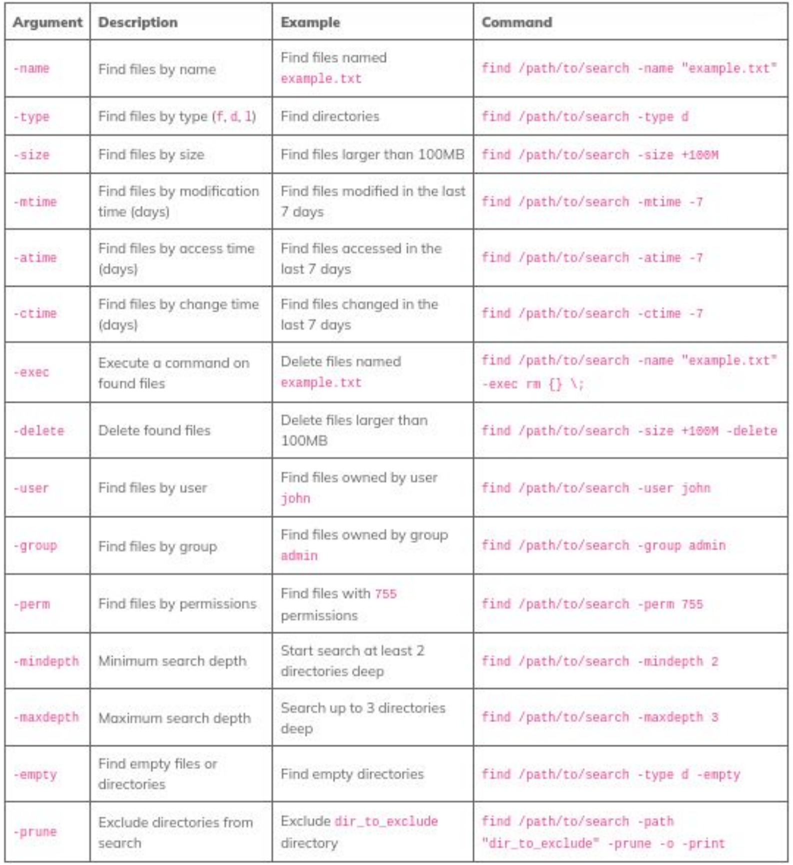
- Creates home directory

```
sudo userdel ayse
```

# Searching/locating files

find [path] [expression]

- Search for files in a directory
- find . -name "example.txt"
-



| Argument | Description | Example | Command |
|---|---|---|---|
| `-name` | Find files by name | Find files named `example.txt` | `find /path/to/search -name "example.txt"` |
| `-type` | Find files by type (f, d, l) | Find directories | `find /path/to/search -type d` |
| `-size` | Find files by size | Find files larger than 100MB | `find /path/to/search -size +100M` |
| `-mtime` | Find files by modification time (days) | Find files modified in the last 7 days | `find /path/to/search -mtime -7` |
| `-atime` | Find files by access time (days) | Find files accessed in the last 7 days | `find /path/to/search -atime -7` |
| `-ctime` | Find files by change time (days) | Find files changed in the last 7 days | `find /path/to/search -ctime -7` |
| `-exec` | Execute a command on found files | Delete files named `example.txt` | `find /path/to/search -name "example.txt" -exec rm {} \;` |
| `-delete` | Delete found files | Delete files larger than 100MB | `find /path/to/search -size +100M -delete` |
| `-user` | Find files by user | Find files owned by user `john` | `find /path/to/search -user john` |
| `-group` | Find files by group | Find files owned by group `admin` | `find /path/to/search -group admin` |
| `-perm` | Find files by permissions | Find files with `755` permissions | `find /path/to/search -perm 755` |
| `-mindepth` | Minimum search depth | Start search at least 2 directories deep | `find /path/to/search -mindepth 2` |
| `-maxdepth` | Maximum search depth | Search up to 3 directories deep | `find /path/to/search -maxdepth 3` |
| `-empty` | Find empty files or directories | Find empty directories | `find /path/to/search -type d -empty` |
| `-prune` | Exclude directories from search | Exclude `dir_to_exclude` directory | `find /path/to/search -path "dir_to_exclude" -prune -o -print` |

https://www.serveracademy.com/blog/linux-find-command/

# Searching patterns in a file

grep [options] pattern [*file ...*]

grep “istanbul” sehirler.txt sehirler2.txt sehirler3.txt

- -r
  - Search all files
- -i
  - Case sensitive
- -c
  - Count number of occurrences
- -e
  - Search for pattern
  - -e “pattern1” -e “pattern2”

`-i`: Ignore case distinctions.

`-v`: Invert the match to select non-matching lines.

`-c`: Count the number of matching lines.

`-l`: List filenames containing the match.

`-L`: List filenames that do not contain the match.

`-n`: Prefix each line of output with the line number.

`-H`: Print the filename for each match.

`-r` or `-R`: Read all files under each directory, recursively.

`-w`: Match whole words only.

`-x`: Match whole lines only.

`-E`: Use extended regular expressions (ERE).

`-F`: Interpret pattern as a list of fixed strings (fgrep).

`-q`: Quiet, do not write anything to standard output.

# sed

Stream editor, perform text transformations

sed SCRIPT INPUTFILE…

- 
- sed 's/hello/world/' input.txt
  - Replace all occurrences of ‘hello’ to ‘world’
- sed -i 's/hello/world/' file.txt
  - Edit files in place
- sed -n '45p' file.txt
  - Print only line 45
    - p for printing
    - -n for suppressing
- sed -n  '1p ; $p' one.txt two.txt three.txt
  - Multiple input considered as a single stream
  - 1st line of one.txt
  - Last line of three

https://www.gnu.org/software/sed/manual/sed.html#Introduction

# awk

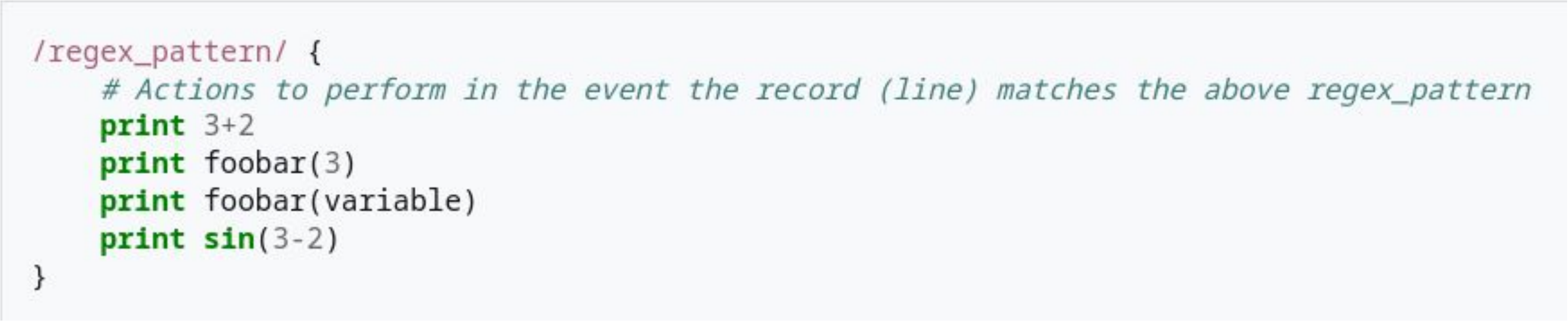
AWK is an interpreted language is designed for text processing

- Mawk,
- Gawk, etc are implementations

An AWK program is a series of pattern action pairs,

condition { action }

condition { action }



```
/regex_pattern/ {
    # Actions to perform in the event the record (line) matches the above regex_pattern
    print 3+2
    print foobar(3)
    print foobar(variable)
    print sin(3-2)
}
```

https://en.wikipedia.org/wiki/AWK

# examples

File advice

```
BEGIN { print "Don't Panic!" }
```

```
$ awk -f advice
```

```
$ awk 'BEGIN { print "Don\47t Panic!" }'
```

Mail-list file

```
Amelia       555-5553     amelia.zodiacusque@gmail.com    F
Anthony      555-3412     anthony.asserturo@hotmail.com   A
Becky        555-7685     becky.algebrarum@gmail.com      A
Bill         555-1675     bill.drowning@hotmail.com       A
Broderick    555-0542     broderick.aliquotiens@yahoo.com R
Camilla      555-2912     camilla.infusarum@skynet.be     R
Fabius       555-1234     fabius.undevicesimus@ucb.edu    F
Julie        555-6699     julie.perscrutabor@skeeve.com   F
Martin       555-6480     martin.codicibus@hotmail.com    A
Samuel       555-3430     samuel.lanceolis@shu.edu        A
Jean-Paul    555-2127     jeanpaul.campanorum@nyu.edu     R
```

```
$ awk '/li/ { print $0 }' mail-list
```

- Search “li”
- When lines with “li” found, they are printed
- $0 means current line

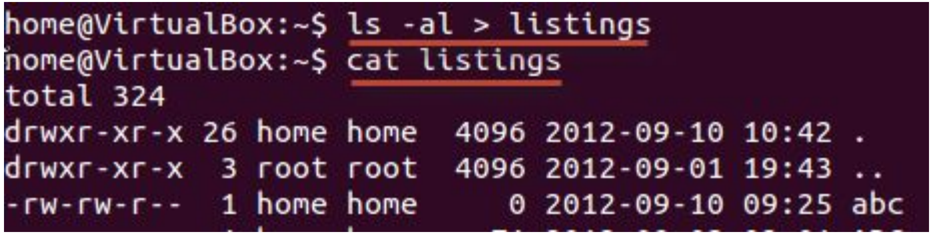
```
$ awk 'length($0) > 80' data
```

- Print every line longer than 80

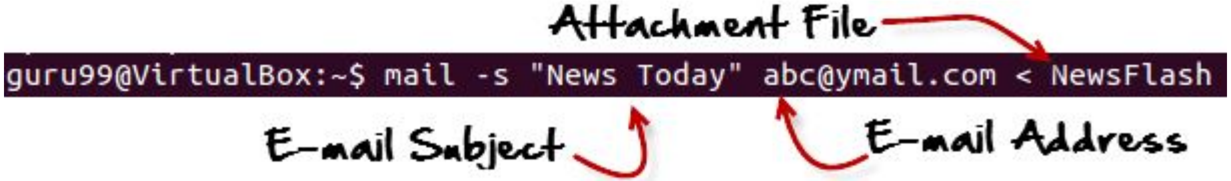
https://www.gnu.org/software/gawk/manual/gawk.html#Running-gawk

# Input Output Redirection

```
ls -al > listings
```



```
home@VirtualBox:~$ ls -al > listings
home@VirtualBox:~$ cat listings
total 324
drwxr-xr-x 26 home home   4096 2012-09-10 10:42 .
drwxr-xr-x  3 root root   4096 2012-09-01 19:43 ..
-rw-rw-r--  1 home home      0 2012-09-10 09:25 abc
```



```
guru99@VirtualBox:~$ mail -s "News Today" abc@ymail.com < NewsFlash
```

[https://www.guru99.com/linux-redirection.html](https://www.guru99.com/linux-redirection.html)

```
sed 's/hello/world/' input.txt > output.txt
```

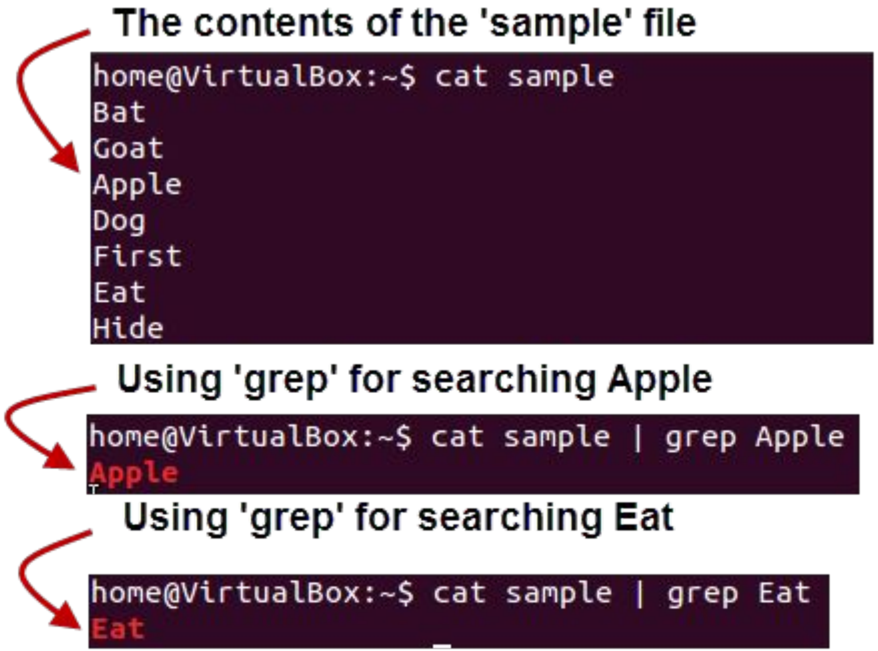
# Pipes

Command-1 | Command-2 | …| Command-N

```
cat contents.txt |grep file
```

```
cat sample | grep -v a | sort - r
```

- -v Shows all the lines that do not match the searched string



The contents of the 'sample' file

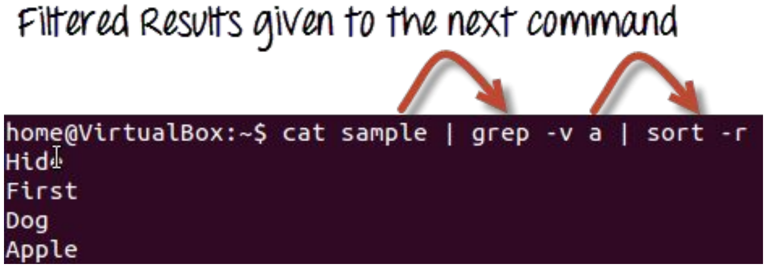
```
home@VirtualBox:~$ cat sample
Bat
Goat
Apple
Dog
First
Eat
Hide
```

Using 'grep' for searching Apple

```
home@VirtualBox:~$ cat sample | grep Apple
Apple
```

Using 'grep' for searching Eat

```
home@VirtualBox:~$ cat sample | grep Eat
Eat
```



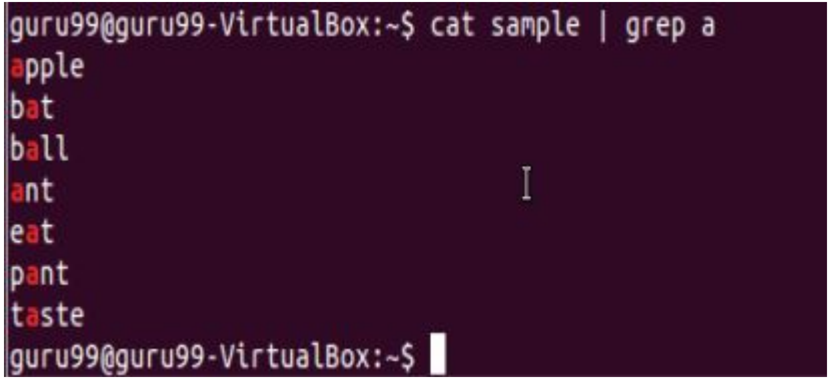
Filtered Results given to the next command

```
home@VirtualBox:~$ cat sample | grep -v a | sort -r
Hide
First
Dog
Apple
```

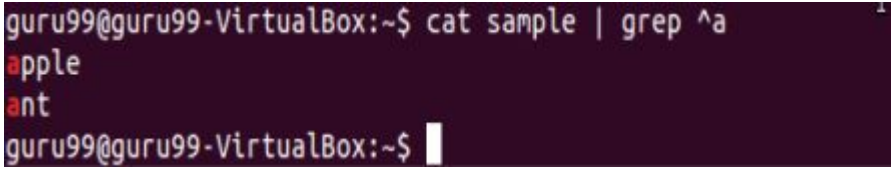
https://www.guru99.com/linux-pipe-grep.html

# Regular expressions in terminal commands

- .
  - replaces any character
- ^
  - matches start of string
- $
  - matches end of string
- *
  - matches up zero or more times the preceding character
- \
  - Represent special characters
- ()
  - Groups regular expressions
- ?
  - Matches up exactly one character

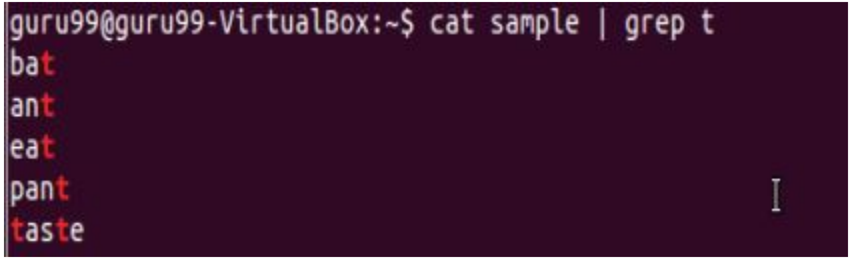


```
guru99@guru99-VirtualBox:~$ cat sample | grep a
apple
bat
ball
ant
eat
pant
taste
guru99@guru99-VirtualBox:~$
```

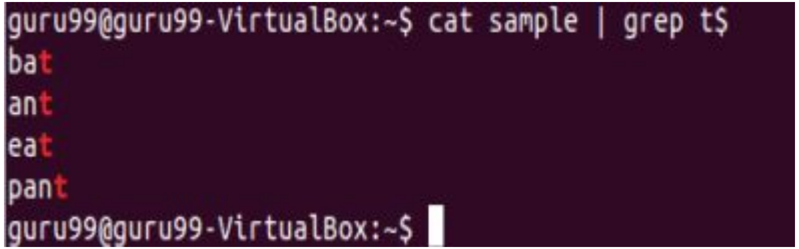


```
guru99@guru99-VirtualBox:~$ cat sample | grep ^a
apple
ant
guru99@guru99-VirtualBox:~$
```

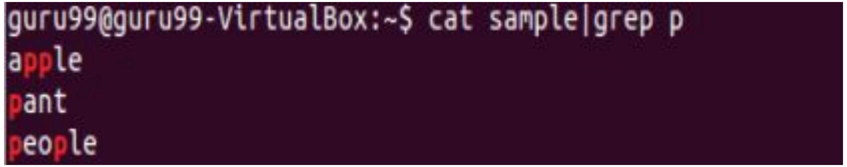
https://www.guru99.com/linux-regular-expressions.html



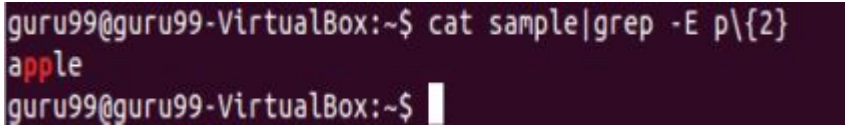
```
guru99@guru99-VirtualBox:~$ cat sample | grep t
bat
ant
eat
pant
taste
```



```
guru99@guru99-VirtualBox:~$ cat sample | grep t$
bat
ant
eat
pant
guru99@guru99-VirtualBox:~$
```



```
guru99@guru99-VirtualBox:~$ cat sample|grep p
apple
pant
people
```



```
guru99@guru99-VirtualBox:~$ cat sample|grep -E p\{2}
apple
guru99@guru99-VirtualBox:~$
```

- {n} Matches the preceding character appearing 'n' times exactly
- {n,m} Matches the preceding character appearing 'n' times but not more than m
- {n, } Matches the preceding character only when it appears 'n' times or more
- \+ Matches one or more occurrence of the previous character
- \? Matches zero or one occurrence of the previous character

https://www.guru99.com/linux-regular-expressions.html

```
sed '/^foo/d ; s/hello/world/' input.txt > output.txt
```

```
sed -e '/^foo/d' -e 's/hello/world/' input.txt > output.txt
```

```
echo 's/hello/world/' > script2.sed
```

```
sed -e '/^foo/d' -f script2.sed input.txt > output.txt
```

https://www.gnu.org/software/sed/manual/sed.html