Introduction to the Command-line

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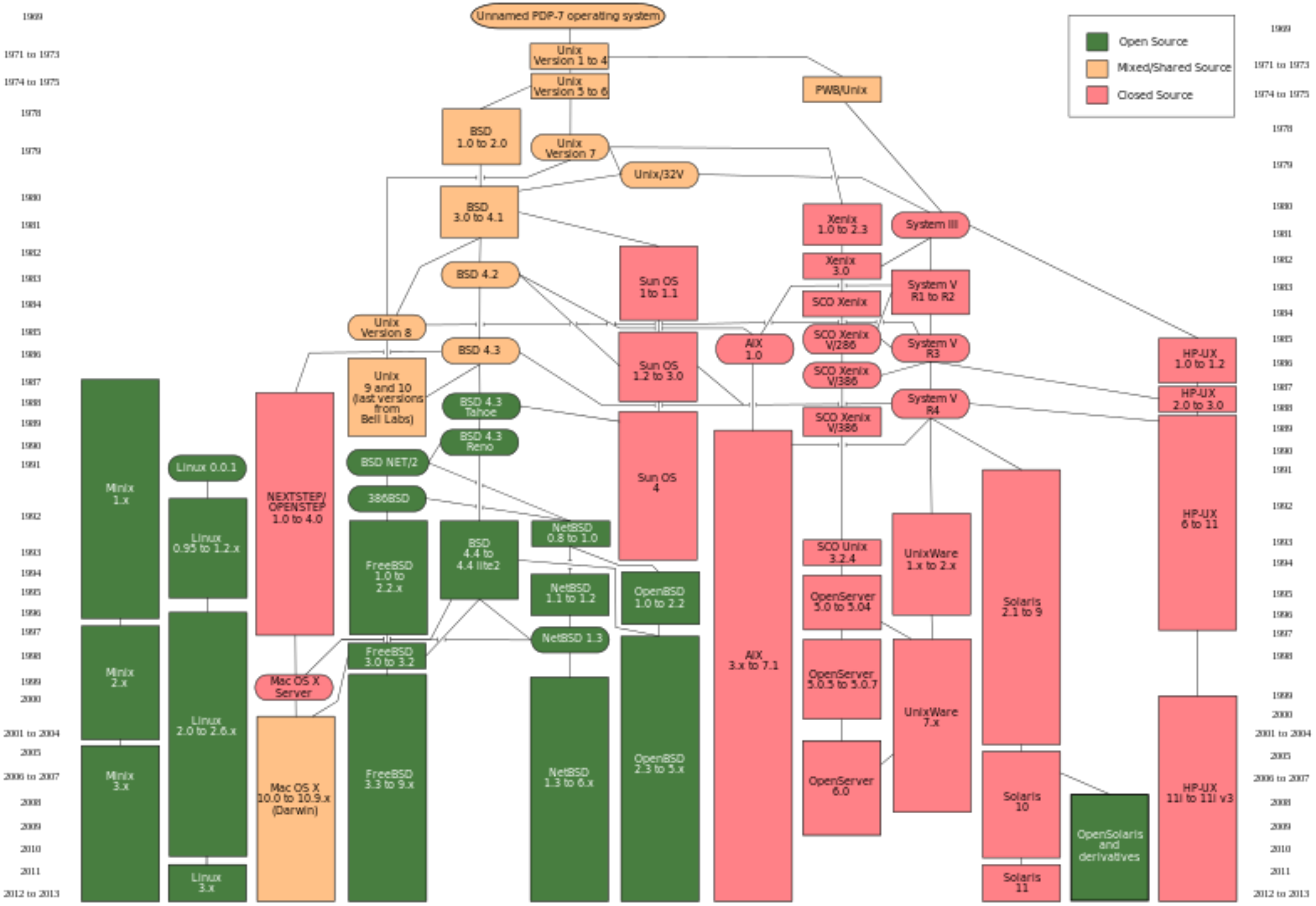
Unix

- The UNIX operating system is a set of programs that act as a link between the computer and the user.
- First developed in the 1960s, and has been under constant development ever since.
- Today Unix is ubiquitous; it is found everywhere from smartphones to supercomputers.


🟩 Open Source
🟧 Mixed/Shared Source
🟥 Closed Source
1969
1971 to 1973
1974 to 1975
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2001 to 2004
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2006 to 2007
2008
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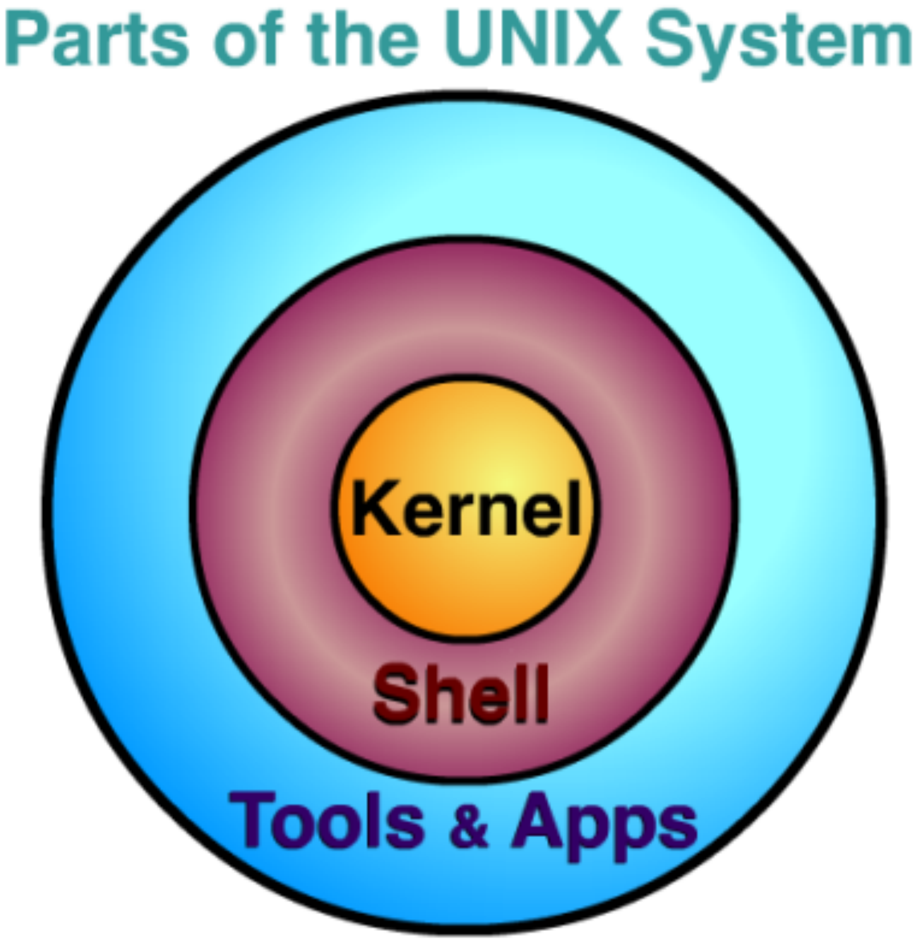
2010
2011
2012 to 2013
Unnamed PDP-7 operating system
Unix Version 1 to 4
Unix Version 5 to 6
PWB/Unix
BSD 1.0 to 2.0
Unix Version 7
Unix/32V
BSD 3.0 to 4.1
Xenix 1.0 to 2.3
System III
Xenix 3.0
BSD 4.2
Sun OS 1 to 1.1
System V R1 to R2
SCO Xenix
Unix Version 8
AIX 1.0
SCO Xenix V/286
System V R3
BSD 4.3
Sun OS 1.2 to 3.0
HP-UX 1.0 to 1.2
SCO Xenix V/386
Unix 9 and 10 (last versions from Bell Labs)
System V R4
HP-UX 2.0 to 3.0
BSD 4.3 Tahoe
SCO Xenix V/386
Minix 1.x
NEXTSTEP/ OPENSTEP 1.0 to 4.0
BSD 4.3 Reno
Sun OS 4
Linux 0.0.1
BSD NET/2
386BSD
HP-UX 6 to 11
NetBSD 0.8 to 1.0
Linux 0.95 to 1.2.x
FreeBSD 1.0 to 2.2.x
BSD 4.4 to 4.4 lite2
SCO Unix 3.2.4
UnixWare 1.x to 2.x
Solaris 2.1 to 9
NetBSD 1.1 to 1.2
OpenBSD 1.0 to 2.2
OpenServer 5.0 to 5.04
NetBSD 1.3
AIX 3.x to 7.1
Minix 2.x
FreeBSD 3.0 to 3.2
Mac OS X Server
OpenServer 5.0.5 to 5.0.7
UnixWare 7.x
Linux 2.0 to 2.6.x
HP-UX 11i to 11i v3
Mac OS X 10.0 to 10.9.x (Darwin)
FreeBSD 3.3 to 9.x
NetBSD 1.3 to 6.x
OpenBSD 2.3 to 5.x
OpenServer 6.0
Solaris 10
Minix 3.x
OpenSolaris and derivatives
Linux 3.x
Solaris 11

Unix Components



Unix Architecture

- Users communicate with the kernel through a program known as the shell.
- The shell is a command line interpreter that processes user requests.
- It translates (interprets) commands entered by the user and converts them into a language that is understood by the kernel.

The UNIX shell

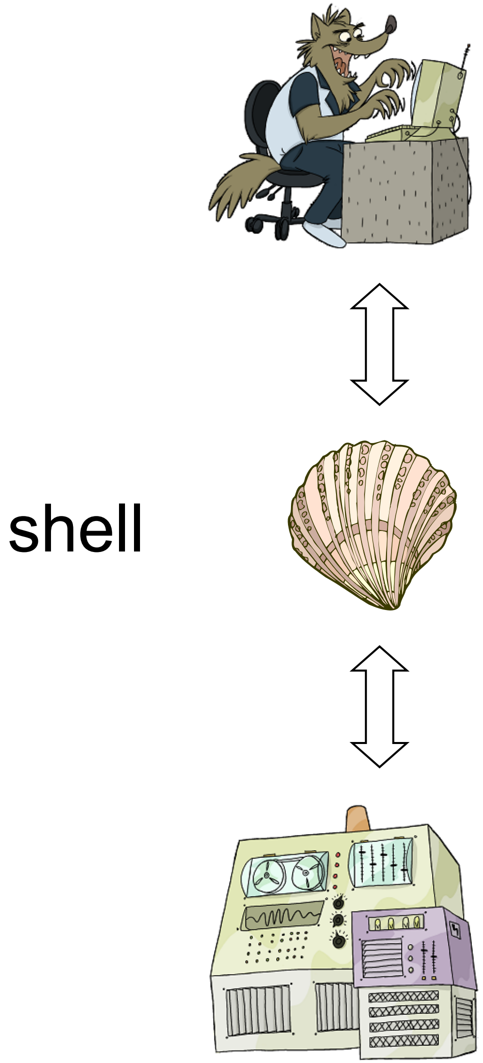
- There are many different “flavours” of the Unix shell but the most popular is bash (the Bourne again shell).
- Commands in UNIX are terse and often cryptic.
- Use it because:
  - many tools only have command-line interfaces
  - allows you to combine tools in powerful new ways

- User logs in

- User types command
- Computer executes command and prints output

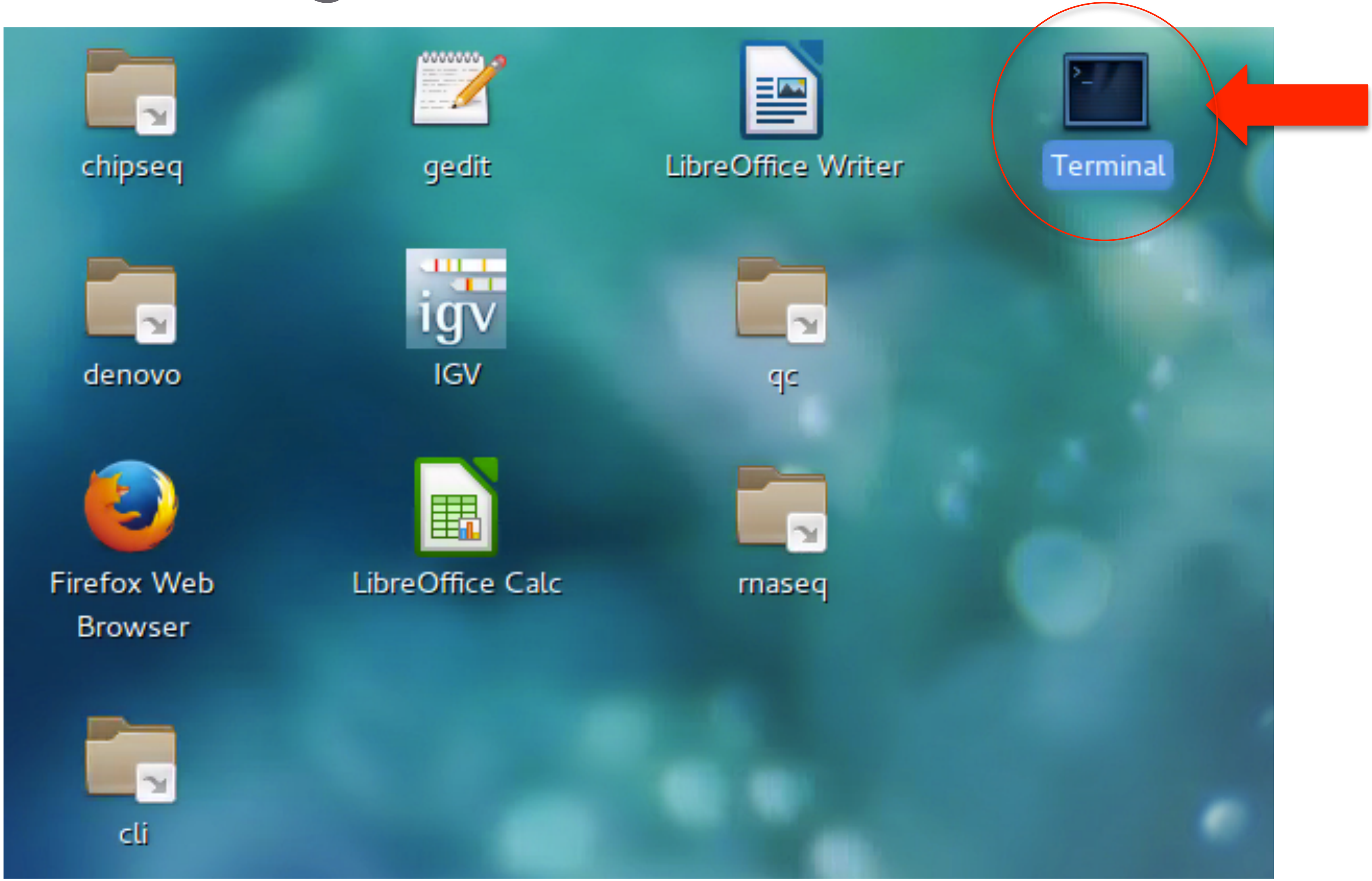
- User types another command
- Computer executes command and prints output

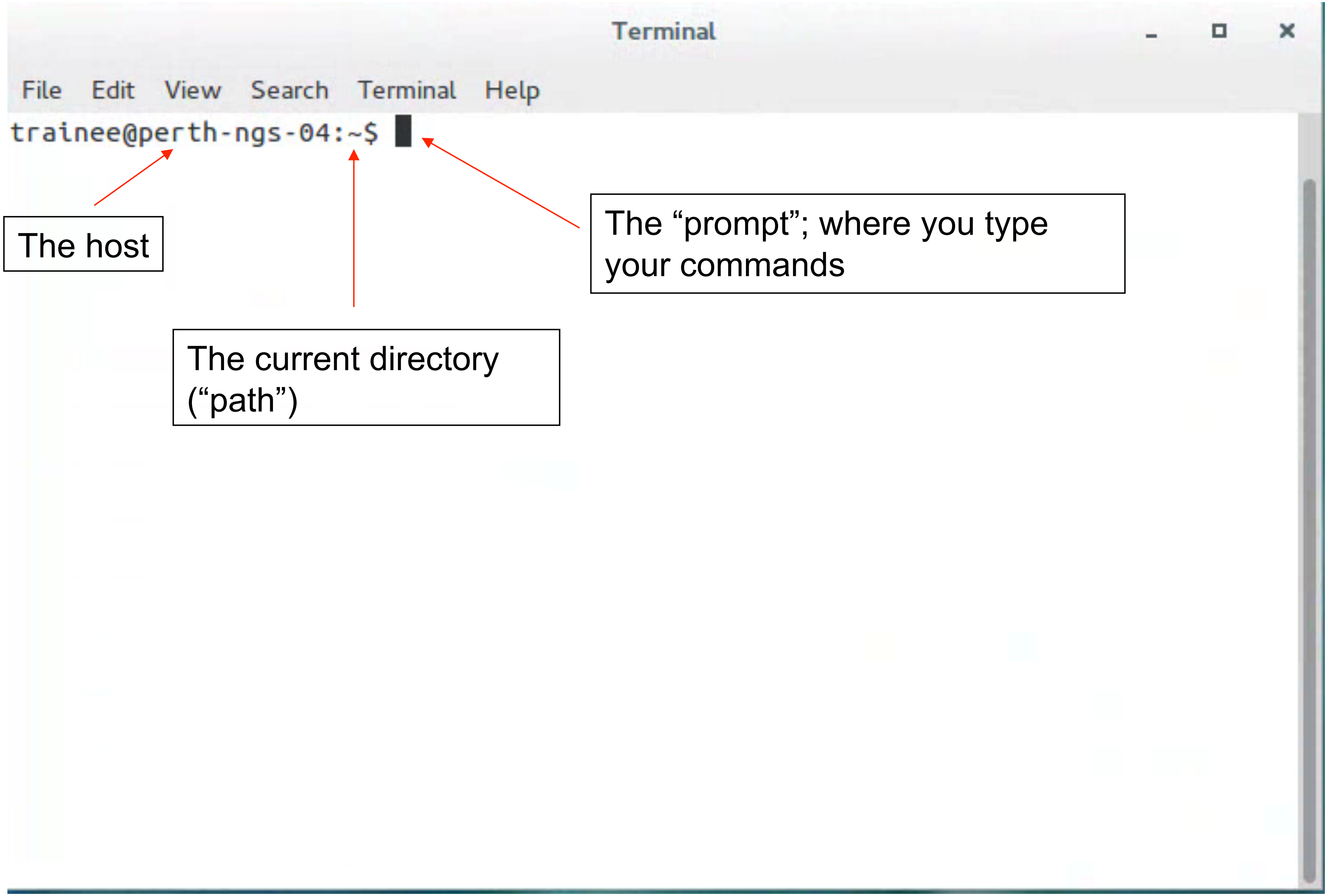
- User logs off



shell

Accessing the command-line





```
trainee@perth-ngs-04:~$
```

The host

The current directory (“path”)

The “prompt”; where you type your commands

Unix Commands

- In general, a Unix command has the format:

  - ‘Command’ ‘flags’ ‘arguments’
  - $ wc -l filename

- Change to your home directory
  $ cd

- To access the documentation/manual for any Unix command type ‘man command’
  $ man pwd

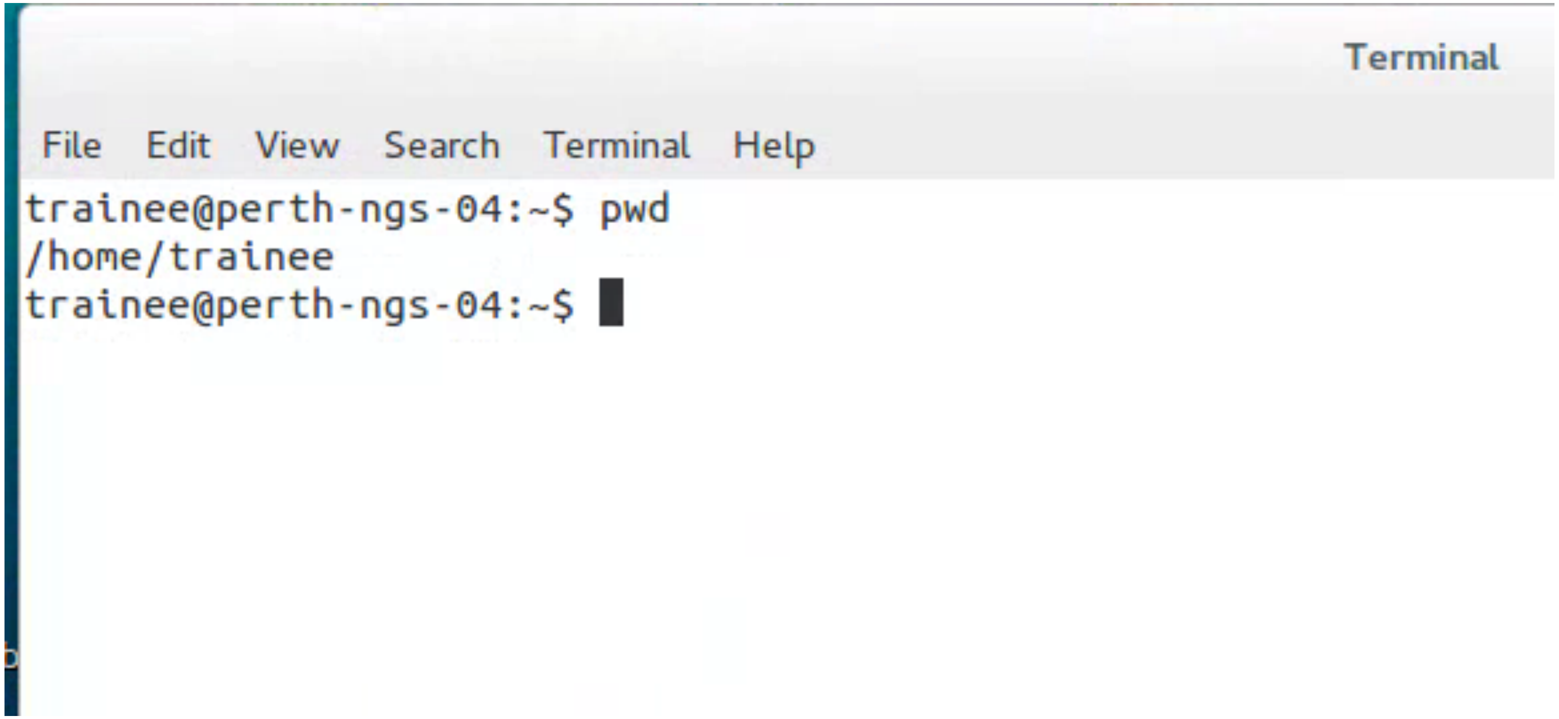
The first command

- Type the command pwd (**p**rint **w**orking **d**irectory), then press the Enter/Return key to send the command to the shell.

- More specifically, when we type pwd into the shell:
  - finds a program called pwd,
  - runs that program,
  - displays that program's output, then
  - displays a new prompt to tell us that it's ready for more commands.

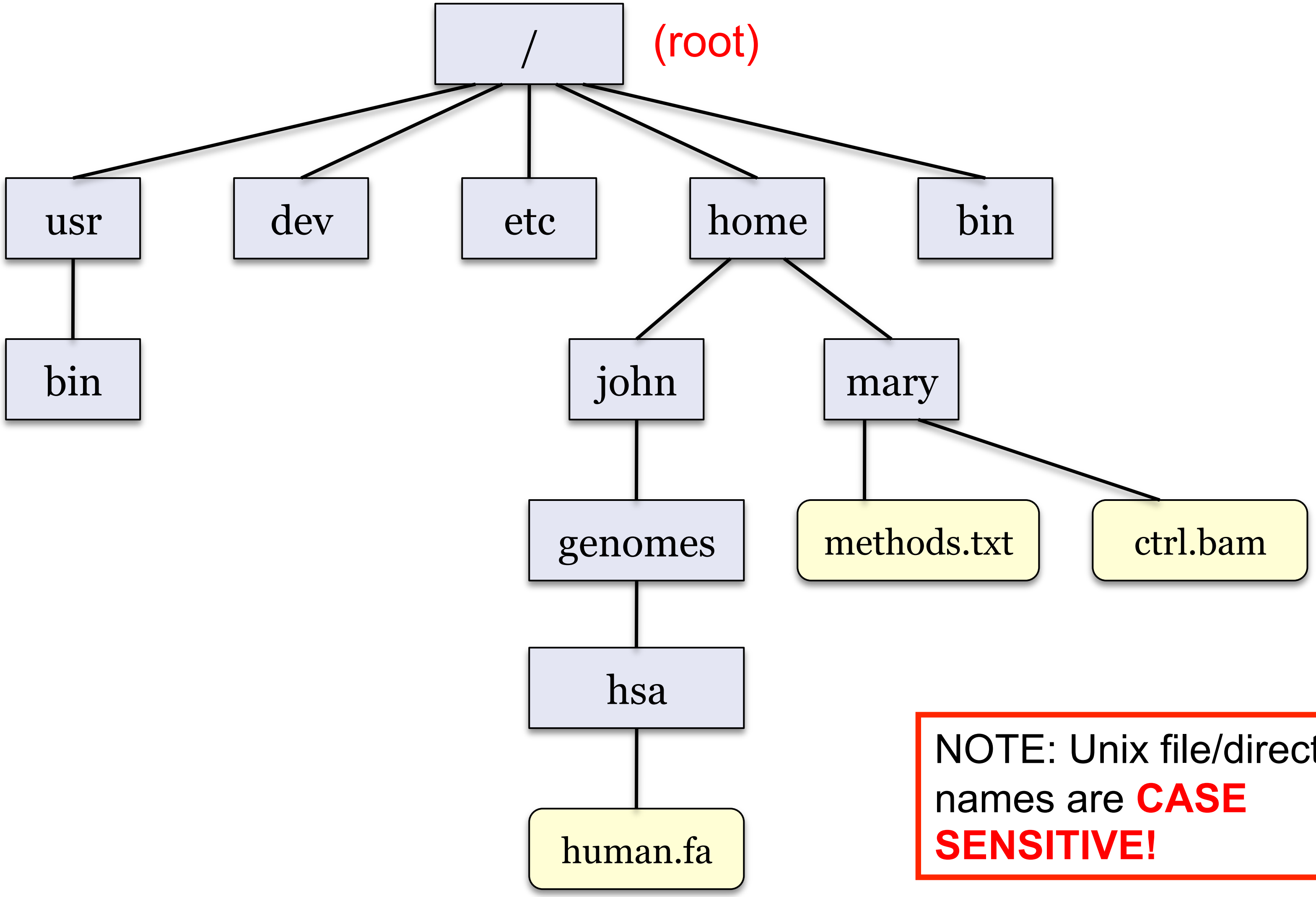
Where are we: **pwd**

- To find your current path use pwd - **p**rint **w**orking **d**irectory



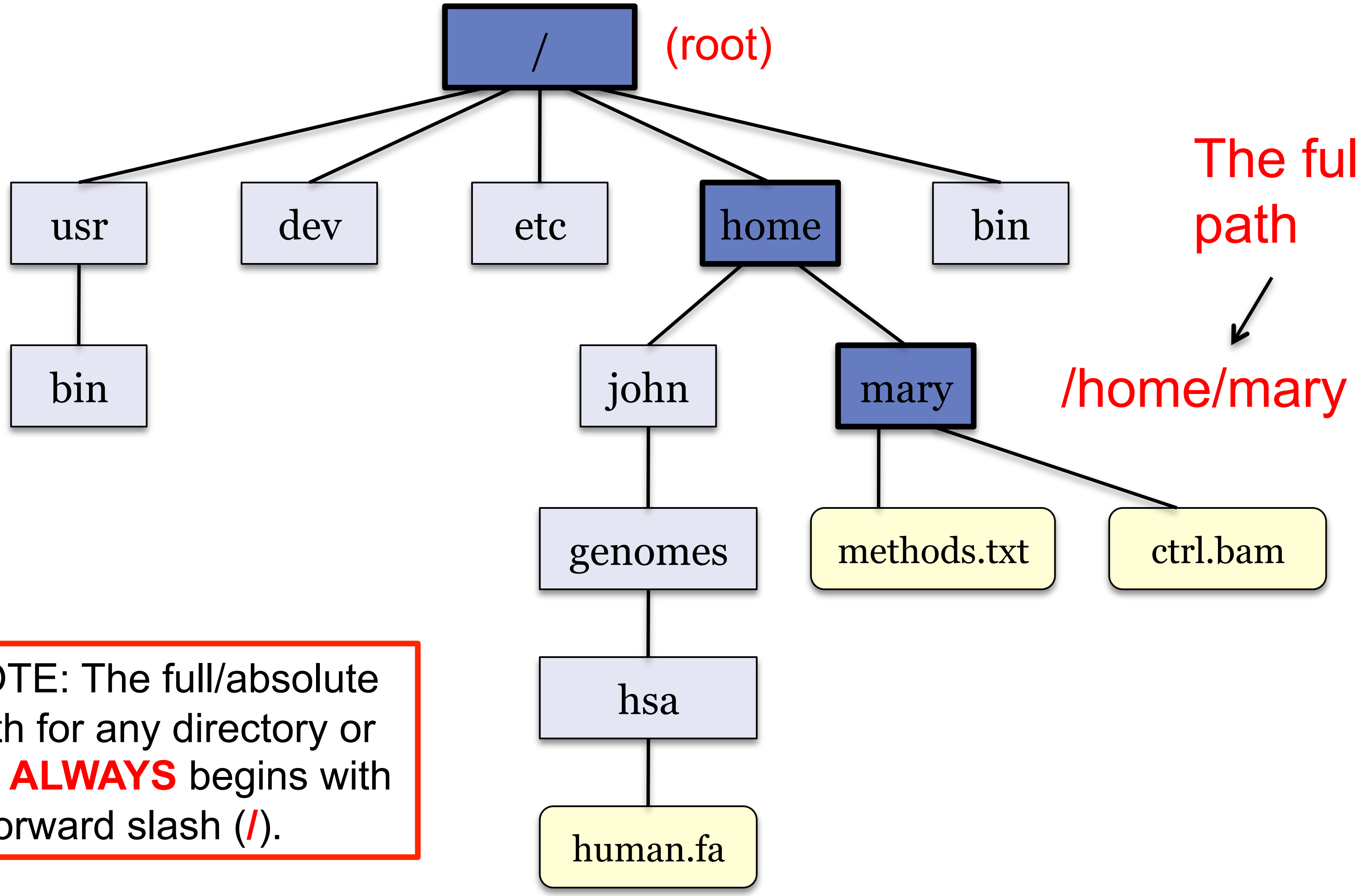
```
trainee@perth-ngs-04:~$ pwd
/home/trainee
trainee@perth-ngs-04:~$ 
```

Unix File System Tree Structure



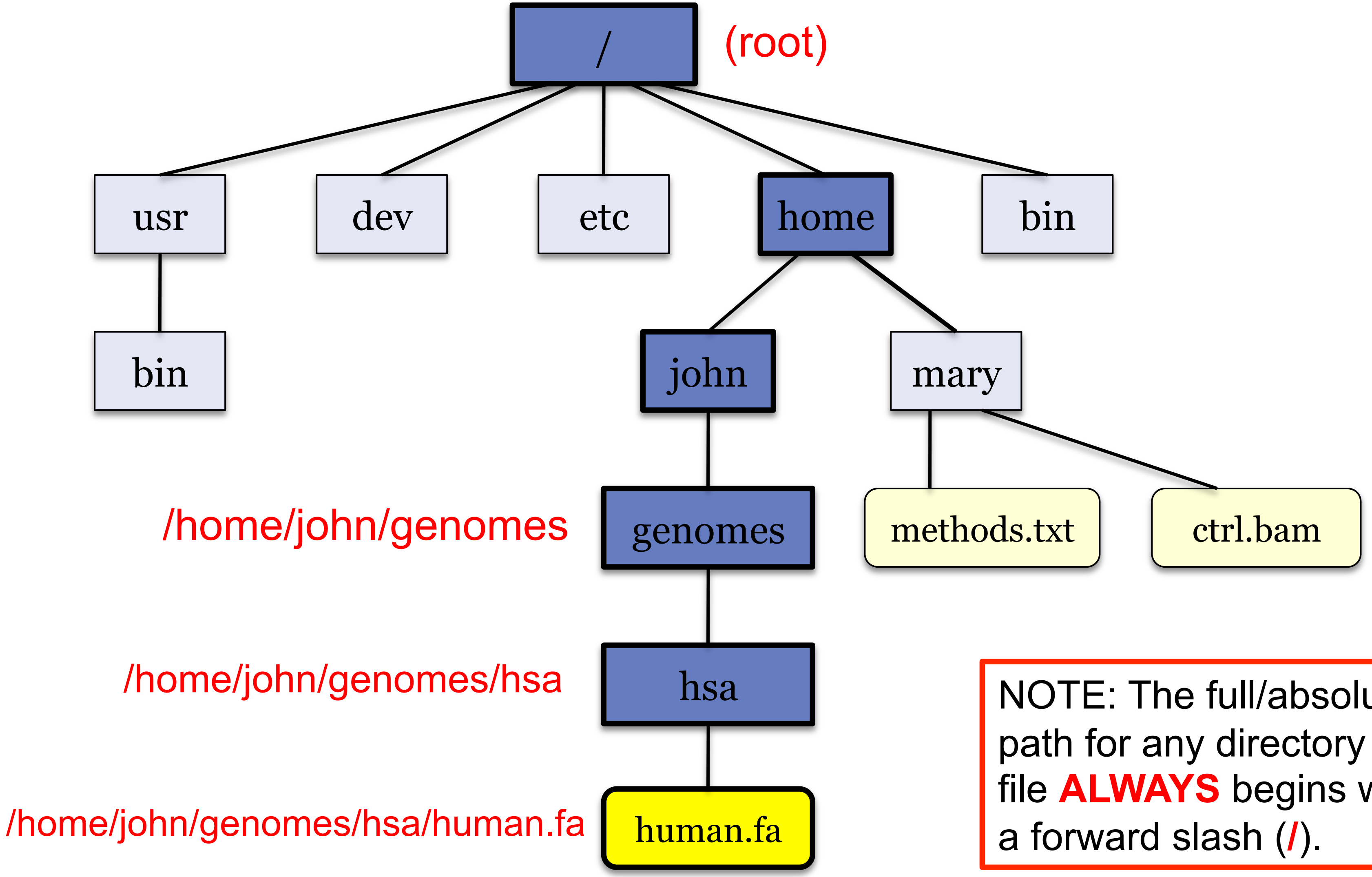
NOTE: Unix file/directory names are **CASE SENSITIVE!**

Full/Absolute File Paths



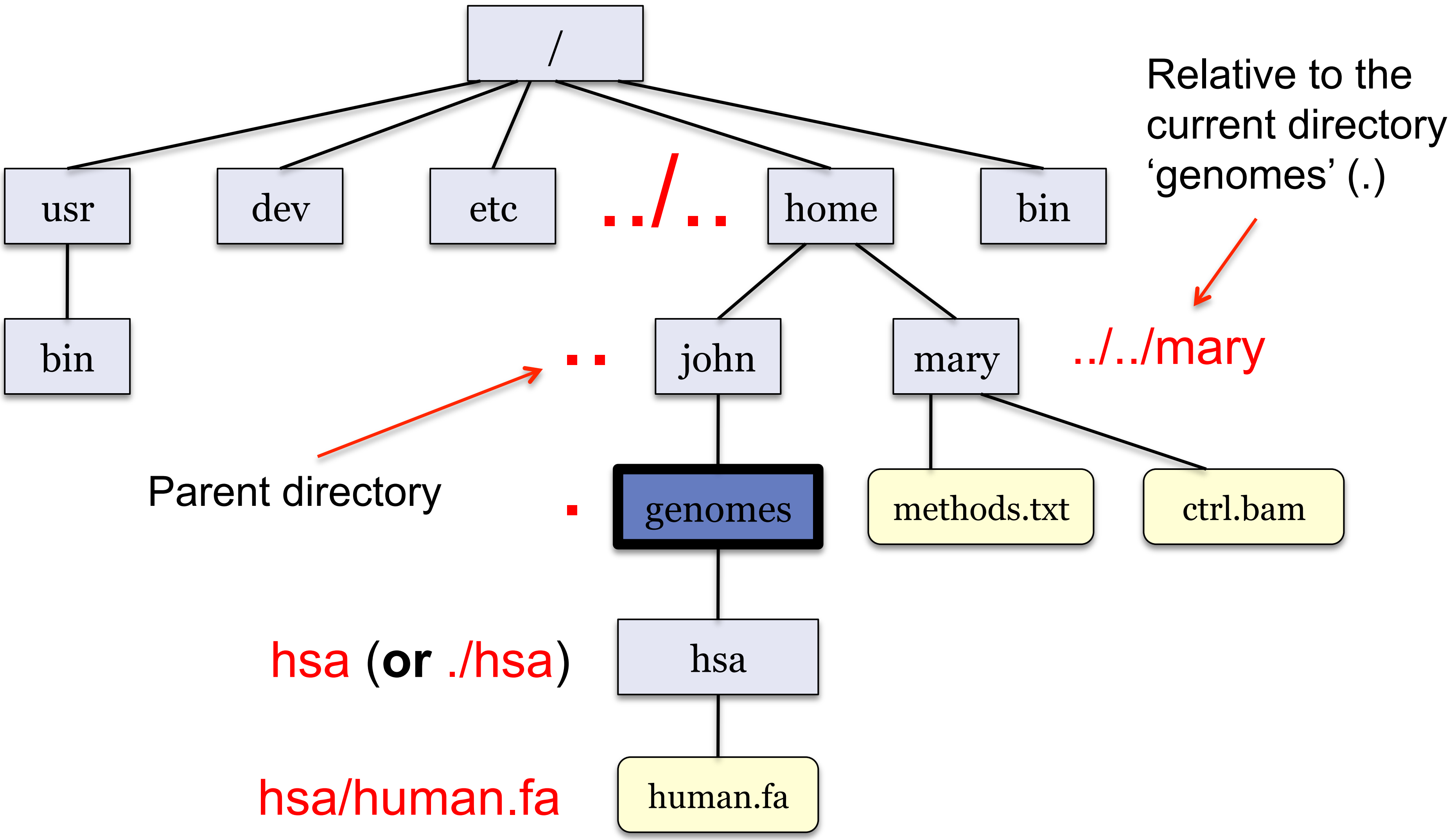
NOTE: The full/absolute path for any directory or file **ALWAYS** begins with a forward slash (/).

Full/Absolute File Paths



NOTE: The full/absolute path for any directory or file **ALWAYS** begins with a forward slash (**/**).

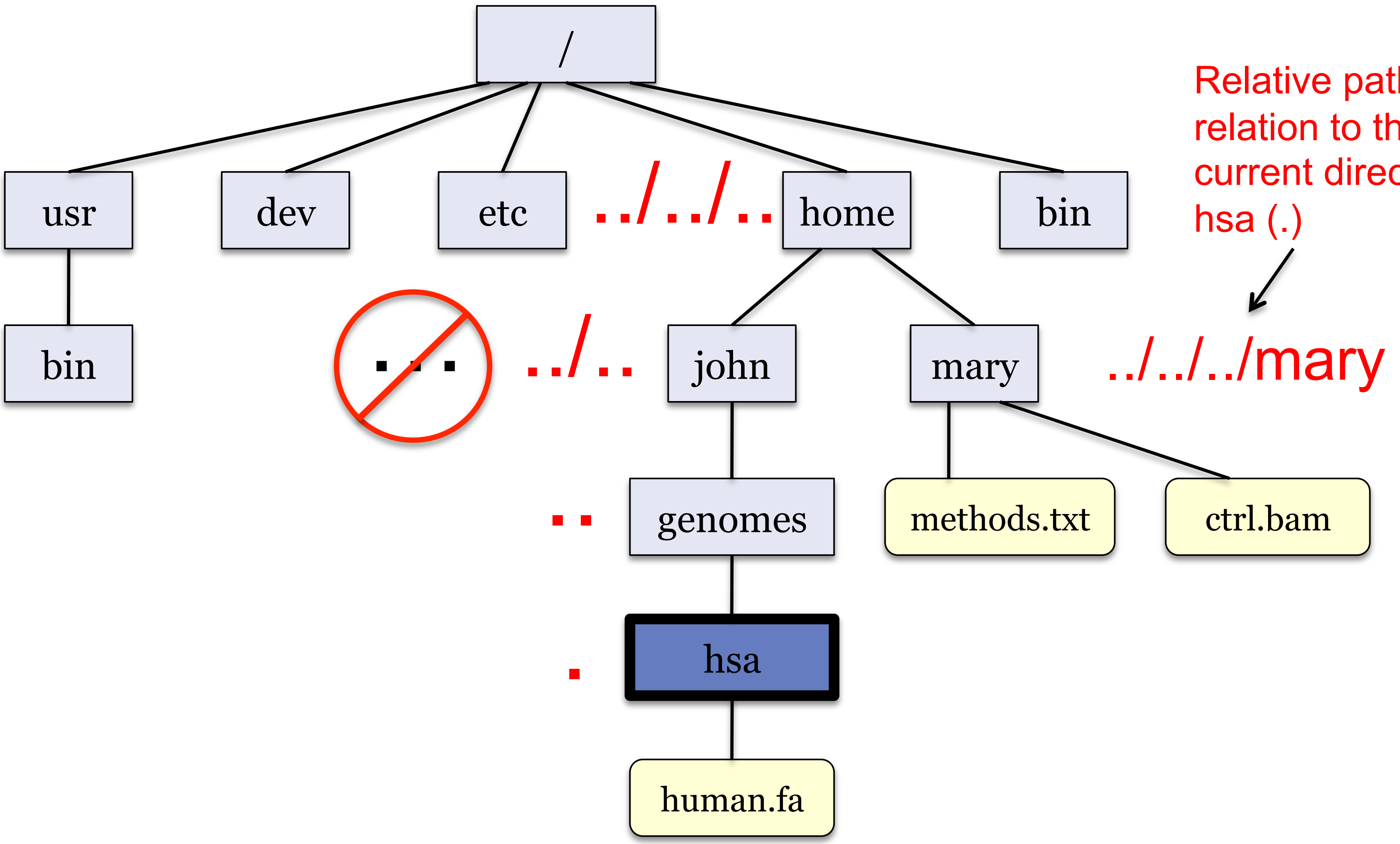
Relative File Paths



Relative to the current directory ‘genomes’ (.)

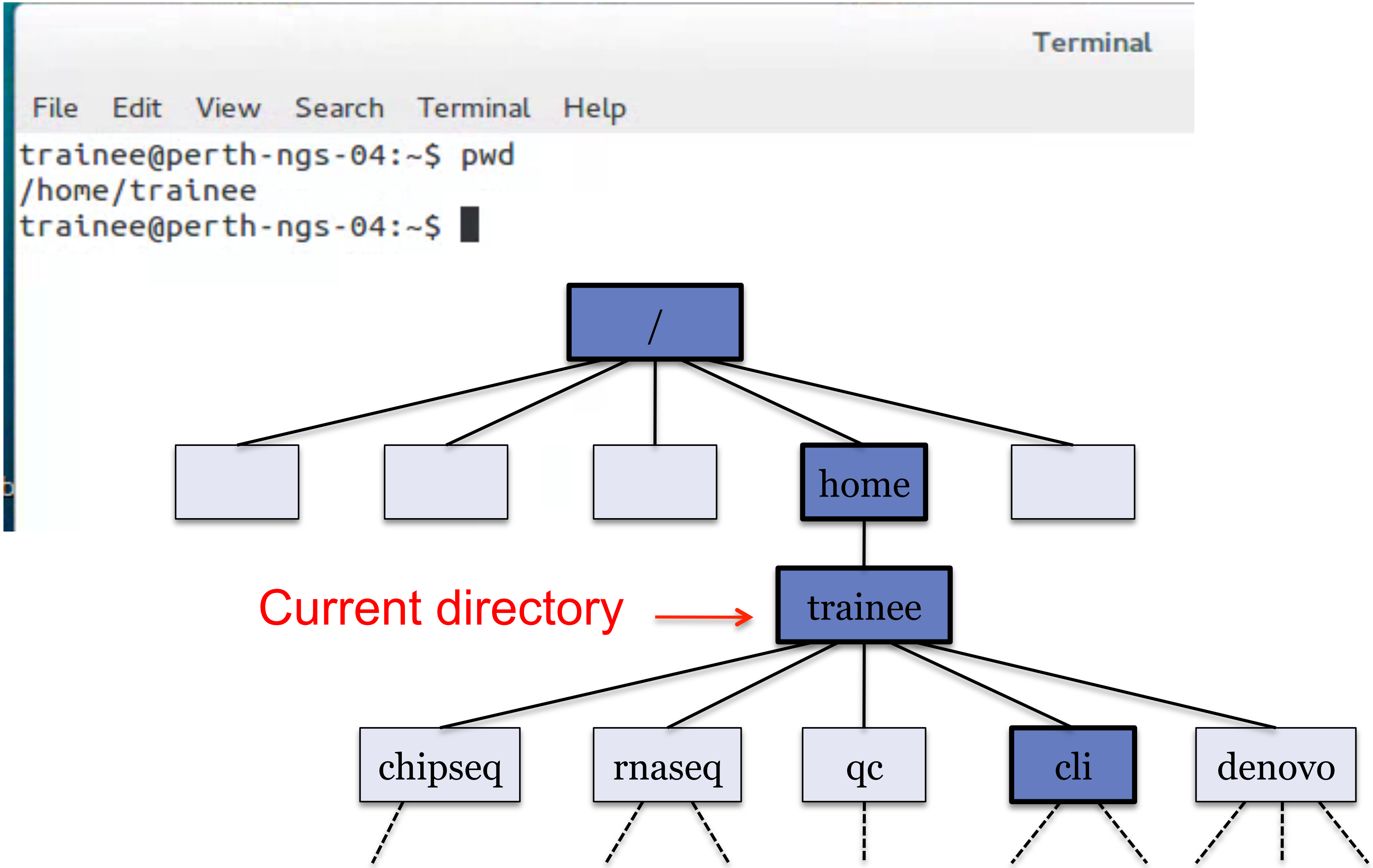
Parent directory

Relative File Paths



Relative path in relation to the current directory hsa (.)

Where am I?: pwd



```
trainee@perth-ngs-04:~$ pwd
/home/trainee
trainee@perth-ngs-04:~$ █
```

Current directory →

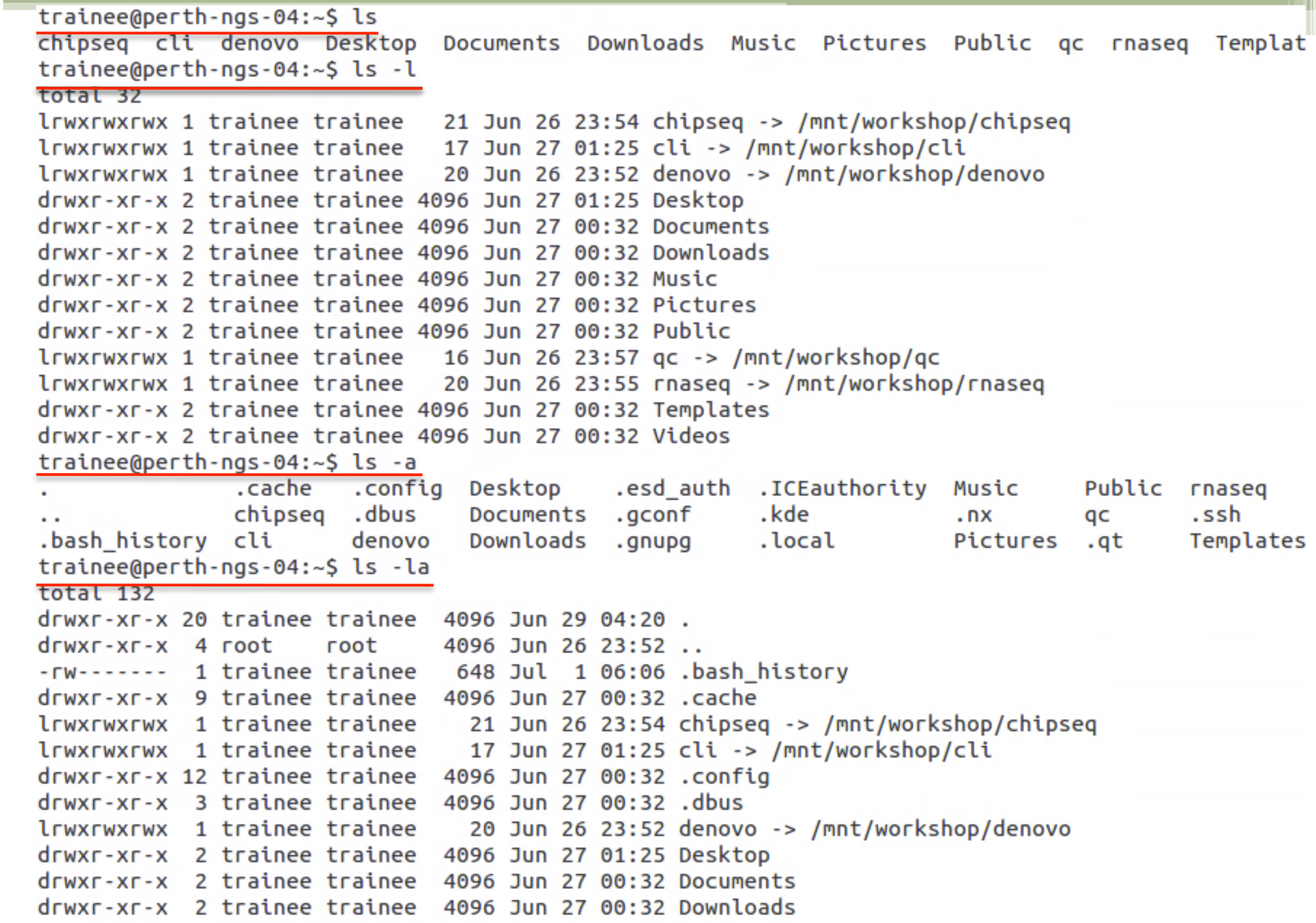
View Files: ls

- To view all the files in your current directory use “ls”

- Unix flags modify default behaviour. E.g.

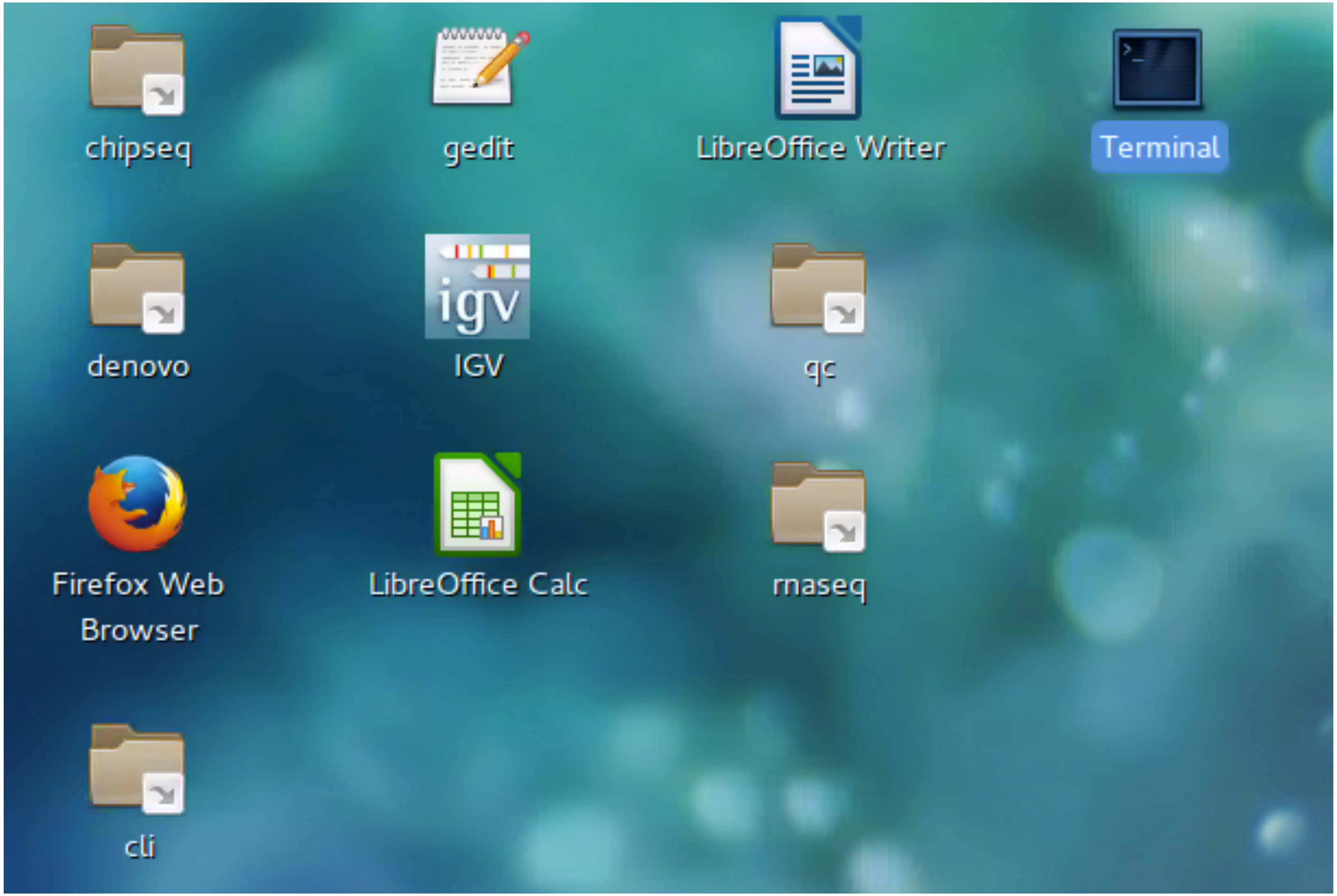
```
$ ls -l
$ ls -a
$ ls -la
```

  - -l flag gives you long list
  - -a stands for "show all”
  - -la combines both behaviours



```
trainee@perth-ngs-04:~$ ls
chipseq  cli  denovo  Desktop  Documents  Downloads  Music  Pictures  Public  qc  rnaseq  Templat
trainee@perth-ngs-04:~$ ls -l
total 32
lrwxrwxrwx 1 trainee trainee   21 Jun 26 23:54 chipseq -> /mnt/workshop/chipseq
lrwxrwxrwx 1 trainee trainee   17 Jun 27 01:25 cli -> /mnt/workshop/cli
lrwxrwxrwx 1 trainee trainee   20 Jun 26 23:52 denovo -> /mnt/workshop/denovo
drwxr-xr-x 2 trainee trainee 4096 Jun 27 01:25 Desktop
drwxr-xr-x 2 trainee trainee 4096 Jun 27 00:32 Documents
drwxr-xr-x 2 trainee trainee 4096 Jun 27 00:32 Downloads
drwxr-xr-x 2 trainee trainee 4096 Jun 27 00:32 Music
drwxr-xr-x 2 trainee trainee 4096 Jun 27 00:32 Pictures
drwxr-xr-x 2 trainee trainee 4096 Jun 27 00:32 Public
lrwxrwxrwx 1 trainee trainee   16 Jun 26 23:57 qc -> /mnt/workshop/qc
lrwxrwxrwx 1 trainee trainee   20 Jun 26 23:55 rnaseq -> /mnt/workshop/rnaseq
drwxr-xr-x 2 trainee trainee 4096 Jun 27 00:32 Templates
drwxr-xr-x 2 trainee trainee 4096 Jun 27 00:32 Videos
trainee@perth-ngs-04:~$ ls -a
.              .cache   .config  Desktop    .esd_auth  .ICEauthority  Music     Public  rnaseq
..             chipseq  .dbus    Documents  .gconf     .kde           .nx       qc      .ssh
.bash_history  cli      denovo   Downloads  .gnupg     .local         Pictures  .qt     Templates
trainee@perth-ngs-04:~$ ls -la
total 132
drwxr-xr-x 20 trainee trainee  4096 Jun 29 04:20 .
drwxr-xr-x  4 root    root     4096 Jun 26 23:52 ..
-rw-------  1 trainee trainee   648 Jul  1 06:06 .bash_history
drwxr-xr-x  9 trainee trainee  4096 Jun 27 00:32 .cache
lrwxrwxrwx  1 trainee trainee    21 Jun 26 23:54 chipseq -> /mnt/workshop/chipseq
lrwxrwxrwx  1 trainee trainee    17 Jun 27 01:25 cli -> /mnt/workshop/cli
drwxr-xr-x 12 trainee trainee  4096 Jun 27 00:32 .config
drwxr-xr-x  3 trainee trainee  4096 Jun 27 00:32 .dbus
lrwxrwxrwx  1 trainee trainee    20 Jun 26 23:52 denovo -> /mnt/workshop/denovo
drwxr-xr-x  2 trainee trainee  4096 Jun 27 01:25 Desktop
drwxr-xr-x  2 trainee trainee  4096 Jun 27 00:32 Documents
drwxr-xr-x  2 trainee trainee  4096 Jun 27 00:32 Downloads
```

View the Files Another Way



Changing Directories: cd

-
  ```
  $ pwd
  /home/trainee
  ```

- cd = "change directory”

- cd does NOT print anything, but if we run pwd after it, we can see where we are:

  ```
  $ cd cli        or        $ cd /home/trainee/cli
  $ pwd
  /home/trainee/cli
  ```

Trick: type ‘cd c’ and hit <TAB>; this is autocomplete

Creating and Deleting Things

- **Objectives**
  - Create a directory
  - Create files using an editor or by copying and renaming existing files.
  - Display the contents of a directory using the command line.
  - Delete specified files and/or directories.

Creating Things

- Create a new directory called ‘thesis’ using the command mkdir (the command has no output):

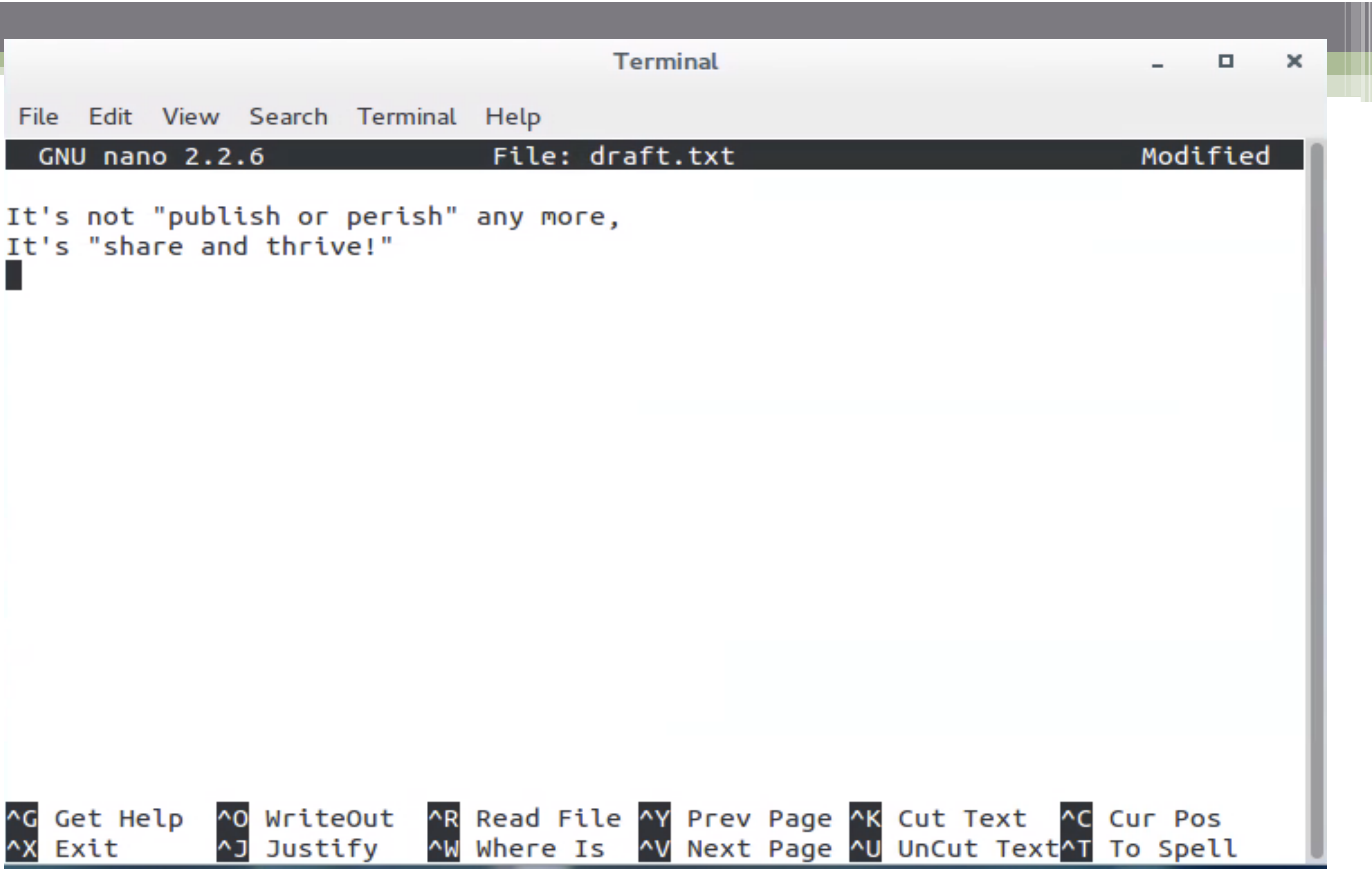
```
$ mkdir thesis
```

- However, there's nothing in it yet:

```
$ ls -F thesis
```

- Change the working directory to thesis using cd, then run a text editor called nano to create a file called draft.txt

```
$ cd thesis
$ nano draft.txt
```



```
  GNU nano 2.2.6              File: draft.txt                          Modified

It's not "publish or perish" any more,
It's "share and thrive!"

^G Get Help    ^O WriteOut    ^R Read File   ^Y Prev Page   ^K Cut Text    ^C Cur Pos
^X Exit        ^J Justify     ^W Where Is    ^V Next Page   ^U UnCut Text^T To Spell
```

Note: Use control-X to exit the editor and return to the shell.
Unix documentation often uses the shorthand “^A” to mean “control-A”.

Displaying the contents of a file

- There’s no output from nano on the screen after it exits, but ls shows that we have created a file called draft.txt.

  ```
  $ ls
  draft.txt
  ```

- The commands cat, less and more can all be used to display/ view the contents of the file draft.txt. cat displays the entire files's contents, while more and less display the file’s contents one page at a time.

  ```
  $ cat draft.txt
  It's not "publish or perish" any more,
  It's "share and thrive!"
  ```

Moving and Copying

- Rename draft.txt to quotes.txt using the command mv.

```
$ mv draft.txt quotes.txt
$ ls
quotes.txt
```

- The “mv” command can be also be used to move files to other locations in the file system e.g. to the directory cli

```
$ pwd
/home/trainee/cli/thesis
$ mv quotes.txt ..        (or $ mv quotes.txt /home/trainee/cli)
$ ls
$ ls ..
1000gp.vcf  molecules  quotes.txt  thesis
```

- **C**hange **d**irectory to ‘cli’

```
$ cd ..  (or $ cd /home/trainee/cli)
```

Moving and Copying

- cp works very much like mv, except it copies a file instead of moving it:

```
$ cp quotes.txt quotations.txt
$ ls
1000gp.vcf  molecules  quotations.txt  quotes.txt  thesis
```

- The “cp” command can also be used to copy the file to other locations in the file system:

```
$ cp quotes.txt thesis  (or $ cp quotes.txt /home/trainee/cli/thesis)
$ ls thesis
quotes.txt
```

Warning: By default the cp and mv commands will overwrite a destination file if it already exists. This means you will lose the old contents of the destination file!

Removing files

- Let’s clean up and remove the file quotations.txt using the command rm

```
$ rm quotations.txt
$ ls
1000gp.vcf  molecules  quotes.txt  thesis
```

- If we try to remove the entire thesis directory using “rm thesis”, we get an error message:

```
$ rm thesis
rm: cannot remove `thesis/': Is a directory
```

NOTE: rm works on files, not directories.

Deleting directories

- rmdir is the command to remove a directory.

```
$ rmdir thesis
rmdir: failed to remove `thesis': Directory not empty
```

- To delete the directory ‘thesis’, it must be empty. The file ‘quotes.txt’ inside of it must be deleted first. This safety feature can save you a lot of grief!

```
$ rm thesis/quotes.txt
$ ls thesis
```

- The directory is now empty, so rmdir can delete it:

```
$ rmdir thesis
```

Deleting is Forever!

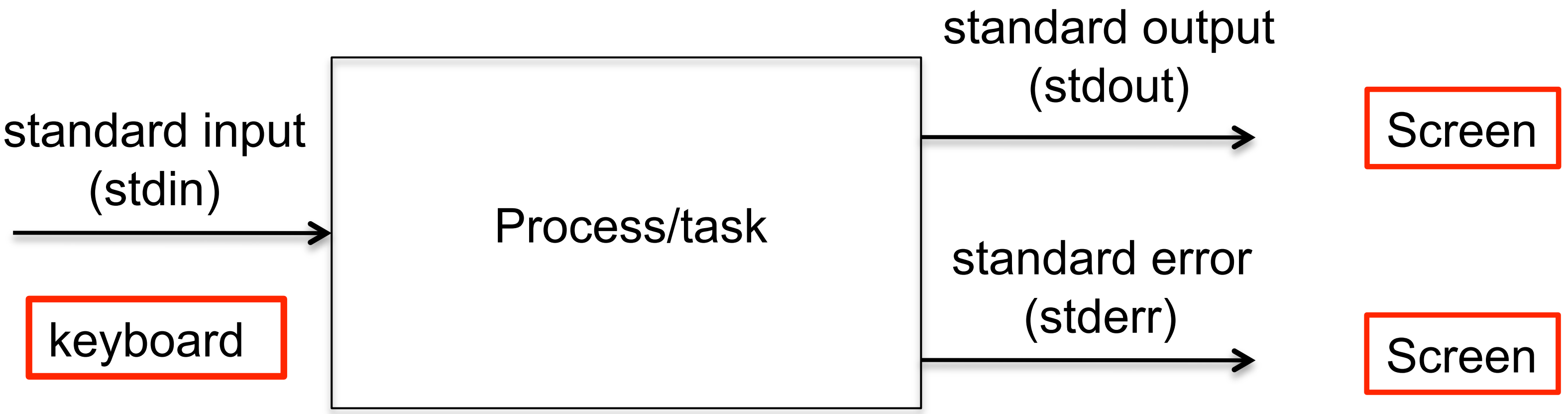
Unix does **NOT** have a trash bin.

Pipes and Filters

- **Objectives**

  - Redirect a command's output to a file.
  - Process a file instead of keyboard input using redirection.
  - Construct command pipelines with two or more stages

Processes

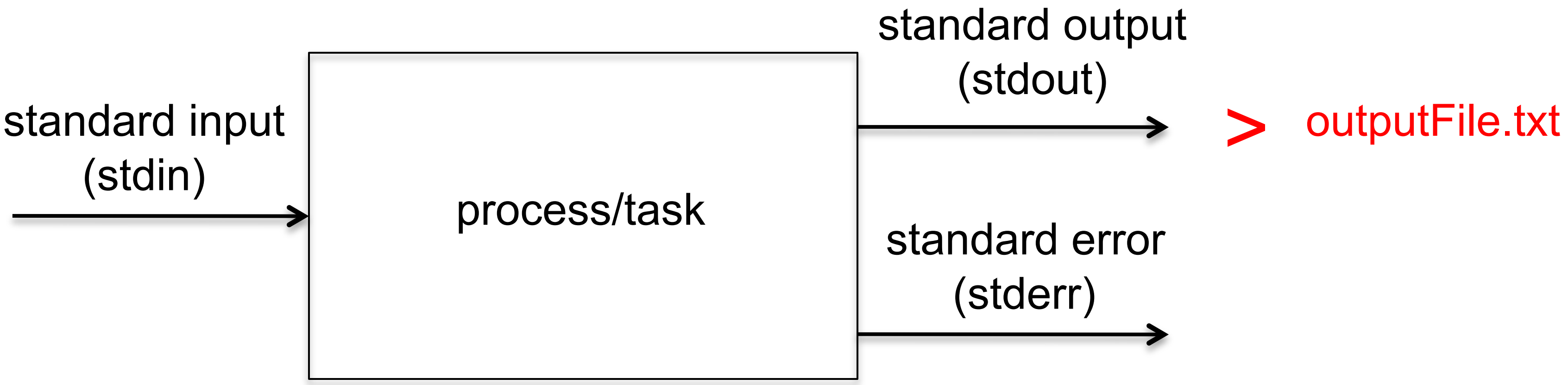


```
$ head -10 inputFile.txt
```

Execute task →

The first 10 lines of inputFile.txt will be outputted to the screen.

Redirecting standard output (> or >>)

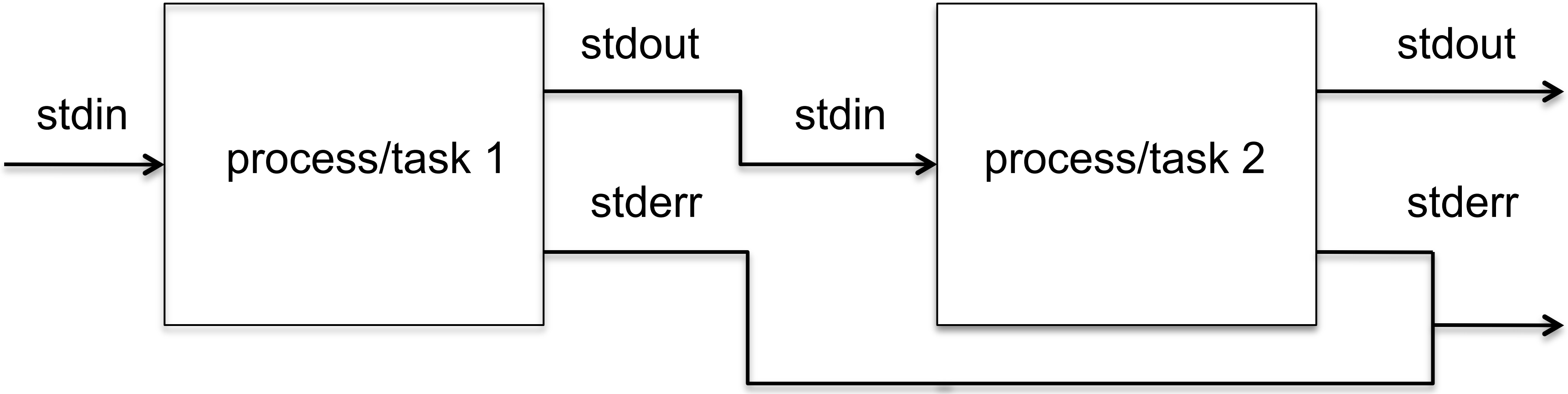


```
$ head -10 inputFile.txt > outputFile.txt
```

If the file outputFile.txt already exists, using '>' will overwrite the file.

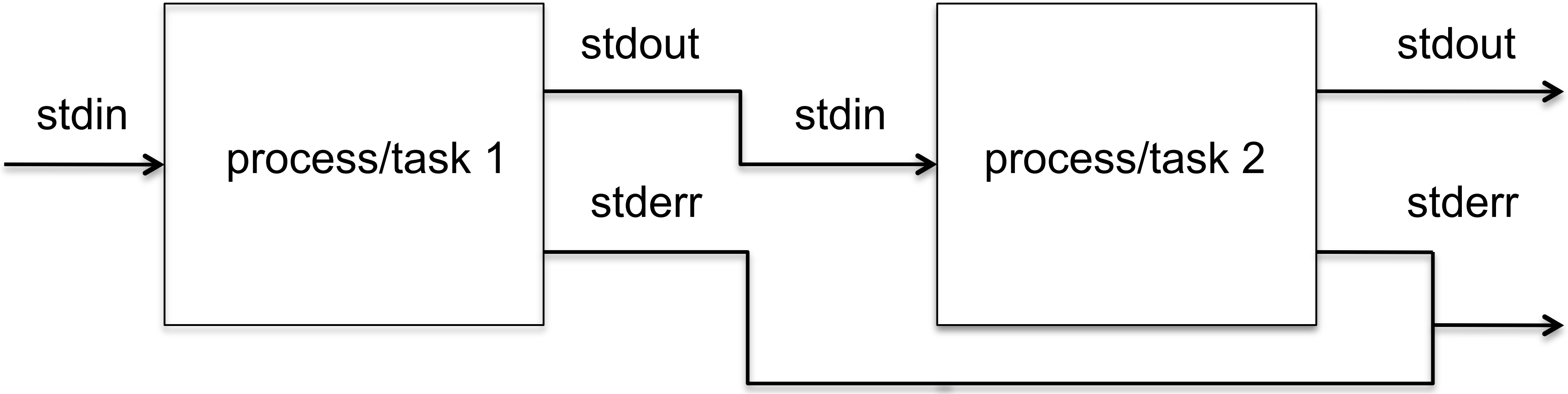
Using '>>' will append the output onto the end of the file.

Pipes - |



This connection of processes is achieved using a pipe (|).

Pipes - |



head -10 inputFile.txt | sort -n

i.e. Get the first 10 lines of inputFile.txt and numerically sort the output.

```
$ head -10 inputFile.txt | sort -n
$ ls molecules
cubane.pdb    ethane.pdb    methane.pdb
octane.pdb    pentane.pdb   propane.pdb

$ cd molecules

$ wc *.pdb
       20   156 1158 cubane.pdb
       12    84  622 ethane.pdb
        9    57  422 methane.pdb
       30   246 1828 octane.pdb
       21   165 1226 pentane.pdb
       15   111  825 propane.pdb
      107   819 6081 total
```

Wildcards

- * is a wildcard. It matches zero or more characters, so *.pdb matches anything ending in .pdb

```
cubane.pdb
ethane.pdb
methane.pdb
octane.pdb
pentane.pdb
propane.pdb
```

- ? is also a wildcard, but it only matches a single character. This means that p?.pdb matches pi.pdb or p5.pdb, but not propane.pdb.

- Show only the number of lines per file (wc -l)

```
$ wc -l *.pdb
      20  cubane.pdb
      12  ethane.pdb
       9  methane.pdb
      30  octane.pdb
      21  pentane.pdb
      15  propane.pdb
     107  Total
$ wc -l *.pdb > lengths.txt
$ ls lengths.txt
lengths.txt

$ cat lengths.txt
     20  cubane.pdb
     12  ethane.pdb
      9  methane.pdb
     30  octane.pdb
     21  pentane.pdb
     15  propane.pdb
    107  total
```

Sorting and piping

```
$ sort -n lengths.txt
  9  methane.pdb
 12  ethane.pdb
 15  propane.pdb
 20  cubane.pdb
 21  pentane.pdb
 30  octane.pdb
107  Total

$ sort -n lengths.txt > sorted_lengths.txt

$ head -1 sorted_lengths.txt
  9  methane.pdb

$ sort -n lengths.txt | head -1
  9  methane.pdb

$ wc -l *.pdb | sort -n | head -1
  9  methane.pdb
```

Finding a pattern with ‘grep’

- Use grep (*__g__lobally search a __r__egular __e__xpression* and *__p__rint*) to select lines from text files that match simple patterns.

```
$  grep "tane" lengths.txt
   30 octane.pdb
   21  pentane.pdb
```

- Option -n, which numbers the lines that match

```
$ grep –n "tane" lengths.txt
   4:     30 octane.pdb
   5:     21 pentane.pdb
```

- grep -i makes matching case-insensitive
- grep -v inverts the match e.g. grep -v "tane" lengths.txt will find everything EXCEPT octane.pdb and pentane.pdb
- Options can be combined, such as: -iv

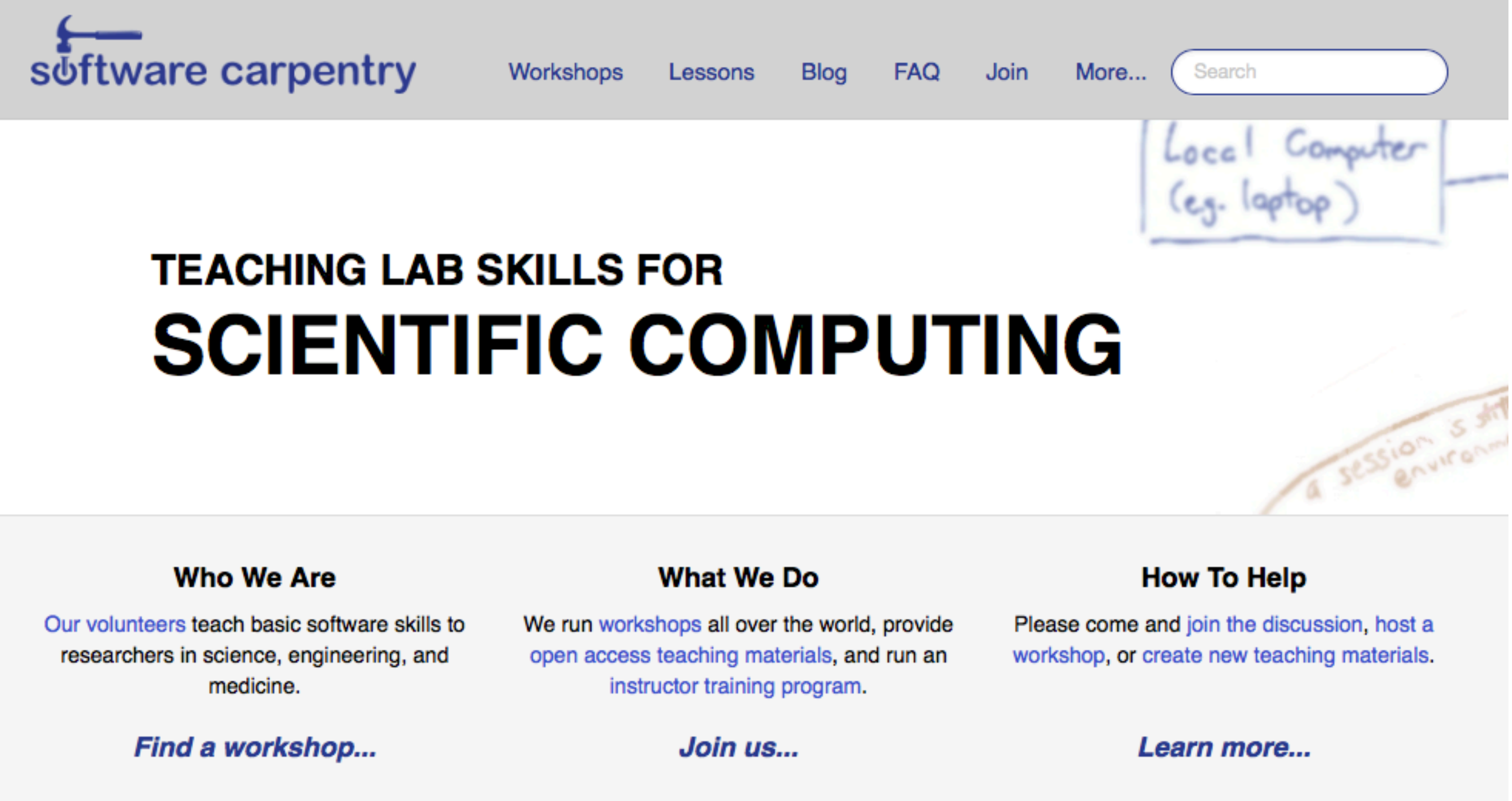
Some other useful tips

- <Tab> to autocomplete (useful to avoid errors)
- Re-run last command: **!!**
- List previous commands: history
- !(command number) to re-run a command e.g. !21
- Up and down arrows to scroll through previous commands -> edit command line
- Go directly to your home directory: cd
- Ctrl-C to terminate a command
- Clear terminal window: clear

- Yes, you can copy and paste

Useful Resource

- http://software-carpentry.org



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Finding files

- “grep” finds lines in files, the “find” command finds files themselves
- `$ cd ..`
- `$ find . -type d`   Finding a directory

```
./
./molecules
```

- `$ find . -type f`   Finding a file

```
./molecules/cubane.pdb
./molecules/ethane.pdb
./molecules/lengths.txt
./molecules/methane.pdb
./molecules/octane.pdb
./molecules/pentane.pdb
./molecules/propane.pdb
```

Finding a file by name

```
$ find . -name *.pdb
  ./molecules/cubane.pdb
  ./molecules/ethane.pdb
  ./molecules/methane.pdb
  ./molecules/octane.pdb
  ./molecules/pentane.pdb
  ./molecules/propane.pdb

$ find . -name cubane.pdb
  ./molecules/cubane.pdb
```

Listing vs. Finding

`ls` and `find` can be made to do similar things given the right options, but under normal circumstances, `ls` lists everything it can, while `find` searches for things with certain properties and shows them.