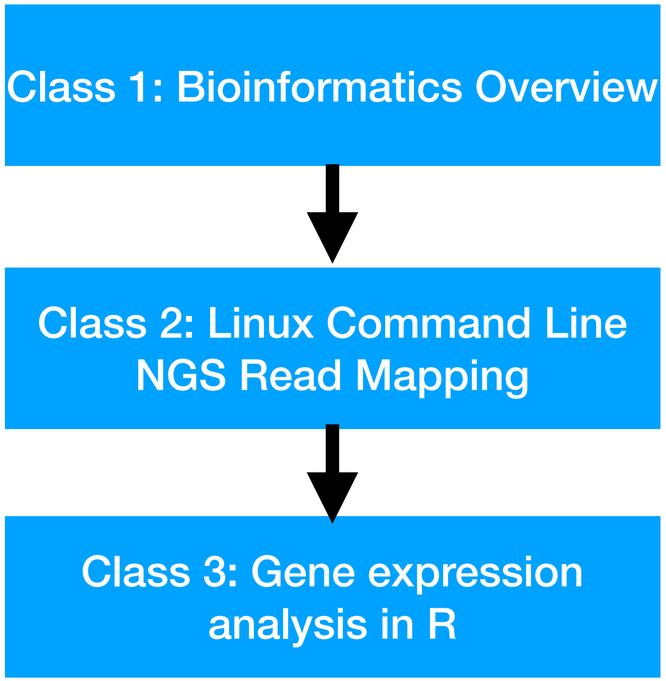
Class 2a: Linux Command Line

June 21, 2023

Course Overview

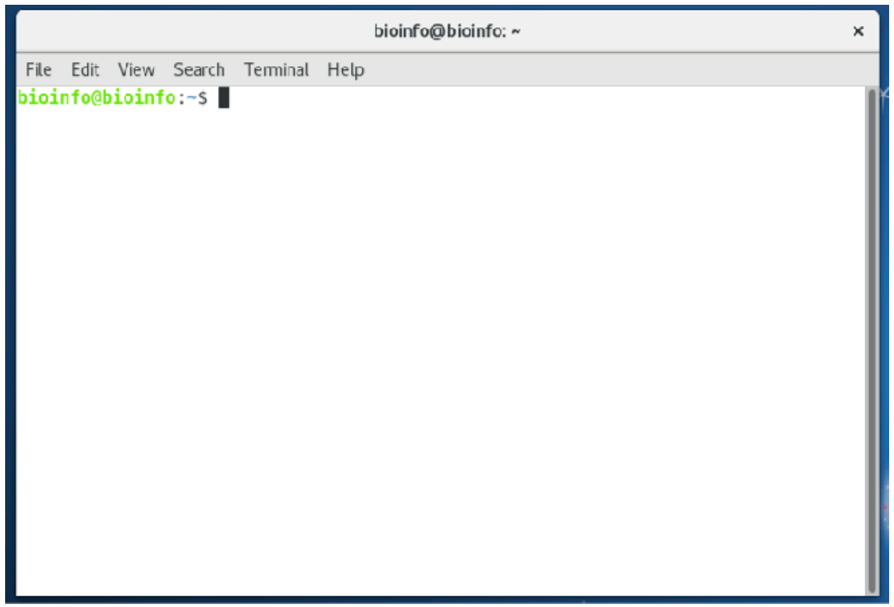


Linux Command Line
Class Content

- Introduction to the Virtual Machine
- Shells, Terminals, & file system navigation
- Anatomy of a UNIX command
- Wildcards, shortcuts and special characters
- File permissions
- Compression UNIX commands
- Networking UNIX commands

What is a Terminal?

- A terminal is a textual interface for interacting with a computer (a shell!)
- Using the terminal, one can issue powerful and concise command-line instructions for the computer to follow.

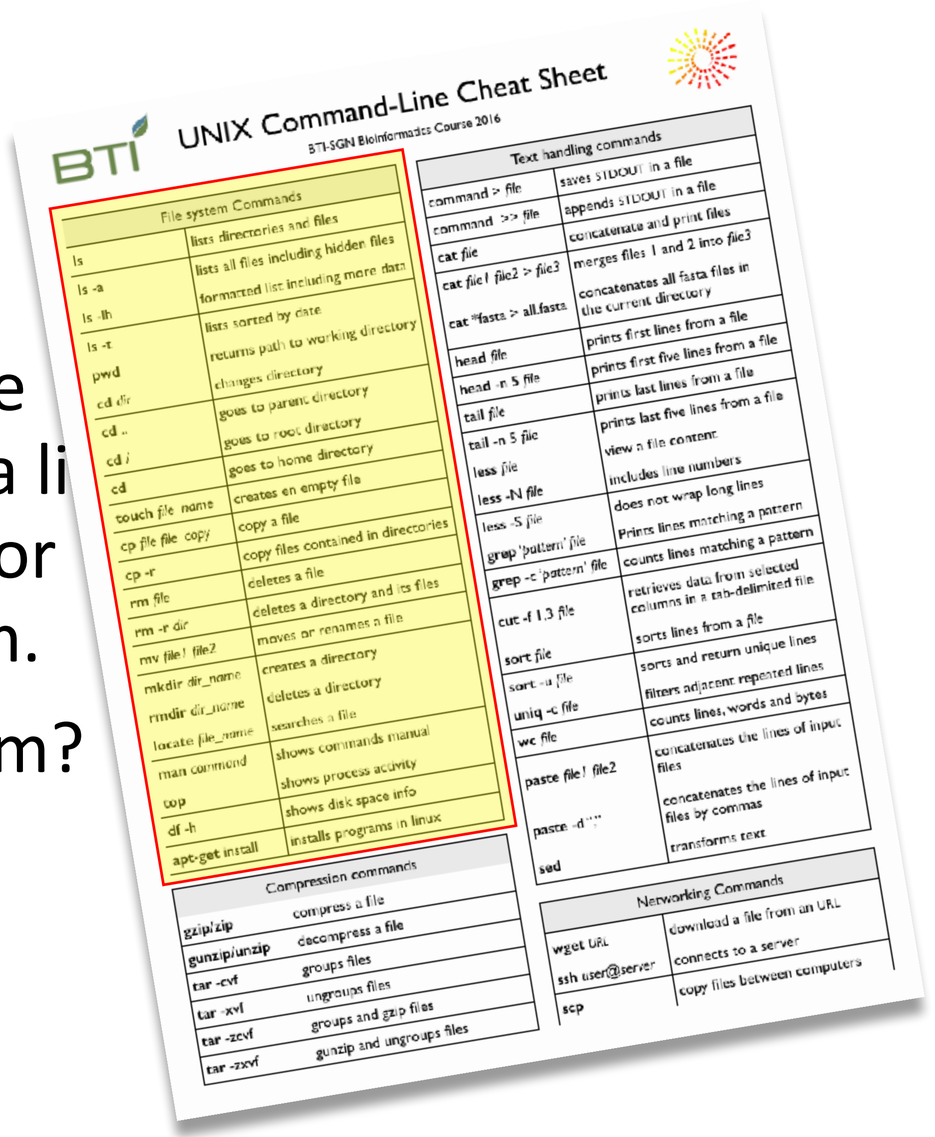


Why use the command-line (terminal)?

- Most software for biological big data analysis is used through UNIX command-line operations.
- Most of the servers for biological data analysis use Linux/Unix as their operating system.
- Data analysis on calculation servers are much faster since we can use more CPUs and RAM than in a PC or laptop (*e.g.* BTI's "Boyce" server has 64 cores and 1TB RAM).
- Large NGS data files can not be opened or loaded in most graphical software and web sites.
- App development is often harder and takes longer when using GUIs

Command-line File System Navigation

- The cheat sheet you have been provided contains a li of common commands for navigating the file system.
- But what *is* the file system?



BTI

UNIX Command-Line Cheat Sheet

BTI-SGN Bioinformatics Course 2016

File system Commands	
ls	lists directories and files
ls -a	lists all files including hidden files
ls -lh	formatted list including more data
ls -t	lists sorted by date
pwd	returns path to working directory
cd dir	changes directory
cd ..	goes to parent directory
cd /	goes to root directory
cd	goes to home directory
touch file_name	creates an empty file
cp file file_copy	copy a file
cp -r	copy files contained in directories
rm file	deletes a file
rm -r dir	deletes a directory and its files
mv file1 file2	moves or renames a file
mkdir dir_name	creates a directory
rmdir dir_name	deletes a directory
locate file_name	searches a file
man command	shows commands manual
top	shows process activity
df -h	shows disk space info
apt-get install	installs programs in linux

Text handling commands	
command > file	saves STDOUT in a file
command >> file	appends STDOUT in a file
cat file	concatenate and print files
cat file1 file2 > file3	merges files 1 and 2 into file3
cat *fasta > all.fasta	concatenates all fasta files in the current directory
head file	prints first lines from a file
head -n 5 file	prints first five lines from a file
tail file	prints last lines from a file
tail -n 5 file	prints last five lines from a file
less file	view a file content
less -N file	includes line numbers
less -S file	does not wrap long lines
grep 'pattern' file	Prints lines matching a pattern
grep -c 'pattern' file	counts lines matching a pattern
cut -f 1,3 file	retrieves data from selected columns in a tab-delimited file
sort file	sorts lines from a file
sort -u file	sorts and return unique lines
uniq -c file	filters adjacent repeated lines
wc file	counts lines, words and bytes
paste file1 file2	concatenates the lines of input files
paste -d ";"	concatenates the lines of input files by commas
sed	transforms text

Compression commands	
gzip/zip	compress a file
gunzip/unzip	decompress a file
tar -cvf	groups files
tar -xvf	ungroups files
tar -zcvf	groups and gzip files
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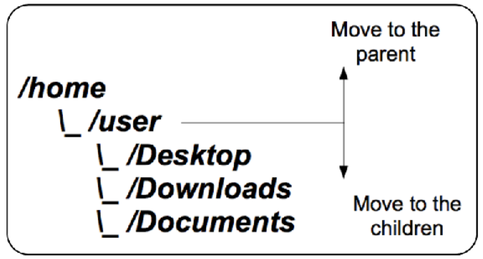
Networking Commands	
wget URL	download a file from an URL
ssh user@server	connects to a server
scp	copy files between computers

Connect to remote server ‘thompson’

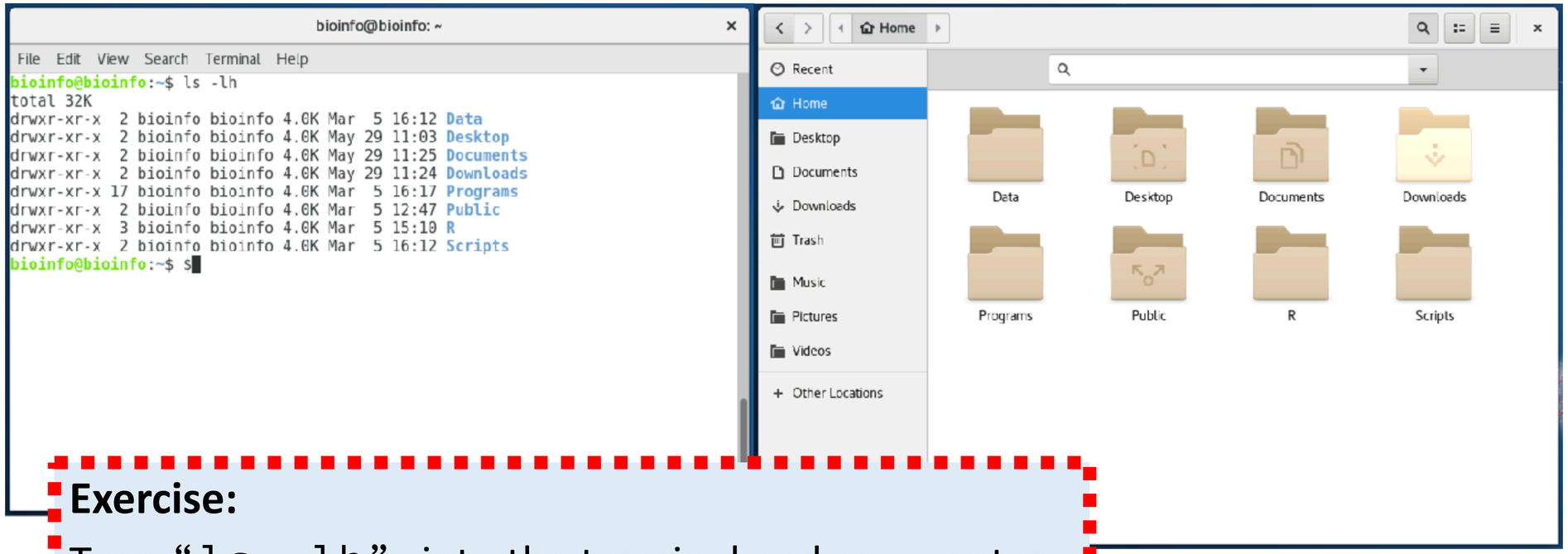
- Open terminal or Putty and type the following (using your username)

ssh bioinfo0@thompson.sgn.cornell.edu

- #The password is bioinfo00



The File System



Exercise:

Type “`ls -lh`” into the terminal and press enter.

Home and Root Directories

```
Noes-MacBook-Pro:~ Noe$ ls -lht
total 0
drwx------+ 29 Noe  staff   986B May 31 11:24 Desktop
drwx------@  8 Noe  staff   272B May 31 08:26 Dropbox
drwx------+ 54 Noe  staff   1.8K May 30 16:01 Downloads
drwx------+  8 Noe  staff   272B May 28 21:06 Pictures
drwxr-xr-x  18 Noe  staff   612B May 17 11:12 BTI
drwxr-xr-x   5 Noe  staff   170B May  8 11:44 programs
drwx------+ 15 Noe  staff   510B Apr 10 08:33 Documents
drwxr-xr-x   6 Noe  staff   204B Mar 18 09:22 VirtualBox VMs
drwxr-xr-x   8 Noe  staff   272B Mar 14 19:26 py_devel
drwx------@ 51 Noe  staff   1.7K Mar 11 15:08 Library
```

Home directory

/home/bioinfo
/home/noe
/home/noe/Desktop

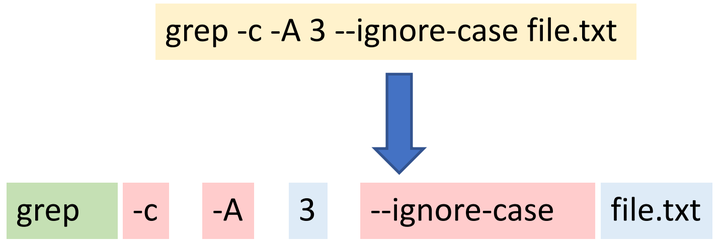
```
noe@debian-virtualbox:~$ ls -l /
total 108
drwxr-xr-x   2 root root  4096 Sep 26  2012 bin
drwxr-xr-x   3 root root  4096 Nov  9  2012 boot
drwxr-xr-x  15 root root  3140 May 31 12:46 dev
drwxr-xr-x 130 root root 12288 May 31 12:45 etc
drwxr-xr-x   5 root root  4096 Feb 28 13:54 export
drwxr-xr-x   4 root root  4096 Nov  7  2012 home
lrwxrwxrwx   1 root root    30 Sep 26  2012 initrd.img
drwxr-xr-x  12 root root 12288 Nov  9  2012 lib
drwxr-xr-x   2 root root 12288 Nov  9  2012 lib32
lrwxrwxrwx   1 root root     4 Sep 26  2012 lib64 -> /l
drwx------   2 root root 16384 Sep 26  2012 lost+found
drwxr-xr-x   3 root root  4096 Sep 26  2012 media
drwxr-xr-x   2 root root  4096 May  1  2012 mnt
drwxr-xr-x   2 root root  4096 Sep 26  2012 opt
dr-xr-xr-x 134 root root     0 May 31 12:45 proc
drwx------  10 root root  4096 Nov 15  2012 root
drwxr-xr-x   2 root root  4096 Nov  9  2012 sbin
drwxr-xr-x   2 root root  4096 Jul 21  2010 selinux
drwxr-xr-x   2 root root  4096 Sep 26  2012 srv
drwxr-xr-x  13 root root     0 May 31 12:45 sys
drwxrwxrwt  11 root root  4096 May 31 19:56 tmp
drwxr-xr-x  11 root root  4096 Sep 26  2012 usr
drwxr-xr-x  14 root root  4096 Sep 26  2012 var
```

Root directory

/bin, /lib, /usr	code and code libraries
/var	logs and other data
/home	user directories
/tmp	temporary files
/etc	configuration information
/proc	special file system in Linux

Anatomy of a UNIX Command

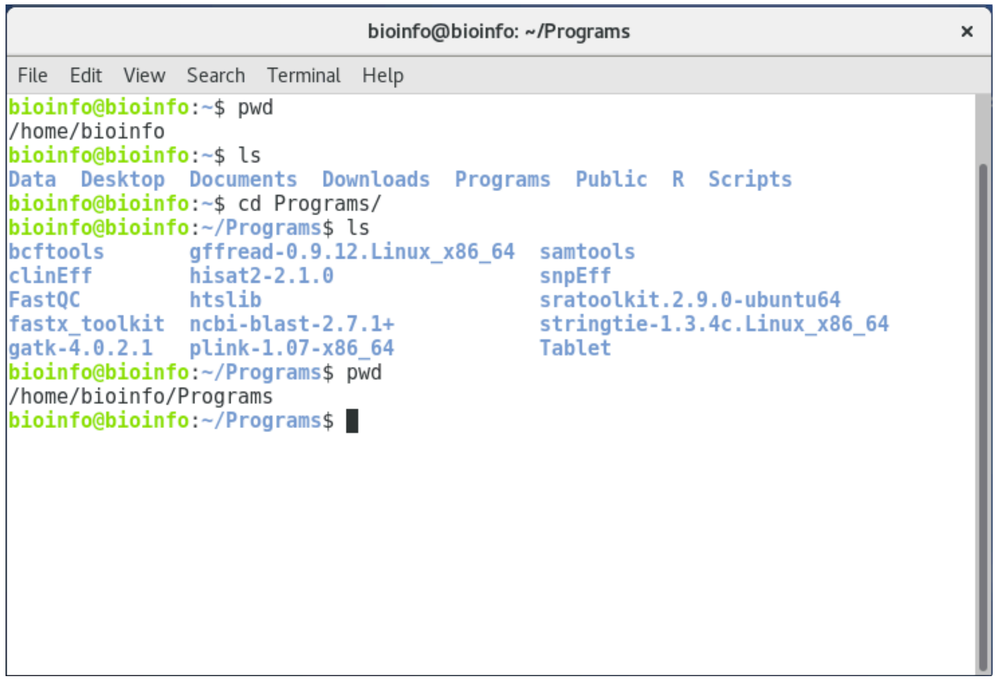
- Every UNIX command is made up of a series of space-separated strings.
- The first of these strings is always the command you will run.
- The user can also provide options (shown in red) and arguments (shown in blue).
- A command can require arguments, as can an option.
- In this example, the “-A” option is being given the argument “3” and the command is being given the argument “file.txt”.



- Options often have a short form (starting with “-”) and a long form (starting with “--”).
- If an option flag does not have any arguments, then can often be concatenated (*e.g.* “ls -h -l -a” is equivalent to “ls -hla”).

pwd, ls, and cd

- **pwd** — where am I?
- **ls** — what is inside the current directory?
- **cd** — change my current directory.

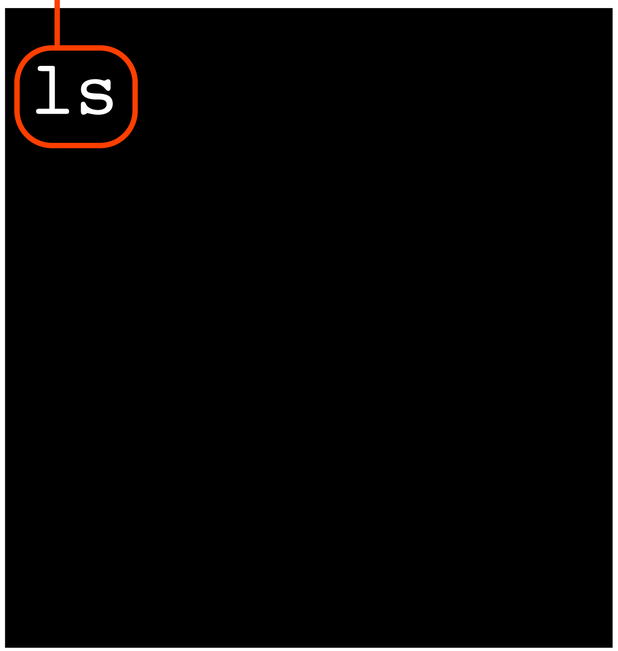


Exercise:

Change into the “Programs” directory and list the files found there.

ls lists files and directories

list directories and files in current directory



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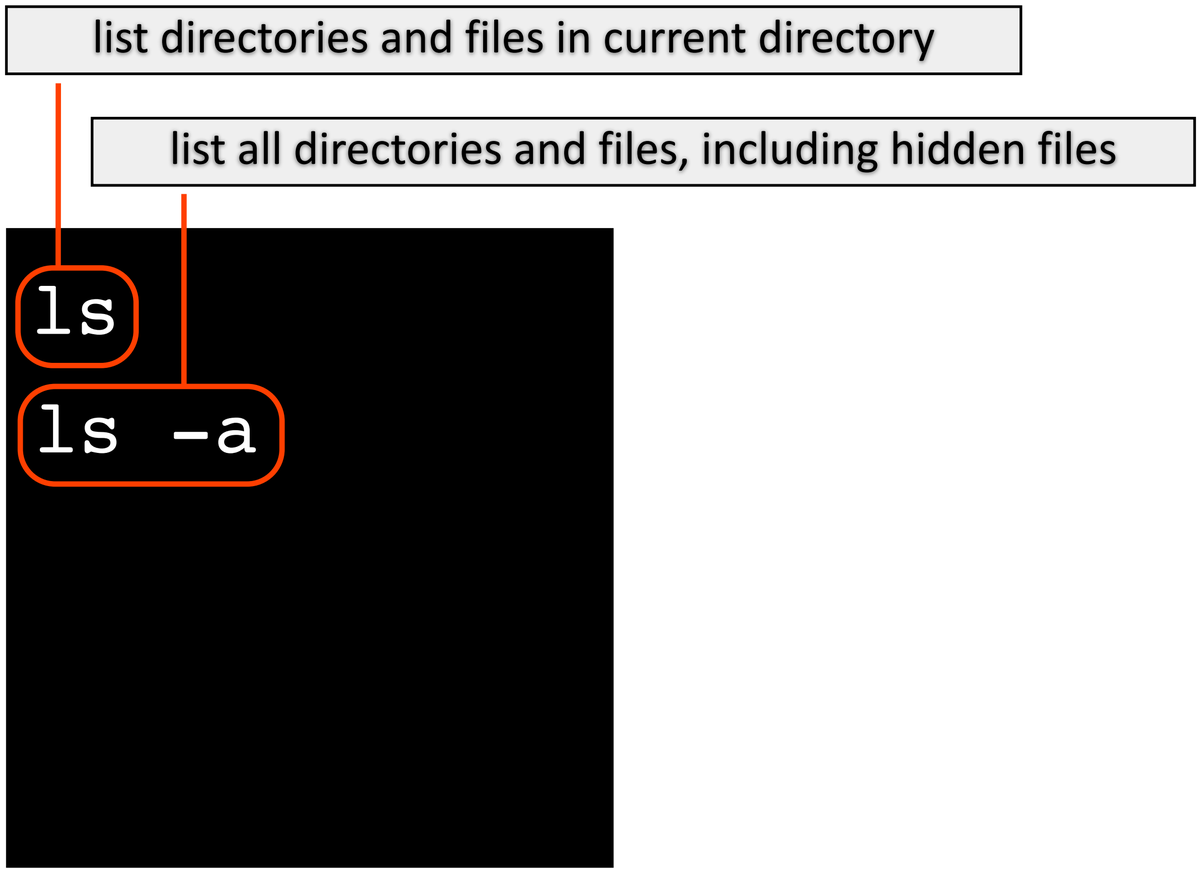
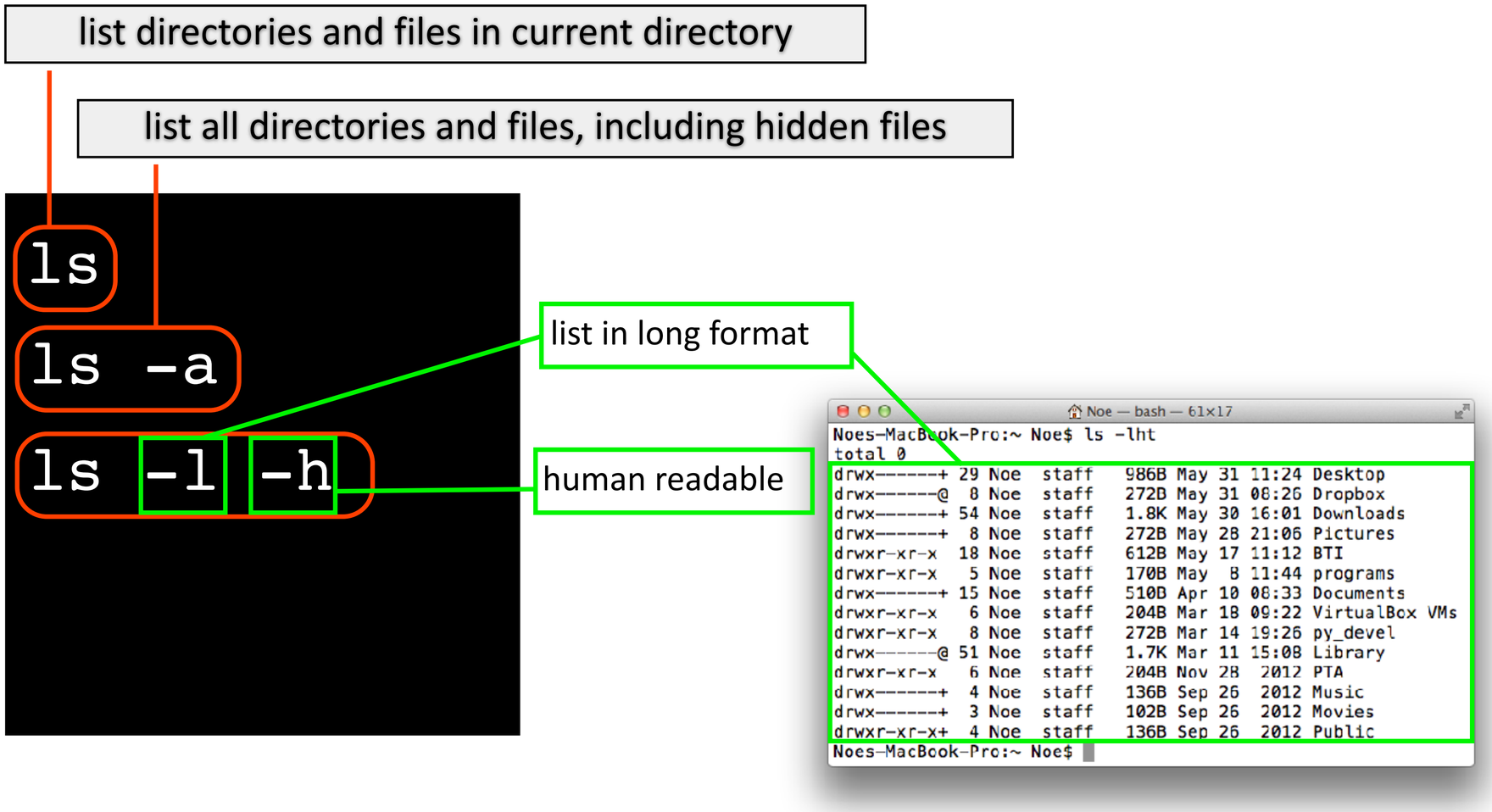
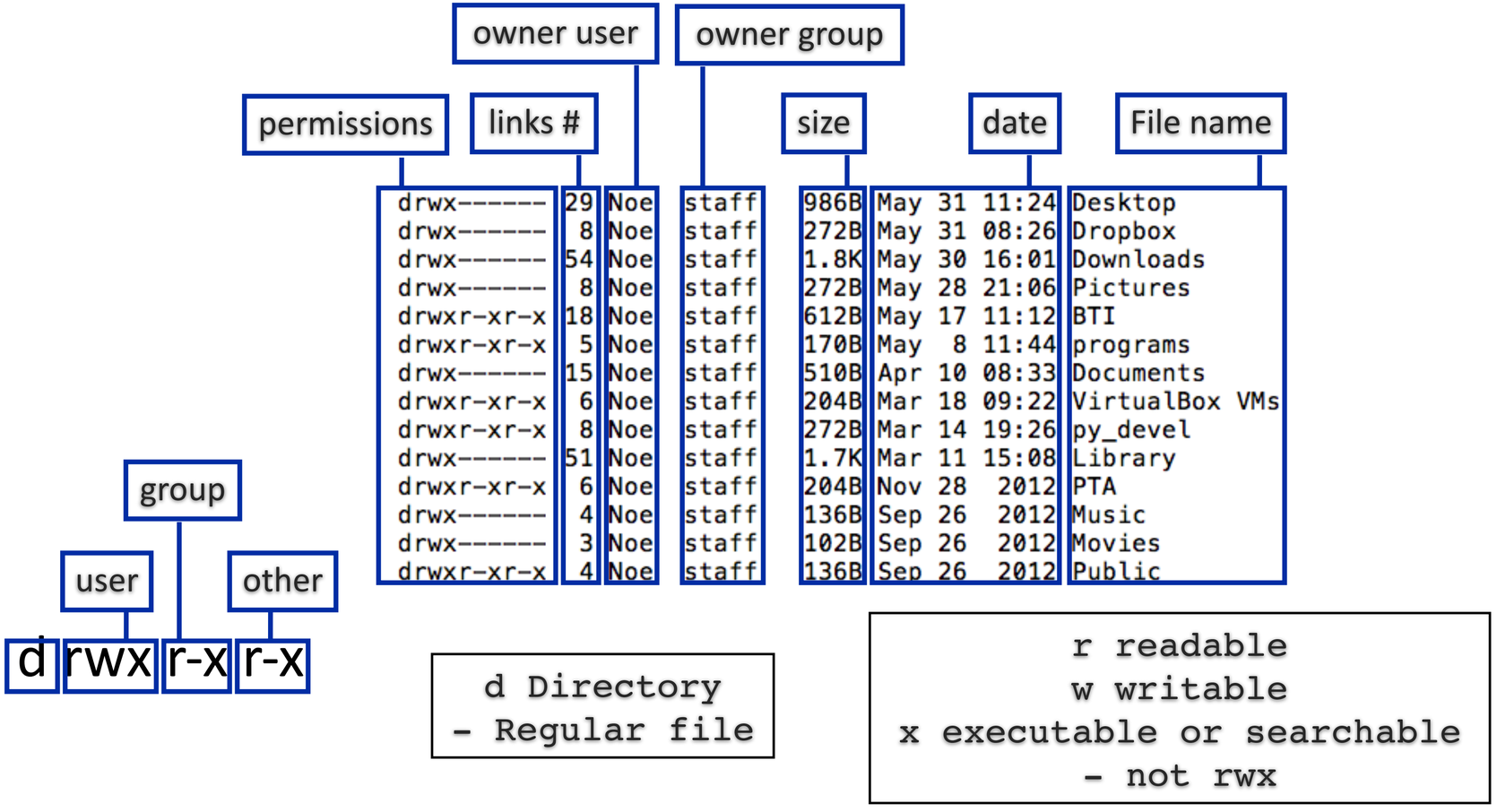


ls lists files and directories



The ls list output



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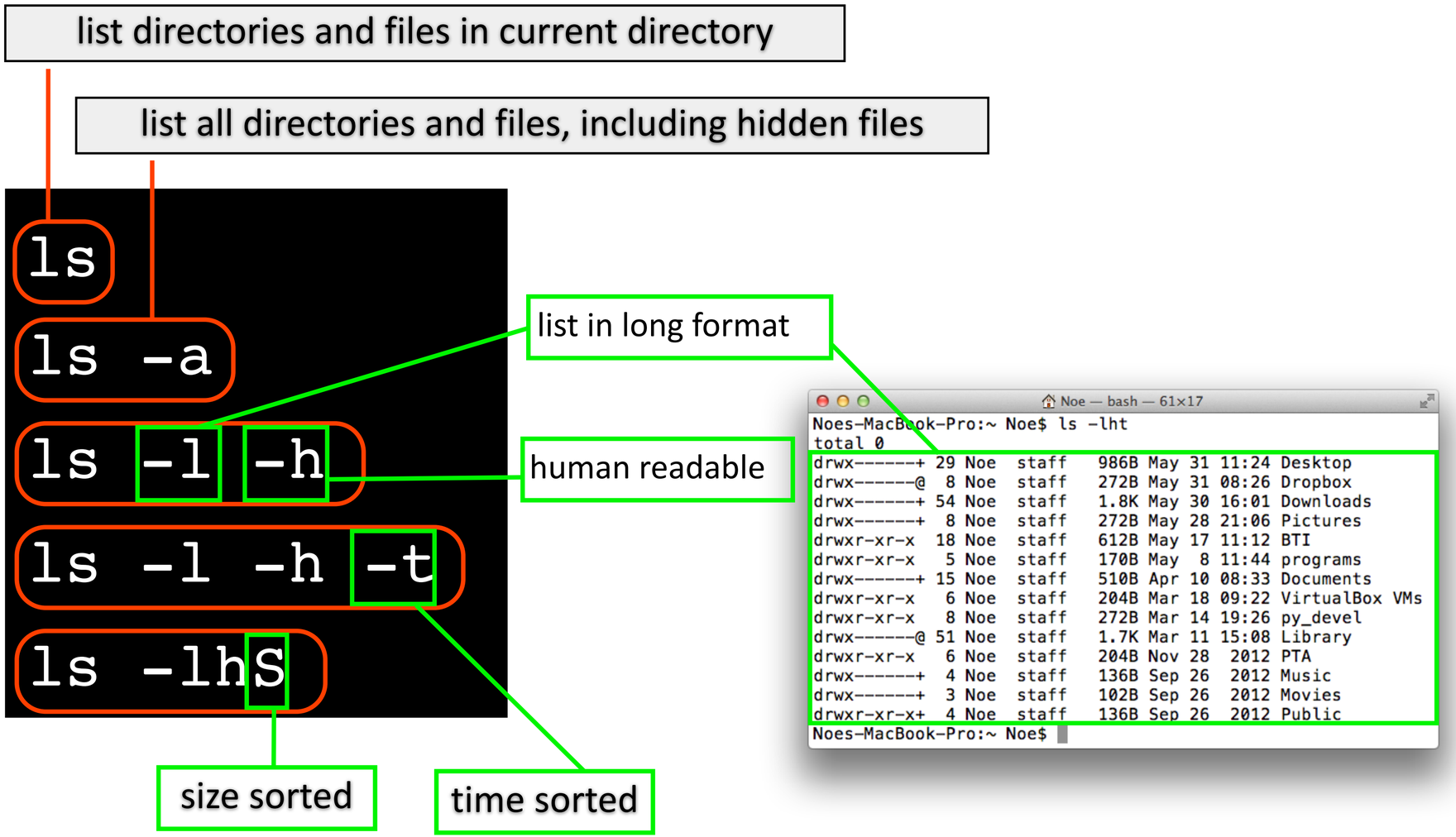
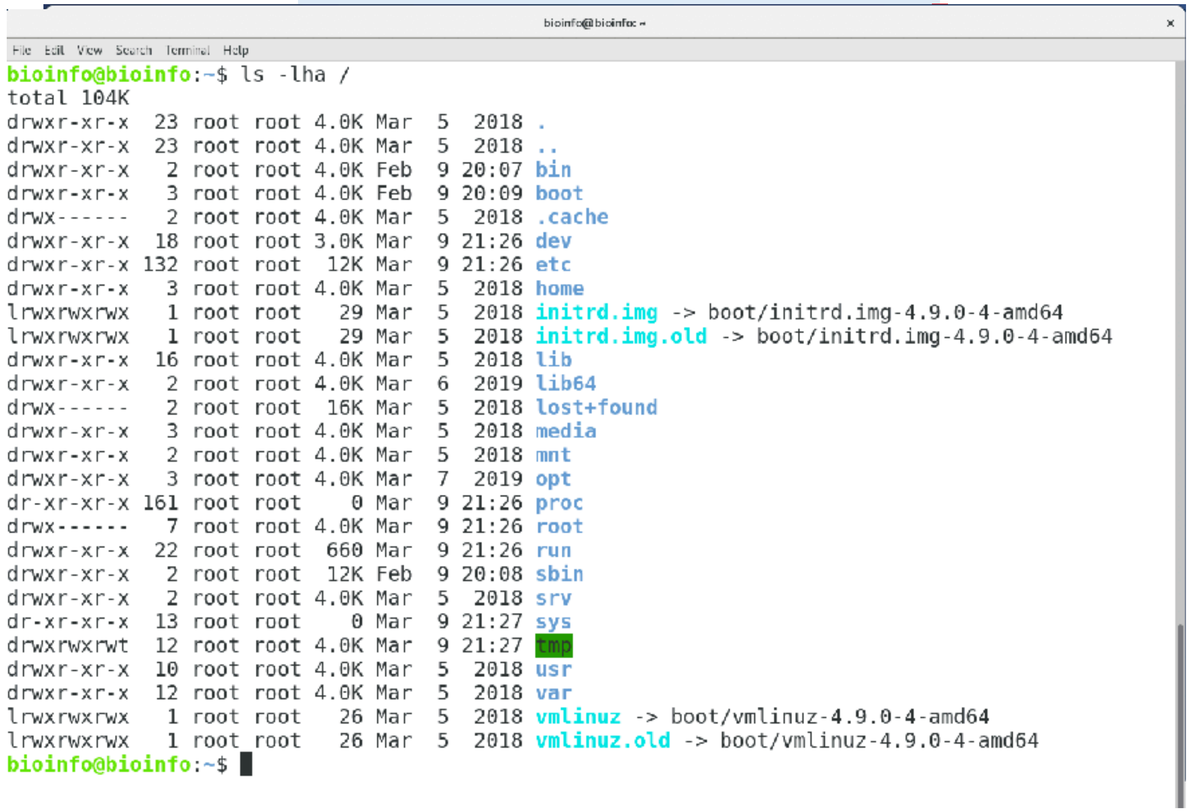


Exercise:

List ALL files present in the root directory (including hidden files)



cd changes directory

changes directory to Desktop

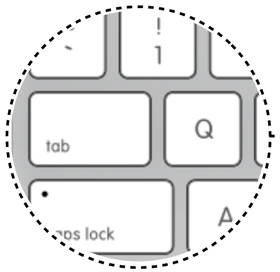
goes to parent directory

```
cd Desktop
cd ..
cd /
cd
cd -
```

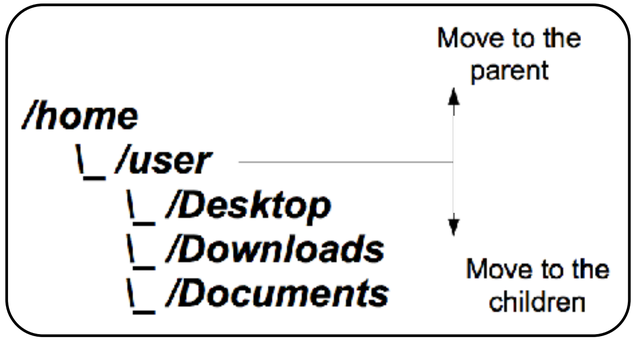
goes to root directory

goes to home directory

goes to previous directory



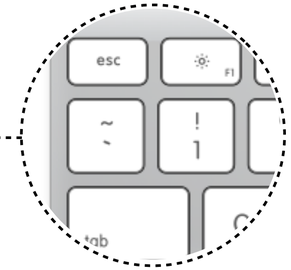
Use tab key to autocomplete names



Absolute and relative paths

list files in Desktop using an absolute path

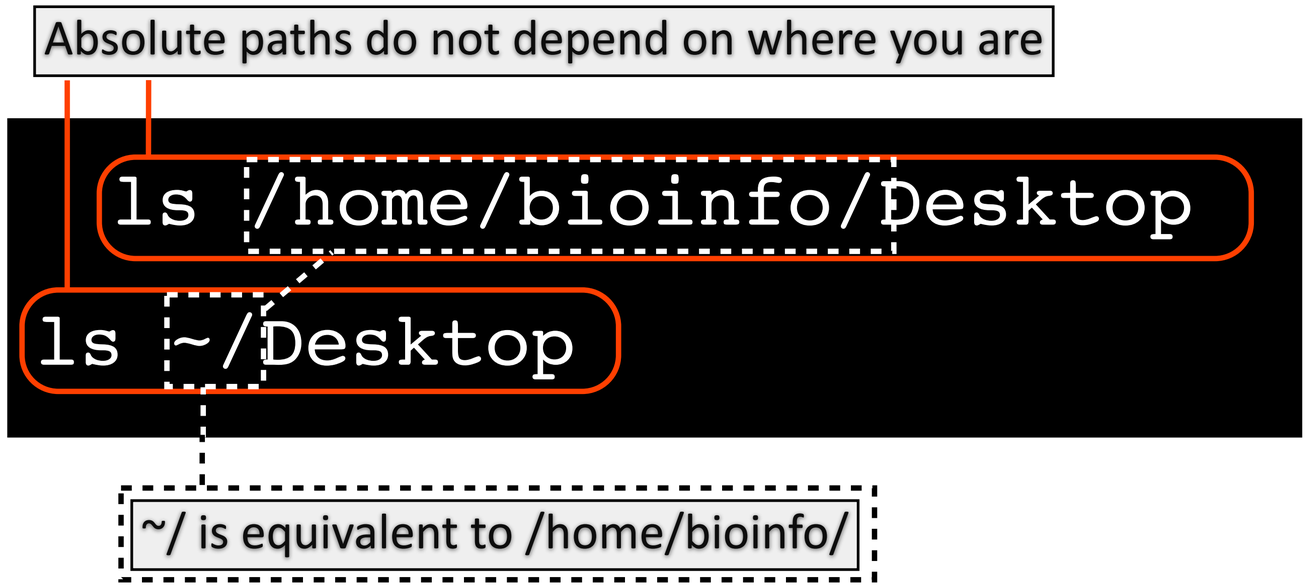
```
ls /home/user/Desktop
ls Desktop/
ls ~/Desktop
```



list files in Desktop using your home as a reference

list files in Desktop using a relative path (from your home: /home/bioinfo)

Absolute and relative paths

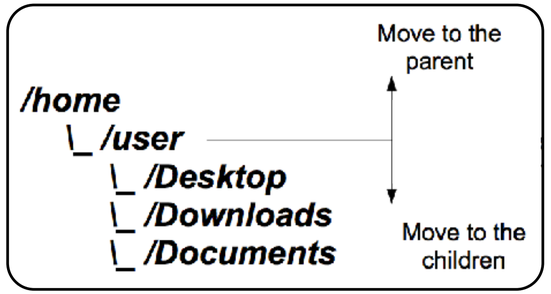


Absolute and relative paths

goes to *Desktop* from when you are in your home (/home/bioinfo)

```
cd Desktop/
ls ../Documents
```

list files from *Documents* when you are in *Desktop*



Wildcards, Shortcuts, and Command History

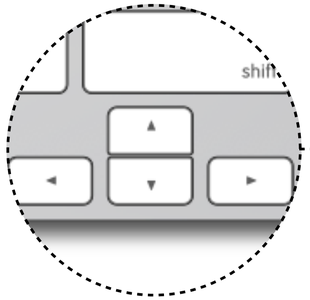
```
ls *txt
```

list all txt files in current directory

```
ls d*v
```

list files starting with d and ending with v

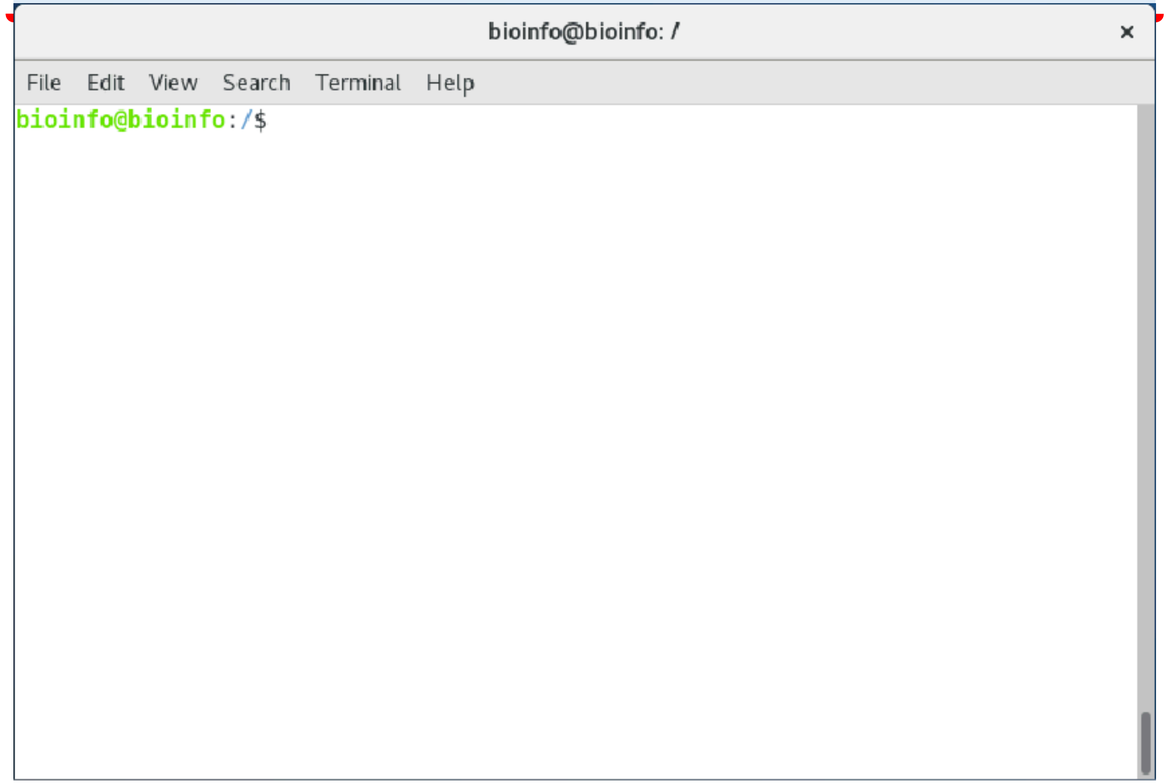
`ctrl-c`	stop process
`ctrl-a`	go to begin of line
`ctrl-e`	go to end of line
`ctrl-r`	search in command history



Use up and down arrows to navigate the command history

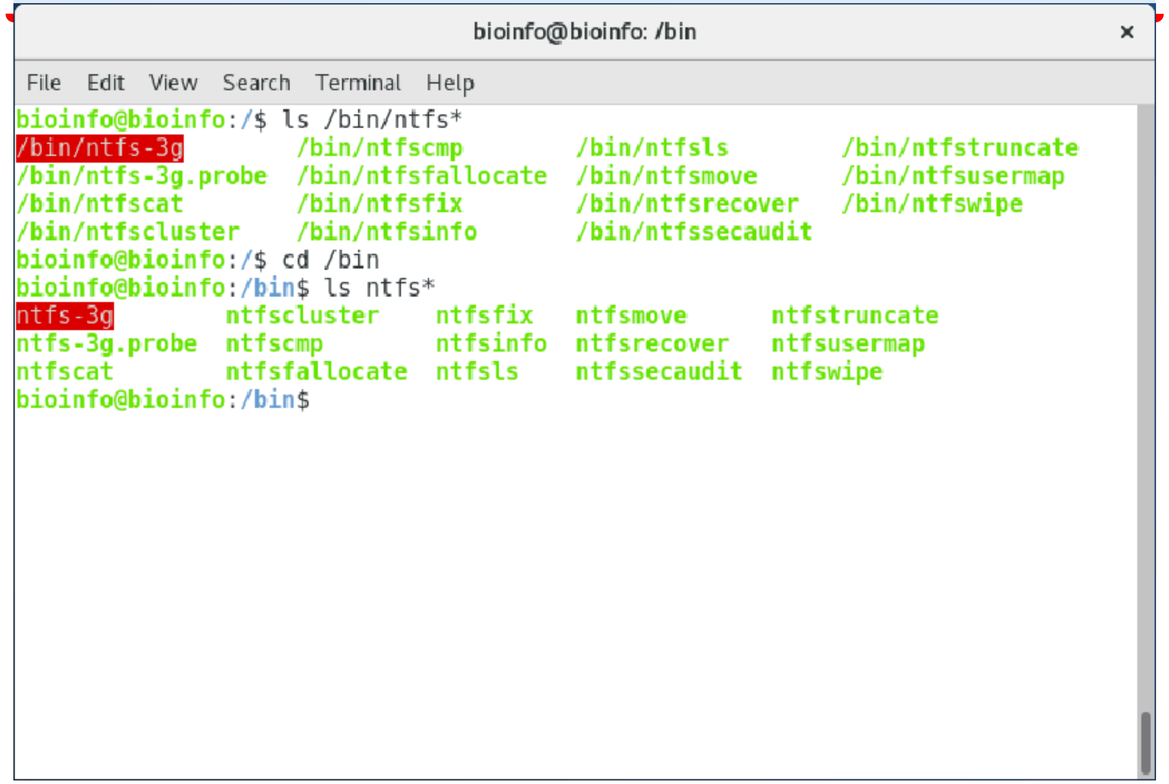
Exercise:

List files in the “/bin” directory that start with “ntfs” (do this once *without* changing your working directory, and once *with* changing your working directory).



Exercise 6:

List files in the “/bin” directory that start with “ntfs” (do this once *without* changing your working directory, and once *with* changing your working directory).



Escaping special characters

! @ $ ^ & * ~ ? . | / [ ] < > \ ` " ;# ( )

```
ls my_folder
```

list a folder

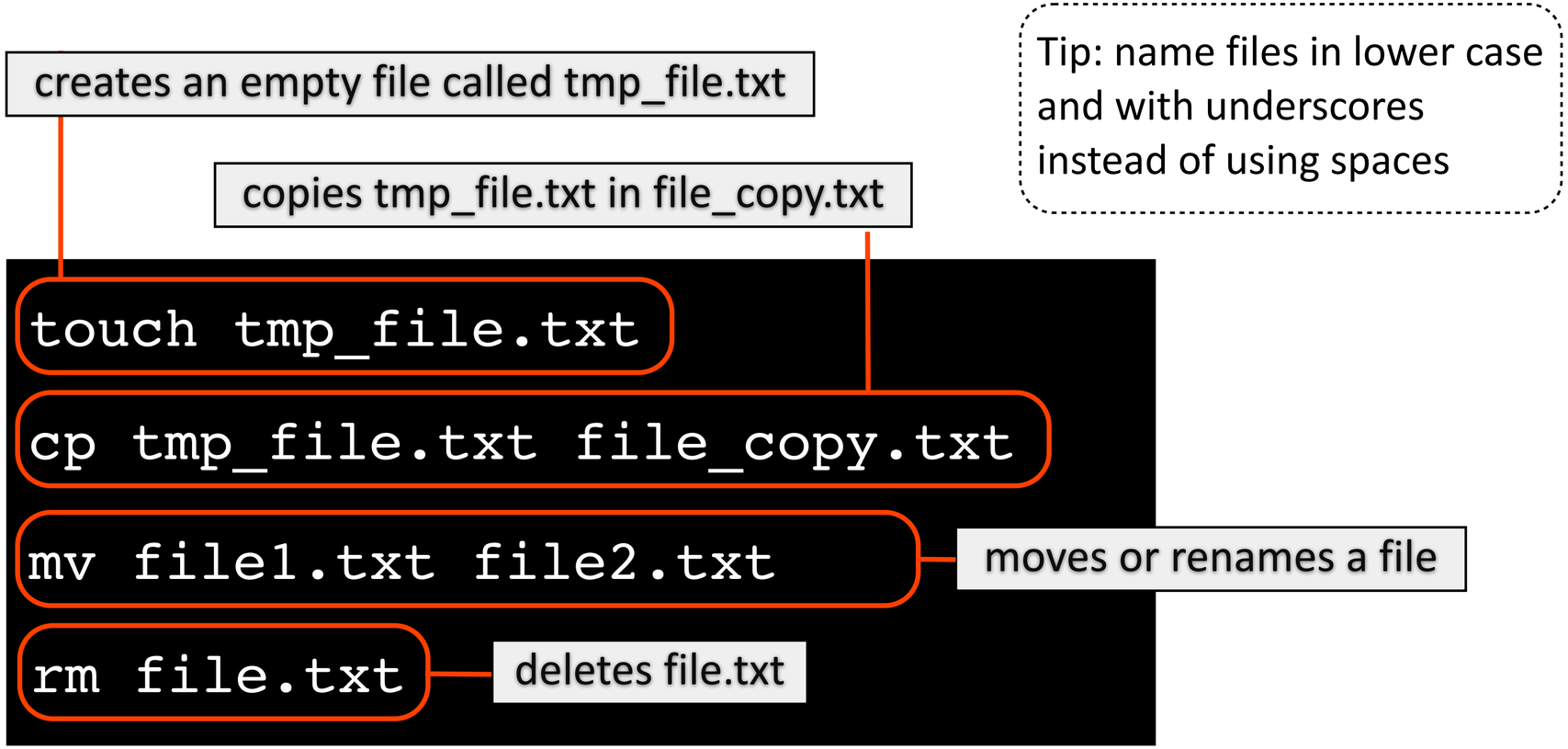
```
ls my\ folder
```

list a folder containing a space

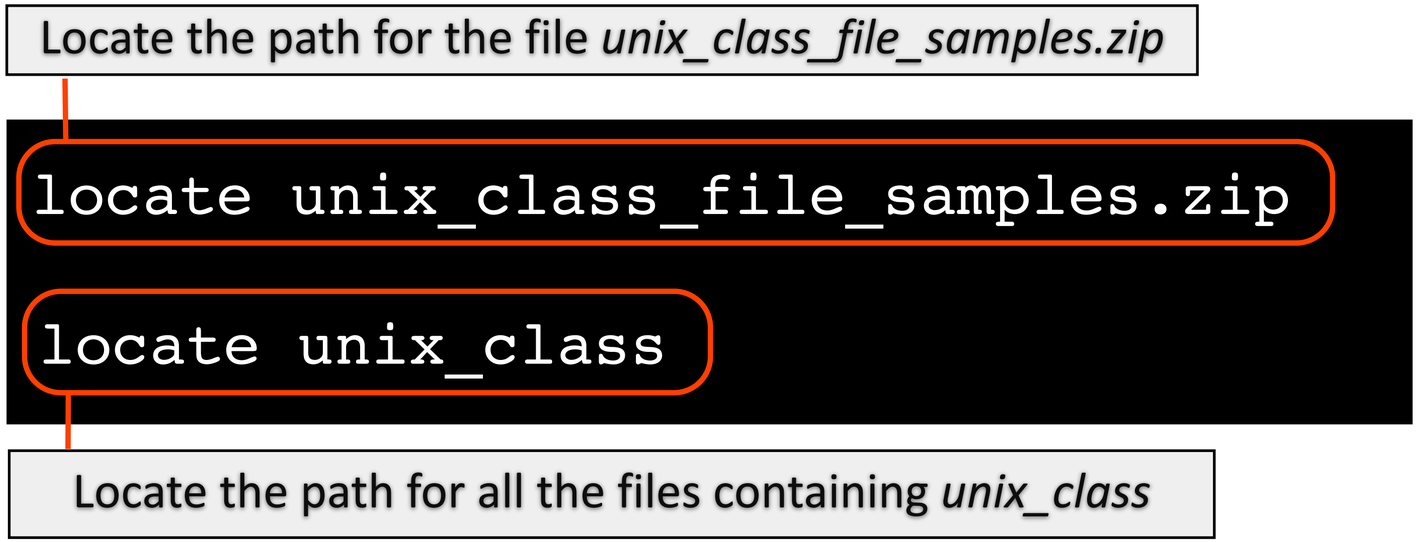
Tip: file names in lower case and with underscores instead of spaces

Use tab key to autocomplete names

Create, copy, move and delete files



Locate a file



Create, copy and delete directories

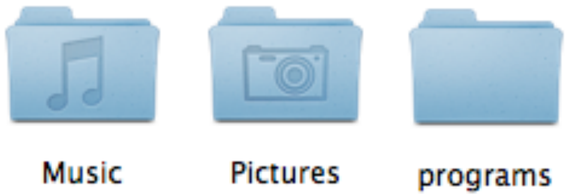
creates an empty directory called *dir_name*

deletes *dir_name* directory if it is empty

```
mkdir dir_name
rmdir dir_name
rm -r dir_name
cp -r dir_name dir_copy
```

delete *dir_name* and its files

copy *dir_name* and its files in a new folder



Compression commands

Compression commands	
gzip/zip	compress a file
gunzip/unzip	decompress a file
tar -cvf	groups files
tar -xvf	ungroups files
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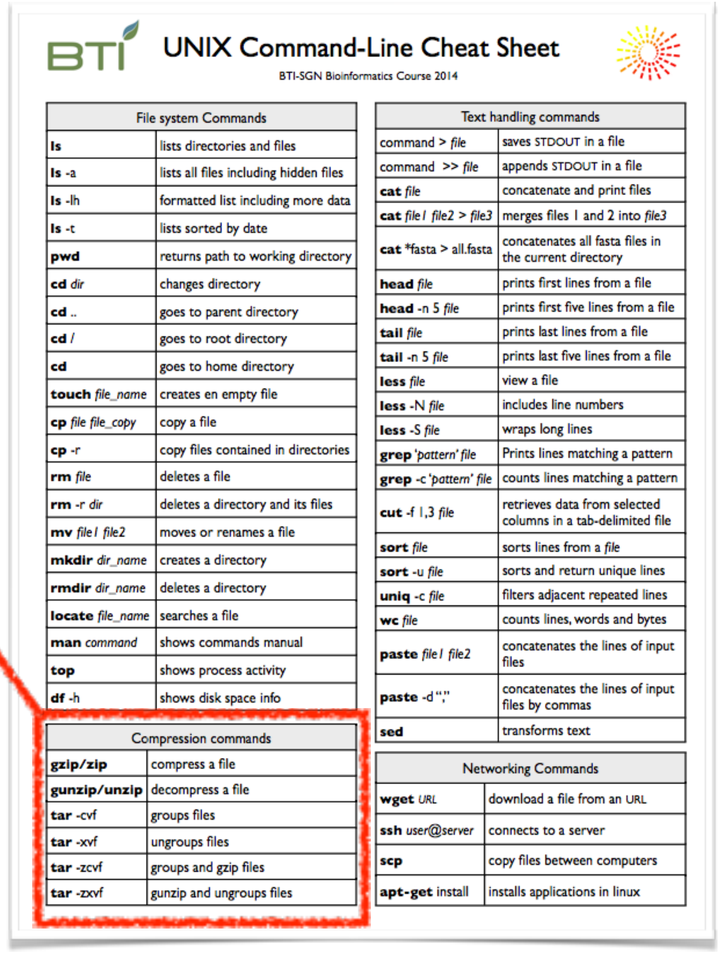

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Networking Commands	
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ssh *user@server*	connects to a server
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apt-get install	installs applications in linux

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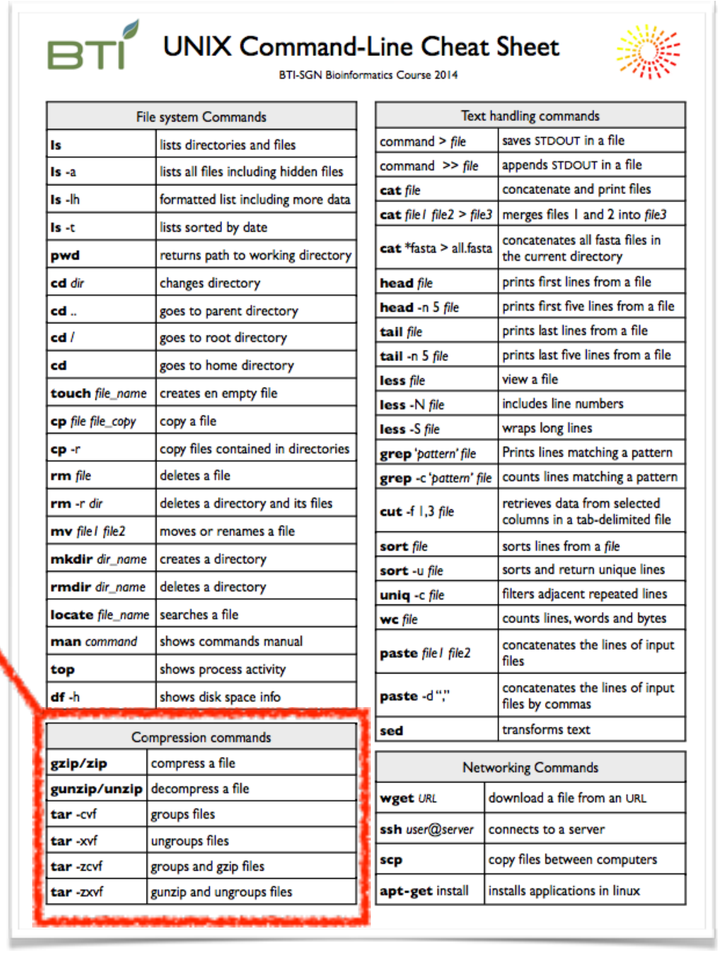
group and compress files

```
tar -zcvf file.tar.gz f1 f2
```

```
tar -zxvf file.tar.gz
```

decompress and ungroup a tar.gz file

files, directories or wildcards



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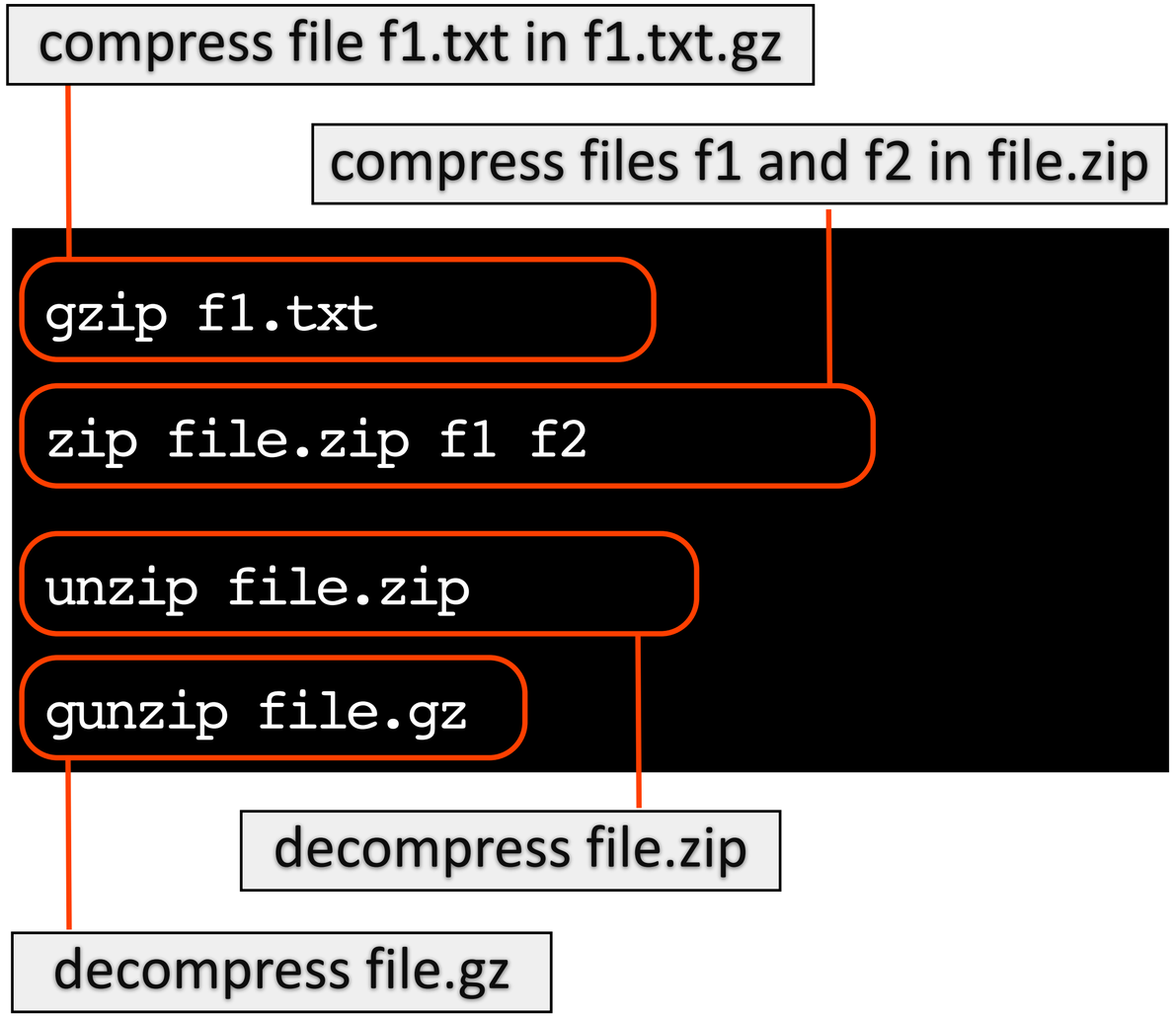
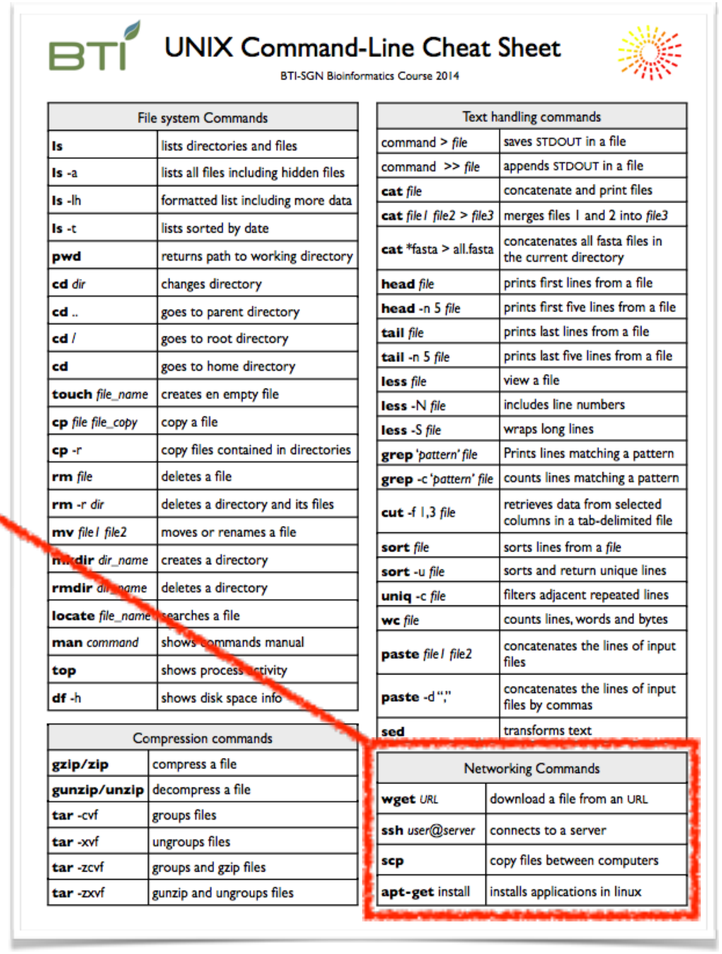
scp	copy files between computers
apt-get install	installs applications in linux

Compression commands



Networking Commands

- Networking commands



BTI **UNIX Command-Line Cheat Sheet**

BTI-SGN Bioinformatics Course 2014

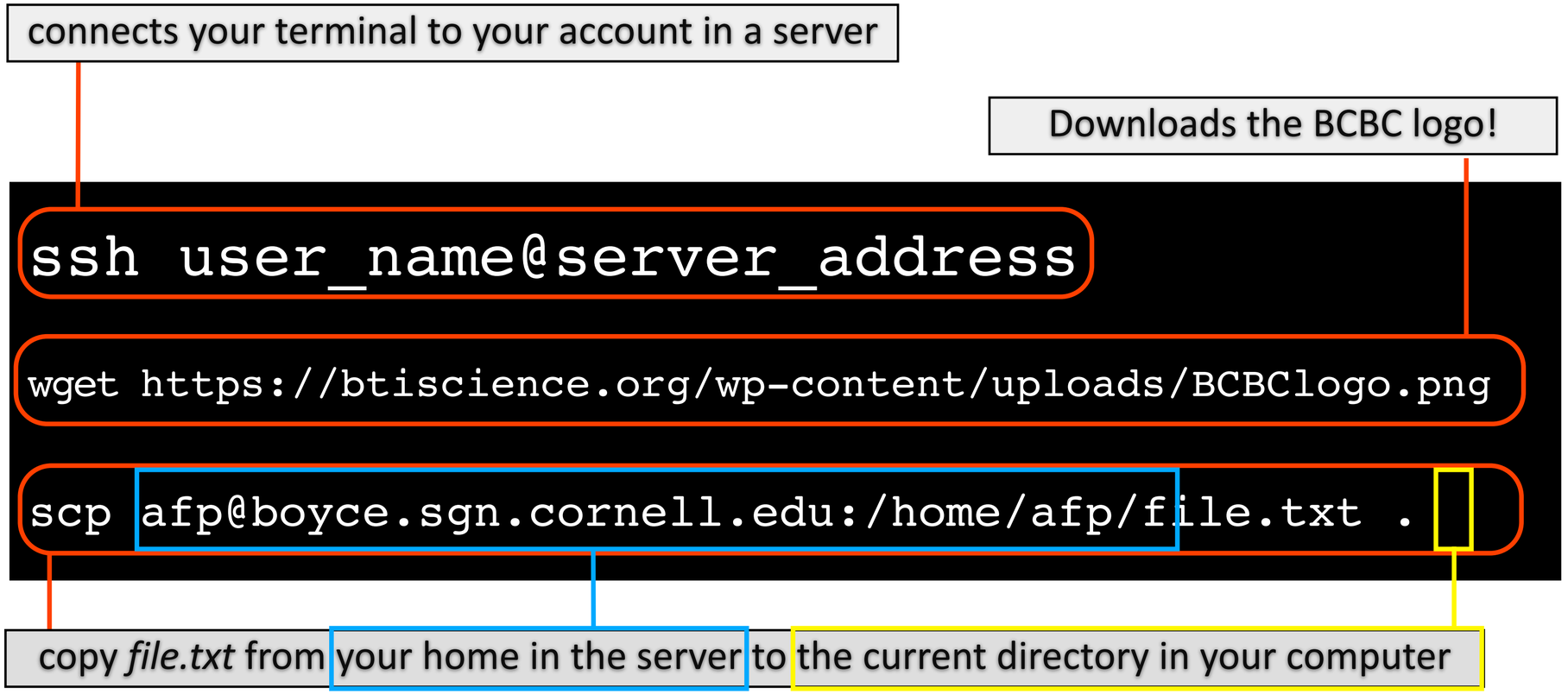
File system Commands	
ls	lists directories and files
ls -a	lists all files including hidden files
ls -lh	formatted list including more data
ls -t	lists sorted by date
pwd	returns path to working directory
cd *dir*	changes directory
cd ..	goes to parent directory
cd /	goes to root directory
cd	goes to home directory
touch *file_name*	creates en empty file
cp *file file_copy*	copy a file
cp -r	copy files contained in directories
rm *file*	deletes a file
rm -r *dir*	deletes a directory and its files
mv *file1 file2*	moves or renames a file
mkdir *dir_name*	creates a directory
rmdir *dir_name*	deletes a directory
locate *file_name*	searches a file
man *command*	shows commands manual
top	shows process activity
df -h	shows disk space info

Compression commands	
gzip/zip	compress a file
gunzip/unzip	decompress a file
tar -cvf	groups files
tar -xvf	ungroups files
tar -zcvf	groups and gzip files
tar -zxvf	gunzip and ungroups files

Text handling commands	
command > *file*	saves STDOUT in a file
command >> *file*	appends STDOUT in a file
cat *file*	concatenate and print files
cat *file1 file2* > *file3*	merges files 1 and 2 into *file3*
cat *fasta > all.fasta	concatenates all fasta files in the current directory
head *file*	prints first lines from a file
head -n 5 *file*	prints first five lines from a file
tail *file*	prints last lines from a file
tail -n 5 *file*	prints last five lines from a file
less *file*	view a file
less -N *file*	includes line numbers
less -S *file*	wraps long lines
grep '*pattern*' *file*	Prints lines matching a pattern
grep -c '*pattern*' *file*	counts lines matching a pattern
cut -f 1,3 *file*	retrieves data from selected columns in a tab-delimited file
sort *file*	sorts lines from a *file*
sort -u *file*	sorts and return unique lines
uniq -c *file*	filters adjacent repeated lines
wc *file*	counts lines, words and bytes
paste *file1 file2*	concatenates the lines of input files
paste -d ","	concatenates the lines of input files by commas
sed	transforms text

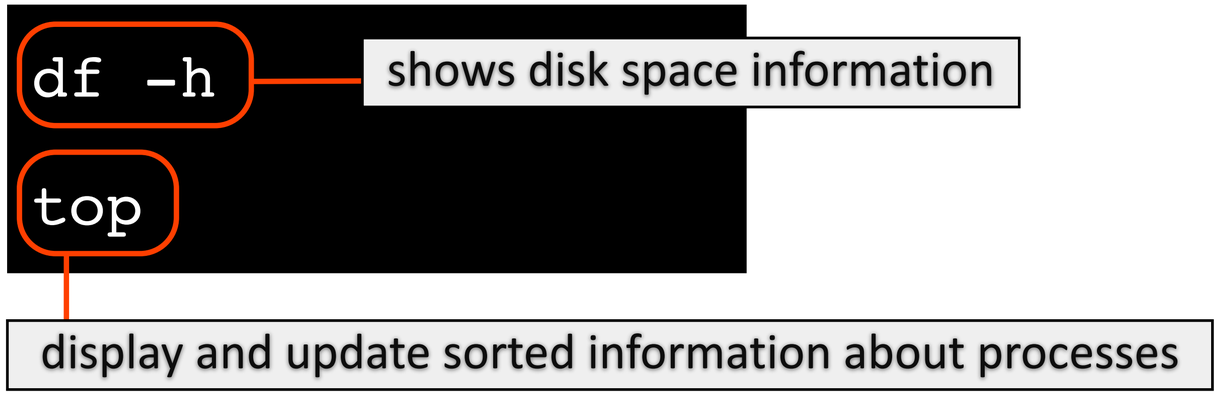
Networking Commands	
wget *URL*	download a file from an URL
ssh *user@server*	connects to a server
scp	copy files between computers
apt-get install	installs applications in linux

Networking Commands



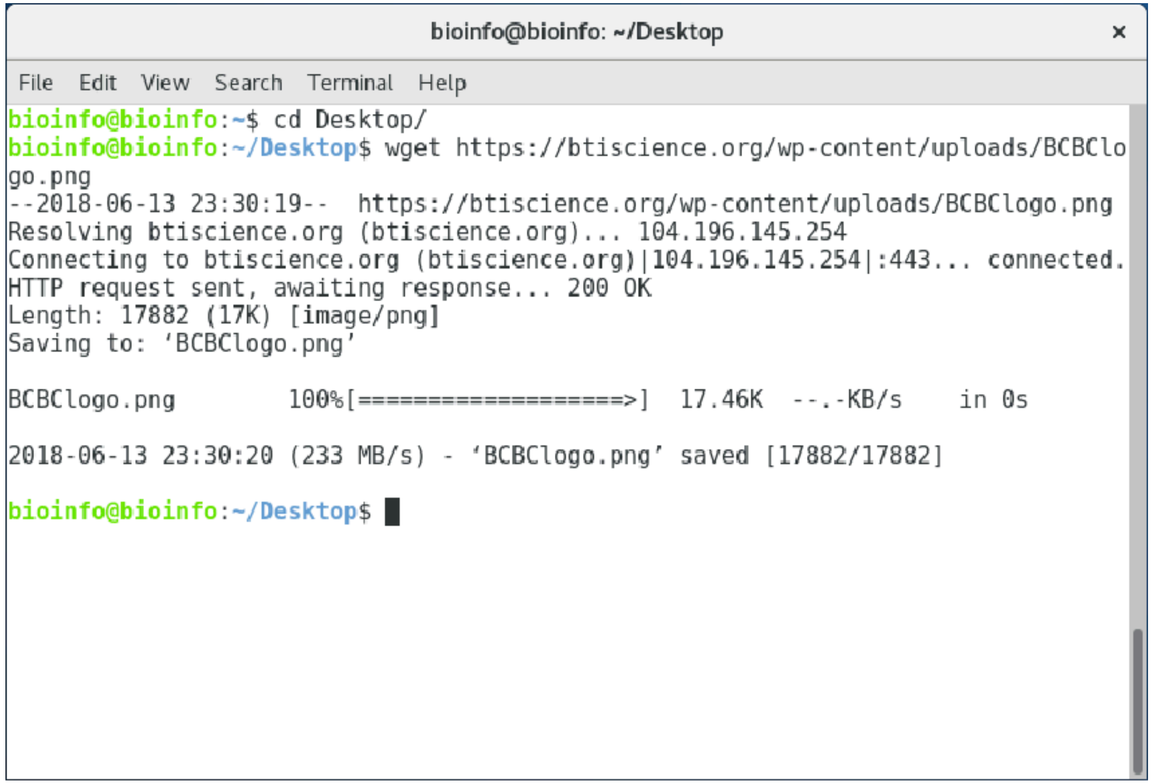
Tip: use the command `pwd` to get the path for `cp` and `scp`

Useful commands in the server



Exercise:

Download the BCBC logo (https://btiscience.org/wp-content/uploads/BCBClogo.png) to your Desktop.



“Man” pages

Man pages are the documentation for UNIX commands

- `$ man <command>`
- `$ man ls`

Searching man pages

- Use the `apropos` command
- `$ apropos “text editor”`

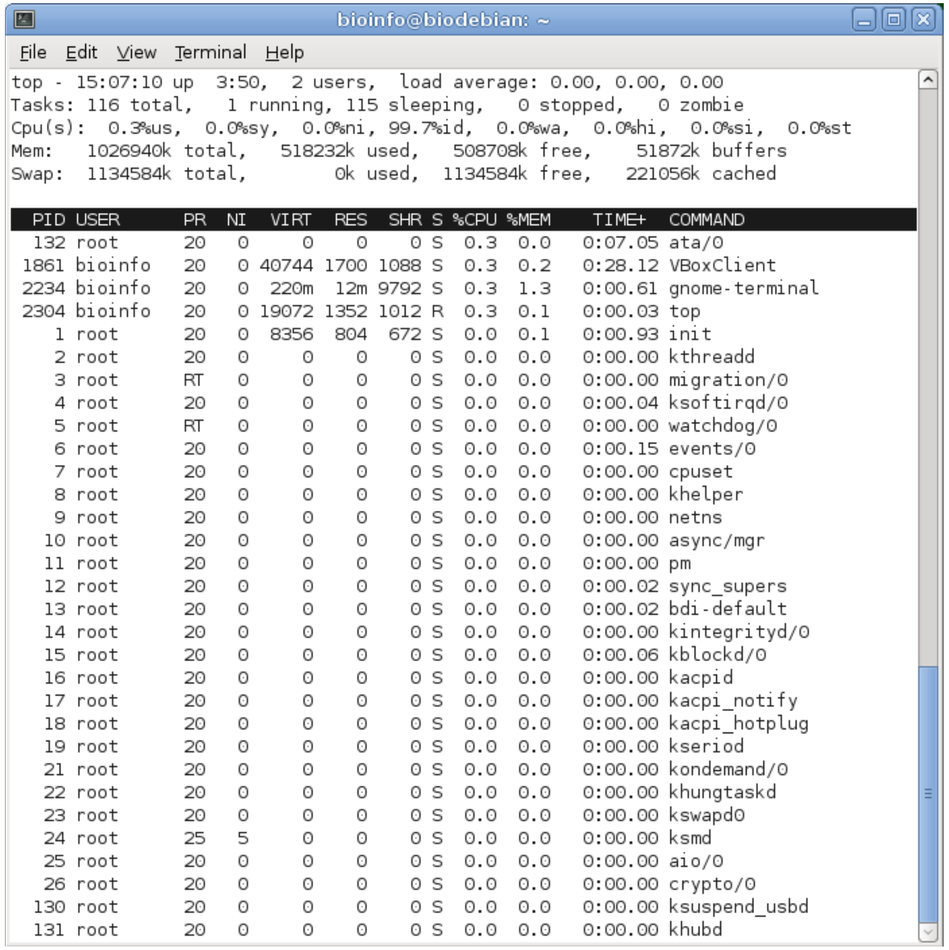
Processes

- Every running program is treated as a process
- Every process has a process ID and an “environment”
- Processes are created only from other processes through a *fork* (parent ID)
- First process is init, with process ID 1
- Viewing processes: ps , jobs , top, pstree
- Terminating processes: kill

Controlling processes

- Interrupting, terminating execution
- control-Z , control-C
- Viewing running jobs (jobs)
- Background/foreground jobs (bg , fg, &)
- Use sleep 100 to test

Top displays and updates sorted information about processes

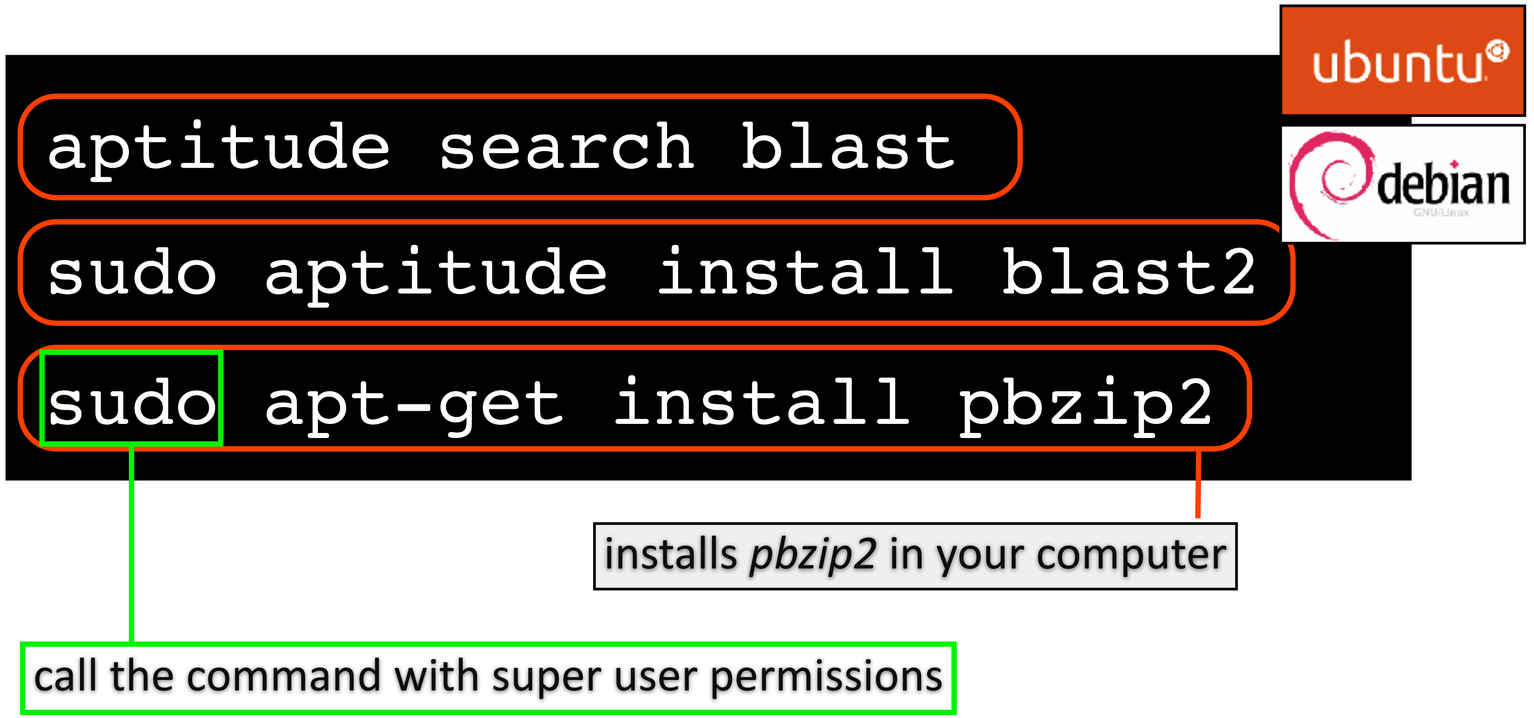


q quit

u user (top -u user)

M sort by memory usage

Commands to install software



Practice Exercises

a) Go to your Desktop directory using the command cd

b) Use the command touch to create a file called:

   Do not Use “special characters” in file names!.txt

c) Use the command rm to delete that file

d) Use the command mkdir to create a folder called unix_data in your desktop

e) Copy the file unix_class_file_samples.zip from your folder Data, in your home, to the folder unix_data, in your desktop

f) Uncompress the file unix_class_file_samples.zip in /home/bioinfo/Desktop/unix_data

g) Use the command rm with the option -r to remove the _MACOSX folder

Solutions

a) `cd Desktop` **(from your home: /home/bioinfo/) or** `cd /home/bioinfo/Desktop` **or** `cd ~/Desktop`

b) `touch Do\ not\ Use\ \“special\ characters\”\ in\ file\ names\!.txt`

c) `rm Do\ not\ Use\ \“special\ characters\”\ in\ file\ names\!.txt` **(use the tab key)**

d) `mkdir unix_data` **(from Desktop: /home/bioinfo/Desktop) or** `mkdir /home/bioinfo/Desktop/unix_data` **or** `mkdir ~/Desktop/unix_data`

e) `cp /home/bioinfo/Data/unix_class_file_samples.zip /home/bioinfo/Desktop/unix_data`

f) `cd /home/bioinfo/Desktop/unix_data` **and then** `unzip unix_class_file_samples.zip`

g) `rm -r _MACOSX`