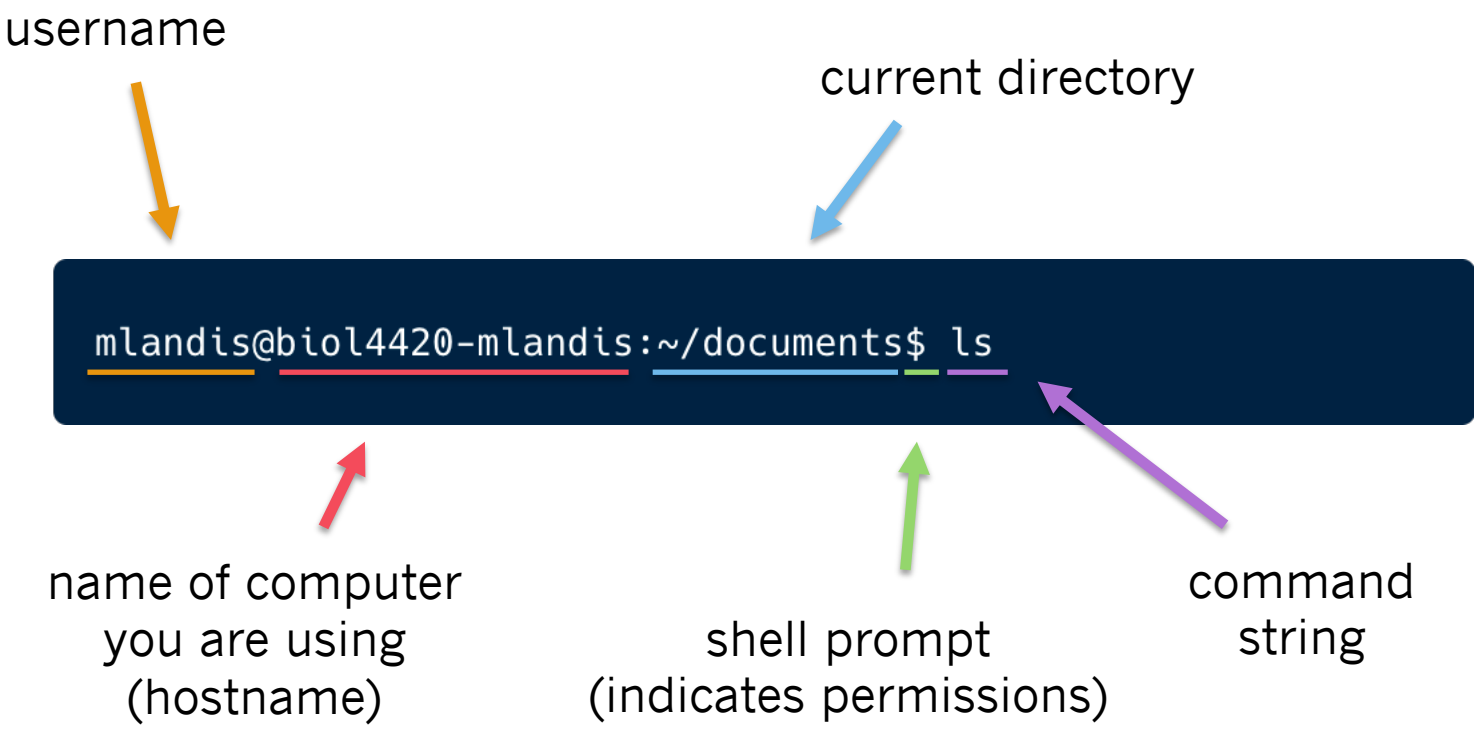
Lecture 02
Unix commands & filesystem

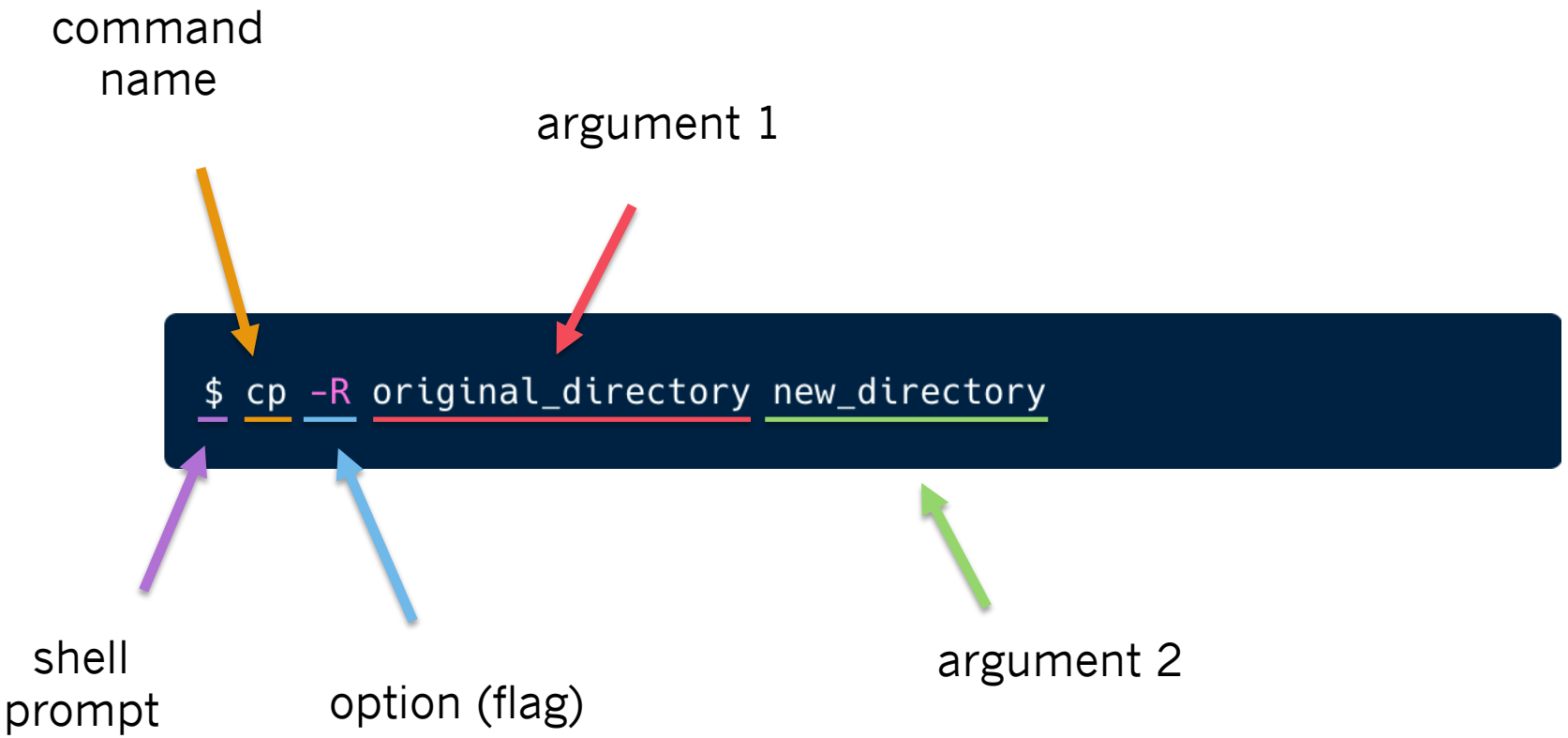
Course: Practical Bioinformatics (BIOL 4220)
Instructor: Michael Landis
Email: michael.landis@wustl.edu

Command line



The ***command line*** accepts commands provided by the user (you!)

Command string



A ***command*** is applied against an ***argument(s)*** and its behavior can be modified by ***option(s)***

Some commands require a specific number of arguments (exactly 0 or 1 or 2 or ...)

```
$ pwd
$ cd documents
$ mv old_name.txt new_name.txt
```

Other commands are flexible

```
$ cat file1.txt file2.txt file3.txt
$ rm tmp1.txt tmp2.txt tmp3.txt
```

Options enable optional(!) extra command features

```
$ ls
$ ls -l -a -r -t
$ ls -lart
```

Some options require arguments

```
$ ssh -p 22 128.252.89.47
```

A ***comment*** is a “non-command” that helps communicate intent to humans

```
$ # list _all_ files by reverse time sort
$ # note: MJL forgot to use the -a flag and accidentally
$ #       deleted all user profiles on 21-08-18
$ ls -lart
```

“Documentation is a love letter that you write to your future self.”

- Damian Conway

Commands are ***executed*** one at a time, and in the order that they are received

```
$ # first we'll create a folder
$ mkdir data
$ # then we'll enter the folder
$ cd data
```

Multiple commands separated by ; can be executed in a single line of text

```
$ # first create then copy output.txt
$ touch output.txt; cp output.txt copy.txt
```

echo, print text

```
$ # `echo` prints the argument(s)
$ # to standard output (stdout)
$ echo Hello, world!
Hello, world!
$ echo GATTACA
GATTACA
```

ls, list files

```
$ # `ls` lists all contents in the current
$ # working directory, printed to stdout
$ ls
labs lectures notes.txt

$ # `ls` accepts target directories as
$ # arguments, too
$ ls labs lectures
labs:
lab_01A  lab_01B
lectures:
lect_01A.pdf  lect_01B.pdf
```

cat, concatenate

```
$ # `cat` concatenates the contents of
$ # one or more files together, then
$ # prints everything to stdout
$ cat hello.txt
Hello,
$ cat world.txt
world!
$ cat hello.txt world.txt
Hello, world!
```

mv, move

```
$ # `mv` moves files and folders within the
$ # filesystem; one use is to rename files
$ ls
notes.txt
$ mv notes.txt old_notes.txt
$ ls
old_notes.txt
```

```
$ # `mv` can rename folders, too
$ ls
lectures
$ mv lectures old_lectures
$ ls
old_lectures
```

cp, copy

```
$ # `cp` copies the first argument (file) to
$ # the second argument (file)
$ ls notes.txt
notes.txt
$ cp notes.txt old_notes.txt
notes.txt  old_notes.txt
```

```
$ # `cp` cannot copy folders (unless option applied)
$ cp lectures old_lectures
cp: lectures is a directory (not copied).
```

rm, remove

```
$ # `rm` removes a file from the filesystem;
$ # removed files are not easily restored!
$ ls
notes.txt
$ rm notes.txt
$ ls

$
```

Unix filesystem

The ***filesystem*** organizes files and folders into a hierarchical structure

- ***files*** contain data, *e.g.*
  - text, programs, music
- ***folders*** contain files and/or other folders

The filesystem also helps secure ***user permissions*** to read/write/execute filesystem objects (*more details later*)

Example filesystem

```
$ tree
.
└── home
    ├── course_project.md
    ├── course_schedule.md
    ├── how_to_guide.md
    ├── labs
    │   ├── lab_01A.md
    │   └── lab_01B.md
    └── lectures
        ├── lect_01A.pdf
        └── lect_01B.pdf

3 directories, 7 files
```

home is the parent directory for *labs;*
labs contains two pdf files

Filesystem paths

A ***path*** is the address of a filesystem object

- the path lists all parent directories, from *deep* to *shallow*, to locate the object
- directories are separated by /
- file paths end with the ***filename,*** *e.g. output.txt*
- folder paths do not end with a filename

```
/home/mlandis/Biol4220/lectures/lect_01B.pdf
```

Filesystem paths

A ***path*** is the address of a filesystem object

- the path lists all parent directories, from *deep* to *shallow*, to locate the object
- directories are separated by /
- file paths end with the ***filename,*** *e.g. output.txt*
- folder paths do not end with a filename

An ***absolute path*** specifies all nested folders, beginning with the deepest folder, the ***root directory***

A ***relative path*** specifies only those folders needed to locate a resource *relative* to your current location in the filesystem

If your current location is */home/mlandis/Biol4220*, these paths refer to the same file

```
/home/mlandis/Biol4220/lectures/lect_01B.pdf
```

```
lectures/lect_01B.pdf
```

Special directories

The ***home directory*** (~) is a shortcut for */home/username*; most of your work takes place in ~

The ***current directory*** (.) is a shortcut for the directory you occupy currently; can be useful to make relative paths explicit

The ***parent directory*** (..) is a shortcut for the directory that *contains* the current directory; useful for moving "up" one directory

These paths are equivalent assuming that you're located in */home*

```
# absolute
/home/mlandis/Biol4420/labs
# relative
mlandis/Biol4220/labs
# using home directory
~/Biol4220/labs
# using current directory (.)
./mlandis/Biol4220/labs
# using parent directory (..)
/home/mlandis/Biol4220/lectures/../labs
```

mkdir, make directory

```
# `mkdir` makes a new directory
# specified by the path argument
~/labs$ ls
# relative path
~/labs$ mkdir lab_01A
~/labs$ ls
lab_01A
# using .. in path
~/labs$ mkdir ../lectures
~/labs$ ls ..
labs  lectures
# absolute path
~/labs$ mkdir /home/mlandis/labs/lab_01B
~/labs$ ls
lab_01A  lab_01B
```

cd, change directory

```
# `cd` changes into the directory
# specified by the path argument
~$ ls
labs
~$ ls labs
lab_01A  lab_01B
# relative path
~$ cd labs/lab_01B
# using .. in path
~/labs/lab_01B$ cd ../lab_01A
# absolute path
~/labs/lab_01A$ cd /home/mlandis
~$
```

rmdir, remove directory

```
# `rmdir` removes and empty directory
# specified by the path argument
~$ ls
labs  lectures
# `labs` isn't empty!
~$ rmdir labs
rmdir: labs: Directory not empty
~$ ls labs
lab_01A  lab_01B
~$ ls labs/lab_01A labs/lab_01B
lab_01A:
lab_01B:
# remove subdirectories
~$ rmdir labs/lab_01A
~$ rmdir labs/lab_01B
# now remove `labs`
~$ rmdir labs
~$ ls
~$
```

cp -R, copy folders

```
# `cp -R` will copy a directory and
# recursively copy all internal
# files and directories
~$ ls lectures
lect_01A.pdf  lect_01B.pdf
# `cp` cannot target directories by default
~$ cp lectures lectures_old
cp: lectures is a directory (not copied).
# add the `-R` flag
~$ cp -R lectures lectures_old
~$ ls
lectures  lecture_old
```

rm -rf, remove completely

```
# WARNING: this is a very dangerous command!
#
# `rm -rf` will remove a file or directory,
# along with all of its contents, without
# any warnings or user interactions
#
$ ls
labs
$ ls labs
lab_01A  lab_01B
$ rmdir labs
rmdir: labs: Directory not empty
$ rm labs
rm: labs: is a directory
$ rm -rf labs
$ ls
$
```

Suppose this lists all filesystem objects

- what directories are shown?
- what files are shown?
- which folder contains three files?
- which folder contains two directories?
- including the root directory, how many directories are in the absolute path for lect_01B.pdf?

```
/home/mlandis/Biol4220
/home/mlandis/Biol4220/notes.txt
/home/mlandis/Biol4220/labs
/home/mlandis/Biol4220/labs/lab_01A.pdf
/home/mlandis/Biol4220/labs/lab_01B.pdf
/home/mlandis/Biol4220/lectures
/home/mlandis/Biol4220/lectures/lect_01A.pdf
/home/mlandis/Biol4220/lectures/lect_01B.pdf
/home/mlandis/Biol4220/lectures/lect_02A_draft.pdf
```

How would you execute this series of commands? (using only what we learned in this lecture)

1. change to the home directory
2. copy the *notes.txt* file into lectures
3. delete the lectures directory
4. copy the labs directory into your home directory

```
/home/mlandis/Biol4220
/home/mlandis/Biol4220/notes.txt
/home/mlandis/Biol4220/labs
/home/mlandis/Biol4220/labs/lab_01A.pdf
/home/mlandis/Biol4220/labs/lab_01B.pdf
/home/mlandis/Biol4220/lectures
/home/mlandis/Biol4220/lectures/lect_01A.pdf
/home/mlandis/Biol4220/lectures/lect_01B.pdf
/home/mlandis/Biol4220/lectures/lect_02A_draft.pdf
```

Overview for Lab 02