EEB 177 Lecture 4

Topics

- Advanced shell commands
- Permissions
- Intro to Python

Office Hours

Tues, Wednesday 11-12

Hershey Courtyard (inside Hershey Hall)

Terasaki 2149 on rainy days

Hacking Sessions

This Thursday from 6-8 in LS 3209

Homework #2

Due this Friday by 5:00 PM

Preliminaries

- Start gedit: `$ gedit` and save the file "classwork-Tuesday-1-24.txt" to your class-assignments directory
- push this to your remote repository
- you can write answers to today's exercises in this file.

wget

wget retrieves files from a web address. Lets try it!

change to the `/sandbox` directory in `CSB/unix`

then...

```
wget http://tinyurl.com/cep-taxa -O cep-taxa.txt
```

this retrieves the remote file and renames it.

grep review

. Grep is a powerful pattern matching command that can be combined with the regular expressions you used in lab.

Useful grep options:

- `-c` to count lines
- `-w` to match words
- `-i` to make case insensitive
- `-n` to show line number of match.

use grep to find all of the protected orchids (Orchidaceae) in this list

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```
grep Orchidaceae cep-taxa.txt
```

how could you count these lines?

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```

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```
grep -c Orchidaceae cep-taxa.txt
```

use grep to find all of the falcons in this list.

try searching for `falcon`. Then try searching for `Falcon`. What is going on? How can you find occurrences regardless of case?

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```
grep -i falcon cep-taxa.txt
```

Macaws are in the genus Ara. Find all of the macaws in this list regardless of case. What is the problem now?

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How can you solve it?

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How can you solve it?

```
grep -i -w ara cep-taxa.txt
```

Other grep options

`-B X` finds x lines before

`-A X` finds X lines after

find the 3 lines before all occurrences of Cebus.

Other grep options

`-n` shows the line number of the match.

what are the line numbers of all iguanas in the file?

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what are the line numbers of all iguanas in the file?

```
grep -i -n -w iguana cep-taxa.txt
```

finding all lines that do not match

`-v` returns everything that does not match the grep pattern

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How many lines do not match ara?

what are the line numbers of those lines?

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`-v` returns everything that does not match the grep pattern

How many lines do not match ara?

```
grep -i -v -c ara cep-taxa.txt
```

what are the line numbers of those lines?

```
grep -i -v -n ara cep-taxa.txt
```

#finding files with `find`

`find` allows you to search for files with specified attributes.

use the wildcard `.*` to find everything in your sandbox directory.

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`find .`

```
.
./temp.txt
./cep-taxa.txt
./.gitignore
./junk
...
```

if you pass find a path it will give all files and folders in that directory

```
find ../data/
```

```
../data
../data/toremove.txt
../data/Gesquiere2011_data.csv
../data/Saavedra2013_about.txt
...
```

if you pass find a path it will give all files and folders in that directory

```
find ../data/
```

```
../data
../data/toremove.txt
../data/Gesquiere2011_data.csv
../data/Saavedra2013_about.txt
...
```

count all of the files and folders within `../data/`

`find` options

You can search for a specific file with `-name`

```
find ../data/ -name "n30.txt"
```

This can be helpful when you don't know exactly where you left a file.

```
find /home/eeb-177-student/Desktop/ -name "classwork-Tues-1-17.txt"
```

```
/home/eeb-177-student/Desktop/eeb-177/class-assignments/c
```

`find` gets even more powerful with wildcards.

for example, to find all of the files with `about` in the data directory....

```
find /home/eeb-177-student/Desktop/eeb-177/CSB/unix/ -iname "*about*"
```

```
/home/eeb-177-student/Desktop/eeb-177/CSB/unix/data/Saave
/home/eeb-177-student/Desktop/eeb-177/CSB/unix/data/Marra
/home/eeb-177-student/Desktop/eeb-177/CSB/unix/data/Pacif
```

note that `-iname` ignores the case in the file names

find the path to all of your classwork files and append these to you classwork file for today.

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```
find /home/eeb-177-student/Desktop/ -iname "*class**" >> /home/eeb-177-student/Desktop/eeb-177/class-assignments/classwork-Tues-1-24.txt
```

specifying the depth of the search

to restrict the depth in the folder hierarchy of the search, use the `-maxdepth N` option.

What will this line do?

```
$ find ../data -maxdepth 1 -name "*.txt" | wc -l
```

How many text files are there in `../data` if you do not restrict the depth?

You can exclude certain files with `not`

```
find ../data/ -not -name "*about*" | wc -l
```

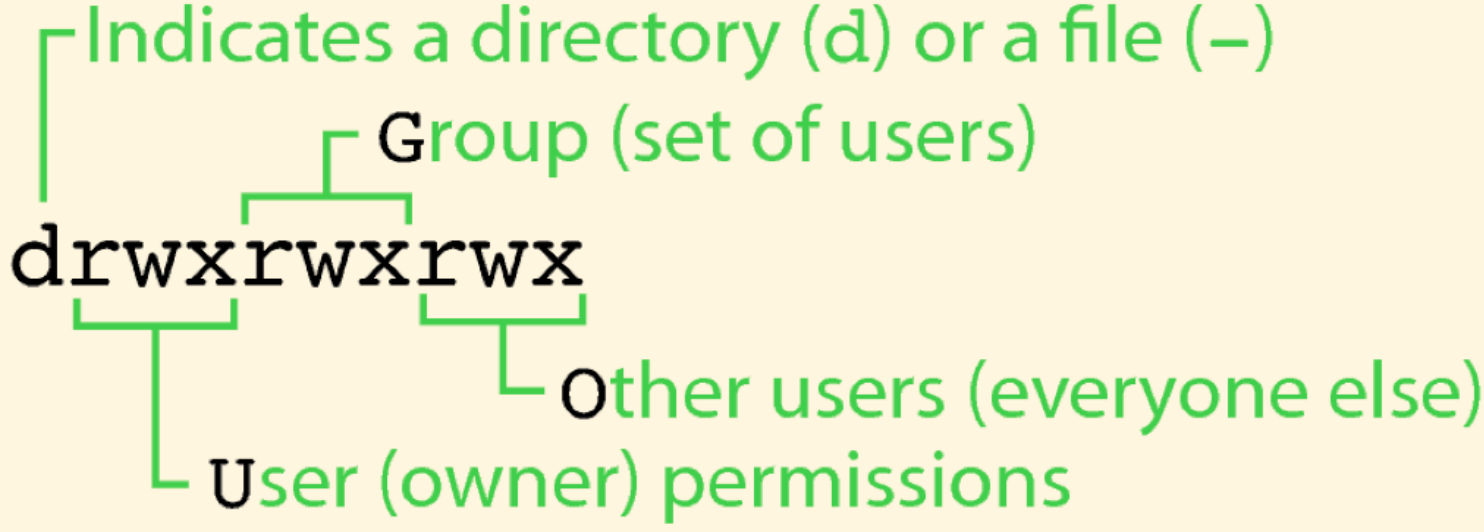
Permissions

In Unix, each file and directory has an attribute that determines who can read (r), write (w), execute (x), or do nothing (-) to a file. There are three categories of file users

- owner
- group (set of users)
- everyone else

you can see permissions with `ls -l`

permissions structure



`chmod` and `chown`

These commands change permissions and ownwership (`u` , `g` , or `o` for user, group or other).

```
touch permissions.txt
ls -l
```

```
-rw-rw-r-- 1 eeb-177-student eeb-177-student 0 Jan 24 07:
```

```
chmod u=rwx permissions.txt
ls -l
-rwxrw-r-- 1 eeb-177-student eeb-177-student     0 Jan 24
```

notice that the user may now execute this file.

you can also add and remove permissions for a user with `+` and `-`.

```
chmod g+w,u+x permissions.txt
ls -l permissions.txt
-rwxrw-rw-
```

Add write permissions for all users.

Remove read, write, and execute permission from others

text editor that will execute a series of shell commands that you have already learned.

open up gedit and type the following lines:

```
#! /bin/bash
ls -la
echo "Above are the directory listings for this folder"
pwd
echo "right now it is :
date
```

save this file as dir.sh

Paths

there are two standard locations for programs-- `/usr/bin` and `/bin`

use `ls` to see what is in them

Creating a scripts directory and adding it to the path

we want a single working copy of each program on our machines so we need to make sure the shell searches for our programs....

- go to your home directory
- create a directory called `scripts`
- to add the scripts directory to the path, open the `.bash_profile` file in gedit
- add this line (exactly) `export PATH="$PATH:$HOME/scripts"`
- exit and save

Now we have created a program we would like to run and created a path to the scripts directory. What else do we need to do?

hint: where is `dir.sh` right now?

hint: what permissions do we need to execute a script?

the shebang (#!)

`#!` is called the shebang--it means that all following contents of script will be sent to the program following the shebang

`#! /bin/bash` sends it all to bash

remember,new scripts are not executable w/o changing permissions

checking permissions

- cd ~/scripts
- check permission with ls -l
- add permission to execute with chmod u+x

try running your program from different directories. Does it work? Why?

exercise

Add your scripts directory to your remote repository. You will need to

- `git init` in your scripts directory
- add your script
- commit your script
- create a remote repo on github
- copy and paste the command lines from the remote repo after you create it.

```
git remote add origin https://github.com/michaelalfaro/eel
git push -u origin master
```

you will be using your scripts directory throughout the quarter, so make sure this repo is working

Programming languages

- There are over 2000
- There is no perfect language for all tasks
- You are already learning several: regular expressions, python, R
- This class does not cover fast, compiled languages like C. Useful for heavy computational tasks

Why `Python`?

- easy to teach
- readable
- powerful string manipulation, web scraping, and other capabilities
- helps enforce good programming practices

Getting started with python

- Python should already be installed on your VM

```
$ ipython
IPython 2.2.0 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's featu
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object', use 'object??' for e
In [1]: import scipy
```

to exit ipython: CTRL-D CTRL-D to exit

IPython interactive mode

You can use python and IPython from the command prompt.

```
In [1]: 2 + 2
Out[1]: 4

In [6]: 2 > 3
Out[6]: False

In [11]: "I'm fine, " + "thank you"
Out[11]: "I'm fine, thank you"
```

try it out....

Python operators

```
+ Addition
- Subtraction
* Multiplication
/ Division
** Power
% Modulo
// Integer division == Equals
!= Differs
> Greater
>= Greater or equal &, and Logical and |, or Logical or
!, not Logical not
```

Variables

You typically manipulate variables in programming languages.

```
In [12]: x = 5
In [13]: x
Out[13]: 5
In [14]: x + 3
Out[14]: 8
In [15]: y = 8
In [16]: x + y
Out[16]: 13
In [17]: x = "My string"
In [18]: x + " is now longer"
Out[18]: "My string is now longer"
In [19]: x + y
TypeError: cannot concatenate "str" and "int" objects
```

Python recognizes variable types and methods for converting among them

```
In [20]: x
Out[20]: "My string"
In [21]: y
Out[21]: 8
In [22]: x + str(y)
Out[22]: "My string8"
In [23]: z = "88"
In [24]: x + z
Out[24]: "My string88"
In [25]: y + int(z)
Out[25]: 96
```

Collections

Python has variables that are collections of other objects. lists are collections of ordered values and are defined by `[]`.

```
# Anything starting with # is a comment
In [26]: MyList = [3,2.44,"green",True]
In [27]: MyList[1]
Out[27]: 2.44
In [28]: MyList[0] # NOTE: FIRST ELEMENT -> 0
Out[28]: 3
In [29]: MyList[3]
Out[29]: True
In [30]: MyList[4]
IndexError: list index out of range
In [31]: MyList[2] = "blue"
In [32]: MyList
Out[32]: [3, 2.44, "blue", True]
```

note that indexing in python starts at 0.

{.smaller}

append, sort, and count are methods that work on lists

```
In [33]: MyList[0] = "blue"
In [34]: MyList
Out[34]: ["blue", 2.44, "blue", True]
In [35]: MyList.append("a new item")
In [36]: MyList
Out[36]: ["blue", 2.44, "blue", True, "a new item"]
In [37]: MyList.sort()
In [38]: MyList
Out[38]: [True, 2.44, "a new item", "blue", "blue"]
In [39]: MyList.count("blue")
Out[39]: 2
```

More list operations

Try these

```
In [71]: apes = ["Homo sapiens", "Pan troglodytes", "Gori
In [72]: #how long is list?
In [73]: len(apes)
Out[73]: 3
In [74]: #index elements with brackets
In [75]: apes[1] # what element will this be
Out[75]: 'Pan troglodytes'
In [76]: apes.reverse() #lists are ordered
In [77]: apes[0]
Out[77]: 'Gorilla gorilla'
#if you know the element but do not know position, use in
In [78]: apes.index("Homo sapiens")
Out[78]: 2
#get the last element of any list with [-1]
In [79]: apes[-1]
Out[79]: 'Homo sapiens'
```

Subsetting lists

You can make a new list by telling python the elements of the original list to include

```
ranks = ["kingdom","phylum", "class", "order", "family"]
In [81]: ranks
Out[81]: ['kingdom', 'phylum', 'class', 'order', 'family'
lower_ranks = ranks[2:5]
In [83]: lower_ranks
Out[83]: ['class', 'order', 'family']
```

Note how python indexing works:numbers are inclusive at the start and exclusive at the end.

Appending to lists

Try this

```
apes = ["Homo sapiens", "Pan troglodytes", "Gorilla goril
print("There are " + str(len(apes)) + " apes")
apes.append("Pan paniscus")
print("Now there are " + str(len(apes)) + " apes")
```

append() changes the variable in place!

+ and extend

Try this

```
apes = ["Homo sapiens", "Pan troglodytes", "Gorilla goril
monkeys = ["Papio ursinus", "Macaca mulatta"]
primates = apes + monkeys
print(str(len(apes)) + " apes")
print(str(len(monkeys)) + " monkeys")
print(str(len(primates)) + " primates")

platyrrhines = ["Cebus", "Sapajus", "Aotus"]
monkeys.extend(platyrrhines)
print monkeys
```

{.smaller}

Dictionaries are collections of key-value pairs. Very useful for data without a natural order. Defined by `{}`.

```
In [1]: GenomeSize={"Homo sapiens": 3200.0,
  "Escherichia coli": 4.6, "Arabidopsis thaliana": 157.0}
In [2]: GenomeSize
Out[2]:
{"Arabidopsis thaliana": 157.0,
 "Escherichia coli": 4.6,
 "Homo sapiens": 3200.0}
```

You can access the value of a dictionary by suppling the key for that pair.

```
In [3]: GenomeSize["Arabidopsis thaliana"]
Out[3]: 157.0
In [4]: GenomeSize["Saccharomyces cerevisiae"] = 12.1
In [5]: GenomeSize
Out[5]:
{"Arabidopsis thaliana": 157.0,
 "Escherichia coli": 4.6,
 "Homo sapiens": 3200.0,  "Saccharomyces cerevisiae": 12.
```

Adding keys and changing values in dictionaries

```
# ALREADY IN DICTIONARY!
In [6]: GenomeSize["Escherichia coli"] = 4.6
In [7]: GenomeSize
Out[7]:
{"Arabidopsis thaliana": 157.0,
 "Escherichia coli": 4.6,
 "Homo sapiens": 3200.0,
 "Saccharomyces cerevisiae": 12.1}
In [8]: GenomeSize["Homo sapiens"] = 3201.1
In [9]: GenomeSize
Out[9]:
{"Arabidopsis thaliana": 157.0,
 "Escherichia coli": 4.6,
 "Homo sapiens": 3201.1,
 "Saccharomyces cerevisiae": 12.1}
```

Creating dictionaries

You will often create a dictionary and then populate it. Try this!

```
enzymes = {}
enzymes['EcoRI'] = r'GAATTC' # r before the string tells
enzymes['AvaII'] =  r'GG(A|T)CC'
enzymes['BisI'] =  r'GC[ATGC]GC'
enzymes.keys()
enzymes.values()
```

You can use zip() to turn two lists into a dictionary

```
keys = ('name', 'age', 'food')
values = ('Monty', 42, 'spam')
zip(keys, values) #makes a list of tuples
my_new_dict = dict(zip(keys, values))
my_new_dict
```

tuples contain sequences that are immutable and are defined by ().

```
In [12]: FoodWeb=[("a","b"),("a","c"),("b","c"),("c","c")
In [13]: FoodWeb[0]
Out[13]: ("a", "b")
In [14]: FoodWeb[0][0]
Out[14]: "a"
# Note that tuples are "immutable"
In [15]: FoodWeb[0][0] = "bbb"
TypeError: "tuple" object does not support item assignmen
In [16]: FoodWeb[0] = ("bbb","ccc")
In [17]: FoodWeb[0]
Out[17]: ("bbb", "ccc")
```

Use tuples when order matters.

sets are lists without duplicate elements

```
In [1]: a = [5,6,7,7,7,8,9,9]
In [2]: b = set(a)
In [3]: b
Out[3]: set([8, 9, 5, 6, 7])
In [4]: c=set([3,4,5,6])
In [5]: b & c
Out[5]: set([5, 6])
In [6]: b | c
Out[6]: set([3, 4, 5, 6, 7, 8, 9])
In [7]: b ^ c
Out[7]: set([3, 4, 7, 8, 9])
```

The operations are: Union | (or); Intersection & (and); symmetric difference (elements in set b but not in c and in c but not in b), ^; and so forth.

You can concatenate similar collection elements with +

```
In [1]: a = [1, 2, 3]
In [2]: b = [4, 5]
In [3]: a + b
Out[3]: [1, 2, 3, 4, 5]
In [4]: a = (1, 2)
In [5]: b = (4, 6)
In [6]: a + b
Out[6]: (1, 2, 4, 6)
In [7]: z1 = {1: "AAA", 2: "BBB"}
In [8]: z2 = {3: "CCC", 4: "DDD"}
In [9]: z1 + z2
     ---------------------------------------
     TypeError  Traceback (most recent call last)
     ----> 1 z1 + z2
TypeError: unsupported operand type(s) for +: "dict" and "
```

Python programming best practices

We will try to instill as many standard practices as we can at the beginning.

- Wrap lines so that they are less than 80 characters long. You can use parentheses () or signal that the line continues using a "backslash" .
- Use 4 spaces for indentation, no tabs.
- Separate functions using a blank line.
- When possible, write comments on separate lines.
- Use docstrings to document how to use the code, and comments to explain why and how the code works.

best practices continued

- Naming conventions:
- _internal_global_variable
- a_variable
- SOME_CONSTANT
- a_function
- Nevercallavariablel 1 or O or o
- use two or more letters for variables: xx better than x
- Use spaces around operators and after commas:
  a = func(x, y) + other(3, 4).