# Unix

Bioinformatics Applications (PLPTH813)

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# Review

- **Flat file**

Two types of line feed (LF, \n) and carriage return (CR, \r)

- **Excel functions** (average, vlookup, ...)

- **Regular expression**

e.g., 1) T{10,12} 2) ^$

- ***vi* has two modes:**
  1. insert mode
  2. command mode

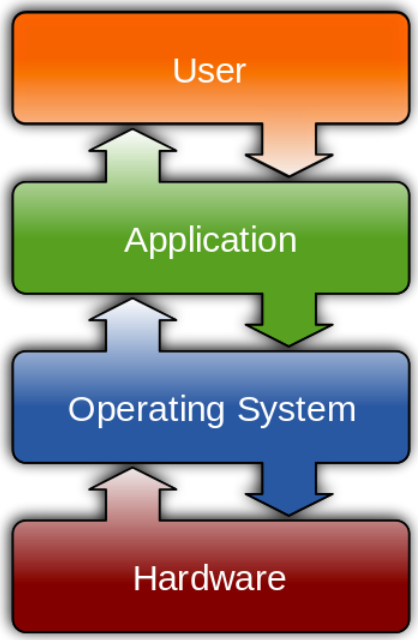
# Today

- What is Unix?
- Why do we need to learn Unix?
- Useful commands

# Unix is one of Operating Systems (OSs)

www.cj-computers.com

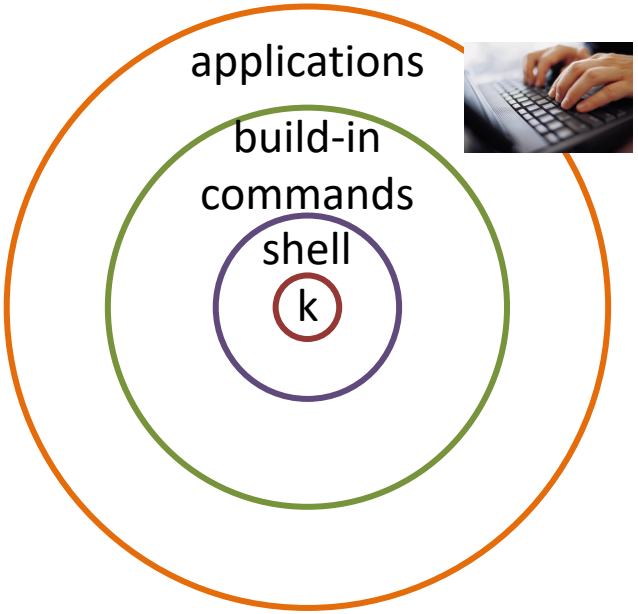
OS, Linux, Window




wikipedia.com

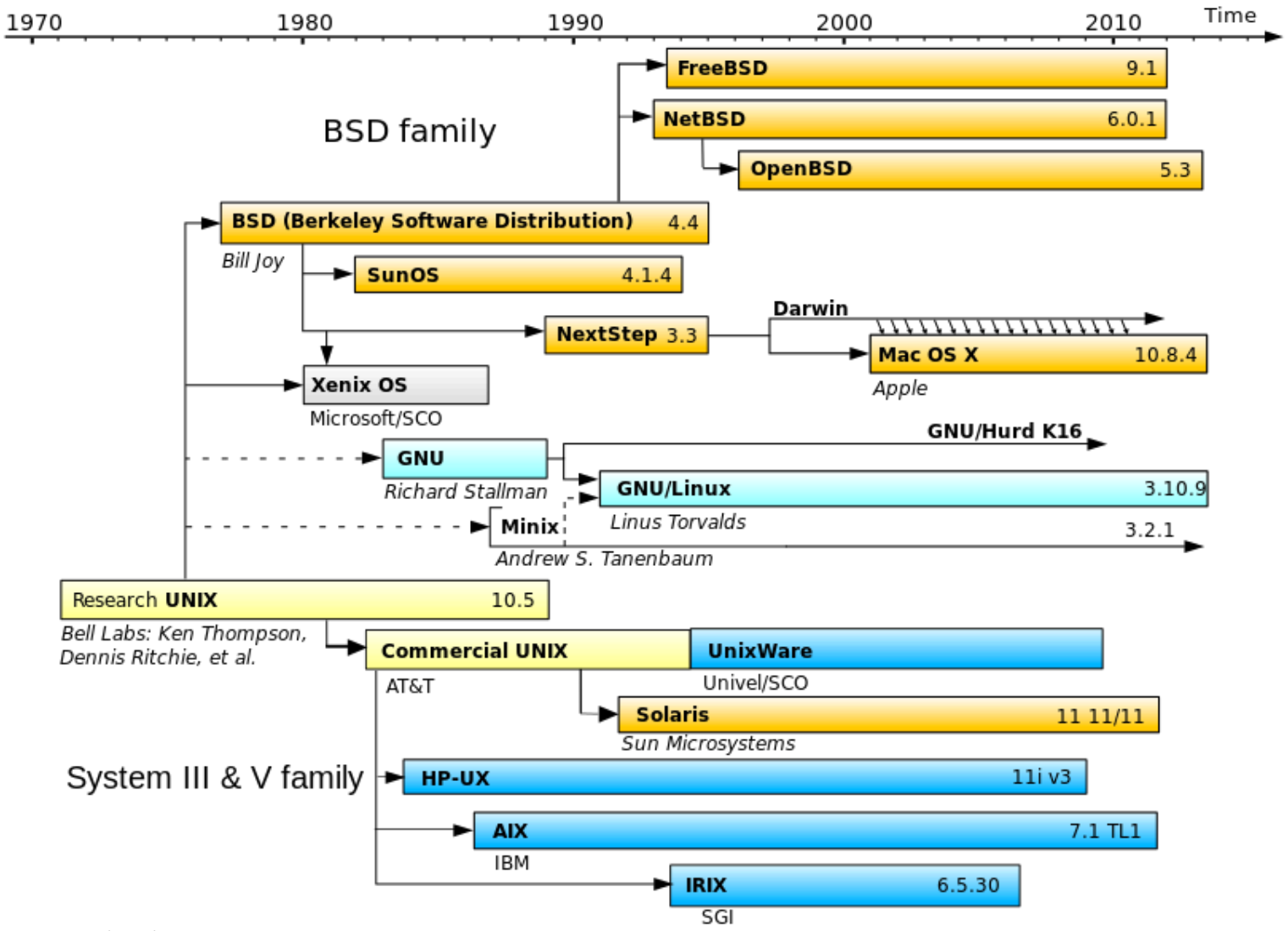
- Control Hardware
- Run Applications
- Manage Data

# Parts of Unix OS




- **kernel** (k) - provides the basic software connection to the hardware, managing memory, schedules, and input/output.
- **shell** - as an interpreter to translate commands and pass them to the kernel for execution.
- **build-in commands** - are the built-in system utilities that provide users basic functions, such as content listing (ls), file copying (cp).
- **applications** - are additional application programs.

# Evolution of UNIX-based Operating Systems




en.wikipedia.org/wiki/Unix-like

# Linux Distributions


cpagnews.com/

**Liu lab**
Ubuntu
VERSION=18.04.1 LTS
ID_LIKE=debian

**Beocat**
CentOS
VERSION=7
ID_LIKE=rhel fedora

**Change the following three file names to file names ended up with .fasta**
a.txt b.txt c.txt

Ubuntu:
rename 's/txt/fasta/' *txt

gentoo:
rename 'txt' 'fasta' *txt

# Why do we need to learn Unix?

- To access to powerful computer servers ( e.g., to enable to handle large data)
- To use advanced tools in research projects (most genomic software packages are run in the Unix system)
- To perform **reproducible** data analyses

*... maybe, easier to find a job*

# The terminal emulator

A terminal emulator allows users to access to a computer or server.

**Mac OS X:**

**Terminal**

iterm2

**Linux:**

**Linux console**

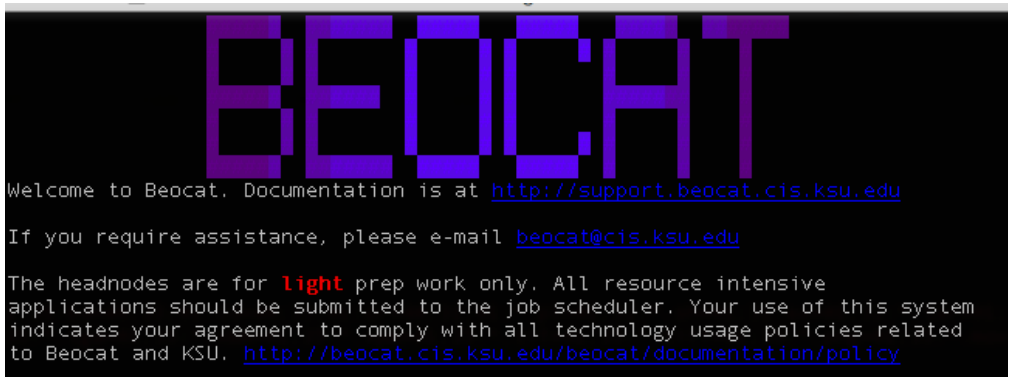
**Microsoft Windows:**

**PuTTY**

AbsoluteTelnet

Mintty

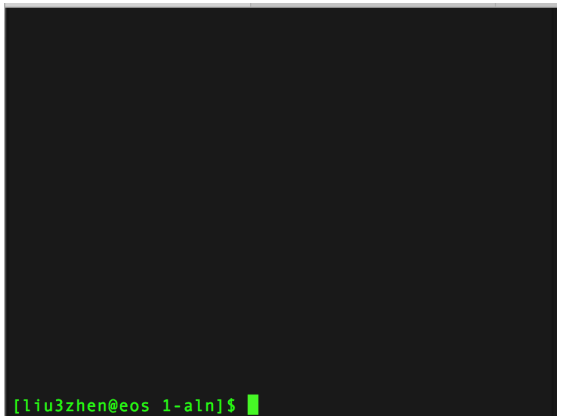
xterm



# Imaging ...

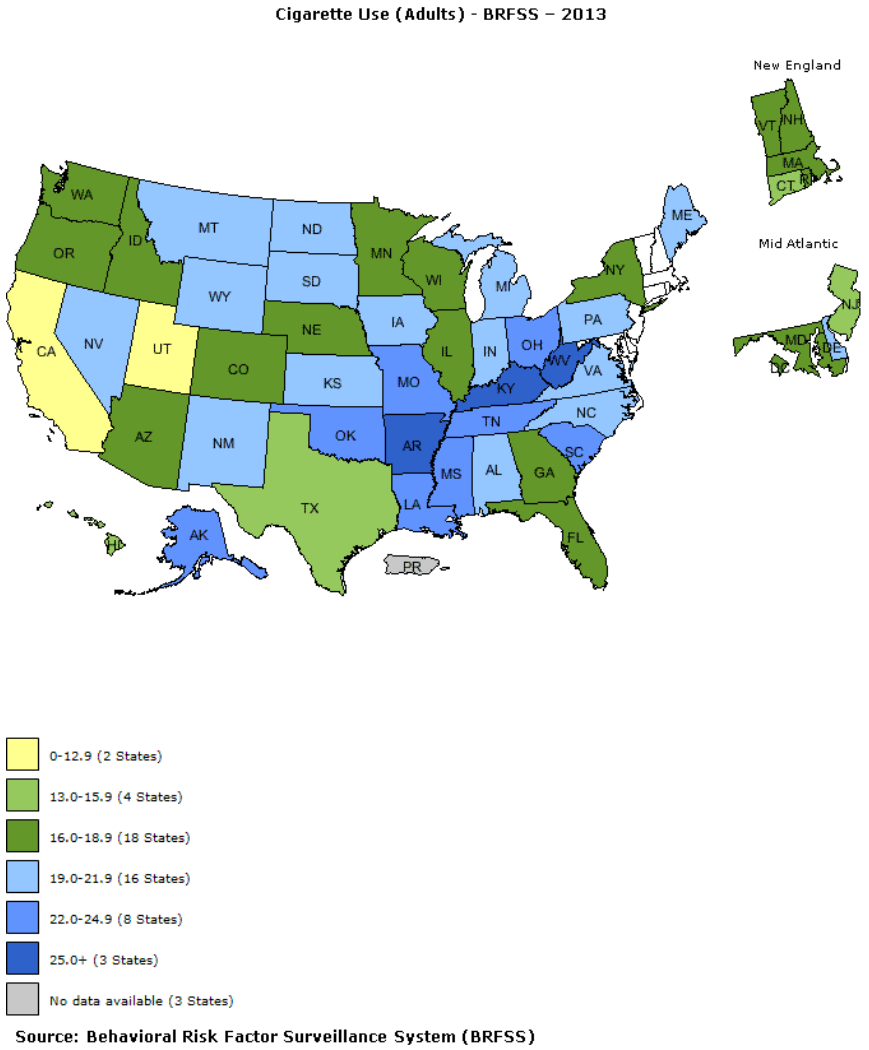
If you are working on data using an OS platform, what

*basic operations* are needed?



# file systems

# Example datasets




| State | Adult Cigarette Use (%) |
|---|---|
| Alabama | 21.5 |
| Alaska | 22.6 |
| … | … |

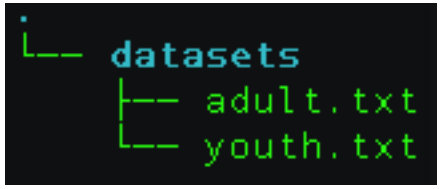
adult.txt

| State | Youth Cigarette Use (%) |
|---|---|
| Alabama | NA |
| Alaska | 10.6 |
| Arizona | 14.1 |
| Arkansas | 19.1 |
| California | NA |
| Colorado | NA |
| Connecticut | 13.5 |
| Delaware | 14.2 |
| District of Columbia | NA |
| … | … |

youth.txt

# Directories and files

Under the directory:
`/homes/liu3zhen/teaching/BA2021`




**Absolute path**

- `/homes/liu3zhen/teaching/BA2021`

**Relative path**

- . (current directory)
- .. (parental directory)
- ~ (home directory, e.g., /homes/liu3zhen)

# cd, mkdir, pwd

Directory: /homes/liu3zhen/teaching/BA2021/datasets

- **cd** - change the working directory

```
% cd /homes/liu3zhen/teaching/
% cd ..
% cd ~
% cd ~/teaching/BA2021/datasets/
```

- **mkdir** - make directories

```
% mkdir xxx
```

- **pwd** - print name of current working directory

```
% pwd
```

# ls

- **ls** – list directory contents

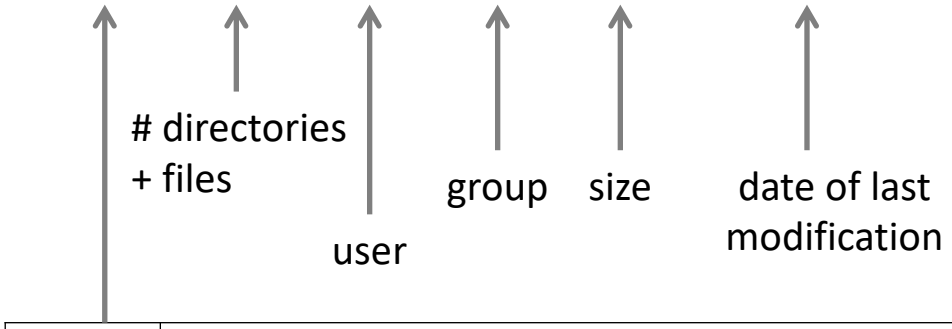
```
% ls
Adult.txt youth.txt

% ls -1
Adult.txt
Youth.txt

% ls -la
# -la = -l & -a, long format and list all files
Total 4
drwxr-xr-x 2 liu3zhen liulab 4096 Jan  1 15:44 .
drwxr-xr-x 3 liu3zhen liulab 4096 Jan  1 13:51 ..
-rw-r--r-- 1 liu3zhen liulab  887 Jan  1 14:03 adult.txt
-rw-r--r-- 1 liu3zhen liulab  869 Jan  1 14:03 youth.txt
```

# File information

```
drwxr-xr-x 2 liu3zhen liulab 4096 Jan  1 15:44 .
drwxr-xr-x 3 liu3zhen liulab 4096 Jan  1 13:51 ..
-rw-r--r-- 1 liu3zhen liulab  887 Jan  1 14:03 adult.txt
-rw-r--r-- 1 liu3zhen liulab  869 Jan  1 14:03 youth.txt
```




| Position | Meaning |
|---|---|
| 1 | "d" if a directory, "-" if a normal file |
| 2, 3, 4 | read, write, execute permission for **user** (owner) of file |
| 5, 6, 7 | read, write, execute permission for **group** |
| 8, 9, 10 | read, write, execute permission for **other** (world) |

**drwxr-xr-x**

**-r-xr-xrwx**

# chmod

- **chmod** - change the access permissions to files and directories

```
-rw-r--r-- 1 liu3zhen liu3zhen_users  887 Jan  1 14:03 adult.txt
```

```
% chmod g+w adult.txt
```

```
-rw-rw-r-- 1 liu3zhen liu3zhen_users  887 Jan  1 14:03 adult.txt
```

```
% chmod ug-w adult.txt
```

```
-r--r--r-- 1 liu3zhen liu3zhen_users  887 Jan  1 14:03 adult.txt
```

```
% chmod u+w,go-r adult.txt
```

```
-r-------- 1 liu3zhen liu3zhen_users  887 Jan  1 14:03 adult.txt
```

- *u (user), g (group), o (other), a (all)*
- *Operators: + (add), - (remove), = (specify the exact mode)*

# cp, mv, rm

- **cp** - copy files and directories

cp <oldfile> <newfile>

```
% cp adult.txt adult.tmp.txt
```

- **mv** - move (rename) files

mv <oldfile> <newfile>

```
% mv adult.tmp.txt adult.second.txt
```

- **rm** - remove files or directories

rm <filename>

rm <directory> -r

```
% rm adult.second.txt
```

# contents of files

# head/tail

## **head** - output the first part of files

```
% head adult.txt
```

```
# Cigarette Usage (Adult 2013)
# Source: Behavioral Risk Factor Surveillance System
# http://apps.nccd.cdc.gov/statesystem
State    Adult Cigarette Use (%)
Alabama        21.5
Alaska  22.6
Arizona        16.3
Arkansas       25.9
California     12.5
Colorado       17.7
```

-n <number of lines>

## **tail** - output the last part of files

```
% tail adult.txt
```

```
South Dakota 19.6
Tennessee      24.3
Texas  15.9
Utah   10.3
Vermont        16.6
Virginia       19
Washingon      16.1
West Virginia 27.3
Wisconsin      18.7
Wyoming        20.6
```

# more/less

**more** and **less** display contents of large files page by page or scroll line by line up and down.

less ("less is more") a bit more smart than more:

```
% less filename
```

To display line numbers:

```
% less -N filename
```

```
% more adult.txt
% less adult.txt
```

# cat, paste

- **cat** - concatenate files and print on the **standard output**

```
% cat adult.txt youth.txt > two.cat.txt
```

**# “>” redirect the output**

- **paste** - merge lines of files

```
% paste adult.txt youth.txt > two.merge.txt
```

| State | Adult Cigarette Use (%) | State | Youth Cigarette Use (%) |
|---|---|---|---|
| Alabama | 21.5 | Alabama | NA |
| Alaska | 22.6 | Alaska | 10.6 |
| … | … | … | … |

# wc

- **wc** - print line, word, and byte counts for each file

```
% wc adult.txt
```

55 133 887 adult.txt

```
% wc -l adult.txt
```

55 adult.txt

```
% wc -l two.cat.txt
```

110 two.cat.txt

# grep

- **grep** - print lines matching a pattern

grep <pattern> filename

```
% grep "Kansas" adult.txt
Kansas 20
```

```
% grep "#" adult.txt
# Cigarette Usage (Adult 2013)
# Source: Behavioral Risk Factor Surveillance System
# http://apps.nccd.cdc.gov/statesystem
```

# grep examples using regular expression

```
% grep -e Kansas -e Alaska adult.txt
Alaska  22.6
Kansas  20

% grep -v -e Kansas -e Alaska adult.txt
```

```
% grep "^>" fasta.file
% grep "^>" fasta.file -c
% grep "^>" fasta.file -v
```

http://www.thegeekstuff.com/2009/03/15-practical-unix-grep-command-examples

# grep examples using regular expression

```
% grep -e Kansas -e Alaska adult.txt
Alaska  22.6
Kansas  20

% grep -v -e Kansas -e Alaska adult.txt


% grep "^>" fasta.file  # names of sequences
% grep "^>" fasta.file -c  # number of sequences
% grep "^>" fasta.file -v  # sequence lines
```

http://www.thegeekstuff.com/2009/03/15-practical-unix-grep-command-examples

# cut

- **cut** - select sections from each line of file

| State | Adult Cigarette Use (%) | State | Youth Cigarette Use (%) |
|---|---|---|---|
| Alabama | 21.5 | Alabama | NA |
| Alaska | 22.6 | Alaska | 10.6 |
| … | … | … | … |

```
% cut two.merge.txt -f 2
```

| Adult Cigarette Use (%) |
|---|
| 21.5 |
| 22.6 |
| … |

```
% cut two.merge.txt -f 1,2,4
```

| State | Adult Cigarette Use (%) | Youth Cigarette Use (%) |
|---|---|---|
| Alabama | 21.5 | NA |
| Alaska | 22.6 | 10.6 |
| … | … | … |

# The concept of “pipe”

- Pipe is a method of inter-process communication
- Pipe collects the output of one program on the left side and inputs the collected data to the program on right side
- | is the pipe symbol
- Combining programs with different functions into one to tackle more complicated tasks


head input -n 10 | tail -n 1

$10^{th}$ line of the input

# Problem

Please apply **grep, head,** and **tail** to extract the 4th line that is not started with "#" from the file of "adult.txt".

```
% head adult.txt
# Cigarette Usage (Adult 2013)
# Source: Behavioral Risk Factor Surveillance System
# http://apps.nccd.cdc.gov/statesystem
State Adult Cigarette Use (%)
Alabama 21.5
Alaska 22.6
Arizona 16.3
Arkansas 25.9
California 12.5
Colorado 17.7
```

# Pipe example

| State | Adult Cigarette Use (%) | State | Youth Cigarette Use (%) |
|---|---|---|---|
| Alabama | 21.5 | Alabama | NA |
| Alaska | 22.6 | Alaska | 10.6 |
| … | … | … | … |

```
% paste adult.txt youth.txt | grep "#" -v | cut -f 1,2,4 | head
```

| State | Adult Cigarette Use (%) | Youth Cigarette Use (%) |
|---|---|---|
| Alabama | 21.5 | NA |
| Alaska | 22.6 | 10.6 |
| Arizona | 16.3 | 14.1 |
| Arkansas | 25.9 | 19.1 |
| California | 12.5 | NA |
| Colorado | 17.7 | NA |
| Connecticut | 15.5 | 13.5 |
| Delaware | 19.6 | 14.2 |
| District of Columbia | 18.8 | NA |

# sort - sort lines of text files

**cat fruit.txt**

```
orange  8
apple   6
peach   12
banana  5
```

**sort fruit.txt**

```
apple   6
banana  5
orange  8
peach   12
```

**sort -k 2 fruit.txt**

```
peach   12
banana  5
apple   6
orange  8
```

**sort -k 2n fruit.txt**

```
banana  5
apple   6
orange  8
peach   12
```

**sort -k 2nr fruit.txt**

```
peach   12
orange  8
apple   6
banana  5
```

**sort -k 1,2 fruit.txt**

```
apple   6
banana  5
orange  8
peach   12
```

http://www.theunixschool.com/2012/08/linux-sort-command-examples.html

# **find** - search for files in a directory hierarchy

```
find [pathnames] [conditions]

# Finding files >10M
find . -size +10M

# Finding files <10M
find . -size -10M

# find a file
find -name "fruit.txt"

# find a file in the current directory
find -maxdepth 1 -name "fruit.txt"
```

# find - II

```
# find files containing a specific word in its name
find -name "fruit*"

# find files whose name are not "fruit.txt"
find -not -name "fruit.txt"

# find files modified within 30 minutes
find . -mmin -30

# find files modified within 1 day
find . -mtime -1

# find files accessed within 1 hour.
find . -amin -60
```

http://www.folkstalk.com/2011/12/101-examples-of-using-find-command-in.html

# **sed** - a stream editor used for modifying files in unix

**fruit.txt**

```
orange  8
apple   6
peach   12
banana  5
```

```
sed 's/apple/strawberry/' fruit.txt
orange 8
strawberry6
peach  12
banana 5

sed 's/apple/strawberry/g' fruit.txt
orange 8
strawberry6
peach  12
banana 5
```

# sed - II

**fruit.txt**

```
orange  8
apple   6
peach   12
banana  5
```

```
sed 's/apple/{&}/' fruit.txt
orange 8
{apple}   6
peach  12
banana 5
```

```
sed '/12/ s/peach/kiwi/' fruit.txt
orange 8
apple  6
kiwi   12
banana 5
```

# wget

```
wget <url link to a file>
wget <a ftp link>

example:
```

**`wget http://129.130.89.83/tmp/public/sequence.cost.png`**


The New York Times

*Snowden Used Low-Cost Tool to Best N.S.A.*

By David E. Sanger and Eric Schmitt

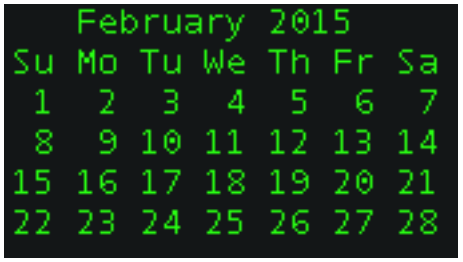
# date, cal, sleep

- **date** - print or set the system date and time

% date

- **cal** - displays a calendar

% cal Feb 2014




- **sleep** - delay for a specified amount of time

% sleep 2 #2 seconds pause

% sleep 1h

# history, clear

- **history** - document of command lines

% history

- **clear** - clear the terminal screen

% clear

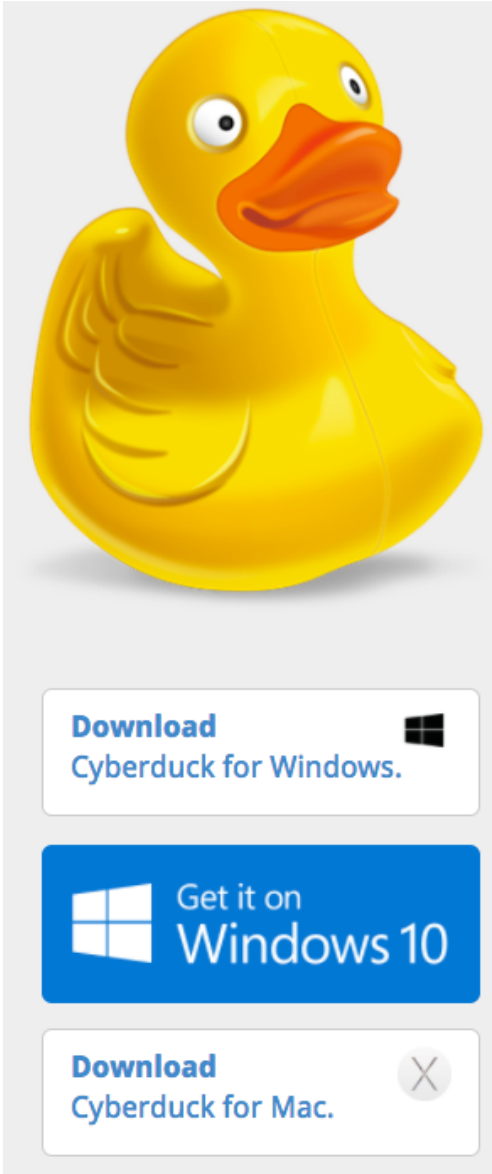
# scp

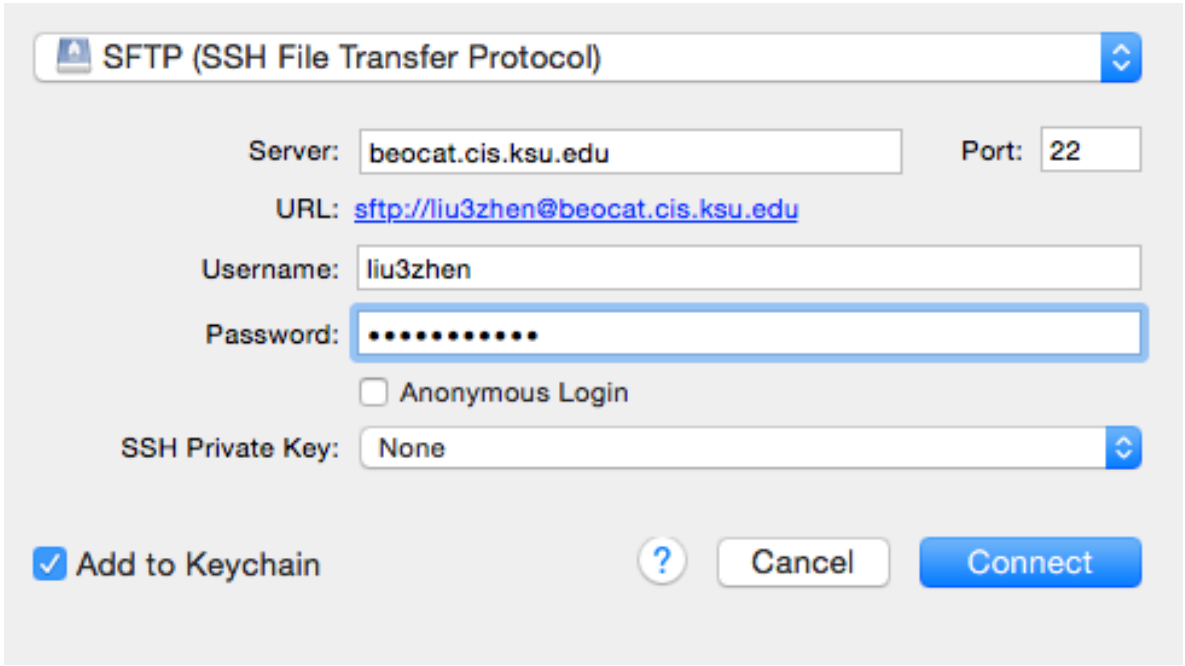
```
scp user@hostname:directory/remotefile localfile
```

**scp <eid>@beocat.cis.ksu.edu:<path/files> .**

*For mac users who transfer data between the server and the laptop

# Cyberduck


Download
Cyberduck for Windows.
Get it on
Windows 10
Download
Cyberduck for Mac.


SFTP (SSH File Transfer Protocol)
Server:
beocat.cis.ksu.edu
Port:
22
URL:
sftp://liu3zhen@beocat.cis.ksu.edu
Username:
liu3zhen
Password:
Anonymous Login
SSH Private Key:
None
Add to Keychain
Cancel
Connect

# man

- Manual Pages

```
% man grep
```

- Detailed information about each command
- Could be too detailed to find the answer

Sometimes it is more efficient to …

- Google “how-to”
- Ask questions