CS 35L- Software Construction Lab 3

Winter 19

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Course Information

- Contact information
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  - **Office hour (Tentative):** Tue 11am-12pm & Thu 10am-11am. @ BH 3256S

- Course Website: http://web.cs.ucla.edu/classes/winter19/cs35L/index.html

- Join Piazza(https://piazza.com): for class discussions
  - Search for CS35L, winter 2019
  - **Use Piazza to discuss about assignments or course related questions!**

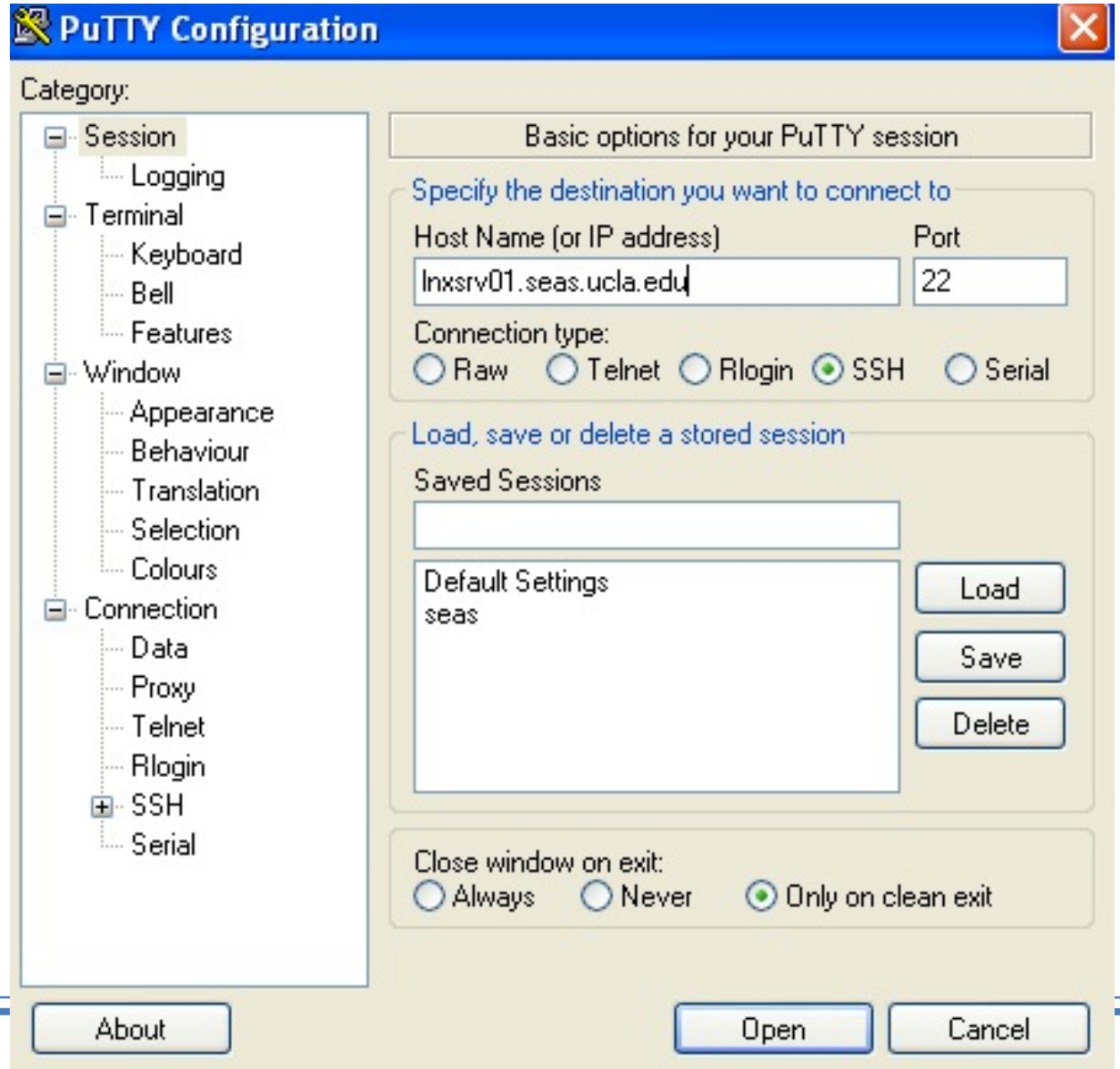
- **Sign up for PTE if haven't after class**

Course Information

- Prepend /usr/local/cs/bin to $PATH (for all future assignment)
- Login and do your homework on the following server
  - lnxsrv06, lnxsrv07, lnxsrv07, or lnxsrv10,
  - ssh username@lnxsrv*.seas.ucla.edu
- Submit your assignment to CCLE by deadline.
- For people who haven't enrolled, please send the assignment to the grading TA by e-mail with you UID, and Name.

Connecting to SEAS from Windows

PuTTY



Connecting to SEAS from OS X or Linux

- Terminal
  - $ ssh username@lnxsrv.seas.ucla.edu
  - Username = your SEAS user name

Some tips for pre-append PATH

To preappend PATH, run the following command:

```
export PATH=/usr/local/cs/bin:$PATH
echo $PATH
```

And it should have "/usr/local/cs/bin" appended to your path.

If you use the above approach, every time you open a new terminal or logged into the lnxsrv0x, you need to execute the command starting with export again.

To avoid the trouble, you can modify the .bashrc and .bash_profile file under your home directory.

1. Open the .bashrc file under your home directory: emacs ~/.bashrc
2. Append "export PATH=/usr/local/cs/bin:$PATH" at the end of .bashrc file
3. Save and exit from emacs.
4. Repeat 1,2,3 on the .bash_profile file.
5. Logged out from the lnxsrv and then logged back in.
6. Run echo $PATH to verify that /usr/local/cs/bin is the first field of the $PATH and separated from the latter field with a column.

Note: If you do not have .bash_rc and the .bash_profile under your home directory, the above command will create one for you. So that should be fine.

.bash_profile vs .bashrc

- **.bash_profile** is executed for login shells, while **.bashrc** is executed for interactive non-login shells.
  - When you login (type username and password) via console, either sitting at the machine, or remotely via ssh: **.bash_profile** is executed to configure your shell before the initial command prompt.
  - But, if you've already logged into your machine and open a new terminal window (xterm) then **.bashrc** is executed before the window command prompt. **.bashrc** is also run when you start a new bash instance by typing /bin/bash in a terminal.
- Tips:
- Better to want to do PATH adjustments in **.bash_profile** instead of **.bashrc**, since these changes are typically not idempotent.
  - **export PATH="$PATH:/some/addition"** If you put that in .bashrc instead, every time you launched an interactive sub-shell, :/some/addition would get tacked on to the end of the PATH again, creating extra work for the shell when you mistype a command.

Introduction to Linux

Week 1

What is Linux

- Operating system
  - Created by Linus and a group of people (online)
- Unix-like open source software
  - Free to contribute, free to use
- Four Components (Linux distribution)
  - Linux kernel
  - GNU utilities
  - Graphical desktop environment
  - Application software

Component I: Linux kernel

- Functionalities
  - Software program management
  - Hardware management
  - Filesystem management
  - System memory management
    - “top” command

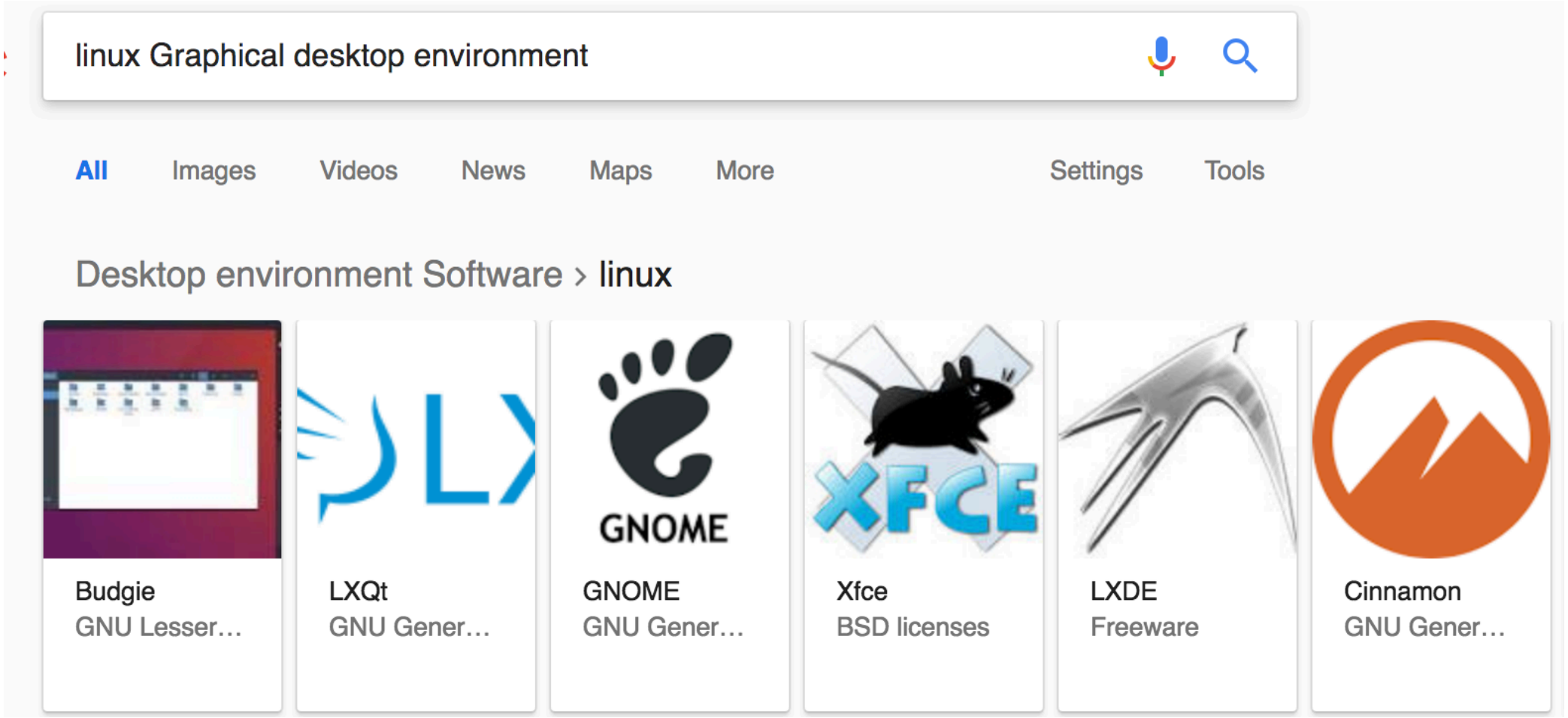
```
Tasks: 375 total,   1 running, 337 sleeping,  37 stopped,   0 zombie
%Cpu(s):  0.0 us,  0.0 sy,  0.0 ni, 99.9 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 65795584 total, 60219548 free,   845064 used,  4730972 buff/cache
KiB Swap: 20479996 total, 20479996 free,        0 used. 64253224 avail Mem

  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
10889 guangyuz  20   0  166472   2660   1680 R   0.3  0.0   0:00.11 top
    1 root      20   0  192180   5228   2600 S   0.0  0.0   1:50.82 systemd
    2 root      20   0       0      0      0 S   0.0  0.0   0:00.08 kthreadd
    3 root      20   0       0      0      0 S   0.0  0.0   0:00.05 ksoftirqd/0
    5 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 kworker/0:0H
    6 root      20   0       0      0      0 S   0.0  0.0   0:04.06 kworker/u64:0
    8 root      rt   0       0      0      0 S   0.0  0.0   0:00.02 migration/0
    9 root      20   0       0      0      0 S   0.0  0.0   0:00.00 rcu_bh
   10 root      20   0       0      0      0 S   0.0  0.0   0:41.30 rcu_sched
   11 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 lru-add-drain
   12 root      rt   0       0      0      0 S   0.0  0.0   0:01.25 watchdog/0
   13 root      rt   0       0      0      0 S   0.0  0.0   0:01.22 watchdog/1
   14 root      rt   0       0      0      0 S   0.0  0.0   0:00.49 migration/1
   15 root      20   0       0      0      0 S   0.0  0.0   0:00.03 ksoftirqd/1
   17 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 kworker/1:0H
   19 root      rt   0       0      0      0 S   0.0  0.0   0:01.12 watchdog/2
   20 root      rt   0       0      0      0 S   0.0  0.0   0:00.02 migration/2
   21 root      20   0       0      0      0 S   0.0  0.0   0:00.02 ksoftirqd/2
   23 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 kworker/2:0H
   24 root      rt   0       0      0      0 S   0.0  0.0   0:01.09 watchdog/3
   25 root      rt   0       0      0      0 S   0.0  0.0   0:00.04 migration/3
   26 root      20   0       0      0      0 S   0.0  0.0   0:00.01 ksoftirqd/3
   28 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 kworker/3:0H
   29 root      rt   0       0      0      0 S   0.0  0.0   0:01.12 watchdog/4
   30 root      rt   0       0      0      0 S   0.0  0.0   0:00.05 migration/4
   31 root      20   0       0      0      0 S   0.0  0.0   0:00.01 ksoftirqd/4
   33 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 kworker/4:0H
   34 root      rt   0       0      0      0 S   0.0  0.0   0:01.10 watchdog/5
   35 root      rt   0       0      0      0 S   0.0  0.0   0:00.03 migration/5
   36 root      20   0       0      0      0 S   0.0  0.0   0:00.04 ksoftirqd/5
   38 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 kworker/5:0H
   39 root      rt   0       0      0      0 S   0.0  0.0   0:01.05 watchdog/6
   40 root      rt   0       0      0      0 S   0.0  0.0   0:00.06 migration/6
```

Component II: GNU utilities

- System utilities to run on Linux kernel
- Contains coreutils package
  - Handling files (touch, rm, mkdir, ls …)
  - Manipulating text (tr, sed …)
- Shell is a special interactive utility (CLI)
  - Bash is the default shell in Linux
    - Bourne shell (sh)
    - C shell (csh)
    - TC shell (tcsh)
    - Korn shell (ksh)
    - Bourne Again shell (bash)
  - Type ‘echo $0’ to see which shell you are using!
  - You can open shells recursively

- Reference: https://www.gnu.org/software/coreutils/coreutils.html

Component III & IV: Graphical desktop environment & Application software



Review of basic commands

- man
- pwd
- cd:
  - ~
  - .
  - /
  - ..

Review of basic commands

- The basics continued…
  - mv:
  - cp:
  - rm: **rm removes files blindly, with no concept of 'trash'.**
    - rm –r:
  - mkdir:
  - rmdir:
  - ls:
    - -d: list only directories
    - -a: list all files including hidden ones
    - -l: show long listing including permission info
    - -s: show size of each file, in blocks

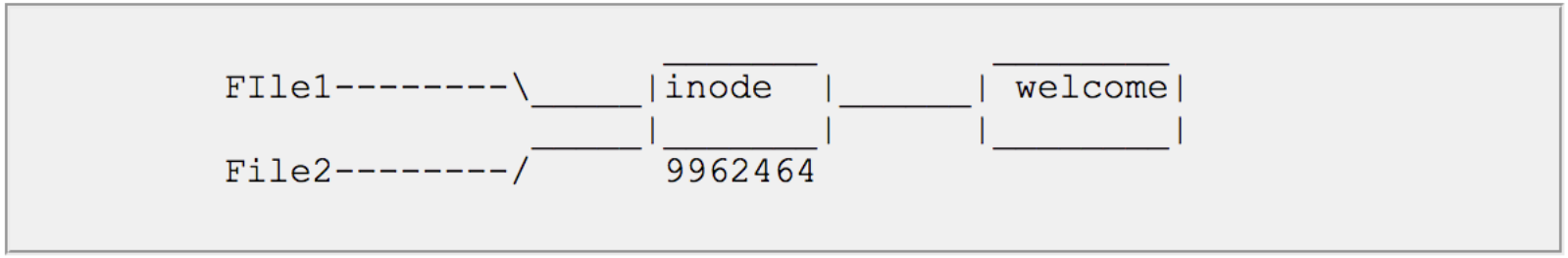
Review of basic commands

- **Touch [Option] [File(s)]** :
  - If file exists:
    - update access & modification time to current time
    - touch -t 201101311759.30 *filename*
      - Change filename's access & modification time to (year 2011 January day 31 time 17:59:30)
  - If file not exists:
    - An empty file is created
- **ln**: create a link
  - Hard links: point to physical data
  - Soft links aka symbolic links (-s): point to a file

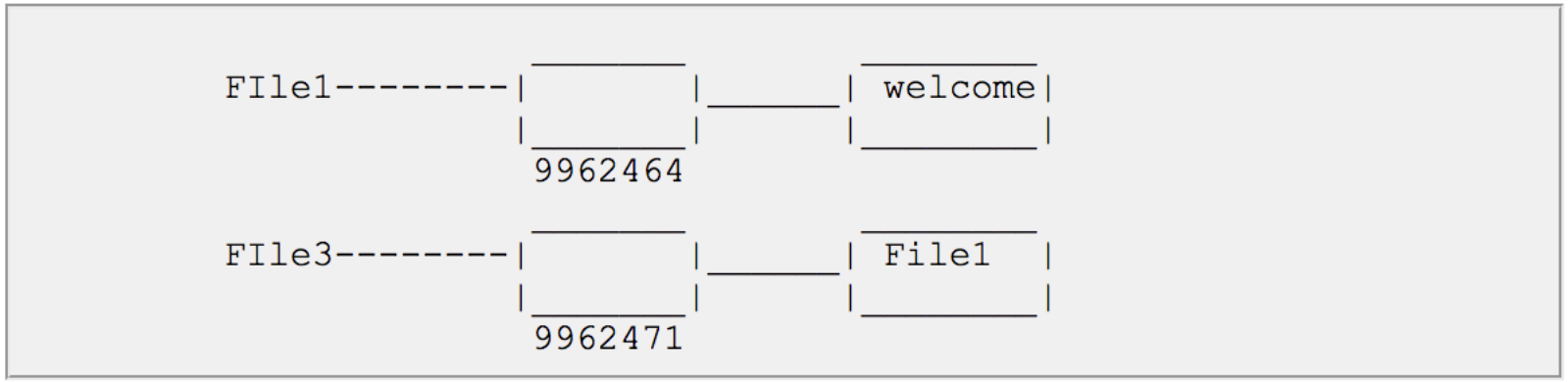
Review: Soft link vs. hard link

```
$ ls -li
total 20
9962464 -rw-r--r-- 2 guru users 8 Mar  9  file1
9962464 -rw-r--r-- 2 guru users 8 Mar  9  file2
9962471 lrwxrwxrwx 1 guru users 5 Mar  9  file3 -> file1
```

Hard link:



Soft link:



- Create two files

  $ touch blah1 ***$ touch blah2***

- Fill contents into the files and print them

  $ echo "Cat" > blah1 ***$ echo "Dog" > blah2***

  $cat blah1; cat blah2

  Cat

  Dog

- Create links:
- ***$ ln blah1 blah1-hard*** ***$ ln -s blah2 blah2-soft*** ***$ ls –li***

  blah1 blah1-hard blah2 blah2-soft -> blah2

- Change the original file

  $ mv blah1 blah1-new ***$ cat blah1-hard***

  Cat

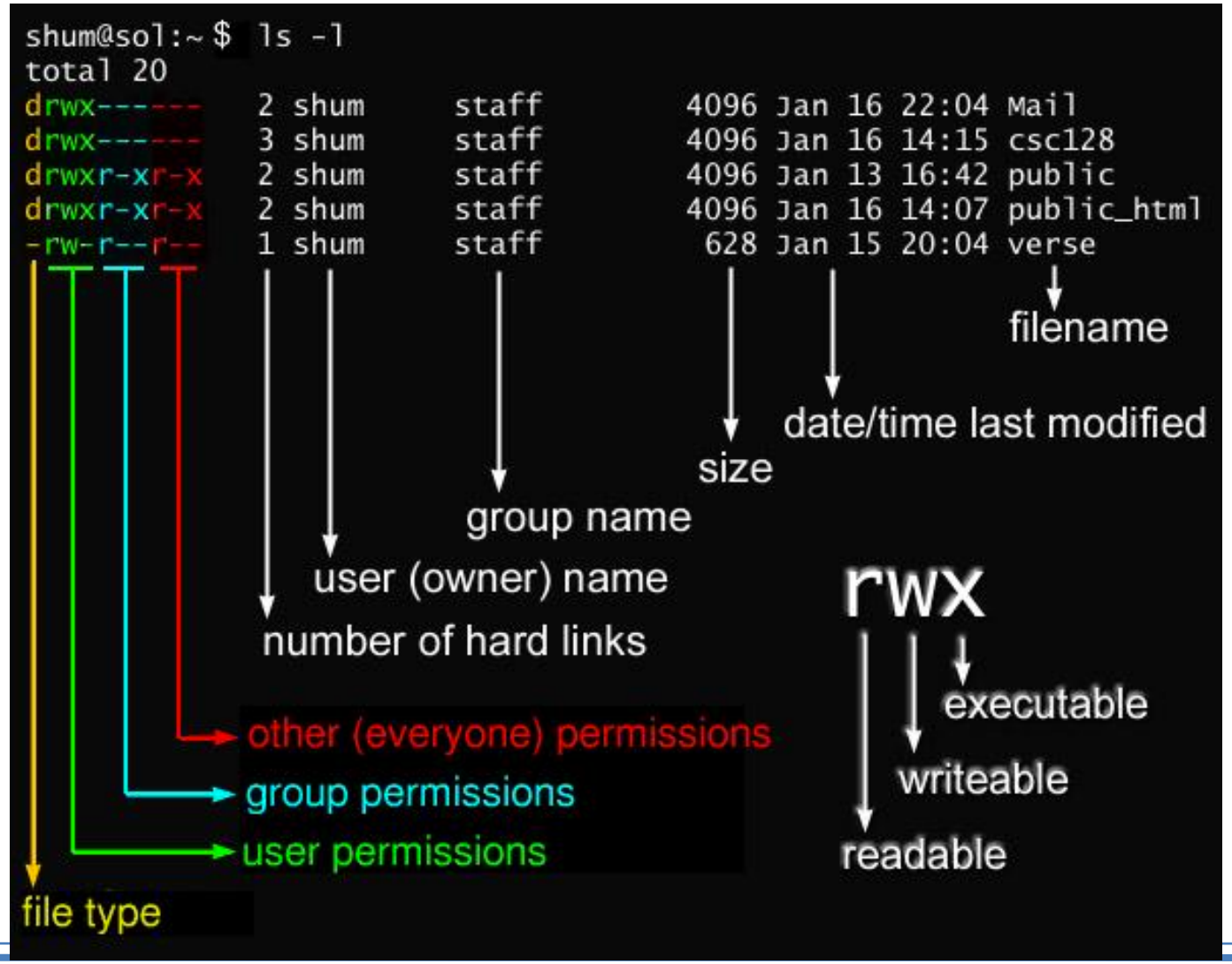
  $ mv blah2 blah2-new ***$ cat blah2-soft***

  cat: blah2-soft: No such file or directory

wh... Commands

```
➜  ~ man -k "wh" | grep "^wh"
what(1)                  - show what versions of object modules were used to construct a file
whatis(1)                - search the whatis database for complete words
whereis(1)               - locate programs
which(1)                 - locate a program file in the user's path
while(ntcl)              - Execute script repeatedly as long as a condition is met
who(1)                   - display who is logged in
whoami(1)                - display effective user id
whois(1)                 - Internet domain name and network number directory service
```

Linux File Permissions



The Basics: chmod (numeric)

#	Permission
7	full
6	read and write
5	read and execute
4	read only
3	write and execute
2	write only
1	execute only
0	none

- Usage

– chmod [''references''][''operator''][''modes''] ''file1'' ...

Example: **chmod** ug+rw mydir, **chmod** a-w myfile,

Example: **chmod** ug=rx mydir, **chmod** 664 myfile

Review: Processes

- Everything is either a **process** or a **file** in Linux:
- Process
  - An instance of a computer program in execution
- ps
  - List processes that are currently running
- kill
  - Terminate a certain process
  - Usage
    - kill PID

diff: command

- A file comparison utility that outputs the differences between two files.
- Shows the changes between one version of a file and a former version of the same file
- Usage
  - diff original_file new_file
  - diff –u original_file new_file (unified format)

- Ref: https://www.gnu.org/software/diffutils/manual/html_node/Unified-Format.html

- **file1.txt**:

  I need to go to the store.

  I need to buy some apples.

  When I get home, I'll wash the dog.
- **file2.txt**:

  I need to go to the store.

  I need to buy some apples.

  Oh yeah, I also need to buy grated cheese.

  When I get home, I'll wash the dog.

- diff file1.txt file2.txt

  2a3

  > Oh yeah, I also need to buy grated cheese.

- **file1.txt**:

  I need to go to the store.

  I need to buy some apples.

  When I get home, I'll wash the dog.

  I promise.

- **file2.txt**:

  I need to go to the store.

  I need to buy some apples.

  When I get home, I'll wash the dog.

- diff file1.txt file2.txt

  4d3

  < I promise.

- **file1.txt**:

  I need to buy apples.

  I need to run the laundry.

  I need to wash the dog.

  I need to get the car detailed.

- **file2.txt**:

  I need to buy apples.

  I need to do the laundry.

  I need to wash the car.

  I need to get the dog detailed.

```
diff file1.txt file2.txt
    2,4c2,4
    < I need to run the laundry.
    < I need to wash the dog.
    < I need to get the car detailed.
    ---
    > I need to do the laundry.
    > I need to wash the car.
    > I need to get the dog detailed.
```

- **file1.txt**:

  apples

  oranges

  kiwis

  carrots

file2.txt:

apples

kiwis

carrots

grapefruits

```
diff -u file1.txt file2.txt
    --- file1.txt 2014-08-21 17:58:29.764656635 -0400
    +++ file2.txt 2014-08-21 17:58:50.768989841 -0400
    @@ -1,4 +1,4 @@
    apples
    -oranges
    kiwis
    carrots
    +grapefruits
```

wget

- A computer program that retrieves content from web servers
- Usage
  - wget <URL>

Introduction to Linux text editors: vi

- Modes
  - Normal: Enter commands
  - Insert: Insert text
  - Visual: Like normal, but you can highlight
  - Replace: Like insert, but you replace characters as you type
  - Recording: Record a sequence of key sequences
- Supplement material: vi editor cheat sheet

Emacs

- Almost like a Windows text editor, but much more powerful
- Different from vi
  - Only one mode
  - Command: use control buttons:
    - Ctrl(C- for short)
    - Alt or Option (also known as Meta, M- for short)
- Supplement material: GNU Emacs Reference Card
- https://www.gnu.org/software/emacs/refcards/pdf/refcard.pdf

- Vim vs Emacs:
  - https://stackoverflow.com/questions/1430164/differences-between-emacs-and-vim

GNU Emacs Reference Card

(for version 26)

Starting Emacs

To enter GNU Emacs 26, just type its name: `emacs`

Leaving Emacs

suspend Emacs (or iconify it under X)	`C-z`
exit Emacs permanently	`C-x C-c`

Files

read a file into Emacs	`C-x C-f`
save a file back to disk	`C-x C-s`
save **all** files	`C-x s`
insert contents of another file into this buffer	`C-x i`
replace this file with the file you really want	`C-x C-v`
write buffer to a specified file	`C-x C-w`
toggle read-only status of buffer	`C-x C-q`

Getting Help

The help system is simple. Type `C-h` (or `F1`) and follow the directions. If you are a first-time user, type `C-h t` for a **tutorial**.

remove help window	`C-x 1`
scroll help window	`C-M-v`
apropos: show commands matching a string	`C-h a`
describe the function a key runs	`C-h k`
describe a function	`C-h f`
get mode-specific information	`C-h m`

Error Recovery

abort partially typed or executing command	`C-g`
recover files lost by a system crash	`M-x recover-session`
undo an unwanted change	`C-x u`, `C-_` or `C-/`
restore a buffer to its original contents	`M-x revert-buffer`
redraw garbaged screen	`C-l`

Incremental Search

search forward	`C-s`
search backward	`C-r`
regular expression search	`C-M-s`
reverse regular expression search	`C-M-r`
select previous search string	`M-p`
select next later search string	`M-n`
exit incremental search	`RET`
undo effect of last character	`DEL`
abort current search	`C-g`

Use `C-s` or `C-r` again to repeat the search in either direction. If Emacs is still searching, `C-g` cancels only the part not matched.

Motion

entity to move over	**backward**	**forward**
character	`C-b`	`C-f`
word	`M-b`	`M-f`
line	`C-p`	`C-n`
go to line beginning (or end)	`C-a`	`C-e`
sentence	`M-a`	`M-e`
paragraph	`M-{`	`M-}`
page	`C-x [`	`C-x ]`
sexp	`C-M-b`	`C-M-f`
function	`C-M-a`	`C-M-e`
go to buffer beginning (or end)	`M-<`	`M->`

scroll to next screen	`C-v`
scroll to previous screen	`M-v`
scroll left	`C-x <`
scroll right	`C-x >`
scroll current line to center, top, bottom	`C-l`
goto line	`M-g g`
goto char	`M-g c`
back to indentation	`M-m`

Killing and Deleting

entity to kill	**backward**	**forward**
character (delete, not kill)	`DEL`	`C-d`
word	`M-DEL`	`M-d`
line (to end of)	`M-0 C-k`	`C-k`
sentence	`C-x DEL`	`M-k`
sexp	`M-- C-M-k`	`C-M-k`

kill **region**	`C-w`
copy region to kill ring	`M-w`
kill through next occurrence of *char*	`M-z` *char*
yank back last thing killed	`C-y`
replace last yank with previous kill	`M-y`

Marking

set mark here	`C-@` or `C-SPC`
exchange point and mark	`C-x C-x`
set mark *arg* **words** away	`M-@`
mark **paragraph**	`M-h`
mark **page**	`C-x C-p`
mark **sexp**	`C-M-@`
mark **function**	`C-M-h`
mark entire **buffer**	`C-x h`

Query Replace

interactively replace a text string	`M-%`
using regular expressions	`M-x query-replace-regexp`

Valid responses in query-replace mode are

replace this one, go on to next	`SPC` or `y`
replace this one, don't move	`,`
skip to next without replacing	`DEL` or `n`
replace all remaining matches	`!`
back up to the previous match	`^`
exit query-replace	`RET`
enter recursive edit (`C-M-c` to exit)	`C-r`

Multiple Windows

When two commands are shown, the second is a similar command for a frame instead of a window.

delete all other windows	`C-x 1`	`C-x 5 1`
split window, above and below	`C-x 2`	`C-x 5 2`
delete this window	`C-x 0`	`C-x 5 0`
split window, side by side	`C-x 3`	
scroll other window	`C-M-v`	
switch cursor to another window	`C-x o`	`C-x 5 o`
select buffer in other window	`C-x 4 b`	`C-x 5 b`
display buffer in other window	`C-x 4 C-o`	`C-x 5 C-o`
find file in other window	`C-x 4 f`	`C-x 5 f`
find file read-only in other window	`C-x 4 r`	`C-x 5 r`
run Dired in other window	`C-x 4 d`	`C-x 5 d`
find tag in other window	`C-x 4 .`	`C-x 5 .`
grow window taller	`C-x ^`	
shrink window narrower	`C-x {`	
grow window wider	`C-x }`	

Formatting

indent current **line** (mode-dependent)	`TAB`
indent **region** (mode-dependent)	`C-M-\`
indent **sexp** (mode-dependent)	`C-M-q`
indent region rigidly *arg* columns	`C-x TAB`
indent for comment	`M-;`
insert newline after point	`C-o`
move rest of line vertically down	`C-M-o`
delete blank lines around point	`C-x C-o`
join line with previous (with arg, next)	`M-^`
delete all white space around point	`M-\`
put exactly one space at point	`M-SPC`
fill paragraph	`M-q`
set fill column to *arg*	`C-x f`
set prefix each line starts with	`C-x .`
set face	`M-o`

Case Change

uppercase word	`M-u`
lowercase word	`M-l`
capitalize word	`M-c`
uppercase region	`C-x C-u`
lowercase region	`C-x C-l`

The Minibuffer

The following keys are defined in the minibuffer.

complete as much as possible	`TAB`
complete up to one word	`SPC`
complete and execute	`RET`
show possible completions	`?`
fetch previous minibuffer input	`M-p`
fetch later minibuffer input or default	`M-n`
regexp search backward through history	`M-r`
regexp search forward through history	`M-s`
abort command	`C-g`

Type `C-x ESC ESC` to edit and repeat the last command that used the minibuffer. Type `F10` to activate menu bar items on text terminals.

Emacs

"The customizable, extensible, self documenting, real-time display editor"

- Customizable (no programming)
  - Users can customize font, colors, etc. in ~/.emacs
- Extensible (programming required)
  - Run Lisp scripts to define new commands (dired)
- Self-documenting
  - C-h r (manual) and C-h t (tutorial)
- Real-time
  - Edits are displayed on screen as they occur

Learning to use Emacs - Pointers

- Navigating with file
  - Move up/down/left/right: C-p, C-n, C-b, C-f (arrow keys also work)
  - Move to the beginning/end of a line: C-a, C-e
  - Move to the first/last line of the text: M-<, M-> (use shift for < and >)
- Search and replace file
  - C-s: search forward
  - C-r: search backward
  - M-%: replace (usage: M-% [source] Enter [dest])
- Erasing a line
  - C-k: erase from current cursor to end of line

Learning to use Emacs

- Copy and paste in a file
  - Begin: C-@ or C-Space (press Ctrl+Shift+2)
  - Use the <up> and <down> buttons to select the contents
  - End: C-w (cut), M-w(copy), C-y (paste)
  - Undo command: C-u

  Note: the “paste” option in Emacs is named as **yanking**

Extended Commands

- Use C-x plus other combined button
  - New file: C-x C-f
  - Quit Emacs: C-x C-c
  - If a file is modified, it will ask you whether to save the file and whether to leave now. (input y, yes)

Extended Command

- Visiting Emacs scratch buffer:
  - Copy(save) current buffer to file

    C-x C-s
  - List all the buffers

    C-x C-b
  - Save current buffer with a specified file name

    C-x C-w [filename]
  - Add(read) a new file to buffer

    C-x C-f

Learning to use Emacs - Compiling

- Visit/swtich to *scratch* buffer

  C-x b
- Compiling ***C*** code with emacs
  - M-x compile
- Running Lisp code
  - M-x emacs-lisp-mode
  - C-x C-e : Evaluate expression up to point

  http://www.emacswiki.org/emacs/EvaluatingExpressions

https://www.youtube.com/watch?v=ujODL7MD04Q

Lab1 hints for first 10 questions:

1. What shell command uses the `man` program to print all the commands that have a specific word in their man page (or at least the description part of the man page)? (hint: `man man`)
2. Where are the `cp` and `sh` programs located in the file system? List any shell commands you used to answer this question.
3. What executable programs have names that are just one character long, and what do they do? List any shell commands you used to answer this question.
4. When you execute the command named by the symbolic link `/usr/bin/emacs`, which file actually is executed? List any shell commands you used to answer this question.
5. What is the version number of the `/usr/bin/emacs` program? of the plain `emacs` program? Why are they different programs?
6. The `chmod` program changes permissions on a file. What does the symbolic mode `g+s,o-x` mean, in terms of permissions?
7. Use the `find` command to find all directories modified in the last 30 days that are located under (or are the same as) the directory `/usr/local/cs`. List any shell commands you used to answer this question.
8. Of the files in the same directory as `find`, how many of them are symbolic links? List any shell commands you used to answer this question.
9. What is the oldest regular file in the `/usr/lib64` directory? Use the last-modified time to determine age. Specify the name of the file without the `/usr/lib64/` prefix. Consider files whose names start with "`.`". List any shell commands you used to answer this question.
10. Where does the `locale` command get its data from? List any shell commands you used to answer this question.

1. man man
2. which
3. find
4. readlink
5. emacs –version
6. man chmod
7. find
8. whereis, man find
9. find, sort
10. localedef

Homework1: Format of submission

- For exercises (key1.txt)
  - Record keystroke of each exercise separately
  - Don’t forget commands to enter/leave emacs
  - The keystrokes for different exercise should be recorded separately, each keystroke for one line

```
Exersise 1.1
1. e m a c s SP assign1.html Enter
2. C-s T
3. C-b
.
.
.
11. C-x C-c

Exersise 1.2
1. e m a c s SP assign2.html Enter
.
.
.
5. ..... Backspace Backspace
```

Some General Tips

- Just use simple commands, this is a warm-up task. Take it easy.
- If you are not sure about complex commands, just use the combination of simple ones

  e.g. <left> <left> …… <left> = C-a
- If you don’t know the exact answers, just write down what you thought and what you have tried

Tips for Emacs Exercises

- Exercise 1.1
  - Basic Navigation Commands

    M-b M-< C-e C-a ……
  - Search Commands

    C-s
- Exercise 1.2
  - Find some thing and delete

    First use search command, then use the command to delete a line
  - Jump to given line

    M-x goto-line [number]

Tips for Emacs Exercises

- Exercise 1.3
  - Search and replace command

    C-s M-%

    If you are not familiar with M-%, just use delete plus insert
- Exercise 1.4
  - Copy and paste (cut)
  - Search and replace

Tips for Emacs Exercises

- Exercise 1.5
  - M-x compile
    - Delete the “make -k” command, type in “gcc –o [bin file name] [source file name]”
  - Buffer commands: Save current buffer with a specified file name
- Exercise 1.6
  - Evaluate expressions

    C-x C-e
  - Be aware of the maximum number in 32-bit integer

Week1 Check List

GUI & CLI basics

Unix file system layout

Unix permission

Basic commands

Documentations and man pages

Emacs basics

Supplement Resources

- emacs commands.pdf
- unix ref.pdf
- vi_cheat sheet.pdf