

Ve280 - Programming and Elementary Data Structures

Lecture 2: Introduction to Linux

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Learning objectives

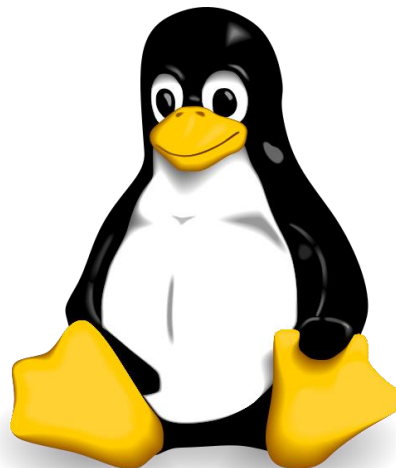
- Learn how to navigate the directory tree
- Learn how to manipulate files/directory
- Understand I/O redirection
- And a few other useful commands (diff, apt-get...)

Unix

- An operating system supporting multitasking and multi-user
- Developed in 1969 by Ken Thompson, Dennis Ritchie, etc. from AT&T Bell Labs
- Many variants (Unix-like OS)
 - Linux
 - BSD (from UC Berkeley)
 - Solaris (from Sun Microsystems)
 - Android (from Google)
 - iOS (from Apple)
 - ...

Linux

- A free and open source Unix-like operating system
- First released in 1991 by Linus Torvalds
- Many distributions
 - Gentoo
 - Red Hat
 - Ubuntu
 - ...

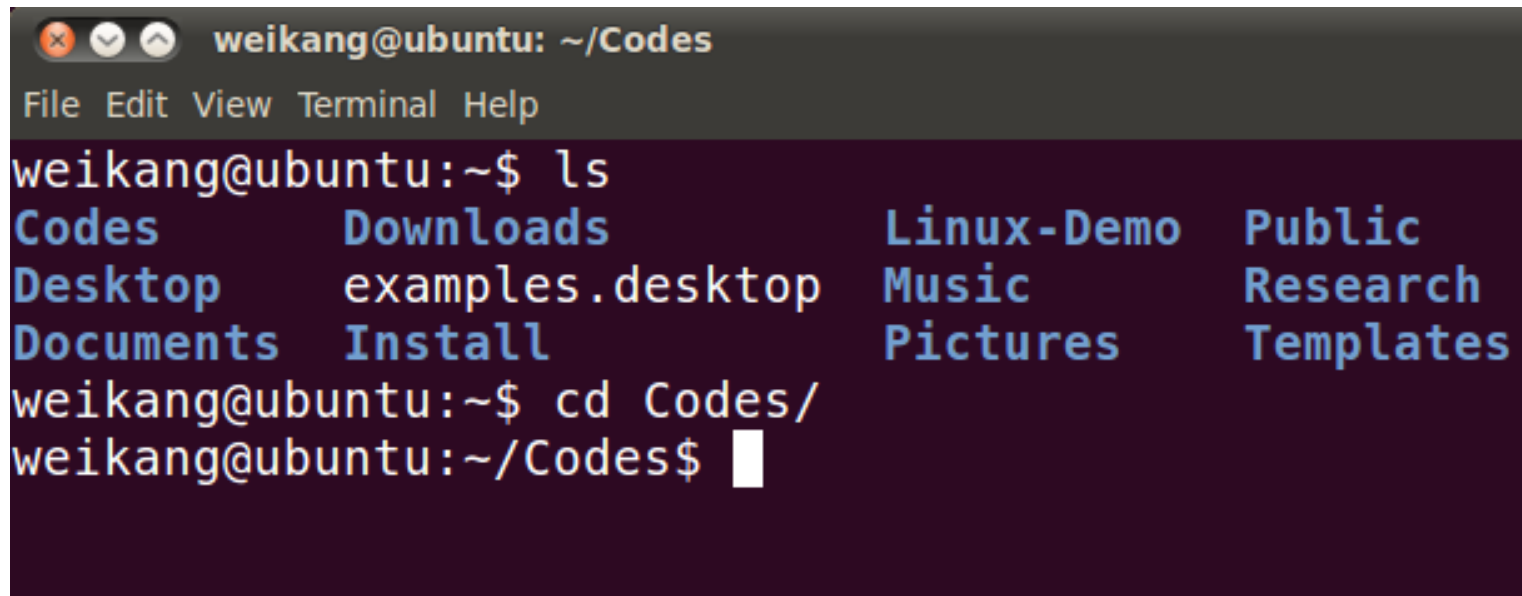


Installing Linux

- Recommended version: **Ubuntu**
 - You can get the .iso file from:
<http://www.ubuntu.com/download/desktop>
 - Suggest to use the latest version.
- Install it directly on your machine
- Windows Subsystem for Linux (WSL)
- OR install it on a virtual machine on your Windows/Mac operating system.
 - Install a virtual machine such as VirtualBox
(<https://www.virtualbox.org/>) or VMware
(<http://www.vmware.com/>) first.
 - SJTU provides free version of VMware at the link:

Using Terminal in Linux

- We type commands in the terminal in Linux



The screenshot shows a terminal window titled "weikang@ubuntu: ~/Codes". The window has a menu bar with "File", "Edit", "View", "Terminal", and "Help". The terminal content shows the user running the command "ls" in the home directory. The output lists various files and directories: Codes, Downloads, Linux-Demo, Public, Desktop, examples.desktop, Music, Research, Documents, Install, Pictures, and Templates. The user then runs "cd Codes/" and the prompt changes to "weikang@ubuntu: ~/Codes\$".

```
weikang@ubuntu: ~/Codes
File Edit View Terminal Help
weikang@ubuntu:~$ ls
Codes      Downloads  Linux-Demo  Public
Desktop    examples.desktop  Music       Research
Documents  Install    Pictures    Templates
weikang@ubuntu:~$ cd Codes/
weikang@ubuntu:~/Codes$
```

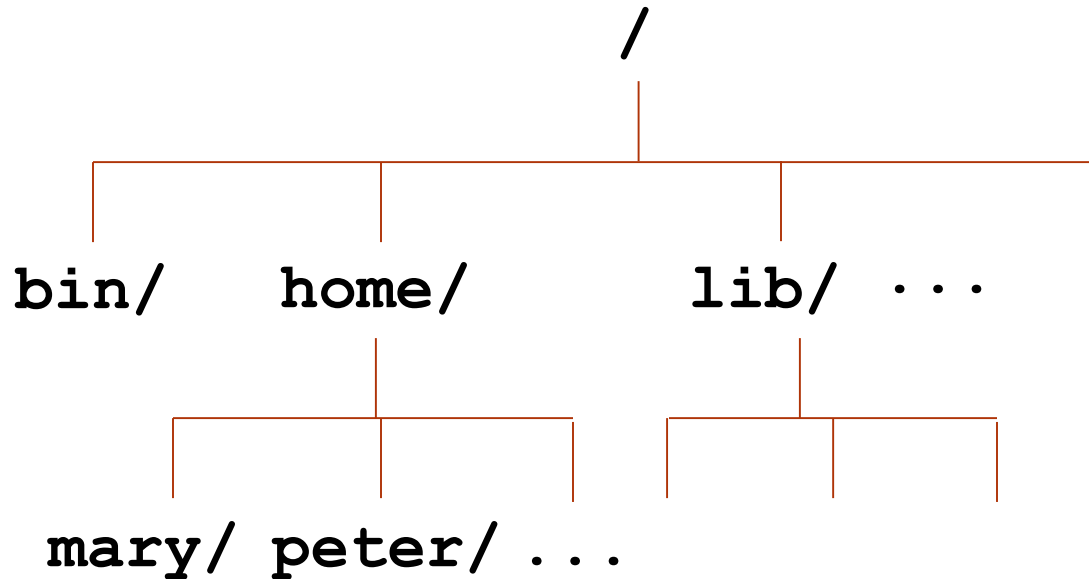
- Multiple ways to start a terminal
 - One simple way is to right click and choose from the shortcut menu

Change Directory

- Basic command: `cd pathname`
 - E.g., `cd /usr/bin`
typical path name format
- Special characters for directories
 - root directory: `/`
 - home directory: `~`
 - Linux is a multi-user operating system. It is your “home directory”.
 - current directory: `.`
 - parent directory: `..`
- Print working directory: `pwd`

Aside: Root Directory

- Directory in Linux is organized as a tree
- The topmost directory is root directory “/”



- Mount from Windows: /mnt/d/ve280

Filesystem

- Binaries: /bin
- Devices: /dev
- Bootstrap: /boot
- Secure binaries: /sbin
- Mounted filesystem: /mnt
- Configuration files: /etc
- Unix system resources: /usr
- Places for users' files: /home

List Contents of a Directory

- Basic command: `ls directory`
 - e.g., `ls /home`
- `ls` (i.e., “`ls`” alone): list the current working directory



Options

- `ls -l [directory]`: list in long format
- `ls -a [directory]`: list all files including the hidden files
 - Hidden files: file name begin with a dot, e.g., “.bash_history”
- In Linux, options can be combined together.
 - “`ls -la`” or “`ls -l -a`”

Aside: Long Format of File Information

- `ls -l`

group modification time

-rw-----	1	john	john	576	Apr 17 1998	weather.txt
drwxr-xr-x	6	john	john	1024	Oct 9 1999	web_page
-rw-rw-r--	1	john	john	276480	Feb 11 20:41	web_site.tar
-rwx-----	1	john	john	5743	Dec 16 1998	my_app

permission

owner

file size
(in bytes)

file name

- File permission
 - First character: '-' regular file; 'd' directory
 - Next three: read, write, execution permission of the owner
 - Next three: read, write, execution permission of the group
 - Final three: read, write, execution permission of everyone else

Manipulating Files/Directories

- Create directories: **mkdir** dir
- Delete directories: **rmdir** dir
 - Can only remove **empty** directory
- Create an empty file: **touch** file

Copy Files/Directories

- Basic command: `cp source dest`
- Variations
 - `cp file1 file2`: copy the content of file1 into file2
 - `cp file1 dir`: copy file into a directory
 - `cp file1 file2 dir`
 - `cp file* dir`
 - *: wildcard. Can represent any character string (even an empty string!)
 - `cp -r dir1 dir2`: If dir2 does not exist, copy dir1 as dir2. If dir2 exists, copy dir1 inside dir2

? Which Commands List ALL Files with the xyz Extension in Current Folder?

Assume no hidden files. Select all the correct answers.

- A. `ls ./*xyz`
- B. `ls *.xyz`
- C. `ls *xyz`
- D. None of the above.



Rename/Move a File

- Basic command: `mv source dest`
- Variations
 - `mv file1 file2`: rename file1 as file2
 - `mv file1 dir`: move file into a directory
 - `mv dir1 dir2`: If dir2 does not exist, then rename dir1 as dir2. If dir2 exists, then move dir1 inside dir2

Delete Files/Directories

- Basic command: `rm file`
- Variations
 - `rm file`: delete file
 - `rm file1 file2`: delete file1 and file2
 - `rm -r dir`: delete dir along with its contents
- Useful options `-i`: prompt before every removal
 - To use: alias `rm='rm -i'`;
 - Put it into `~/.bashrc`

Edit/Show a File

- Edit file: **nano file** **gedit file**
 - advanced editor: vi, vim, emacs
 - To quit vi/vim editor, press “Esc” and then enter “:q” or “:wq” w 表示保存, q表示退出
- Show file content
 - **cat file**: Concatenate files
 - **more file**
 - **less file**
 - quit ‘less’: press ‘q’
 - go to the end: press ‘G’ (shift + g)
 - go to the beginning: press ‘g’
 - search: press ‘/’, then enter the thing to be searched
 - press ‘n’ for the next match; press ‘N’ for the previous match.

I/O Redirection

- Most command line programs display their results on the **standard output**.
 - By default, standard output is our display.
- Pipeline “|”
 - `prog1 | prog2`: Connects the stdout of prog1 to stdin of prog2
- We can redirect from standard output to a file by using ‘>’.
 - E.g., `ls -l > ls_rst.txt`: the “ls” result is now in ls_rst.txt
 - `exec >> output`: Similar to >, but it appends to output.

I/O Redirection

- Many commands can accept input from a facility called **standard input**.
 - By default, standard input is our keyboard.
- We can redirect standard input from a file instead of keyboard by using '<'.
 - One application: testing
 - E.g., `my_add < input.txt`
my_add is a program taking two inputs from keyboard and output their sum on screen



What does the Following Command Do?

```
sort < fruit.txt > my_favorite.txt
```

Select all the correct answers.

- **A.** The command reads fruit.txt and my_favorite.txt
- **B.** The command reads fruit.txt and writes in my_favorite.txt
- **C.** The elements of fruit.txt are in alphabetic order
- **D.** The elements of my_favorite are in alphabetic order



Other Commands

- Auto completion: type a few characters; then press ‘Tab’
 - If there is a single match, Linux completes the remaining.
 - If there are multiple matches, hit the second time, Linux shows all the possible candidates.
- Compare two files: `diff file1 file2`
 - If files are the same, no output
 - If there are differences: lines after “<” are from the first file; lines after “>” are from the second file
 - In a summary line: ‘c’: change; ‘a’: add; ‘d’: delete
 - Useful option “-w”: ignore white spaces (space, tab)
 - “-y”: A side by side view

Other Commands

- grep: globally search a regular expression and print
- find: search file
- du: disk usage
- top: table of process
- ps: process tatus
- w: who is on the server
- echo: prints its arguments to stdout
- Signal
 - ctrl+c: break current process
 - ctrl+d: eof / output terminal
 - ctrl+z: sleep current process, command 'fg' can wake up the process

Other Commands

- su: Command that starts a temporary shell as root
- sudo: A command that temporarily grant superuser privilege to current user. Namely, “execute the following command as ‘root’”.
- Install a program: `sudo apt-get install program`
 - E.g., `sudo apt-get install emacs`
 - `sudo command`: execute command as a superuser
 - Requires you to type your password
- Remove a program: `sudo apt-get autoremove program`
- Looking for help? `man command` e.g., `man ls`
 - Browse the manual using the same command as for ‘less’

Reference

- <http://linuxcommand.org/>