Linux Basics

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Why should we learn Linux?

- ~~So that you can play cool and impress your friends.~~

- Most computing servers use Linux, so it's necessary to learn some basics.

- Linux is favored by open source communities, so the Linux platform usually gets the latest computing technologies first.

- Mac OS X is highly similar to Linux, which has a large user base (especially in the U.S.) – another reason why Linux gets the latest computing techs first.

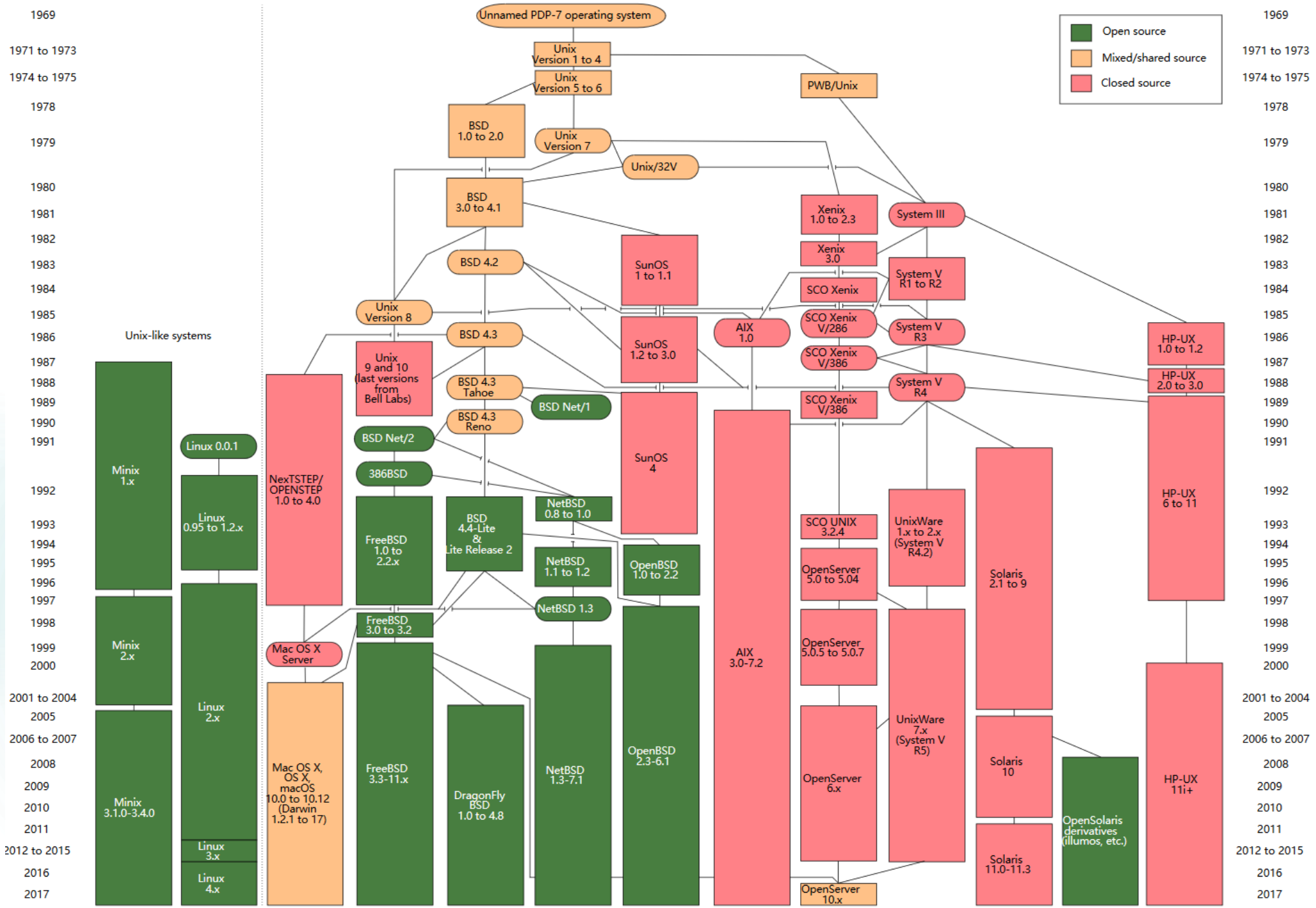
- Windows 10 has a Linux subsystem, so now you can use your Linux skills on Windows, too.

A bit of history…

- Linux is a clone of Unix – completely rewritten.
- Unix was originally developed at AT&T Bell Labs in the 1970s.
- Due to an earlier antitrust case, AT&T was required to license the operating system's source code to anyone who asked basically for free.
  - Unix grew quickly and became widely adopted by academic institutions and businesses.

A bit of history…

- A second antitrust case in 1984 separated Bell Labs from AT&T.
  - Bell Labs began selling Unix as a proprietary product, where users were not legally allowed to modify Unix.
- Hobbyists became unhappy and started the Free Software Movement.
  - Unix branched into BSD, System V, etc.
  - The GNU Project had the goal of creating a "complete Unix-compatible software system" composed entirely of free software, and completed many components, such as compilers, text editors, a Unix shell, and a windowing system.
  - Linus Torvalds developed the Linux kernel in 1991 when he was a student.


Open source
Mixed/shared source
Closed source
Unix-like systems
1969
1971 to 1973
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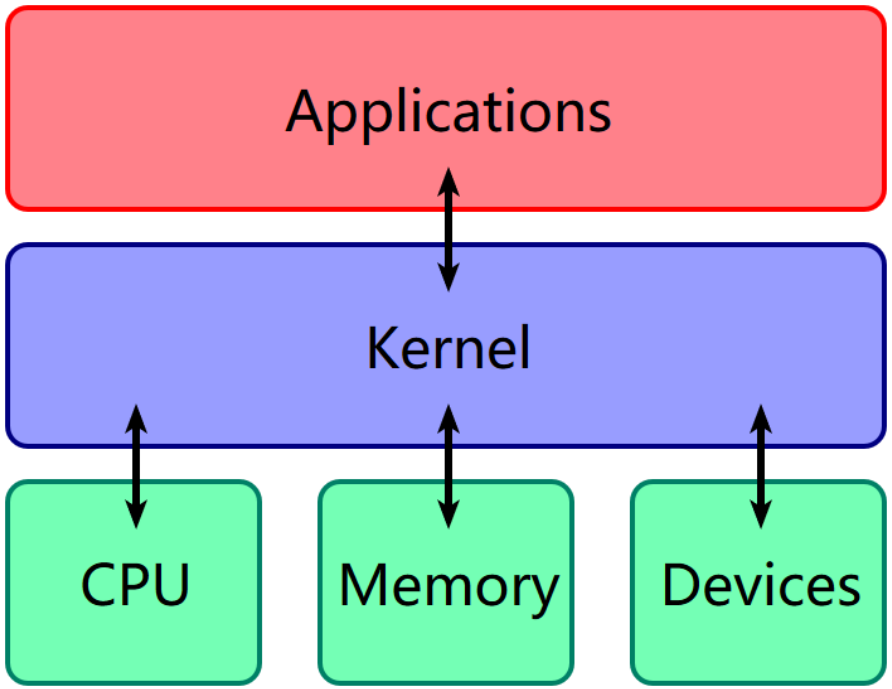
Unnamed PDP-7 operating system
Unix Version 1 to 4
Unix Version 5 to 6
Unix Version 7
PWB/Unix
BSD 1.0 to 2.0
Unix/32V
BSD 3.0 to 4.1
Xenix 1.0 to 2.3
Xenix 3.0
System III
BSD 4.2
SunOS 1 to 1.1
SCO Xenix
System V R1 to R2
Unix Version 8
AIX 1.0
SCO Xenix V/286
System V R3
BSD 4.3
SunOS 1.2 to 3.0
SCO Xenix V/386
HP-UX 1.0 to 1.2
Unix 9 and 10 (last versions from Bell Labs)
BSD 4.3 Tahoe
BSD Net/1
System V R4
HP-UX 2.0 to 3.0
BSD 4.3 Reno
BSD Net/2
SunOS 4
386BSD
NetBSD 0.8 to 1.0
HP-UX 6 to 11
SCO UNIX 3.2.4
UnixWare 1.x to 2.x (System V R4.2)
Minix 1.x
Linux 0.0.1
NextSTEP/ OPENSTEP 1.0 to 4.0
Linux 0.95 to 1.2.x
FreeBSD 1.0 to 2.2.x
BSD 4.4-Lite & Lite Release 2
NetBSD 1.1 to 1.2
OpenBSD 1.0 to 2.2
OpenServer 5.0 to 5.04
Solaris 2.1 to 9
NetBSD 1.3
FreeBSD 3.0 to 3.2
Minix 2.x
Linux 2.x
Mac OS X Server
OpenServer 5.0.5 to 5.0.7
AIX 3.0-7.2
UnixWare 7.x (System V R5)
Mac OS X, OS X, macOS 10.0 to 10.12 (Darwin 1.2.1 to 17)
FreeBSD 3.3-11.x
DragonFly BSD 1.0 to 4.8
NetBSD 1.3-7.1
OpenBSD 2.3-6.1
OpenServer 6.x
Solaris 10
HP-UX 11i+
Minix 3.1.0-3.4.0
Linux 3.x
Linux 4.x
OpenSolaris derivatives (illumos, etc.)
Solaris 11.0-11.3
OpenServer 10.x

Basic concepts

- Linux may refer to
  - The Linux kernel



Basic concepts

- Linux may refer to
  - The Linux kernel
  - A Linux distribution/ecosystem

User mode	**User applications**	For example, bash, LibreOffice, GIMP, Blender, 0 A.D., Mozilla Firefox, etc.				
	Low-level system components:	**System daemons**: *systemd*, *runit*, *logind*, *networkd*, *PulseAudio*, ...	**Windowing system**: *X11*, *Wayland*, *SurfaceFlinger* (Android)	**Other libraries:** *GTK+*, *Qt*, *EFL*, *SDL*, *SFML*, *FLTK*, *GNUstep*, etc.	**Graphics**: *Mesa*, *AMD Catalyst*, ...	
	C standard library	`open()`, `exec()`, `sbrk()`, `socket()`, `fopen()`, `calloc()`, ... (up to 2000 subroutines) *glibc* aims to be POSIX/SUS-compatible, *uClibc* targets embedded systems, *bionic* written for Android, etc.				
Kernel mode	**Linux kernel**	`stat`, `splice`, `dup`, `read`, `open`, `ioctl`, `write`, `mmap`, `close`, `exit`, etc. (about 380 system calls) The Linux kernel System Call Interface (SCI, aims to be POSIX/SUS-compatible)				
		Process scheduling subsystem	IPC subsystem	Memory management subsystem	Virtual files subsystem	Network subsystem
		Other components: ALSA, DRI, evdev, LVM, device mapper, Linux Network Scheduler, Netfilter Linux Security Modules: *SELinux*, *TOMOYO*, *AppArmor*, *Smack*				

Basic concepts

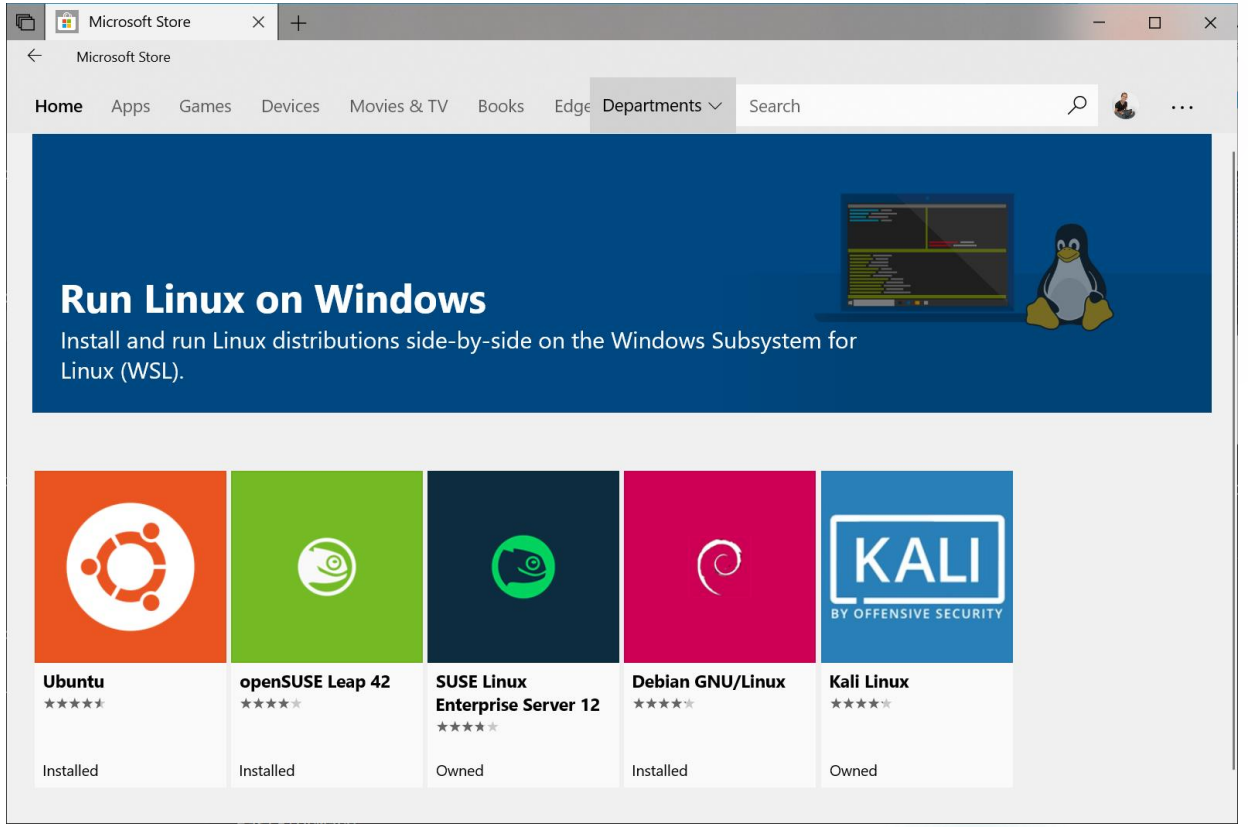
- Linux may refer to
  - The Linux kernel
  - A Linux distribution/ecosystem
  - The shell commands

Getting your copy of “Linux”

- For learning purposes, you can
  - Install a real Linux system (Ubuntu, CentOS, etc.) on your computer (dual systems, virtual boxes…).
  - Rent a cloud server for a small fee.
  - Mac OS X is already Unix-based.
  - Windows
    - Early systems – Cygwin
    - Windows 10 – Windows Subsystem for Linux (WSL)

Windows Subsystem for Linux (WSL)

1. Open PowerShell as Administrator and run:
   `Enable-WindowsOptionalFeature -Online -FeatureName Microsoft-Windows-Subsystem-Linux`
2. Restart your computer.
3. Install a Linux distro of your choice from Windows Store.



Directory structure

/ - Linux File System Root

/bin	User Binary Files
/boot	Boot Loader Files
/dev	Device Files
/etc	Configuration Files
/home	Home Directories
/lib	System Libraries
/media	Mount point for removable media
/mnt	Mount point for temporary file systems
/opt	Optional Addon Applications
/sbin	System Binaries
/srv	Service Data
/tmp	Temporary Files
/usr	User programs
/var	Variable Files
/root	Root User Directory
/proc	Process Information
/lost + found	

Navigating

- pwd – print working directory
- ls – show the content of the current directory
  - -a – show hidden files
  - -l – show more details
- cd – change directory
  - . – the current dir
  - .. – the parent dir
  - ~ - your home dir
  - cd without argument is the same as cd ~

Working with files and directories

- mkdir – create a folder at the current directory

用file来看一个文件的类型

- rm – remove files or directories
  - -r – remove directory recursively
  - -f – remove without prompt

Working with files and directories

- cp – copy files or directories
  - `cp picture.jpg picture-02.jpg`
  - `cp ~/pictures/picture.jpg ~/backup/picture.jpg`
  - `cp ~/pictures/picture-*.jpg ~/picture-backup`
  - `cp ~/pictures/picture-01.jpg ~/pictures/picture-02.jpg ~/picture-backup`
  - `cp -r ~/files ~/files-backup`
    - If the directory **files-backup** already exists, the directory **files** will be placed inside.
    - If **files-backup** does *not* already exist, it *will* be created and the *contents* of the **files** directory will be placed inside it.
- mv – move files or directories
  - Similar to cp
  - Can be used to rename files.

Viewing file contents

- cat – displays the file content
- less – works better with long files
  - Press u/d/space_bar to go up and down.
  - Press q to quit.
- head – display the first ten lines of a file
  - head -5 – the first 5 lines
- Tail – display the last ten lines of a file
  - head -5 – the last 5 lines

Searching the contents of a file

- In less, press '/', then type the pattern for search.
  - Press 'n' to search for the next occurrence.

- grep 'pattern' filename
  - **-i** ignore upper/lower case distinctions
  - **-v** display those lines that do NOT match
  - **-n** precede each matching line with the line number
  - **-c** print only the total count of matched lines

Text editing

- Linux comes with a powerful text editor `vi`
  - `vi` is also notoriously hard to learn
- We most likely only do light editing in a pure command line environment, so `nano` is more intuitive and recommended.

Redirection

Command	Meaning
>	redirect standard output to a file
>>	append standard output to a file
<	redirect standard input from a file
|	pipe the output of command1 to the input of command2

Redirection

- Example
  - Enter `cat`, then enter a few words, then press `^D` (end-of-file)
  - Do the same but with `cat > list1.txt`
  - Add more words with `cat >> list1.txt`
  - Similarly create `list2.txt`
  - Combine and sort and save the first 3 with `cat list1.txt list2.txt | sort | head -3 > top3.txt`

Wild cards

- * – matches 0 or more characters.
  - E.g., remove the previous lists with `rm *.txt`
- ? – matches exactly 1 character.

Get help

- man – check the manual of a command
- whatis – gives a one line description of a command
- whereis – locate the binary or source or manual pages for a command

Killing a process

- Killing means forcing a process to terminate. It is different from a normal quit.
- To kill a job running in the foreground, type ^C.
  - E.g., `sleep 1000`
- Killing a job running in the background with `kill`
  - `sleep 1000 &`
  - `ps` (find pid of `sleep`)
  - `kill [pid of sleep]`

Jobs

- The `&` at the end puts a process at the background.
- A processing running at the background is called a job.
- Use `jobs` to see the jobs running.
- Kill a job by job number: `kill %[job number]`

Connecting to a remote server

- On Windows, use PuTTY
- On Unix-like systems, use `ssh user_name@server_location`

Installing software

- The most common way to install a software is by using the *package management system*.

Operating System	Format	Tool(s)
Debian	`.deb`	`apt`, `apt-cache`, `apt-get`, `dpkg`
Ubuntu	`.deb`	`apt`, `apt-cache`, `apt-get`, `dpkg`
CentOS	`.rpm`	`yum`
Fedora	`.rpm`	`dnf`
FreeBSD	Ports, `.txz`	`make`, `pkg`

- It’s generally best to update package information before installing.
  1. sudo apt update
  2. sudo apt install [package_name]

Installing software

- Install a package from a local file

System	Command	Notes
Debian / Ubuntu	`sudo dpkg -i package.deb`	
	`sudo apt-get install -y gdebi && sudo gdebi package.deb`	Installs and uses `gdebi` to install `package.deb` and retrieve any missing dependencies.
CentOS	`sudo yum install package.rpm`	
Fedora	`sudo dnf install package.rpm`	
FreeBSD Packages	`sudo pkg add package.txz`	
	`sudo pkg add -f package.txz`	Installs package even if already installed.

Compile locally

- Some Linux software not in the package management system need to be compiled locally.

- To build a software, one must have compilers installed first.
  - `sudo apt update`
  - `sudo apt install build-essential`

- Download the files with `wget`
  - Or maybe you want to transfer the code to the server from your local computer. You can use ftp tools like FileZilla.

Example

- Create a Downloads folder at your home directory.
- Download http://www.ee.surrey.ac.uk/Teaching/Unix/units-1.74.tar.gz

Compressed files

- Linux compressed files are usually named like .tar.gz or .tar.bz2
  - .tar is an archive file, called a tarball, which is a single file that packages many.
  - .gz or .bz2 is the compression format, using gzip or bzip2.

- A single tar command can handle the archiving and zipping at the same time.

```
tar -czvf name-of-archive.tar.gz /path/to/directory-or-file
```

  - -c – create an archive
  - -z/j – compress the archive with gzip/bzip2
  - -v – verbose
  - -f – allow you to specify the filename of the archive

Compressed files

- tar can also used to unzip compressed files.
  - Replace -c with -x to extract.
  - tar -xzvf archive.tar.gz will extract locally
  - tar -xzvf archive.tar.gz -C /tmp will extract to the /tmp folder
- Linux also has `zip` and `unzip`

Example

- Unzip the downloaded file.

Configure and make

- When a program gets large, the compiling order and logic becomes complex. `Makefile` is a file provided with a program source code that tells the system which compilers to use, the compiling order, where to install, etc.
- When `Makefile` is present, use the command `make` to compile, and `make install` to install the program to specified location.
- Additionally, a program usually provides a standardized `configure` script instead of Makefile, which will check your environment (such as availability of compilers) and generate the Makefile.
- Normally you only need to specify the `--prefix` and the `--exec-prefix` options for installation location.

Example

- Compile and install the unit conversion program under ~/Programs/units
- Validate that the program has been installed correctly.