# Lec 25 - Basic linux system administration

## Statistical Computing and Computation

### Sta 663 | Spring 2022

**Dr. Colin Rundel**

# Duke Virtual Computing Manager

# Welcome to Virtual Computing Manager!

Virtual Computing Manager is a service providing the Duke community with easy access to virtual software packages, and semester-long virtual machine (VM) reservations. Access specialized software without installing it on your own computer, host your own server for development projects and coursework, or customize your own environment to use for the semester.

**My Reservations**

No reserved resources for the current semester

## Virtual Machines (aka VMs)

Your Duke VM is like having a second computer that lives in OIT. You can log into and use your VM from your own machine.

- Run Windows or Linux
- Install zero, one or multiple apps for free

**Reserve a VM**

## Virtual Software (aka Containers)

A Container lets you use a desktop software application in your browser without installing it on your machine or your VM.

- Simple to use
- Launch an app in a click!
- Use anywhere you can run a browser

**Reserve a Container**

Not sure what you need? Check out the Help page or contact vm-manager-help@duke.edu for assistance

## https://vcm.duke.edu/

# New Virtual Machine Reservation

## Plain VM: No Apps

CentOS Stream 8

Generic CentOS 7 The CentOS Linux distribution is community-driven free software derived from the sources of Red Hat Enterprise Linux (RHEL).

Ubuntu Server 20.04 Ubuntu Server 20.04 LTS (Focal Fossa)

Ubuntu18.04 Ubuntu 18.04 LTS (Bionic Beaver) operating system

Windows 10 Windows 10 operating system

## Linux Apps

Lamp Stack Linux, Apache, MySQL, PHP development environment

Linux Matlab MATLAB R2021a numerical computation, visualization, & programming for Linux

## Windows Apps

ArcGIS Desktop & Pro ArcGIS Desktop and ArcGIS Pro

Bio202 AppStack This AppStack is running on top of Windows 10 and contains the following apps: AlleleA1, Bugsville, DnaSP, and VGLII.

Bio212 AppStack This application stack is targeted toward the course Bio212 and contains Windows 10, DnaStart 15.2 and FigTree

BioOce Windows 10 virtual machine for use with Biological Oceanography course at the Marine Lab which contains MATLAB, R, RStudio, Ocean Data View with optional package for North Atlantic coastline (https://odv.awi.de/), GoogleEarth, and Google Chrome.

# Getting Started

# Connecting

```
rundel@tbBook [~]$ ssh cr173@vcm-26406.vm.duke.edu
```

```
The authenticity of host 'vcm-26406.vm.duke.edu (67.159.94.29)' can't be established.
ED25519 key fingerprint is SHA256:7Ukmob4JBk3K3Vd2PnlZjy8vgZFN90lmUvs5961kePA.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'vcm-26406.vm.duke.edu' (ED25519) to the list of known hosts.

cr173@vcm-26406.vm.duke.edu's password:
```

```
Welcome to Ubuntu 20.04.4 LTS (GNU/Linux 5.4.0-107-generic x86_64)

...
...
...

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

cr173@vcm-26406:~$
```

# Determining Distribution

This does not work 100% of the time but is generally pretty reliable,

```
cat /etc/*-release
```

**Ubuntu**

```
cr173@vcm-26406:~$ ls -l /etc/*-release
-rw-r--r-- 1 root root 105 Aug 19 19:43 /etc/lsb-release
lrwxrwxrwx 1 root root  21 Aug 19 19:44 /etc/os-release -> ../u

cr173@vcm-26406:~$ cat /etc/*-release
DISTRIB_ID=Ubuntu
DISTRIB_RELEASE=18.04
DISTRIB_CODENAME=bionic
DISTRIB_DESCRIPTION="Ubuntu 18.04.1 LTS"
NAME="Ubuntu"
VERSION="18.04.1 LTS (Bionic Beaver)"
ID=ubuntu
ID_LIKE=debian
PRETTY_NAME="Ubuntu 18.04.1 LTS"
VERSION_ID="18.04"
HOME_URL="https://www.ubuntu.com/"
SUPPORT_URL="https://help.ubuntu.com/"
BUG_REPORT_URL="https://bugs.launchpad.net/ubuntu/"
PRIVACY_POLICY_URL="https://www.ubuntu.com/legal/terms-and-poli
VERSION_CODENAME=bionic
UBUNTU_CODENAME=bionic
```

**Fedora**

```
cr173@algebra2 [~]$ ls -l /etc/*-release
lrwxrwxrwx 1 root root 25 Nov 25 02:36 /etc/fedora-release -> .
lrwxrwxrwx 1 root root 21 Nov 25 02:36 /etc/os-release -> ../us
lrwxrwxrwx 1 root root 14 Nov 25 02:36 /etc/redhat-release -> f
lrwxrwxrwx 1 root root 14 Nov 25 02:36 /etc/system-release -> f

cr173@algebra2 [~]$ cat /etc/os-release
NAME="Fedora Linux"
VERSION="35 (MATE-Compiz)"
ID=fedora
VERSION_ID=35
VERSION_CODENAME=""
PLATFORM_ID="platform:f35"
PRETTY_NAME="Fedora Linux 35 (MATE-Compiz)"
ANSI_COLOR="0;38;2;60;110;180"
LOGO=fedora-logo-icon
CPE_NAME="cpe:/o:fedoraproject:fedora:35"
HOME_URL="https://fedoraproject.org/"
DOCUMENTATION_URL="https://docs.fedoraproject.org/en-US/fedora/
SUPPORT_URL="https://ask.fedoraproject.org/"
BUG_REPORT_URL="https://bugzilla.redhat.com/"
REDHAT_BUGZILLA_PRODUCT="Fedora"
```

# System Details

# Filesystem Hierarchy Standard - /

## Ubuntu

```
cr173@vcm-26406:~$ tree -d -L 1 /
/
├── bin
├── boot
├── dev
├── etc
├── home
├── lib
├── lib64
├── media
├── mnt
├── opt
├── proc
├── root
├── run
├── sbin
├── srv
├── sys
├── tmp
├── usr
└── var
```

## Fedora

```
cr173@algebra2 [~]$ tree -d -L 1 /
/
├── bibtex
├── bin -> usr/bin
├── boot
├── custom-bib
├── data
├── dev
├── doc
├── dvips
├── etc
├── fonts
├── geometry
├── home
├── lib -> usr/lib
├── lib64 -> usr/lib64
├── lost+found
├── media
├── mnt
├── opt
├── pdftex
├── proc
├── proj
├── root
├── run
├── sbin -> usr/sbin
├── source
├── srv
├── sys
├── tex
├── tmp
├── usr
├── var
├── web
└── xdvi
```

https://en.wikipedia.org/wiki/Filesystem_Hierarchy_Standard

# Secondary, Tertiarty, etc.

```
Fedora
cr173@algebra2 [~]$ tree -d -L 1 /usr
/usr
├── bin
├── etc
├── games
├── include
├── lib
├── lib64
├── libexec
├── local
├── sbin
├── share
├── src
└── tmp -> ../var/tmp
```
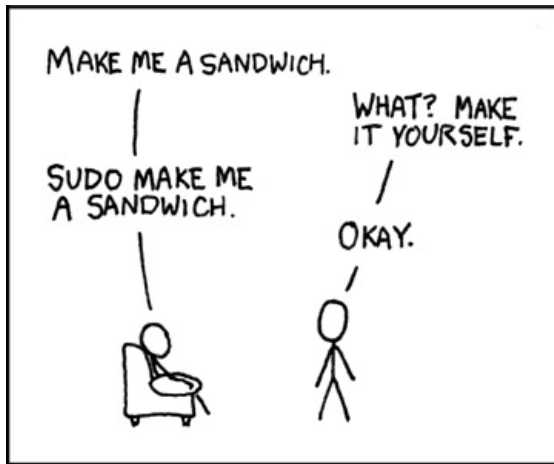
```
Fedora
cr173@algebra2 [~]$ tree -d -L 1 /usr/local
/usr/local
├── bin
├── etc
├── games
├── include
├── lib
├── lib64
├── libexec
├── sbin
├── share
└── src
```

# Installing packages with apt

# Update the package list

```
cr173@vcm-26406:~$ apt update
Reading package lists... Done
E: Could not open lock file /var/lib/apt/lists/lock - open (13: Permission denied)
E: Unable to lock directory /var/lib/apt/lists/
W: Problem unlinking the file /var/cache/apt/pkgcache.bin - RemoveCaches (13: Permission denied)
W: Problem unlinking the file /var/cache/apt/srcpkgcache.bin - RemoveCaches (13: Permission denied)
```

# Update the package list

Ubuntu

```
cr173@vcm-26406:~$ sudo apt update
Hit:1 http://archive.linux.duke.edu/ubuntu focal InRelease
Get:2 http://archive.linux.duke.edu/ubuntu focal-updates InRelease [114 kB]
Hit:3 https://falcon-dl.oit.duke.edu/ubuntu focal InRelease
Get:4 http://archive.linux.duke.edu/ubuntu focal-backports InRelease [108 kB]
Get:5 http://archive.linux.duke.edu/ubuntu focal-security InRelease [114 kB]
Get:6 http://archive.linux.duke.edu/ubuntu focal-updates/main amd64 Packages [1,711 kB]
Get:7 http://archive.linux.duke.edu/ubuntu focal-updates/main i386 Packages [628 kB]
Get:8 http://archive.linux.duke.edu/ubuntu focal-updates/main Translation-en [320 kB]
Get:9 http://archive.linux.duke.edu/ubuntu focal-updates/restricted amd64 Packages [917 kB]
Get:10 http://archive.linux.duke.edu/ubuntu focal-updates/restricted Translation-en [131 kB]
Get:11 http://archive.linux.duke.edu/ubuntu focal-updates/universe amd64 Packages [916 kB]
Get:12 http://archive.linux.duke.edu/ubuntu focal-updates/universe i386 Packages [676 kB]
Get:13 http://archive.linux.duke.edu/ubuntu focal-updates/universe Translation-en [204 kB]
Get:14 http://archive.linux.duke.edu/ubuntu focal-updates/universe amd64 c-n-f Metadata [20.4 kB]
Get:15 http://archive.linux.duke.edu/ubuntu focal-security/main i386 Packages [416 kB]
Get:16 http://archive.linux.duke.edu/ubuntu focal-security/main amd64 Packages [1,383 kB]
Get:17 http://archive.linux.duke.edu/ubuntu focal-security/main Translation-en [239 kB]
Get:18 http://archive.linux.duke.edu/ubuntu focal-security/restricted amd64 Packages [859 kB]
Get:19 http://archive.linux.duke.edu/ubuntu focal-security/restricted Translation-en [122 kB]
Get:20 http://archive.linux.duke.edu/ubuntu focal-security/universe i386 Packages [547 kB]
Get:21 http://archive.linux.duke.edu/ubuntu focal-security/universe amd64 Packages [696 kB]
Get:22 http://archive.linux.duke.edu/ubuntu focal-security/universe Translation-en [122 kB]
Get:23 http://archive.linux.duke.edu/ubuntu focal-security/universe amd64 c-n-f Metadata [14.1 kB]
Fetched 10.3 MB in 3s (4,100 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
1 package can be upgraded. Run 'apt list --upgradable' to see it.
```

# Installing R

**Ubuntu**

```
cr173@vcm-26406:~$ sudo apt install r-base
[sudo] password for cr173:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  build-essential bzip2-doc cpp cpp-9 dpkg-dev fakeroot fontconfig fontconfig-config fonts-dejavu-core g++ g++-9 gcc gcc-9 gcc-9-base gfortran gfortran-9 icu-devtools
  libalgorithm-diff-perl libalgorithm-diff-xs-perl libalgorithm-merge-perl libasan5 libatomic1 libauthen-sasl-perl libblas-dev libblas3 libbz2-dev libcairo2 libcc1-0
  libdata-dump-perl libdatrie1 libdpkg-perl libdrm-amdgpu1 libdrm-intel1 libdrm-nouveau2 libdrm-radeon1 libencode-locale-perl libfakeroot libfile-basedir-perl
  libfile-desktopentry-perl libfile-fcntllock-perl libfile-listing-perl libfile-mimeinfo-perl libfont-afm-perl libfontconfig1 libfontenc1 libgcc-9-dev libgfortran-9-dev
  libgfortran5 libgl1 libgl1-mesa-dri libglapi-mesa libglvnd0 libglx-mesa0 libglx0 libgomp1 libgraphite2-3 libharfbuzz0b libhtml-form-perl libhtml-format-perl
  libhtml-parser-perl libhtml-tagset-perl libhtml-tree-perl libhttp-cookies-perl libhttp-daemon-perl libhttp-date-perl libhttp-message-perl libhttp-negotiate-perl libice6
  libicu-dev libio-html-perl libio-socket-ssl-perl libio-stringy-perl libipc-system-simple-perl libisl22 libitm1 libjbig0 libjpeg-dev libjpeg-turbo8 libjpeg-turbo8-dev li
  libjpeg8-dev liblapack-dev liblapack3 libllvm12 liblsan0 liblwp-mediatypes-perl liblwp-protocol-https-perl liblzma-dev libmailtools-perl libmpc3 libmpfr6 libncurses-dev
  libncurses5-dev libnet-dbus-perl libnet-http-perl libnet-smtp-ssl-perl libnet-ssleay-perl libpango-1.0-0 libpangocairo-1.0-0 libpangoft2-1.0-0 libpaper-utils libpaper1
  libpciaccess0 libpcre16-3 libpcre2-16-0 libpcre2-32-0 libpcre2-dev libpcre2-posix2 libpcre3-dev libpcre32-3 libpcrecpp0v5 libpixman-1-0 libpng-dev libpng-tools libquadm
  libreadline-dev libsensors-config libsensors5 libsm6 libstdc++-9-dev libtcl8.6 libthai-data libthai0 libtie-ixhash-perl libtiff5 libtimedate-perl libtk8.6 libtry-tiny-p
  libtsan0 libubsan1 liburi-perl libvulkan1 libwayland-client0 libwebp6 libwww-perl libwww-robotrules-perl libx11-protocol-perl libx11-xcb1 libxaw7 libxcb-dri2-0 libxcb-d
  libxcb-glx0 libxcb-present0 libxcb-randr0 libxcb-render0 libxcb-shape0 libxcb-shm0 libxcb-sync1 libxcb-xfixes0 libxcomposite1 libxcursor1 libxfixes3 libxft2 libxi6
  libxinerama1 libxkbfile1 libxml-parser-perl libxml-twig-perl libxml-xpathengine-perl libxmu6 libxpm4 libxrandr2 libxrender1 libxshmfence1 libxss1 libxt6 libxtst6 libxv1
  libxxf86dga1 libxxf86vm1 make mesa-vulkan-drivers perl-openssl-defaults pkg-config r-base-core r-base-dev r-base-html r-cran-boot r-cran-class r-cran-cluster r-cran-cod
  r-cran-foreign r-cran-kernsmooth r-cran-lattice r-cran-mass r-cran-matrix r-cran-mgcv r-cran-nlme r-cran-nnet r-cran-rpart r-cran-spatial r-cran-survival r-doc-html
  r-recommended unzip x11-common x11-utils x11-xserver-utils xdg-utils zip zlib1g-dev
Suggested packages:
  cpp-doc gcc-9-locales debian-keyring g++-multilib g++-9-multilib gcc-9-doc gcc-multilib autoconf automake libtool flex bison gdb gcc-doc gcc-9-multilib gfortran-multili
  gfortran-doc gfortran-9-multilib gfortran-9-doc libcoarrays-dev libdigest-hmac-perl libgssapi-perl liblapack-doc bzr icu-doc libcrypt-ssleay-perl liblzma-doc ncurses-do
  readline-doc lm-sensors libstdc++-9-doc tcl8.6 tk8.6 libauthen-ntlm-perl libunicode-map8-perl libunicode-string-perl xml-twig-tools make-doc elpa-ess r-doc-info | r-doc
  r-mathlib texlive-base texlive-latex-base texlive-plain-generic texlive-fonts-recommended texlive-fonts-extra texlive-extra-utils texlive-latex-recommended texlive-late
  texinfo mozilla | www-browser mesa-utils nickle cairo-5c xorg-docs-core
The following NEW packages will be installed:
  build-essential bzip2-doc cpp cpp-9 dpkg-dev fakeroot fontconfig fontconfig-config fonts-dejavu-core g++ g++-9 gcc gcc-9 gcc-9-base gfortran gfortran-9 icu-devtools
  libalgorithm-diff-perl libalgorithm-diff-xs-perl libalgorithm-merge-perl libasan5 libatomic1 libauthen-sasl-perl libblas-dev libblas3 libbz2-dev libcairo2 libcc1-0
  libdata-dump-perl libdatrie1 libdpkg-perl libdrm-amdgpu1 libdrm-intel1 libdrm-nouveau2 libdrm-radeon1 libencode-locale-perl libfakeroot libfile-basedir-perl
  libfile-desktopentry-perl libfile-fcntllock-perl libfile-listing-perl libfile-mimeinfo-perl libfont-afm-perl libfontconfig1 libfontenc1 libgcc-9-dev libgfortran-9-dev
  libgfortran5 libgl1 libgl1-mesa-dri libglapi-mesa libglvnd0 libglx-mesa0 libglx0 libgomp1 libgraphite2-3 libharfbuzz0b libhtml-form-perl libhtml-format-perl
  libhtml-parser-perl libhtml-tagset-perl libhtml-tree-perl libhttp-cookies-perl libhttp-daemon-perl libhttp-date-perl libhttp-message-perl libhttp-negotiate-perl libice6
```

# Removing R

```
cr173@vcm-26406:~$ sudo apt remove r-base
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  fontconfig fontconfig-config fonts-dejavu-core gfortran gfortran-9 icu-devtools libblas-dev libblas3 libbz2-dev libcairo2 libdatrie1 libdrm-amdgpu1 libdrm-intel1
  libdrm-nouveau2 libdrm-radeon1 libfile-basedir-perl libfile-desktopentry-perl libfile-mimeinfo-perl libfontconfig1 libfontenc1 libgfortran-9-dev libgfortran5 libgl1
  libgl1-mesa-dri libglapi-mesa libglvnd0 libglx-mesa0 libglx0 libgraphite2-3 libharfbuzz0b libice6 libicu-dev libio-stringy-perl libipc-system-simple-perl libjbig0 libjp
  libjpeg-turbo8 libjpeg-turbo8-dev libjpeg8 libjpeg8-dev liblapack-dev liblapack3 libllvm12 liblzma-dev libncurses-dev libncurses5-dev libnet-dbus-perl libpango-1.0-0
  libpangocairo-1.0-0 libpangoft2-1.0-0 libpaper-utils libpaper1 libpciaccess0 libpcre16-3 libpcre2-16-0 libpcre2-32-0 libpcre2-dev libpcre2-posix2 libpcre3-dev libpcre32
  libpcrecpp0v5 libpixman-1-0 libpng-dev libpng-tools libreadline-dev libsensors-config libsensors5 libsm6 libtcl8.6 libthai-data libthai0 libtie-ixhash-perl libtiff5 lib
  libvulkan1 libwayland-client0 libwebp6 libx11-protocol-perl libx11-xcb1 libxaw7 libxcb-dri2-0 libxcb-dri3-0 libxcb-glx0 libxcb-present0 libxcb-randr0 libxcb-render0
  libxcb-shape0 libxcb-shm0 libxcb-sync1 libxcb-xfixes0 libxcomposite1 libxcursor1 libxfixes3 libxft2 libxi6 libxinerama1 libxkbfile1 libxml-parser-perl libxml-twig-perl
  libxml-xpathengine-perl libxmu6 libxpm4 libxrandr2 libxrender1 libxshmfence1 libxss1 libxt6 libxtst6 libxv1 libxxf86dga1 libxxf86vm1 mesa-vulkan-drivers pkg-config r-ba
  r-base-dev r-base-html r-cran-boot r-cran-class r-cran-cluster r-cran-codetools r-cran-foreign r-cran-kernsmooth r-cran-lattice r-cran-mass r-cran-matrix r-cran-mgcv
  r-cran-nlme r-cran-nnet r-cran-rpart r-cran-spatial r-cran-survival r-doc-html r-recommended unzip x11-common x11-utils x11-xserver-utils xdg-utils zip zlib1g-dev
Use 'sudo apt autoremove' to remove them.
The following packages will be REMOVED:
  r-base
0 upgraded, 0 newly installed, 1 to remove and 1 not upgraded.
After this operation, 62.5 kB disk space will be freed.
```

and all of its dependencies,

```
cr173@vcm-26406:~$ sudo apt autoremove
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages will be REMOVED:
  fontconfig fontconfig-config fonts-dejavu-core gfortran gfortran-9 icu-devtools libblas-dev libblas3 libbz2-dev libcairo2 libdatrie1 libdrm-amdgpu1 libdrm-intel1
  libdrm-nouveau2 libdrm-radeon1 libfile-basedir-perl libfile-desktopentry-perl libfile-mimeinfo-perl libfontconfig1 libfontenc1 libgfortran-9-dev libgfortran5 libgl1
```

# Updating & Upgrading

```
cr173@vcm-26406:~$ sudo apt update
Hit:1 http://archive.linux.duke.edu/ubuntu focal InRelease
Hit:2 http://archive.linux.duke.edu/ubuntu focal-updates InRelease
Hit:3 http://archive.linux.duke.edu/ubuntu focal-backports InRelease
Hit:4 http://archive.linux.duke.edu/ubuntu focal-security InRelease
Hit:5 https://falcon-dl.oit.duke.edu/ubuntu focal InRelease
Reading package lists... Done
Building dependency tree
Reading state information... Done
1 package can be upgraded. Run 'apt list --upgradable' to see it.
```

Ubuntu

```
cr173@vcm-26406:~$ sudo apt upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages will be upgraded:
  libfribidi0
1 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
1 standard security update
Need to get 24.2 kB of archives.
After this operation, 0 B of additional disk space will be used.
Do you want to continue? [Y/n]
```

# Aside - Conflicts

```
  Ubuntu

...

update-initramfs: deferring update (trigger activated)
amd64-microcode: microcode will be updated at next boot
Setting up intel-microcode (3.20180807a.0ubuntu0.18.04.1) ...
update-initramfs: deferring update (trigger activated)
intel-microcode: microcode will be updated at next boot
Setting up kmod (24-1ubuntu3.1) ...

Configuration file '/etc/modprobe.d/blacklist.conf'
  ==> Modified (by you or by a script) since installation.
  ==> Package distributor has shipped an updated version.
    What would you like to do about it ?  Your options are:
     Y or I  : install the package maintainer's version
     N or O  : keep your currently-installed version
        D     : show the differences between the versions
        Z     : start a shell to examine the situation
  The default action is to keep your current version.
*** blacklist.conf (Y/I/N/O/D/Z) [default=N] ?
Setting up initramfs-tools-core (0.130ubuntu3.6) ...
Setting up linux-headers-4.15.0-43-generic (4.15.0-43.46) ...
Setting up initramfs-tools (0.130ubuntu3.6) ...

...
```

# Package Contents & Details

```
cr173@vcm-26406:~$ apt show r-base
Package: r-base
Version: 3.6.3-2
Priority: optional
Section: universe/math
Origin: Ubuntu
Maintainer: Ubuntu Developers <ubuntu-devel-discuss@lists.ubuntu.com>
Original-Maintainer: Dirk Eddelbuettel <edd@debian.org>
Bugs: https://bugs.launchpad.net/ubuntu/+filebug
Installed-Size: 62.5 kB
Depends: r-base-core (>= 3.6.3-2), r-recommended (= 3.6.3-2)
Recommends: r-base-html, r-doc-html
Suggests: elpa-ess, r-doc-info | r-doc-pdf
Homepage: http://www.r-project.org/
Download-Size: 9,308 B
APT-Manual-Installed: yes
APT-Sources: http://archive.linux.duke.edu/ubuntu focal/universe amd64 Packages
Description: GNU R statistical computation and graphics system
 R is a system for statistical computation and graphics.  It consists
 of a language plus a run-time environment with graphics, a debugger,
 access to certain system functions, and the ability to run programs
 stored in script files.
...
```

Ubuntu

```
cr173@vcm-26406:~$ dpkg -L r-base
/.
```

# File -> Package

Ubuntu

```
cr173@vcm-26406:~$ dpkg -S /usr/bin/R
r-base-core: /usr/bin/R
```

Ubuntu

```
cr173@vcm-26406:~$ dpkg -L r-base-core
/.
/etc
/etc/R
/etc/R/Makeconf
/etc/R/Renviron.site
/etc/R/Rprofile.site
/etc/R/ldpaths
/etc/R/repositories
/etc/ld.so.conf.d
/usr
/usr/bin
/usr/bin/R
/usr/bin/Rscript
/usr/lib
/usr/lib/R
/usr/lib/R/SVN-REVISION
/usr/lib/R/bin
/usr/lib/R/bin/BATCH
/usr/lib/R/bin/COMPILE
/usr/lib/R/bin/INSTALL
/usr/lib/R/bin/LINK
/usr/lib/R/bin/R
```

# Package Manager Comparison

| | Ubuntu / Debian | RHEL | Fedora | Requires root |
|---|---|---|---|---|
| Install Package | `apt install` | `yum install` | `dnf install` | Yes |
| Install Local Package | `dpkg -i pkg.deb` | `yum install pkg.rpm` | `dnf install pkg.rpm` | Yes |
| Remove Package | `apt remove` | `yum remove` | `dnf remove` | Yes |
| Update Package List | `apt update` | `yum check-update` | `dnf check-update` | Yes |
| Upgrade Packages | `apt upgrade`<br>`apt full-upgrade` | `yum upgrade` | `dnf upgrade` | Yes |
| Clean Dependencies | `apt autoremove` | `yum autoremove` | `dnf autoremove` | Yes |
| Reinstall Package | `apt install --reinstall` | `yum reinstall` | `dnf reinstall` | Yes |
| Package Details | `apt show` | `yum info` | `dnf info` | No |
| Package Dependencies | `apt show` | `yum deplist` | `dnf repoquery --requires` | No |
| Package -> Files | `dpkg -L` | `rpm -qf` | `rpm -qf` | No |
| Files -> Package | `dpkg -S` | `rpm -ql` | `rpm -ql` or `dnf repoquery -l` | No |

# Upgrading R

The R project maintains separate package repositories with the latest version of R - see distribution specific instructions here: https://cran.r-project.org/bin/linux/

Ubuntu

```
sudo apt update -qq
sudo apt install --no-install-recommends -y software-properties-common dirmngr
wget -qO- https://cloud.r-project.org/bin/linux/ubuntu/marutter_pubkey.asc | sudo tee -a /etc/apt/trusted.gpg.d/cran_ubuntu_key.asc
sudo add-apt-repository "deb https://cloud.r-project.org/bin/linux/ubuntu $(lsb_release -cs)-cran40/"
```

Ubuntu

```
cr173@vcm-26406:~$ cat /etc/apt/sources.list

...
deb https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/
# deb-src https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/
```

Ubuntu

```
cr173@vcm-26406:~$ sudo apt update
Hit:1 http://archive.linux.duke.edu/ubuntu focal InRelease
Get:2 http://archive.linux.duke.edu/ubuntu focal-updates InRelease [114 kB]
Hit:3 http://archive.linux.duke.edu/ubuntu focal-backports InRelease
Get:4 http://archive.linux.duke.edu/ubuntu focal-security InRelease [114 kB]
Hit:5 https://falcon-dl.oit.duke.edu/ubuntu focal InRelease
Hit:6 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ InRelease
```

```
cr173@vcm-26406:~$ sudo apt upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages will be upgraded:
  libfribidi0 r-base r-base-core r-base-dev r-base-html r-cran-boot r-cran-class r-cran-cluster r-cran-codetools r-cran-foreign r-cran
  r-cran-matrix r-cran-mgcv r-cran-nlme r-cran-nnet r-cran-rpart r-cran-spatial r-cran-survival r-doc-html r-recommended
22 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
1 standard security update
Need to get 47.9 MB of archives.
After this operation, 3,829 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://archive.linux.duke.edu/ubuntu focal-updates/main amd64 libfribidi0 amd64 1.0.8-2ubuntu0.1 [24.2 kB]
Get:2 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-lattice 0.20-45-1.2004.0 [1,134 kB]
Get:3 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-matrix 1.4-1-1.2004.0 [4,303 kB]
Get:4 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-survival 3.2-13-1cran1.2004.0 [6,614 kB]
Get:5 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-spatial 7.3-11-2focal0 [127 kB]
Get:6 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-rpart 4.1.16-1.2004.0 [910 kB]
Get:7 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-nnet 7.3-17-1.2004.0 [112 kB]
Get:8 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-nlme 3.1.157-1.2004.0 [2,250 kB]
Get:9 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-mgcv 1.8-40-1cran1.2004.0 [3,021 kB]
Get:10 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-mass 7.3-56-1.2004.0 [1,117 kB]
Get:11 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-kernsmooth 2.23-20-1cran1.2004.0 [89.7 kB]
Get:12 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-foreign 0.8.82-1.2004.0 [238 kB]
Get:13 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-codetools 0.2-18-1cran1.2004.0 [90.0 kB]
Get:14 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-cluster 2.1.3-1.2004.0 [543 kB]
Get:15 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-class 7.3-20-1.2004.0 [87.8 kB]
Get:16 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-cran-boot 1.3-28-1cran1.2004.0 [619 kB]
Get:17 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-base-core 4.1.3-1.2004.0 [25.9 MB]
Get:18 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-base 4.1.3-1.2004.0 [44.6 kB]
Get:19 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-recommended 4.1.3-1.2004.0 [2,780 B]
Get:20 https://cloud.r-project.org/bin/linux/ubuntu focal-cran40/ r-base-dev 4.1.3-1.2004.0 [4,484 B]
```

# System dependencies

```
Ubuntu

cr173@vcm-26406:~$ R

R version 4.1.3 (2022-03-10) -- "One Push-Up"
Copyright (C) 2022 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)

...

> install.packages("curl")
  Installing package into '/usr/local/lib/R/site-library'
  (as 'lib' is unspecified)
  trying URL 'https://cloud.r-project.org/src/contrib/curl_4.3.2.tar.gz'
  Content type 'application/x-gzip' length 793345 bytes (774 KB)
  ==================================================
  downloaded 774 KB

  * installing *source* package 'curl' ...
  ** package 'curl' successfully unpacked and MD5 sums checked
  ** using staged installation
  Package libcurl was not found in the pkg-config search path.
  Perhaps you should add the directory containing `libcurl.pc'
  to the PKG_CONFIG_PATH environment variable
  No package 'libcurl' found
  Package libcurl was not found in the pkg-config search path.
  Perhaps you should add the directory containing `libcurl.pc'
  to the PKG_CONFIG_PATH environment variable
  No package 'libcurl' found
  Using PKG_CFLAGS=
  Using PKG_LIBS=-lcurl
  ------------------------ ANTICONF ERROR ---------------------------
  Configuration failed because libcurl was not found. Try installing:
   * deb: libcurl4-openssl-dev (Debian, Ubuntu, etc)
   * rpm: libcurl-devel (Fedora, CentOS, RHEL)
```

# Installing libcurl4-openssl-dev

```
cr173@vcm-26406:~$ sudo apt install libcurl4-openssl-dev
Reading package lists... Done
Building dependency tree
Reading state information... Done
Suggested packages:
  libcurl4-doc libidn11-dev libkrb5-dev libldap2-dev librtmp-dev libssh2-1-dev libssl-dev
The following NEW packages will be installed:
  libcurl4-openssl-dev
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 321 kB of archives.
After this operation, 1,541 kB of additional disk space will be used.
Get:1 http://archive.linux.duke.edu/ubuntu focal-updates/main amd64 libcurl4-openssl-dev amd64 7.68.0-1ubuntu2.7 [321 kB]
Fetched 321 kB in 0s (2,051 kB/s)
Selecting previously unselected package libcurl4-openssl-dev:amd64.
(Reading database ... 126123 files and directories currently installed.)
Preparing to unpack .../libcurl4-openssl-dev_7.68.0-1ubuntu2.7_amd64.deb ...
Unpacking libcurl4-openssl-dev:amd64 (7.68.0-1ubuntu2.7) ...
Setting up libcurl4-openssl-dev:amd64 (7.68.0-1ubuntu2.7) ...
Processing triggers for man-db (2.9.1-1) ...
```

```
cr173@vcm-26406:~$ R
...
> install.packages("curl")
 Installing package into '/home/cr173/R/x86_64-pc-linux-gnu-library/4.1'
 (as 'lib' is unspecified)
 trying URL 'https://cloud.r-project.org/src/contrib/curl_4.3.2.tar.gz'
 Content type 'application/x-gzip' length 793345 bytes (774 KB)
 ==================================================
 downloaded 774 KB

 * installing *source* package 'curl' ...
 ** package 'curl' successfully unpacked and MD5 sums checked
 ** using staged installation
 Found pkg-config cflags and libs!
 Using PKG_CFLAGS=-I/usr/include/x86_64-linux-gnu
 Using PKG_LIBS=-lcurl
 ** libs
 rm -f curl.so callbacks.o curl.o download.o escape.o fetch.o form.o getdate.o handle.o ieproxy.o init.o interrupt.o multi.o nslookup.o reflist.o split.o ssl.o typechecki
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -I"/usr/share/R/include" -DNDEBUG -I/usr/include/x86_64-linux-gnu -DSTRICT_R_HEADERS    -fvisibility=hidden -fpic  -g -O2 -fdebug-prefix-map=/build/r-base-1ENDSu/r-b
 gcc -shared -L/usr/lib/R/lib -Wl,-Bsymbolic-functions -Wl,-z,relro -o curl.so callbacks.o curl.o download.o escape.o fetch.o form.o getdate.o handle.o ieproxy.o init.o i
 installing to /home/cr173/R/x86_64-pc-linux-gnu-library/4.1/00LOCK-curl/00new/curl/libs
```

# What is `libcurl4-openssl-dev`?

## Ubuntu

```
cr173@vcm-26406:~$ apt show libcurl4-openssl-dev
Package: libcurl4-openssl-dev
Version: 7.68.0-1ubuntu2.7
Priority: optional
Section: libdevel
Source: curl
Origin: Ubuntu
Maintainer: Ubuntu Developers <ubuntu-devel-discuss@lists.ubuntu.com>
Original-Maintainer: Alessandro Ghedini <ghedo@debian.org>
Bugs: https://bugs.launchpad.net/ubuntu/+filebug
Installed-Size: 1,541 kB
Provides: libcurl-dev, libcurl-ssl-dev, libcurl3-dev, libcurl3-openssl-dev, libcurl4-dev
Depends: libcurl4 (= 7.68.0-1ubuntu2.7)
Suggests: libcurl4-doc, libidn11-dev, libkrb5-dev, libldap2-dev, librtmp-dev, libssh2-1-dev, libssl-dev (>= 1.1), pkg-config, zlib1g-dev
Conflicts: libcurl4-gnutls-dev, libcurl4-nss-dev, libssl-dev (<< 1.1), libssl1.0-dev
Homepage: http://curl.haxx.se
Download-Size: 321 kB
APT-Manual-Installed: yes
APT-Sources: http://archive.linux.duke.edu/ubuntu focal-updates/main amd64 Packages
Description: development files and documentation for libcurl (OpenSSL flavour)
 libcurl is an easy-to-use client-side URL transfer library, supporting DICT,
 FILE, FTP, FTPS, GOPHER, HTTP, HTTPS, IMAP, IMAPS, LDAP, LDAPS, POP3, POP3S,
 RTMP, RTSP, SCP, SFTP, SMTP, SMTPS, TELNET and TFTP.
 .
 libcurl supports SSL certificates, HTTP POST, HTTP PUT, FTP uploading, HTTP
 form based upload, proxies, cookies, user+password authentication (Basic,
 Digest, NTLM, Negotiate, Kerberos), file transfer resume, http proxy tunneling
 and more!
 .
 libcurl is free, thread-safe, IPv6 compatible, feature rich, well supported,
 fast, thoroughly documented and is already used by many known, big and
 successful companies and numerous applications.
 .
 This package provides the development files (ie. includes, static library,
 manual pages) that allow one to build software which uses libcurl.
 .
```

# What is in `libcurl4-openssl-dev`?

```
  Ubuntu
```

```
cr173@vcm-26406:~$ dpkg -L libcurl4-openssl-dev
/.
/usr
/usr/bin
/usr/bin/curl-config
/usr/include
/usr/include/x86_64-linux-gnu
/usr/include/x86_64-linux-gnu/curl
/usr/include/x86_64-linux-gnu/curl/curl.h
/usr/include/x86_64-linux-gnu/curl/curlver.h
/usr/include/x86_64-linux-gnu/curl/easy.h
/usr/include/x86_64-linux-gnu/curl/mprintf.h
/usr/include/x86_64-linux-gnu/curl/multi.h
/usr/include/x86_64-linux-gnu/curl/stdcheaders.h
/usr/include/x86_64-linux-gnu/curl/system.h
/usr/include/x86_64-linux-gnu/curl/typecheck-gcc.h
/usr/include/x86_64-linux-gnu/curl/urlapi.h
/usr/lib
/usr/lib/x86_64-linux-gnu
/usr/lib/x86_64-linux-gnu/libcurl.a
/usr/lib/x86_64-linux-gnu/libcurl.la
/usr/lib/x86_64-linux-gnu/pkgconfig
/usr/lib/x86_64-linux-gnu/pkgconfig/libcurl.pc
/usr/share
/usr/share/aclocal
/usr/share/aclocal/libcurl.m4
/usr/share/doc
/usr/share/doc/libcurl4-openssl-dev
/usr/share/doc/libcurl4-openssl-dev/copyright
/usr/share/man
/usr/share/man/man1
/usr/share/man/man1/curl-config.1.gz
/usr/lib/x86_64-linux-gnu/libcurl.so
/usr/share/doc/libcurl4-openssl-dev/NEWS.Debian.gz
/usr/share/doc/libcurl4-openssl-dev/changelog.Debian.gz
```

# Lets try sf

```
cr173@vcm-26406:~$ R
...
> install.packages("sf")
Installing package into '/home/cr173/R/x86_64-pc-linux-gnu-library/4.1'
(as 'lib' is unspecified)
trying URL 'https://cloud.r-project.org/src/contrib/sf_1.0-7.tar.gz'
Content type 'application/x-gzip' length 3529597 bytes (3.4 MB)
==================================================
downloaded 3.4 MB

* installing *source* package 'sf' ...
** package 'sf' successfully unpacked and MD5 sums checked
** using staged installation
configure: CC: gcc
configure: CXX: g++ -std=gnu++11
checking for gdal-config... no
no
configure: error: gdal-config not found or not executable.
ERROR: configuration failed for package 'sf'
* removing '/home/cr173/R/x86_64-pc-linux-gnu-library/4.1/sf'

The downloaded source packages are in
    '/tmp/RtmpAt7DId/downloaded_packages'
Warning message:
In install.packages("sf") :
  installation of package 'sf' had non-zero exit status
```

## What next?

https://packagemanager.rstudio.com/

# A bit about libraries

# System libraries

These are shared common components that are used by a variety of software on a linux system. For the most part they are a collection of compiled code (typically C / C++) that are stored in a single file.

- Allows for code reuse
- Allows for multiple (concurrent) versions
- Avoids reinventing the wheel
- Installed in `/lib`, `/usr/lib`, `/usr/local/lib`, etc.
- Two flavors: static (`.a`) and dynamic (`.so`)

# libcurl

**Ubuntu**

```
cr173@vcm-26406:~$ ls -la /usr/lib/x86_64-linux-gnu/libcurl*
-rw-r--r-- 1 root root 1057632 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl.a
lrwxrwxrwx 1 root root      19 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl-gnutls.so.3 -> libcurl-gnutls.so.4
lrwxrwxrwx 1 root root      23 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl-gnutls.so.4 -> libcurl-gnutls.so.4.5.0
-rw-r--r-- 1 root root  510408 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl-gnutls.so.4.5.0
-rw-r--r-- 1 root root     951 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl.la
lrwxrwxrwx 1 root root      16 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl.so -> libcurl.so.4.5.0
lrwxrwxrwx 1 root root      16 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl.so.4 -> libcurl.so.4.5.0
-rw-r--r-- 1 root root  518600 Oct 29 08:10 /usr/lib/x86_64-linux-gnu/libcurl.so.4.5.0
```

**RHEL**

```
[cr173@vcm-8157 ~]$ ls -la /usr/lib64/libcurl*
lrwxrwxrwx. 1 root root      16 Jan 14 12:05 /usr/lib64/libcurl.so -> libcurl.so.4.3.0
lrwxrwxrwx. 1 root root      16 Jan 10 07:45 /usr/lib64/libcurl.so.4 -> libcurl.so.4.3.0
-rwxr-xr-x. 1 root root  435176 Aug  8 09:28 /usr/lib64/libcurl.so.4.3.0
```

# Getting what you want

The following is a basic heuristic of library package naming schemes for these distro families, there are exceptions and edge cases.

These are the names that would then be used with something like `apt install` or `yum install` respectively.

|  | **Debian** | **Redhat** |
|---|---|---|
| Dynamic library (.so) | `lib{name}` | `{name}` |
| Headers | `lib{name}-dev` | `{name}-devel` |
| Static library (.a) | `lib{name}-dev` | `{name}-static` |
| Documentation | `lib{name}-doc` | `{name}-devel` |

# Troubleshooting dynamic libraries

Ubuntu

```
cr173@vcm-26406:~$ ldd /usr/lib/x86_64-linux-gnu/libcurl.so
    linux-vdso.so.1 (0x00007ffd98176000)
    libnghttp2.so.14 => /usr/lib/x86_64-linux-gnu/libnghttp2.so.14 (0x00007f1e3dc60000)
    libidn2.so.0 => /usr/lib/x86_64-linux-gnu/libidn2.so.0 (0x00007f1e3da43000)
    librtmp.so.1 => /usr/lib/x86_64-linux-gnu/librtmp.so.1 (0x00007f1e3d827000)
    libpsl.so.5 => /usr/lib/x86_64-linux-gnu/libpsl.so.5 (0x00007f1e3d619000)
    libssl.so.1.1 => /usr/lib/x86_64-linux-gnu/libssl.so.1.1 (0x00007f1e3d3af000)
    libcrypto.so.1.1 => /usr/lib/x86_64-linux-gnu/libcrypto.so.1.1 (0x00007f1e3cf37000)
    libgssapi_krb5.so.2 => /usr/lib/x86_64-linux-gnu/libgssapi_krb5.so.2 (0x00007f1e3ccec000)
    libldap_r-2.4.so.2 => /usr/lib/x86_64-linux-gnu/libldap_r-2.4.so.2 (0x00007f1e3ca9a000)
    liblber-2.4.so.2 => /usr/lib/x86_64-linux-gnu/liblber-2.4.so.2 (0x00007f1e3c88c000)
    libz.so.1 => /lib/x86_64-linux-gnu/libz.so.1 (0x00007f1e3c66f000)
    libpthread.so.0 => /lib/x86_64-linux-gnu/libpthread.so.0 (0x00007f1e3c450000)
    libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00007f1e3c05f000)
    libunistring.so.2 => /usr/lib/x86_64-linux-gnu/libunistring.so.2 (0x00007f1e3bce1000)
    libgnutls.so.30 => /usr/lib/x86_64-linux-gnu/libgnutls.so.30 (0x00007f1e3b97c000)
    libhogweed.so.4 => /usr/lib/x86_64-linux-gnu/libhogweed.so.4 (0x00007f1e3b748000)
    libnettle.so.6 => /usr/lib/x86_64-linux-gnu/libnettle.so.6 (0x00007f1e3b512000)
    libgmp.so.10 => /usr/lib/x86_64-linux-gnu/libgmp.so.10 (0x00007f1e3b291000)
    libdl.so.2 => /lib/x86_64-linux-gnu/libdl.so.2 (0x00007f1e3b08d000)
    libkrb5.so.3 => /usr/lib/x86_64-linux-gnu/libkrb5.so.3 (0x00007f1e3adb7000)
    libk5crypto.so.3 => /usr/lib/x86_64-linux-gnu/libk5crypto.so.3 (0x00007f1e3ab85000)
    libcom_err.so.2 => /lib/x86_64-linux-gnu/libcom_err.so.2 (0x00007f1e3a981000)
    libkrb5support.so.0 => /usr/lib/x86_64-linux-gnu/libkrb5support.so.0 (0x00007f1e3a776000)
    libresolv.so.2 => /lib/x86_64-linux-gnu/libresolv.so.2 (0x00007f1e3a55b000)
    libsasl2.so.2 => /usr/lib/x86_64-linux-gnu/libsasl2.so.2 (0x00007f1e3a340000)
    libgssapi.so.3 => /usr/lib/x86_64-linux-gnu/libgssapi.so.3 (0x00007f1e3a0ff000)
    /lib64/ld-linux-x86-64.so.2 (0x00007f1e3e104000)
    libp11-kit.so.0 => /usr/lib/x86_64-linux-gnu/libp11-kit.so.0 (0x00007f1e39dd0000)
    libtasn1.so.6 => /usr/lib/x86_64-linux-gnu/libtasn1.so.6 (0x00007f1e39bbd000)
    libkeyutils.so.1 => /lib/x86_64-linux-gnu/libkeyutils.so.1 (0x00007f1e399b9000)
    libheimntlm.so.0 => /usr/lib/x86_64-linux-gnu/libheimntlm.so.0 (0x00007f1e397b0000)
    libkrb5.so.26 => /usr/lib/x86_64-linux-gnu/libkrb5.so.26 (0x00007f1e39523000)
    libasn1.so.8 => /usr/lib/x86_64-linux-gnu/libasn1.so.8 (0x00007f1e39281000)
    libhcrypto.so.4 => /usr/lib/x86_64-linux-gnu/libhcrypto.so.4 (0x00007f1e3904b000)
    libroken.so.18 => /usr/lib/x86_64-linux-gnu/libroken.so.18 (0x00007f1e38e35000)
```

# Python management

```
cr173@vcm-26406:~$ pip install torch

Command 'pip' not found, but can be installed with:

apt install python3-pip
Please ask your administrator.
```

```
cr173@vcm-26406:~$ sudo apt install python3-pip
[sudo] password for cr173:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libexpat1-dev libpython3-dev libpython3.8-dev python-pip-whl python3-dev python3-wheel python3.8-dev
The following NEW packages will be installed:
  libexpat1-dev libpython3-dev libpython3.8-dev python-pip-whl python3-dev python3-pip python3-wheel pyt
0 upgraded, 8 newly installed, 0 to remove and 0 not upgraded.
Need to get 6,651 kB of archives.
After this operation, 25.0 MB of additional disk space will be used.
Do you want to continue? [Y/n]
```

# Package manager vs pip

```
cr173@vcm-26406:~$ sudo apt install python3-numpy
Reading package lists... Done
Building dependency tree
Reading state information... Done
python3-numpy is already the newest version (1:1.17.4-5ubuntu3).
python3-numpy set to manually installed.
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

Ubuntu

```
cr173@vcm-26406:~$ sudo pip install numpy --upgrade
Collecting numpy
  Downloading numpy-1.22.3-cp38-cp38-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (16.8 MB)
       |████████████████████████████████| 16.8 MB 3.6 MB/s
Installing collected packages: numpy
  Attempting uninstall: numpy
    Found existing installation: numpy 1.17.4
    Not uninstalling numpy at /usr/lib/python3/dist-packages, outside environment /usr
    Can't uninstall 'numpy'. No files were found to uninstall.
Successfully installed numpy-1.22.3
```

Ubuntu

```
cr173@vcm-26406:~$ sudo pip install numpy --upgrade --ignore-installed
Collecting numpy
  Using cached numpy-1.22.3-cp38-cp38-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (16.8 MB)
Installing collected packages: numpy
Successfully installed numpy-1.22.3
```

# Outdated python libraries

```
Ubuntu
```

```
cr173@vcm-26406:~$ sudo pip list --outdated
Package            Version     Latest     Type
------------------ ----------- ---------- -----
ansible            2.9.6       5.6.0      sdist
apache-libcloud    2.8.0       3.5.1      wheel
argcomplete        1.8.1       2.0.0      wheel
certifi            2019.11.28  2021.10.8  wheel
chardet            3.0.4       4.0.0      wheel
cryptography       2.8         36.0.2     wheel
dbus-python        1.2.16      1.2.18     sdist
distro             1.4.0       1.7.0      wheel
distro-info        0.23ubuntu1 1.0        wheel
dnspython          1.16.0      2.2.1      wheel
entrypoints        0.3         0.4        wheel
GDAL               3.0.4       3.4.2      sdist
httplib2           0.14.0      0.20.4     wheel
idna               2.8         3.3        wheel
Jinja2             2.10.1      3.1.1      wheel
jmespath           0.9.4       1.0.0      wheel
keyring            18.0.1      23.5.0     wheel
launchpadlib       1.10.13     1.10.16    wheel
lazr.restfulclient 0.14.2      0.14.4     sdist
lazr.uri           1.0.3       1.0.6      sdist
MarkupSafe         1.1.0       2.1.1      wheel
netaddr            0.7.19      0.8.0      wheel
netifaces          0.10.4      0.11.0     wheel
ntlm-auth          1.1.0       1.5.0      wheel
oauthlib           3.1.0       3.2.0      wheel
pip                20.0.2      22.0.4     wheel
```