

Basic linux & Docker

Lecture 20

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1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

Linux distro timeline

Version 7.2 by NPU (nonplusx@gmail.com)

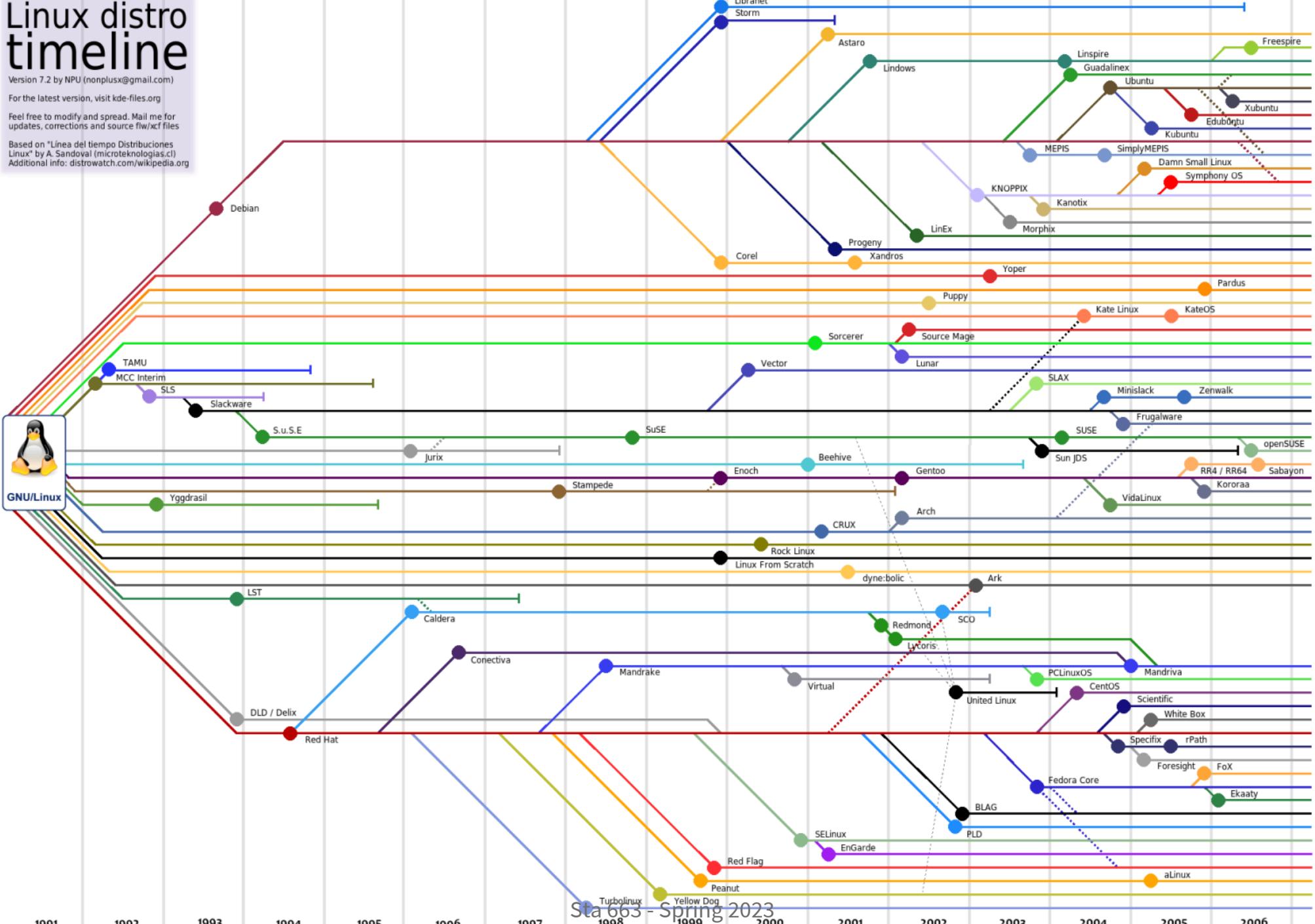
For the latest version, visit kde-files.org

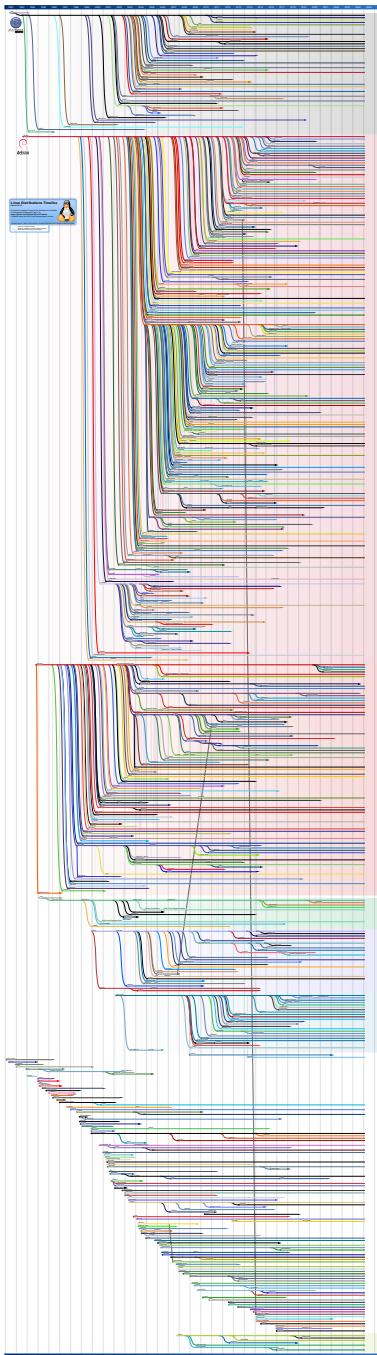
Feel free to modify and spread. Mail me for updates, corrections and source flw/xcf files

Based on "Línea del tiempo Distribuciones Linux" by A. Sandoval (microtecnologias.cl)
Additional info: distrowatch.com/wikipedia.org



GNU/Linux





Sta 663 - Spring 2023

Duke VCM

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

vcm.duke.edu

Most Popular



[Windows 10](#)

Windows 10 operating system



[Ubuntu Server 20.04](#)

Ubuntu Server 20.04 LTS (Focal Fossa)



[Fuqua Office 2019 64-Bit](#)

Microsoft Office 2019 Professional Plus 64-bit:
Word 2019, Excel 2019, PowerPoint 2019, Outlook,
OneNote (2016), Publisher and Access.

Course



[COMPSCI 390](#)

Ubuntu 20.04 Mate desktop with Chrome, Java and Ghidra

Everything

All

Linux

[Windows](#)

[CentOS Stream 8](#)

[COMPSCI 390](#) Ubuntu 20.04 Mate desktop with Chrome, Java and Ghidra

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

[Lamp Stack](#) Linux, Apache, MySQL, PHP development environment

[Linux Matlab](#) MATLAB R2021a numerical computation, visualization, & programming for Linux

[Ubuntu Server 20.04](#) Ubuntu Server 20.04 LTS (Focal Fossa)

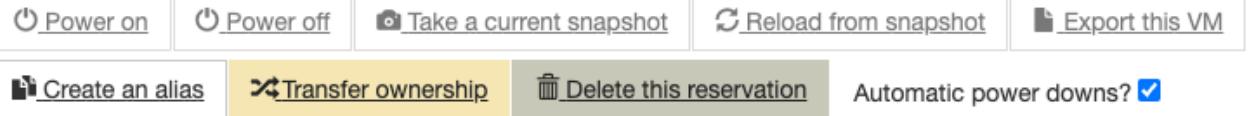
[Ubuntu Server 22.04](#) Ubuntu Server 22.04 (Jammy Jellyfish)

My Reservations

VIRTUAL MACHINES

[vcm-26406.vm.duke.edu](#)

VM Management Tools



Adding your account to your VM. In a few minutes an email will be sent to cr173@duke.edu to let you know it is ready.

THIS VM WILL POWER DOWN AUTOMATICALLY

To make efficient use of the shared VCM resources and reduce our carbon footprint, this VM will be powered down **every morning at 6:00 AM**. Click the Power on button to turn your VM back on before you log into it. If your VM is being used as server or runs very long computations and must remain on continuously, you can uncheck the **Automatic power down** check box above to opt out of automatic shutdowns.

General Information

Hostname:	vcm-26406.vm.duke.edu
Operating System:	Ubuntu Server 20.04
Base memory:	4 GB
Processors:	2
VM Status:	reserving

Getting Started

Connecting

```
1 rundel@tbBook [~]$ ssh cr173@vcm-47003.vm.duke.edu
```

The authenticity of host 'vcm-47003.vm.duke.edu (67.159.69.176)' can't be established.
ED25519 key fingerprint is SHA256:fSZfURPpnL4M+0bWv6S3jMYtalAeKZWSLH6DR+sx0e0.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])?

Warning: Permanently added 'vcm-47003.vm.duke.edu' (ED25519) to the list of known hosts.
cr173@vcm-47003.vm.duke.edu's password:

Welcome to Ubuntu 24.04.2 LTS (GNU/Linux 6.8.0-56-generic x86_64)

- * Documentation: <https://help.ubuntu.com>
- * Management: <https://landscape.canonical.com>
- * Support: <https://ubuntu.com/pro>

System information as of Thu Mar 27 10:11:09 AM EDT 2025

System load:	0.55	Processes:	193
Usage of /home:	2.1% of 17.93GB	Users logged in:	0
Memory usage:	18%	IPv4 address for eth0:	67.159.69.176
Swap usage:	0%		

- * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s just raised the bar for easy, resilient and secure K8s cluster deployment.

<https://ubuntu.com/engage/secure-kubernetes-at-the-edge>

Determining Distribution

Ubuntu / Debian

Fedora / RHEL

```
1 cr173@vcm-47003:~$ cat /etc/os-release
```

```
PRETTY_NAME="Ubuntu 24.04.2 LTS"
NAME="Ubuntu"
VERSION_ID="24.04"
VERSION="24.04.2 LTS (Noble Numbat)"
VERSION_CODENAME=noble
ID=ubuntu
ID_LIKE=debian
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-policies/privacy-policy"
UBUNTU_CODENAME=noble
LOGO=ubuntu-logo
```

System Details

Filesystem Hierarchy Standard

Primary

Secondary

```
1 cr173@vcm-47003:~$ tree -d -L 1 /
```

```
/  
├── bin    -> usr/bin  
├── bin usr-is-merged  
├── boot  
├── cdrom  
├── dev  
├── etc  
├── home  
├── lib    -> usr/lib  
├── lib64  -> usr/lib64  
├── lib usr-is-merged  
├── media  
├── mnt  
├── opt  
├── proc  
├── root  
└── run  
    └── shbin -> usr/shbin
```

Some common folders:

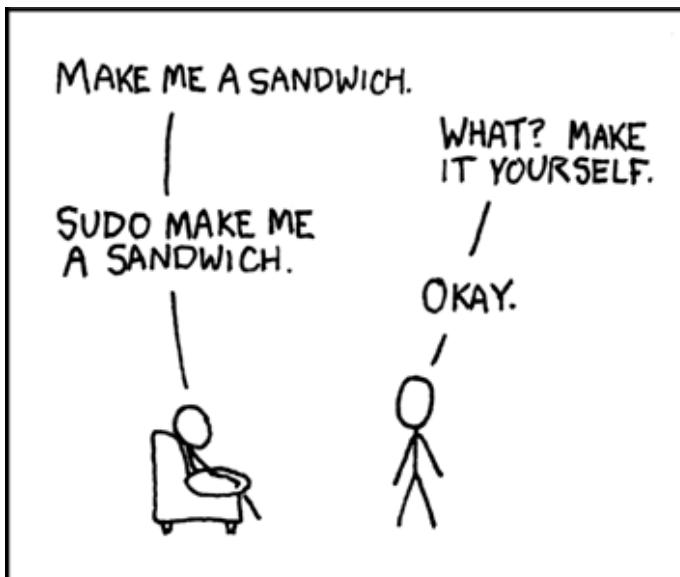
- </bin/> & </usr/bin/> - executeables
- </etc/> - configuration files
- /lib*/ & /usr/lib*/ - Static and shared libraries
- </usr/include/> - header files
- </home/> - home directories
- </var/> - logs
- </tmp/> - temporary files

Installing packages with apt (Ubuntu, Debian, etc.)

Update the package list

```
1 cr173@vcm-47003:~$ 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)
```



XKCD 149 - Sandwich

Update the package list

```
1 cr173@vcm-47003:~$ sudo apt update
```

```
[sudo] password for cr173:  
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 https://archive.linux.duke.edu/ubuntu focal-security/main Translation-en [220 kB]
```

Installing R

```
1 cr173@vcm-47003:~$ 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:

Removing R

```
1 cr173@vcm-47003:~$ 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 libblk libdrm-nouveau2 libdrm-radeon1 libfile-basedir-perl libfile-desktopentry-perl libfile-mimeinfo-perl libgl1-mesa-dri libglapi-mesa libglvnd0 libglx-mesa0 libglx0 libgraphite2-3 libharfbuzz0b libice libjpeg-turbo8 libjpeg-turbo8-dev libjpeg8 libjpeg8-dev liblapack-dev liblapack3 libllvm12 liblzma libpangocairo-1.0-0 libpangoft2-1.0-0 libpaper-utils libpaper1 libpciaccess0 libpcre16-3 libpcrecpp libpcrecpp0v5 libpixman-1-0 libpng-dev libpng-tools libreadline-dev libsensors-config libsensors2 libvulkan1 libwayland-client0 libwebp6 libx11-protocol-perl libx11-xcb1 libxaw7 libxcb-dri2-0 libxcb-shape0 libxcb-shm0 libxcb-sync1 libxcb-xfixes0 libcomposite1 libxcursor1 libxfixes3 libxml-xpathengine-perl libxmu6 libxpm4 libxrandr2 libxrender1 libxshmfence1 libxss1 libxt6 libxvt1 r-base-dev r-base-html r-cran-boot r-cran-class r-cran-cluster r-cran-codetools r-cran-foreign r-cran-lattice r-cran-nlme r-cran-nnet r-cran-rpart r-cran-spatial r-cran-survival r-doc-html r-recommended unRAR

Use 'sudo apt autoremove' to remove them.

The following packages will be REMOVED:

r-base

and all of its dependencies

```
1 cr173@vcm-47003:~$ 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 libblk libdrm-nouveau2 libdrm-radeon1 libfile-basedir-perl libfile-desktopentry-perl libfile-mimeinfo-perl libgl1-mesa-dri libglapi-mesa libglvnd0 libglx-mesa0 libglx0 libgraphite2-3 libharfbuzz0b libice libjpeg-turbo8 libjpeg-turbo8-dev libjpeg8 libjpeg8-dev liblapack-dev liblapack3 libllvm12 liblzma libpangocairo-1.0-0 libpangoft2-1.0-0 libpaper-utils libpaper1 libpciaccess0 libpcre16-3 libpcrecpp libpcrecpp0v5 libpixman-1-0 libpng-dev libpng-tools libreadline-dev libsensors-config libsensors2 libvulkan1 libwayland-client0 libwebp6 libx11-protocol-perl libx11-xcb1 libxaw7 libxcb-dri2-0 libxcb-shape0 libxcb-shm0 libxcb-sync1 libxcb-xfixes0 libcomposite1 libxcursor1 libxfixes3 libxml-xpathengine-perl libxmu6 libxpm4 libxrandr2 libxrender1 libxshmfence1 libxss1 libxt6 libz r-base-dev r-base-html r-cran-boot r-cran-class r-cran-cluster r-cran-codetools r-cran-foreign r-cran-nlme r-cran-nnet r-cran-rpart r-cran-spatial r-cran-survival r-doc-html r-recommended uninstalled 0 upgraded, 0 newly installed, 140 to remove and 1 not upgraded.
```

After this operation, 749 MB disk space will be freed.

Do you want to continue? [y/n]

Updating & Upgrading

```
1 cr173@vcm-47003:~$ 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.
```

```
1 cr173@vcm-47003:~$ 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

```
1 ...
2 update-initramfs: deferring update (trigger activated)
3 amd64-microcode: microcode will be updated at next boot
4 Setting up intel-microcode (3.20180807a.0ubuntu0.18.04.1) ...
5 update-initramfs: deferring update (trigger activated)
6 intel-microcode: microcode will be updated at next boot
7 Setting up kmod (24-1ubuntu3.1) ...
8
9 *Configuration file '/etc/modprobe.d/blacklist.conf'
10 * ==> Modified (by you or by a script) since installation.
11 * ==> Package distributor has shipped an updated version.
12 *   What would you like to do about it ? Your options are:
13 *       Y or I  : install the package maintainer's version
14 *       N or O  : keep your currently-installed version
15 *       D      : show the differences between the versions
16 *       Z      : start a shell to examine the situation
17 * The default action is to keep your current version.
18 *** blacklist.conf (Y/I/N/O/D/Z) [default=N] ?
19 Setting up initramfs-tools-core (0.130ubuntu3.6) ...
20 Setting up linux-headers-4.15.0-43-generic (4.15.0-43.46) ...
21 Setting up initramfs-tools (0.130ubuntu3.6) ...
22
23 ...
```

Package Details

```
1 cr173@vcm-47003:~$ 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

Package Contents

To list the files installed by a package,

```
1 cr173@vcm-47003:~$ dpkg -L r-base  
  
/.  
/usr  
/usr/share  
/usr/share/doc  
/usr/share/doc/r-base  
/usr/share/doc/r-base/README.Debian  
/usr/share/doc/r-base/copyright  
/usr/share/doc/r-base/changelog.Debian.gz
```

or if you want to find which package created a file,

```
1 cr173@vcm-47003:~$ dpkg -S /usr/bin/R  
  
r-base-core: /usr/bin/R
```

Package Manager Comparison

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

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 / shared (`.so`)

libcurl

```
1 cr173@vcm-47003:~$ 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.4.5.0
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
```

Getting what you want

The following is a basic heuristic of library package naming schemes for the two primary 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)	<code>lib{name}</code>	<code>{name}</code>
Headers	<code>lib{name}-dev</code>	<code>{name}-devel</code>
Static library (.a)	<code>lib{name}-dev</code>	<code>{name}-static</code>
Documentation	<code>lib{name}-doc</code>	<code>{name}-devel</code>

Troubleshooting dynamic libraries

```
1 cr173@vcm-47003:~$ ldd /usr/lib/x86_64-linux-gnu/libcurl.so
```

```
linux-vdso.so.1 (0x00007ffd98176000)
libnnghttp2.so.14 => /usr/lib/x86_64-linux-gnu/libnnghttp2.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 (0x00007f1e3ccecc000)
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)
libhmp.so.10 => /usr/lib/x86_64-linux-gnu/libhmp.so.10 (0x00007f1e3b201000)
```

Python management

```
1 cr173@vcm-47003:~$ pip install torch
```

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

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

```
1 cr173@vcm-47003:~$ sudo apt install python3-pip
```

[sudo] password for cr173:

```
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done
```

The following additional packages will be installed:

```
build-essential bzip2 cpp cpp-13 cpp-13-x86-64-linux-gnu cpp-x86-64-linux-gnu dpkg-dev fakeroot  
gcc-13-x86-64-linux-gnu gcc-x86-64-linux-gnu javascript-common libalgorithm-diff-perl libalgorithm  
libexpat1-dev libfakeroot libfile-fcntllock-perl libgcc-13-dev libgomp1 libhwasan0 libisl23 lib:  
libpython3.12-dev libquadmath0 libstdc++-13-dev libtsan2 libubsan1 lto-disabled-list make python  
Suggested packages:
```

```
bzip2-doc cpp-doc gcc-13-locales cpp-13-doc debian-keyring g++-multilib g++-13-multilib gcc-13-  
gdb-x86-64-linux-gnu apache2 | lighttpd | httpd bsr libstdc++-13-doc make-doc
```

The following NEW packages will be installed:

```
build-essential bzip2 cpp cpp-13 cpp-13-x86-64-linux-gnu cpp-x86-64-linux-gnu dpkg-dev fakeroot  
gcc-13-x86-64-linux-gnu gcc-x86-64-linux-gnu javascript-common libalgorithm-diff-perl libalgorithm  
libexpat1-dev libfakeroot libfile-fcntllock-perl libgcc-13-dev libgomp1 libhwasan0 libisl23 lib:  
libpython3.12-dev libquadmath0 libstdc++-13-dev libtsan2 libubsan1 lto-disabled-list make python  
0 upgraded, 51 newly installed, 0 to remove and 0 not upgraded.
```

Need to get 72.6 MB of archives.

Package manager vs pip

```
1 cr173@vcm-47003:~$ sudo apt install python3-numpy
```

```
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libblas3 libgfortran5 liblapack3
Suggested packages:
  gfortran python3-pytest
The following NEW packages will be installed:
  libblas3 libgfortran5 liblapack3 python3-numpy
0 upgraded, 4 newly installed, 0 to remove and 0 not upgraded.
Need to get 8,238 kB of archives.
After this operation, 35.2 MB of additional disk space will be used.
Do you want to continue? [Y/n]
```

pip install & PEP 668

pip force

```
1 cr173@vcm-47003:~$ sudo pip install numpy --upgrade
```

```
sudo pip install numpy --upgrade
error: externally-managed-environment
```

```
× This environment is externally managed
↳ To install Python packages system-wide, try apt install
  python3-xyz, where xyz is the package you are trying to
  install.
```

If you wish to install a non-Debian-packaged Python package, create a virtual environment using `python3 -m venv path/to/venv`. Then use `path/to/venv/bin/python` and `path/to/venv/bin/pip`. Make sure you have `python3-full` installed.

If you wish to install a non-Debian packaged Python application, it may be easiest to use `pipx install xyz`, which will manage a virtual environment for you. Make sure you have `pipx` installed.

See `/usr/share/doc/python3.12/README.venv` for more information

Outdated python libraries

```
1 cr173@vcm-47003:~$ sudo pip list --outdated
```

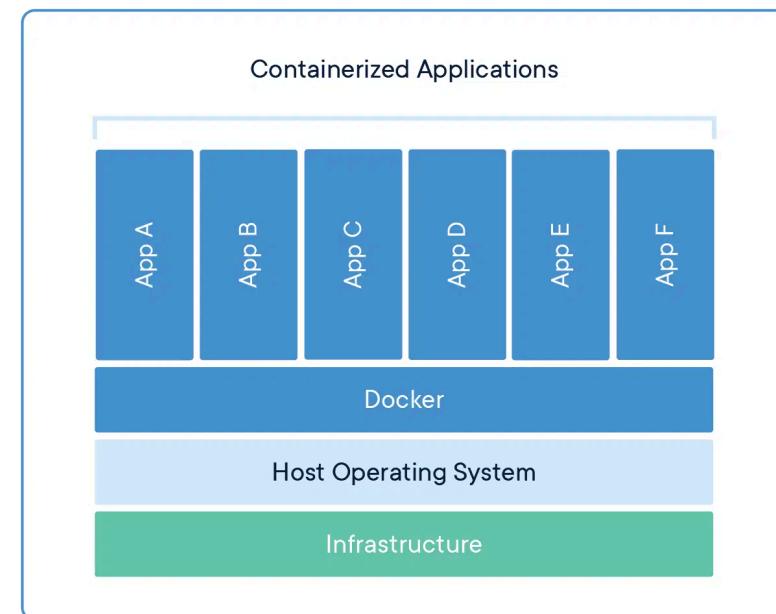
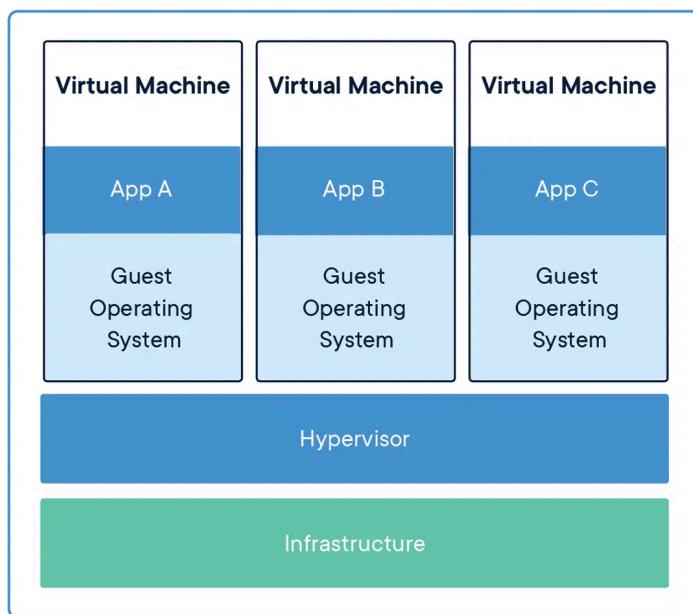
Package	Version	Latest	Type
ansible	9.2.0	11.4.0	wheel
ansible-core	2.16.3	2.18.4	wheel
apache-libcloud	3.4.1	3.8.0	wheel
argcomplete	3.1.4	3.6.1	wheel
attrs	23.2.0	25.3.0	wheel
Automat	22.10.0	24.8.1	wheel
Babel	2.10.3	2.17.0	wheel
bcrypt	3.2.2	4.3.0	wheel
blinker	1.7.0	1.9.0	wheel
boto3	1.34.46	1.37.22	wheel
botocore	1.34.46	1.37.22	wheel
certifi	2023.11.17	2025.1.31	wheel
click	8.1.6	8.1.8	wheel
configobj	5.0.8	5.0.9	wheel
cryptography	41.0.7	44.0.2	wheel
dbus-python	1.2.2	1.4.2	bdist+ c d e i n s t u x

Docker

Docker

Docker can package an application and its dependencies in a virtual container that can run on any Linux, Windows, or macOS computer. This enables the application to run in a variety of locations, such as on-premises, in the public or private cloud. When running on Linux, Docker uses the resource isolation features of the Linux kernel (such as cgroups and kernel namespaces) and a union-capable file system to allow containers to run within a single Linux instance, avoiding the overhead of starting and maintaining virtual machines.

From Wikipedia



Installation - Ubuntu / Debian

```
1 # Remove system packages
2 sudo apt-get remove docker docker-engine docker.io containerd runc
3
4 # Utility Packages
5 sudo apt-get update
6 sudo apt-get install \
7   ca-certificates \
8   curl \
9   gnupg \
10  lsb-release
11
12 # Add apt repo signing key
13 curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo gpg --dearmor -o /usr/share/ke
14
15 # Add apt repo
16 echo \
17   "deb [arch=$(dpkg --print-architecture) signed-by=/usr/share/keyrings/docker-archive-keyrin
18   $(lsb_release -cs) stable" | sudo tee /etc/apt/sources.list.d/docker.list > /dev/null
19
20 # Install Docker
21 sudo apt-get update
22 sudo apt-get install docker-ce docker-ce-cli containerd.io
```

Troubleshooting - daemon

```
1 $ sudo docker run hello-world
```

docker: Cannot connect to the Docker daemon at unix:///var/run/docker.sock. Is the docker daemon running?
See 'docker run --help'.

This occurs when the docker daemon (service) is not running, this can be fixed by enabling & starting the docker service / daemon,

```
1 # Make sure the daemon runs automatically in the future  
2 sudo systemctl enable docker
```

Synchronizing state of docker.service with SysV service script with /usr/lib/systemd/systemd-sysv-
Executing: /usr/lib/systemd/systemd-sysv-install enable docker

```
1 # Start the daemon  
2 sudo systemctl start docker
```

Success

```
1 sudo docker run hello-world
```

```
Unable to find image 'hello-world:latest' locally
latest: Pulling from library/hello-world
1b930d010525: Pull complete
Digest: sha256:2557e3c07ed1e38f26e389462d03ed943586f744621577a99efb77324b0fe535
Status: Downloaded newer image for hello-world:latest
```

Hello from Docker!

This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:

1. The Docker client contacted the Docker daemon.
2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
(amd64)
3. The Docker daemon created a new container from that image which runs the executable that produces the output you are currently reading.
4. The Docker daemon streamed that output to the Docker client, which sent it to your terminal.

Troubleshooting - permissions

```
1 docker run hello-world
```

```
docker: Got permission denied while trying to connect to the Docker daemon socket at
unix:///var/run/docker.sock: Post http://%2Fvar%2Frun%2Fdocker.sock/v1.39/containers/create:
dial unix /var/run/docker.sock: connect: permission denied.
See 'docker run --help'.
```

You must either be root or be a member of the `docker` group to use docker. Currently, your VM may or may not have a docker group and your account is likely not a member. If you get tired of typing sudo + your password there is an easy fix,

```
1 # Make sure the docker group exists
2 sudo groupadd docker
3
4 # Add your user to the docker group
5 sudo usermod -aG docker $USER
6
7 # Check memberships
8 groups
9 # If docker is not listed you should log out and log back in
```

Success

```
1 docker run hello-world
```

Hello from Docker!

This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:

1. The Docker client contacted the Docker daemon.
2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
(amd64)
3. The Docker daemon created a new container from that image which runs the executable that produces the output you are currently reading.
4. The Docker daemon streamed that output to the Docker client, which sent it to your terminal.

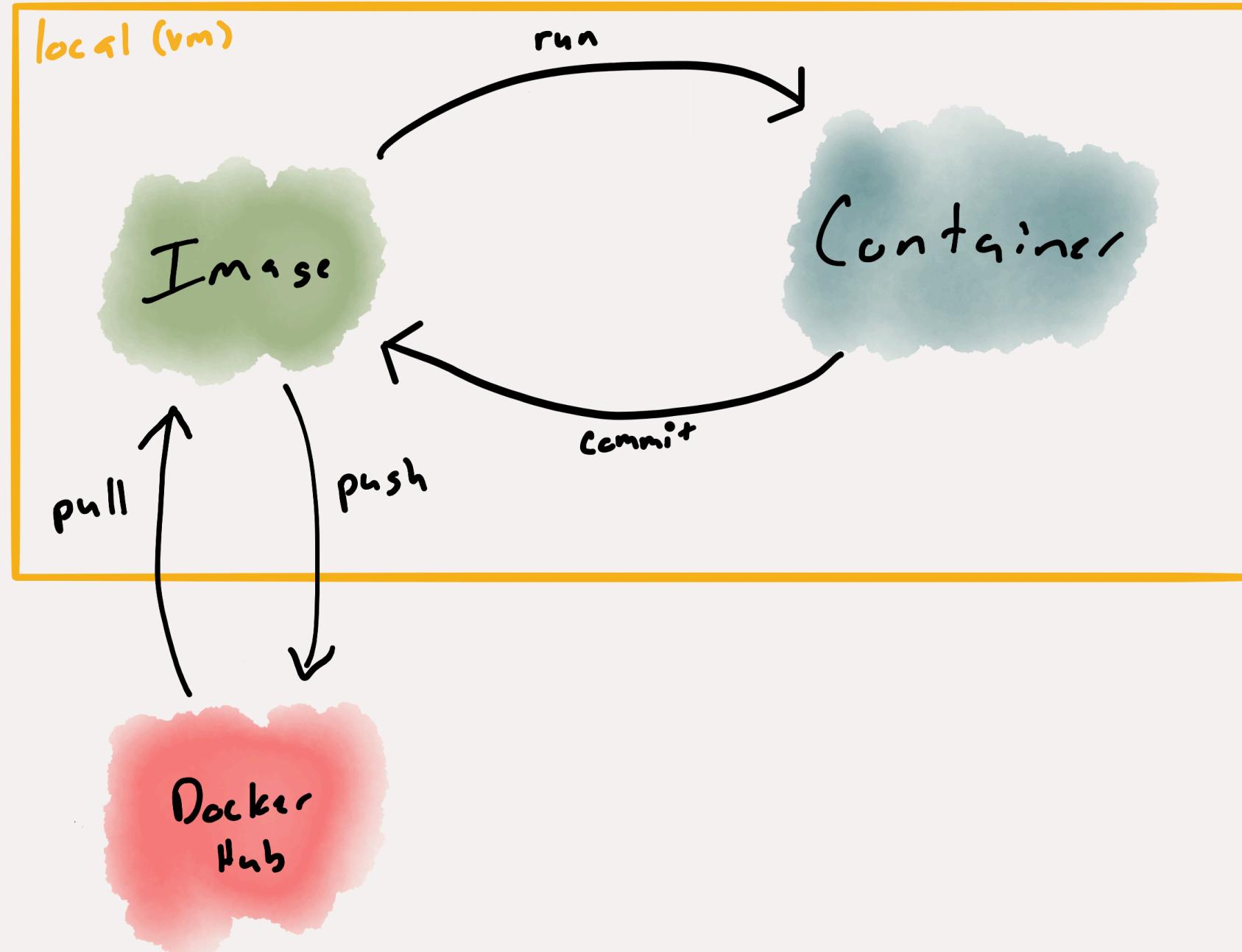
To try something more ambitious, you can run an Ubuntu container with:

```
$ docker run -it ubuntu bash
```

Share images, automate workflows, and more with a free Docker ID:

<https://hub.docker.com/>

Getting Started



Getting images

```
1 docker pull ubuntu
```

Using default tag: latest
latest: Pulling from library/ubuntu
5a7813e071bf: Pull complete
Digest: sha256:72297848456d5d37d1262630108ab308d3e9ec7ed1c3286a32fe09856619a782
Status: Downloaded newer image for ubuntu:latest
docker.io/library/ubuntu:latest

```
1 docker images
```

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
ubuntu	latest	a04dc4851cbc	8 weeks ago	78.1MB
hello-world	latest	74cc54e27dc4	2 months ago	10.1kB

ubuntu - Official Image | Docker Hub

hub.docker.com/_/ubuntu

dockerhub

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 ubuntu Docker Official Image • 1B+ • 10K+

Ubuntu is a Debian-based Linux operating system based on free software.

OPERATING SYSTEMS

docker pull ubuntu Copy

Overview Tags

Quick reference

- Maintained by:
[Canonical](#)
- Where to get help:
[the Docker Community Slack](#), [Server Fault](#), [Unix & Linux](#), or [Stack Overflow](#)

Supported tags and respective Dockerfile links

- [20.04](#), [focal-20241011](#), [focal](#)
- [22.04](#), [jammy-20250126](#), [jammy](#)
- [24.04](#), [noble-20250127](#), [noble](#), [latest](#)
- [24.10](#), [oracular-20241120](#), [oracular](#), [rolling](#)

Recent tags

noble-20250127 noble latest jammy-20250126
jammy 24.04 22.04 plucky-20241213 plucky devel

About Official Images

Docker Official Images are a curated set of Docker open source and drop-in solution repositories.

Why Official Images?

These images have clear documentation, promote best practices, and are designed for the most common use cases.

Tags (Versions)

```
1 docker pull ubuntu:24.10
```

24.10: Pulling from library/ubuntu

31734b193a81: Pull complete

Digest: sha256:102bc1874fdb136fc2d218473f03cf84135cb7496fefdb9c026c0f553cfe1b6d

Status: Downloaded newer image for ubuntu:24.10

docker.io/library/ubuntu:24.10

```
1 docker pull ubuntu:24.04
```

24.04: Pulling from library/ubuntu

Digest: sha256:72297848456d5d37d1262630108ab308d3e9ec7ed1c3286a32fe09856619a782

Status: Downloaded newer image for ubuntu:24.04

docker.io/library/ubuntu:24.04

```
1 docker images
```

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
ubuntu	24.04	a04dc4851cbc	8 weeks ago	78.1MB
ubuntu	latest	a04dc4851cbc	8 weeks ago	78.1MB
hello-world	latest	74cc54e27dc4	2 months ago	10.1kB
ubuntu	24.10	e40b6e31bd8c	4 months ago	80.1MB

Other sources

DockerHub is not the only source of images - there are many other possible hosts and all you need to provide is a URL along with the image name.

```
1 docker pull ghcr.io/sta663-sp25/sta663-base:latest
```

```
latest: Pulling from sta663-sp25/sta663-base
5a7813e071bf: Already exists
8b4eecc45940: Pull complete
8a0564787037: Pull complete
3696d23a471e: Pull complete
23672a6cf33: Pull complete
942334ec7964: Pull complete
423b2646039f: Pull complete
68b5b1f45ce3: Pull complete
4f4fb700ef54: Pull complete
2b80b363e49e: Pull complete
5e022bd8982c: Pull complete
7ebaab8841b3: Pull complete
5af20e6ba13b: Pull complete
824e38cc86cc: Pull complete
b12348c1e7d6: Pull complete
5dd53c23776c: Pull complete
106321470...: Pull complete
```

1 docker images

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
ghcr.io/sta663-sp25/sta663-base	latest	0b725e0ad9c9	3 weeks ago	7.75GB
ubuntu	24.04	a04dc4851cbc	8 weeks ago	78.1MB
ubuntu	latest	a04dc4851cbc	8 weeks ago	78.1MB
hello-world	latest	74cc54e27dc4	2 months ago	10.1kB
ubuntu	24.10	e40b6e31bd8c	4 months ago	80.1MB

Running a container

```
1 docker run --rm ubuntu cat /etc/os-release
```

```
PRETTY_NAME="Ubuntu 24.04.1 LTS"  
NAME="Ubuntu"  
VERSION_ID="24.04"  
VERSION="24.04.1 LTS (Noble Numbat)"  
VERSION_CODENAME=noble  
ID=ubuntu  
ID_LIKE=debian  
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/  
UBUNTU_CODENAME=noble  
LOGO=ubuntu-logo
```

```
1 docker run --rm ubuntu:24.10 cat /etc/os-re
```

```
PRETTY_NAME="Ubuntu 24.10"  
NAME="Ubuntu"  
VERSION_ID="24.10"  
VERSION="24.10 (Oracular Oriole)"  
VERSION_CODENAME=oracular  
ID=ubuntu  
ID_LIKE=debian  
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/  
UBUNTU_CODENAME=oracular  
LOGO=ubuntu-logo
```

```
1 docker run --rm fedora:latest cat /etc/os-release
```

```
Unable to find image 'fedora:latest' locally
latest: Pulling from library/fedora
0c5a86865c5d: Pull complete
Digest: sha256:3ec60eb34fa1a095c0c34dd37cead9fd38afb62612d43892fcf1d3425c32bc1e
Status: Downloaded newer image for fedora:latest
NAME="Fedora Linux"
VERSION="41 (Container Image)"
RELEASE_TYPE=stable
ID=fedora
VERSION_ID=41
VERSION_CODENAME=""
PLATFORM_ID="platform:f41"
PRETTY_NAME="Fedora Linux 41 (Container Image)"
ANSI_COLOR="0;38;2;60;110;180"
LOGO=fedora-logo-icon
CPE_NAME="cpe:/o:fedoraproject:fedora:41"
DEFAULT_HOSTNAME="fedora"
HOME_URL="https://fedoraproject.org/"
```

docker run common options

```
docker run [OPTIONS] IMAGE[:TAG|@DIGEST] [COMMAND] [ARG...]
```

Option	Description
--name	Give your container a name
--rm	Automatically remove the container when it exits
-i -t	Allow for interaction with container (STDIN & tty specifically)
-p host:cont	Publish a container's port
-v host:cont	Share filesystems
-e "VAR=VAL"	Define environmental variables

Other useful commands

command	Description
<code>docker pull NAME[:TAG]</code>	Pull docker image (usually from DockerHub)
<code>docker images</code>	List docker images
<code>docker rmi IMAGE</code>	Remove an image
<code>docker container ls [--all]</code>	List (all) docker containers
<code>docker rm CONTAINER</code>	Remove a container
<code>docker stop CONTAINER</code>	Stop a running container
<code>docker start CONTAINER</code>	Start a stopped container
<code>docker attach CONTAINER</code>	Attach to a running container
<code>docker exec CONTAINER CMD</code>	Runs a new command in a running container
<code>docker commit CONTAINER REPO[:TAG]</code>	Create an image from a container
<code>docker rename CONTAINER NAME</code>	Rename a container

rocker



The rocker project provides a collection of containers suited for different needs. find a base image to extend or images with popular software and optimized libraries pre-installed. Get the latest version or a reproducibly fixed environment.

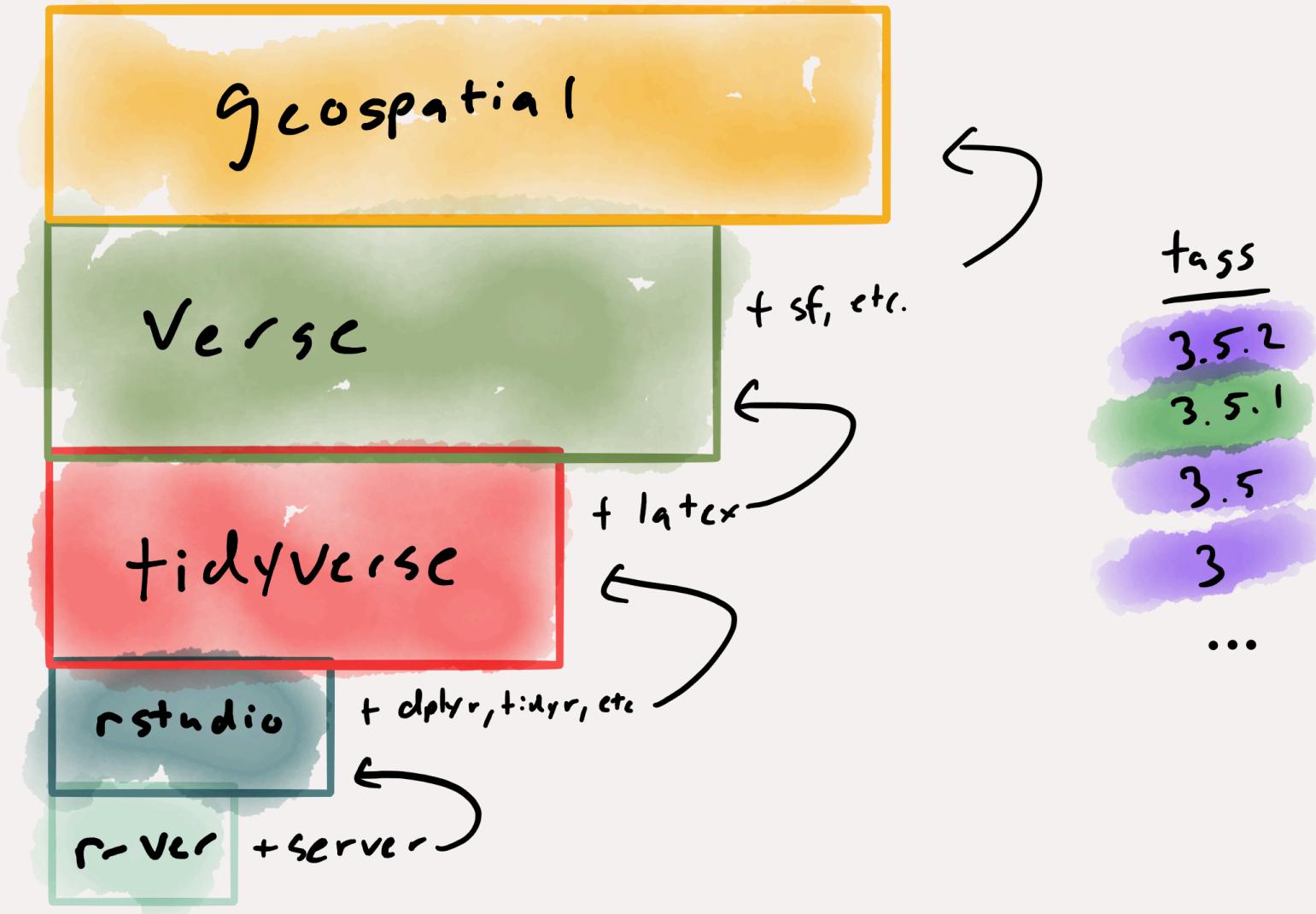
2.1 The versioned stack

image	base image	description
rocker/r-ver	ubuntu	Install R from source and set RSPM as default CRAN mirror
rocker/rstudio	rocker/r-ver	Adds RStudio Server
rocker/tidyverse	rocker/rstudio	Adds tidyverse packages & devtools
rocker/verse	rocker/tidyverse	Adds tex & publishing-related package
rocker/geospatial	rocker/verse	Adds geospatial packages
rocker/binder	rocker/geospatial	Adds requirements to run repositories on mybinder.org
rocker/shiny	rocker/r-ver	Adds shiny server
rocker/shiny-verse	rocker/shiny	Adds tidyverse packages
rocker/cuda	rocker/r-ver	Adds CUDA support to rocker/r-ver
rocker/ml	rocker/cuda	Adds CUDA support to rocker/tidyverse
rocker/ml-verse	rocker/ml	Adds CUDA support to rocker/geospatial

2.2 The base stack

image	base image	description
r-base	debian:testing	Install current R from unstable repos
rocker/r-base		
rocker/r-devel	r-base	R-devel added side-by-side onto r-base (using alias RD)
rocker/dr	r-base	Lighter rocker/r-devel
rocker/dr	r-base	R-patched added side-by-side onto r-base (using alias RP)
rocker/r-devel-san	r-base	as rocker/r-devel , but built with compiler sanitizers
rocker/r-devel-ubsan-clang	r-base	Sanitizers, clang c compiler (instead of gcc)

Rocker
versioned



python - Official Image | Docker Hub

hub.docker.com/_/python

dockerhub

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Python is an interpreted, interactive, object-oriented, open-source programming language.

LANGUAGES & FRAMEWORKS

Overview Tags

docker pull python Copy

Quick reference

- Maintained by:
[the Docker Community](#)
- Where to get help:
[the Docker Community Slack](#), [Server Fault](#), [Unix & Linux](#), or [Stack Overflow](#)

Recent tags

3.9.21-bookworm 3.9.21 3.9-bookworm 3.9
3.14.0a6-bullseye 3.14.0a6-bookworm 3.14.0a6
3.14-rc-bullseye 3.14-rc-bookworm 3.14-rc

Docker + Python

```
1 docker pull python:latest
```

```
latest: Pulling from library/python
7cd785773db4: Pull complete
091eb8249475: Pull complete
255774e0027b: Pull complete
353e14e5cc47: Pull complete
70847531e23d: Pull complete
af0b544b1a82: Pull complete
379f06e37dbb: Pull complete
Digest: sha256:8c55c44b9e81d537f8404d0000b7331863d134db87c1385dd0ec7fefff656495
Status: Downloaded newer image for python:latest
docker.io/library/python:latest
```

```
1 docker run --rm python:latest python -V
```

```
Python 3.13.2
```

```
1 docker run --rm python:latest pip install numpy
```

```
Collecting numpy
  Downloading numpy-2.2.4-cp313-cp313-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (62
  Downloading numpy-2.2.4-cp313-cp313-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (16.1 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 16.1/16.1 MB 77.0 MB/s eta 0:00:00
Installing collected packages: numpy
Successfully installed numpy-2.2.4
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviou
```

Interactive usage

For interactive use we use the `-it` (or `-i -t`) flags,

```
1 docker run -it python:latest
```

```
Python 3.13.2 (main, Mar 18 2025, 03:30:45) [GCC 12.2.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

```
1 docker run -it python:latest bash
```

```
root@0200ab573e93:/#
```

```
1 docker ps
```

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS	NAMES
--------------	-------	---------	---------	--------	-------	-------

```
1 docker ps --all
```

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS
fa52839a6bb0	python:latest	"bash"	4 seconds ago	Exited (0) 2 seconds ago	
41de571bce2d	python:latest	"python3"	12 seconds ago	Exited (0) 10 seconds ago	

Building a container interactively

```
1 docker run python:latest
```

```
root@e45df4642247:/# pip install numpy pandas seaborn
Collecting numpy
  Downloading numpy-2.2.4-cp313-cp313-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (62
Collecting pandas
  Downloading pandas-2.2.3-cp313-cp313-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (89
Collecting seaborn
  Downloading seaborn-0.13.2-py3-none-any.whl.metadata (5.4 kB)
Collecting python-dateutil>=2.8.2 (from pandas)
  Downloading python_dateutil-2.9.0.post0-py2.py3-none-any.whl.metadata (8.4 kB)
Collecting pytz>=2020.1 (from pandas)
  Downloading pytz-2025.2-py2.py3-none-any.whl.metadata (22 kB)
Collecting tzdata>=2022.7 (from pandas)
  Downloading tzdata-2025.2-py2.py3-none-any.whl.metadata (1.4 kB)
Collecting matplotlib!=3.6.1,>=3.4 (from seaborn)
  Downloading matplotlib-3.10.1-cp313-cp313-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (1
Collecting contourpy>=1.0.1 (from matplotlib!=3.6.1,>=3.4->seaborn)
  Downloading contourpy-1.3.1-cp313-cp313-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (1
Collecting cycler->0.10 (from matplotlib!=3.6.1,>=3.4->seaborn)
```

Container -> Image

```
1 docker ps --all
```

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS
e45df4642247	python:latest	"bash"	About a minute ago	Exited (0) 4 seconds ago	
fa52839a6bb0	python:latest	"bash"	6 minutes ago	Exited (0) 6 minutes ago	
41de571bce2d	python:latest	"python3"	6 minutes ago	Exited (0) 6 minutes ago	

```
1 docker commit python-test python-test:latest
```

```
sha256:a69a3249750f888838192869a29cc035403c7cbe70a4c9be98fa1f6e3c2a9546
```

```
1 docker images
```

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
python-test	latest	a69a3249750f	33 seconds ago	1.3GB
ghcr.io/sta663-sp25/sta663-base	latest	0b725e0ad9c9	3 weeks ago	7.75GB
python	latest	e6c8fe2e1108	7 weeks ago	1.02GB
ubuntu	24.04	a04dc4851cbc	8 weeks ago	78.1MB
ubuntu	latest	a04dc4851cbc	8 weeks ago	78.1MB
hello-world	latest	74cc54e27dc4	2 months ago	10.1kB
ubuntu	24.10	e40b6e31bd8c	4 months ago	80.1MB
fedora	latest	aa6787b90fe6	4 months ago	158MB

Using the image

```
1 docker run --rm -it python-test:latest
```

```
root@ee76fcc4451f:/# python
Python 3.13.2 (main, Mar 18 2025, 03:30:45) [GCC 12.2.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import numpy
>>> numpy.__version__
'2.2.4'
>>> import seaborn as sns
>>> sns.__version__
'0.13.2'
>>> import seaborn as sns
>>> sns.__version__
'0.13.2'
>>> import pandas as pd
>>> pd.__version__
'2.2.3'
```