

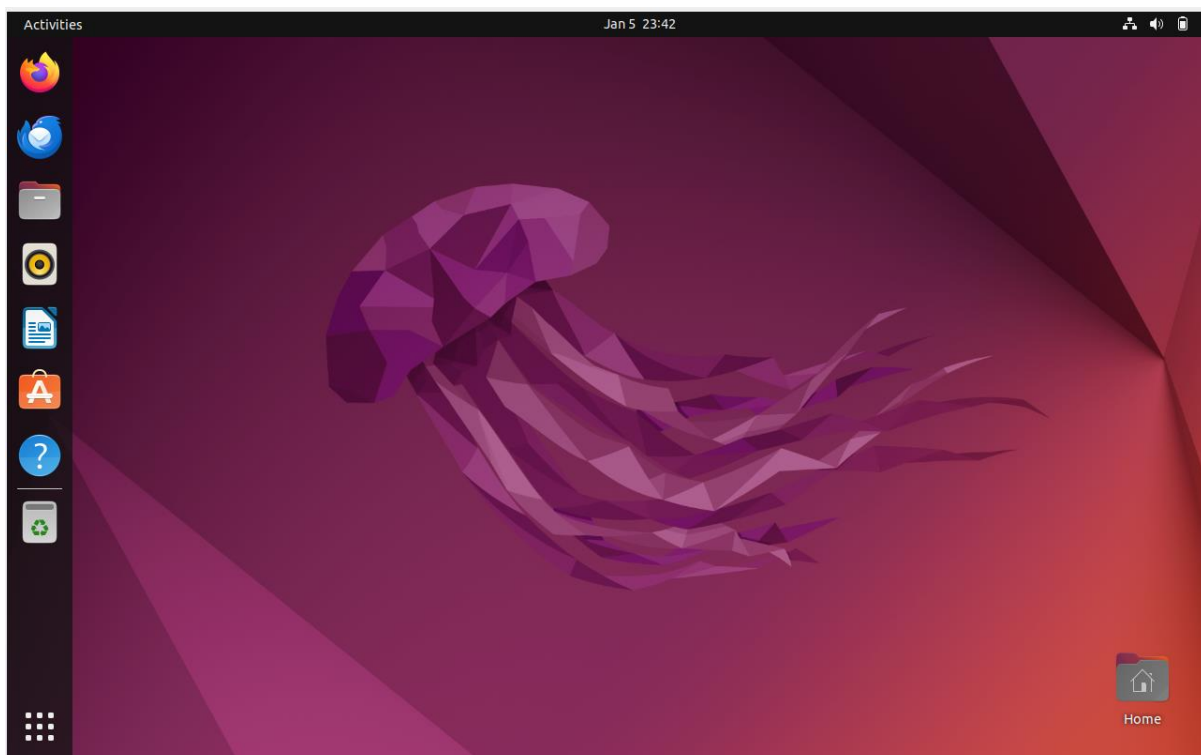
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Chapter 1

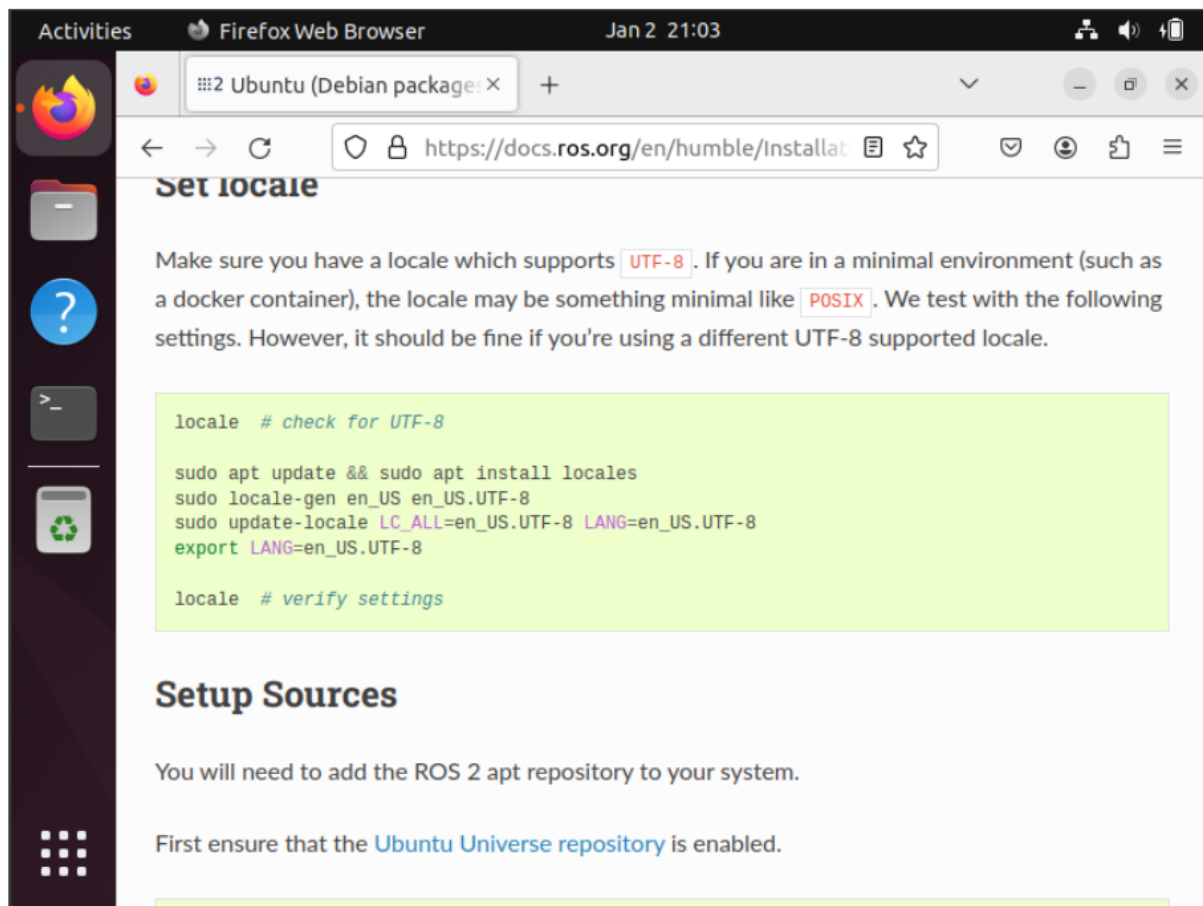
Robot Operating System (ROS) adalah kerangka kerja sumber terbuka yang dirancang untuk mempermudah pengembangan perangkat lunak untuk robot. Awalnya dikembangkan oleh Stanford Artificial Intelligence Laboratory bekerja sama dengan Willow Garage, ROS telah berkembang menjadi platform serbaguna yang banyak diadopsi dalam bidang robotika. Apa yang membedakan ROS adalah sifat modular dan terdistribusinya, menyediakan seperangkat alat dan pustaka yang komprehensif untuk pengembangan sistem robotik. Hal ini memungkinkan para peneliti dan pengembang untuk fokus pada fungsionalitas tertentu tanpa perlu membuat ulang, mendorong kolaborasi dan berbagi pengetahuan dalam komunitas robotika. Baik mengendalikan perangkat keras robot, mengimplementasikan algoritma persepsi, atau mengatur perilaku robotik yang kompleks, ROS menawarkan kerangka kerja yang standar dan dapat dioperasikan yang mempercepat pengembangan dan implementasi aplikasi robotik. Dengan komunitas yang terus berkembang dan pengembangan yang berkelanjutan, ROS terus memainkan peran penting dalam meningkatkan kemampuan dan interoperabilitas sistem robotik di berbagai bidang.

Instal Ros 2

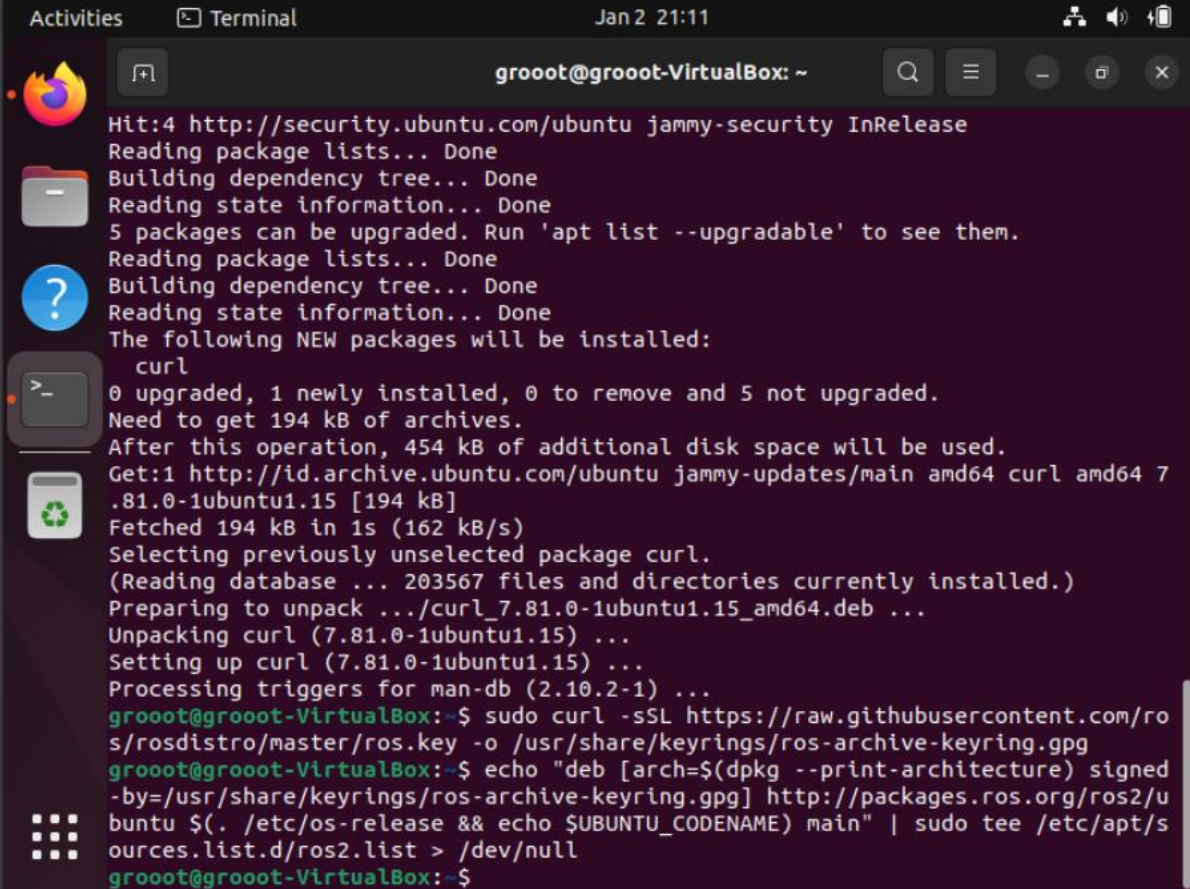
1. Buka VM ubuntu



2. Akses internet dan cari instalasi ros 2 humble Debian Packages dan ikuti perinrah instalasinya



3. Menyiapkan persiapan sumber-sumber dari ros2

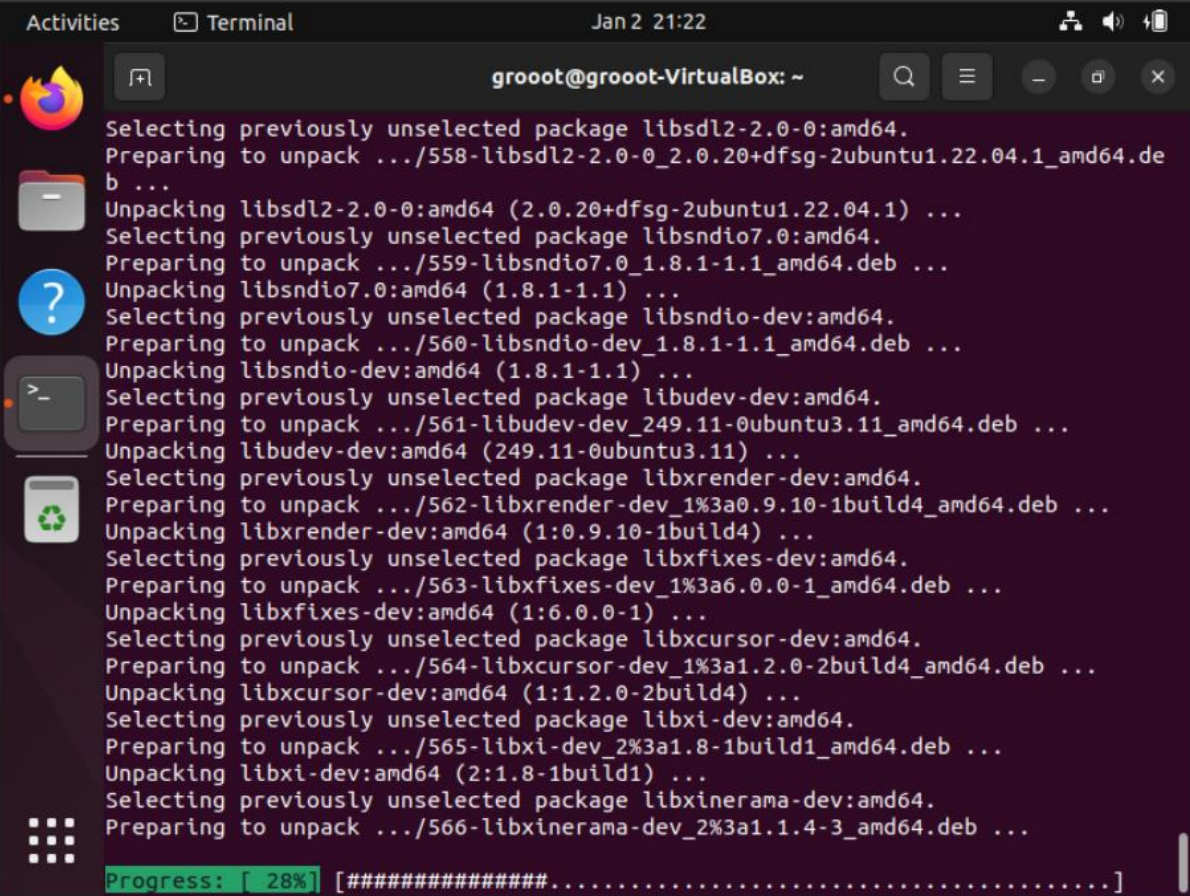


The image shows a terminal window titled "grooot@grooot-VirtualBox: ~" with a search bar and window controls. The terminal output shows the following sequence of events:

```
Hit:4 http://security.ubuntu.com/ubuntu jammy-security InRelease
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
5 packages can be upgraded. Run 'apt list --upgradable' to see them.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  curl
0 upgraded, 1 newly installed, 0 to remove and 5 not upgraded.
Need to get 194 kB of archives.
After this operation, 454 kB of additional disk space will be used.
Get:1 http://id.archive.ubuntu.com/ubuntu jammy-updates/main amd64 curl amd64 7.81.0-1ubuntu1.15 [194 kB]
Fetched 194 kB in 1s (162 kB/s)
Selecting previously unselected package curl.
(Reading database ... 203567 files and directories currently installed.)
Preparing to unpack .../curl_7.81.0-1ubuntu1.15_amd64.deb ...
Unpacking curl (7.81.0-1ubuntu1.15) ...
Setting up curl (7.81.0-1ubuntu1.15) ...
Processing triggers for man-db (2.10.2-1) ...
grooot@grooot-VirtualBox:~$ sudo curl -sSL https://raw.githubusercontent.com/ros/rosdistro/master/ros.key -o /usr/share/keyrings/ros-archive-keyring.gpg
grooot@grooot-VirtualBox:~$ echo "deb [arch=$(dpkg --print-architecture) signed-by=/usr/share/keyrings/ros-archive-keyring.gpg] http://packages.ros.org/ros2/ubuntu $(. /etc/os-release && echo $UBUNTU_CODENAME) main" | sudo tee /etc/apt/sources.list.d/ros2.list > /dev/null
grooot@grooot-VirtualBox:~$
```

The terminal window includes a sidebar with icons for Activities, Terminal, and a search bar. The top bar shows the date and time as "Jan 2 21:11".

4. Instal ROS 2



The image shows a terminal window titled "grooot@grooot-VirtualBox: ~" with a search bar and window controls. The terminal output lists the selection and unpacking of several previously unselected packages for amd64 architecture. The packages include libSDL2-2.0-0, libsndio7.0, libsndio-dev, libudev-dev, libxrender-dev, libxfixes-dev, libxcursor-dev, libxi-dev, and libxinerama-dev. A progress bar at the bottom indicates that 28% of the installation is complete.

```
Activities Terminal Jan 2 21:22 grooot@grooot-VirtualBox: ~

Selecting previously unselected package libsdl2-2.0-0:amd64.
Preparing to unpack .../558-libsdl2-2.0-0_2.0.20+dfsg-2ubuntu1.22.04.1_amd64.de
b ...
Unpacking libsdl2-2.0-0:amd64 (2.0.20+dfsg-2ubuntu1.22.04.1) ...
Selecting previously unselected package libsndio7.0:amd64.
Preparing to unpack .../559-libsndio7.0_1.8.1-1.1_amd64.deb ...
Unpacking libsndio7.0:amd64 (1.8.1-1.1) ...
Selecting previously unselected package libsndio-dev:amd64.
Preparing to unpack .../560-libsndio-dev_1.8.1-1.1_amd64.deb ...
Unpacking libsndio-dev:amd64 (1.8.1-1.1) ...
Selecting previously unselected package libudev-dev:amd64.
Preparing to unpack .../561-libudev-dev_249.11-0ubuntu3.11_amd64.deb ...
Unpacking libudev-dev:amd64 (249.11-0ubuntu3.11) ...
Selecting previously unselected package libxrender-dev:amd64.
Preparing to unpack .../562-libxrender-dev_1%3a0.9.10-1build4_amd64.deb ...
Unpacking libxrender-dev:amd64 (1:0.9.10-1build4) ...
Selecting previously unselected package libxfixes-dev:amd64.
Preparing to unpack .../563-libxfixes-dev_1%3a6.0.0-1_amd64.deb ...
Unpacking libxfixes-dev:amd64 (1:6.0.0-1) ...
Selecting previously unselected package libxcursor-dev:amd64.
Preparing to unpack .../564-libxcursor-dev_1%3a1.2.0-2build4_amd64.deb ...
Unpacking libxcursor-dev:amd64 (1:1.2.0-2build4) ...
Selecting previously unselected package libxi-dev:amd64.
Preparing to unpack .../565-libxi-dev_2%3a1.8-1build1_amd64.deb ...
Unpacking libxi-dev:amd64 (2:1.8-1build1) ...
Selecting previously unselected package libxinerama-dev:amd64.
Preparing to unpack .../566-libxinerama-dev_2%3a1.1.4-3_amd64.deb ...

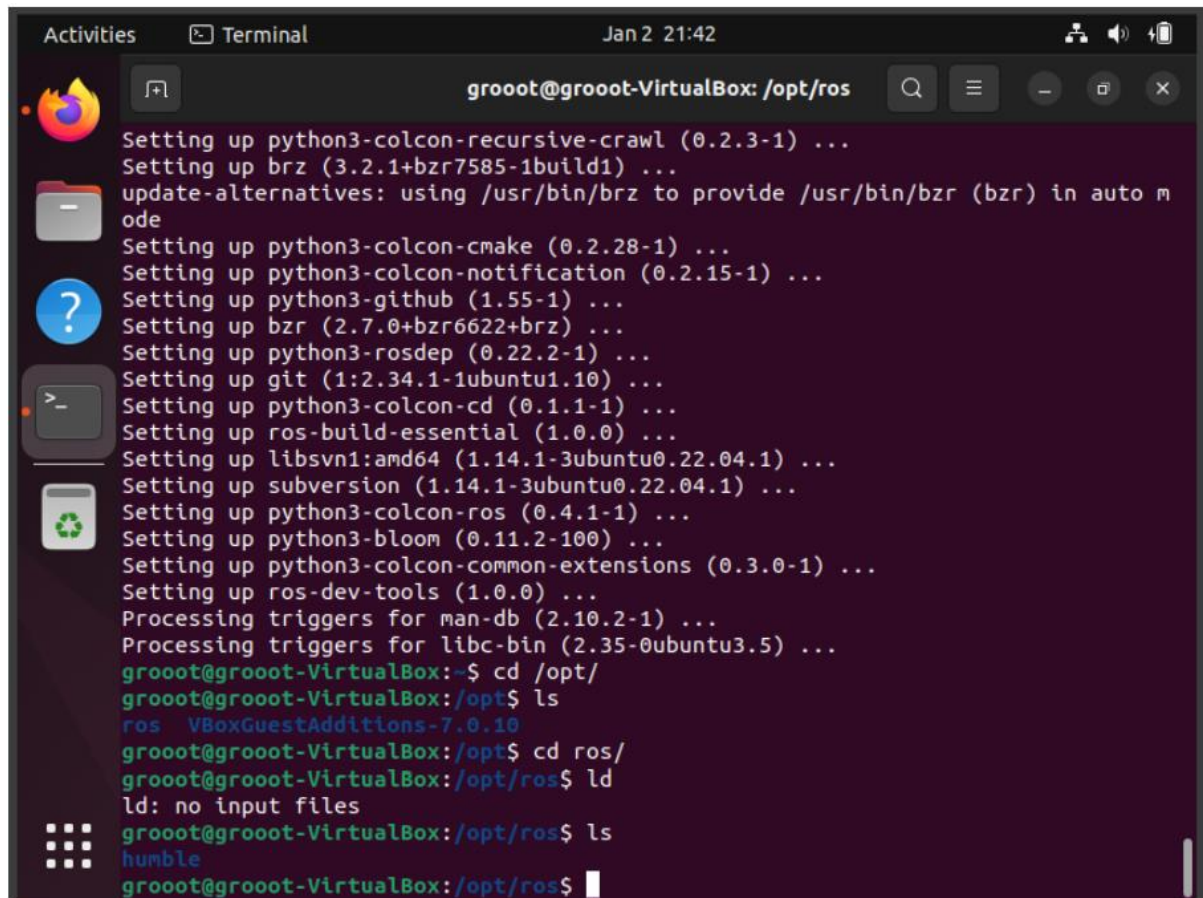
Progress: [ 28%] [#####.....]
```

Activities Terminal Jan 2 21:32

grooot@grooot-VirtualBox: ~

```
Setting up python3-colcon-bash (0.5.0-1) ...
Setting up libserf-1-1:amd64 (1.3.9-10ubuntu2) ...
Setting up python3-breezy (3.2.1+bzr7585-1build1) ...
Setting up python3-pytest-cov (3.0.0-1) ...
Setting up python3-colcon-parallel-executor (0.3.0-1) ...
Setting up python3-colcon-argcomplete (0.3.3-1) ...
Setting up python3-colcon-recursive-crawl (0.2.3-1) ...
Setting up brz (3.2.1+bzr7585-1build1) ...
update-alternatives: using /usr/bin/brz to provide /usr/bin/bzr (bzr) in auto m
ode
Setting up python3-colcon-cmake (0.2.28-1) ...
Setting up python3-colcon-notification (0.2.15-1) ...
Setting up python3-github (1.55-1) ...
Setting up brz (2.7.0+bzr6622+brz) ...
Setting up python3-rosdep (0.22.2-1) ...
Setting up git (1:2.34.1-1ubuntu1.10) ...
Setting up python3-colcon-cd (0.1.1-1) ...
Setting up ros-build-essential (1.0.0) ...
Setting up libsvn1:amd64 (1.14.1-3ubuntu0.22.04.1) ...
Setting up subversion (1.14.1-3ubuntu0.22.04.1) ...
Setting up python3-colcon-ros (0.4.1-1) ...
Setting up python3-bloom (0.11.2-100) ...
Setting up python3-colcon-common-extensions (0.3.0-1) ...
Setting up ros-dev-tools (1.0.0) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.5) ...
grooot@grooot-VirtualBox:~$
```


5. Sudah terinstal ROS 2 Humble

A terminal window titled 'grooot@grooot-VirtualBox: /opt/ros' showing the installation of ROS 2 Humble. The window has a dark background with light-colored text. On the left side, there is a vertical sidebar with icons for Activities, Terminal, and a file manager. The terminal output shows a series of 'Setting up' messages for various ROS 2 packages and tools, followed by directory navigation commands and a final 'ls' command showing the installed directory structure.

```
Activities Terminal Jan 2 21:42 grooot@grooot-VirtualBox: /opt/ros

Setting up python3-colcon-recursive-crawl (0.2.3-1) ...
Setting up brz (3.2.1+bzr7585-1build1) ...
update-alternatives: using /usr/bin/brz to provide /usr/bin/bzr (bzr) in auto m
ode
Setting up python3-colcon-cmake (0.2.28-1) ...
Setting up python3-colcon-notification (0.2.15-1) ...
Setting up python3-github (1.55-1) ...
Setting up bazaar (2.7.0+bzr6622+brz) ...
Setting up python3-rosdep (0.22.2-1) ...
Setting up git (1:2.34.1-1ubuntu1.10) ...
Setting up python3-colcon-cd (0.1.1-1) ...
Setting up ros-build-essential (1.0.0) ...
Setting up libsvn1:amd64 (1.14.1-3ubuntu0.22.04.1) ...
Setting up subversion (1.14.1-3ubuntu0.22.04.1) ...
Setting up python3-colcon-ros (0.4.1-1) ...
Setting up python3-bloom (0.11.2-100) ...
Setting up python3-colcon-common-extensions (0.3.0-1) ...
Setting up ros-dev-tools (1.0.0) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.5) ...
grooot@grooot-VirtualBox:~$ cd /opt/
grooot@grooot-VirtualBox:/opt$ ls
ros  VBoxGuestAdditions-7.0.10
grooot@grooot-VirtualBox:/opt$ cd ros/
grooot@grooot-VirtualBox:/opt/ros$ ld
ld: no input files
grooot@grooot-VirtualBox:/opt/ros$ ls
humble
grooot@grooot-VirtualBox:/opt/ros$
```

```
Activities  Terminal  Jan 2 21:45  grooot@grooot-VirtualBox: ~

options:
-h, --help          show this help message and exit
--use-python-default-buffering
                    Do not force line buffering in stdout and instead use
                    the python default buffering, which might be affected
                    by PYTHONUNBUFFERED/-u and depends on whatever stdout
                    is interactive or not

Commands:
action             Various action related sub-commands
bag                Various rosbag related sub-commands
component          Various component related sub-commands
daemon            Various daemon related sub-commands
doctor            Check ROS setup and other potential issues
interface          Show information about ROS interfaces
launch            Run a launch file
lifecycle          Various lifecycle related sub-commands
multicast          Various multicast related sub-commands
node              Various node related sub-commands
param             Various param related sub-commands
pkg               Various package related sub-commands
run               Run a package specific executable
security          Various security related sub-commands
service           Various service related sub-commands
topic            Various topic related sub-commands
wtf               Use 'wtf' as alias to 'doctor'

Call 'ros2 <command> -h' for more detailed usage.
grooot@grooot-VirtualBox:~$
```

Install Noetic

```
Activities Terminal Jan 4 00:50
grooot@grooot-VirtualBox: ~
M: Target DEP-11-Icons (main/debian/icons-64x64.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11-Icons-hidpi (main/debian/icons-64x64q2.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target CNF (main/cnf/commands-and4) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target CNF (main/cnf/commands-all) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
Warning: apt-key is deprecated. Manage keyring files in trusted.gpg.d instead (see apt-key(8)).
OK
grooot@grooot-VirtualBox: ~$ sudo apt update
Hit:1 http://id.archive.ubuntu.com/ubuntu jammy InRelease
Hit:2 http://id.archive.ubuntu.com/ubuntu jammy-updates InRelease
Hit:3 http://id.archive.ubuntu.com/ubuntu jammy-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu jammy-security InRelease
Ign:5 http://packages.ros.org/ros/ubuntu jammy InRelease
Hit:6 http://packages.ros.org/ros/ubuntu jammy InRelease
Err:7 http://packages.ros.org/ros/ubuntu jammy Release
404 Not Found [IP: 146.211.166.134 80]
Reading package lists... Done
E: The repository 'http://packages.ros.org/ros/ubuntu jammy Release' does not have a Release file.
N: Updating from such a repository can't be done securely, and is therefore disabled by default.
N: See apt-secure(8) manpage for repository creation and user configuration details.
M: Target Packages (main/binary-and4/Packages) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target Packages (main/binary-all/Packages) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target Translations (main/libn/translation-en-US) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target Translations (main/libn/translation-en) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11 (main/debian/components-and4.yml) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11 (main/debian/components-all.yml) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11-Icons-small (main/debian/icons-48x48.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11-Icons (main/debian/icons-64x64.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11-Icons-hidpi (main/debian/icons-64x64q2.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target CNF (main/cnf/commands-and4) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target CNF (main/cnf/commands-all) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target Packages (main/binary-and4/Packages) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target Packages (main/binary-all/Packages) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target Translations (main/libn/translation-en-US) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target Translations (main/libn/translation-en) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11 (main/debian/components-and4.yml) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11 (main/debian/components-all.yml) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11-Icons-small (main/debian/icons-48x48.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11-Icons (main/debian/icons-64x64.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target DEP-11-Icons-hidpi (main/debian/icons-64x64q2.tar) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target CNF (main/cnf/commands-and4) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
M: Target CNF (main/cnf/commands-all) is configured multiple times in /etc/apt/sources.list.d/ros2-latest.list:1 and /etc/apt/sources.list.d/ros2.list:1
grooot@grooot-VirtualBox: ~$ sudo apt install ros-noetic-desktop-full
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
E: Unable to locate package ros-noetic-desktop-full
grooot@grooot-VirtualBox: ~$
```

Analisis : Saya sudah mencoba untuk install ros noetic di ubuntu 20.04 seperti perintah di buku mastering ros, tetapi gagal, saya telah mencoba untuk mencari Solusi di komunitas ros, dan hasilnya bahwa ros noetic sudah tidak kompitabel di ubuntu 20.04, lalu saya cari Solusi lain dan ketemu bahwa bisa untuk mencari source di ubuntu 20.04, tetapi masih error :

```
grooot@grooot-VirtualBox: ~/ros_noetic_base
or undo this operation with:
git switch -

Turn off this advice by setting config variable advice.detachedHead to false

grooot@grooot-VirtualBox: ~/ros_noetic_base/catk1n$ cd ..
git clone https://github.com/ros-infrastructure/catk1n_pkg.git -b 1.0.0
git clone https://github.com/ros-infrastructure/rospkg.git -b 0.5.2
Cloning into 'catkin_pkg'...
remote: Enumerating objects: 2907, done.
remote: Counting objects: 100% (277/277), done.
remote: Compressing objects: 100% (127/127), done.
remote: Total 2907 (delta 139), reused 209 (delta 102), pack-reused 2630
Receiving objects: 100% (2907/2907), 666.10 KiB | 452.00 KiB/s, done.
Resolving deltas: 100% (1630/1630), done.
Note: switching to 'fb24686ec2565882bc3ef6134a76db76ae9f3632'.

You are in 'detached HEAD' state. You can look around, make experimental
changes and commit them, and you can discard any commits you make in this
state without impacting any branches by switching back to a branch.

If you want to create a new branch to retain commits you create, you may
do so (now or later) by using -c with the switch command. Example:

git switch -c <new-branch-name>

or undo this operation with:
git switch -

Turn off this advice by setting config variable advice.detachedHead to false

Cloning into 'rospkg'...
fatal: Remote branch 0.5.2 not found in upstream origin
grooot@grooot-VirtualBox: ~/ros_noetic_base$ cd catkin_ws/src/ros_comm
git apply --ignore-whitespace ros_comm.patch

cd ../roscconsole
git apply --ignore-whitespace roscconsole.patch
bash: cd: catkin_ws/src/ros_comm: No such file or directory
error: can't open patch '-': No such file or directory
bash: cd: ../roscconsole: No such file or directory
error: can't open patch 'roscconsole.patch': No such file or directory
grooot@grooot-VirtualBox: ~/ros_noetic_base$
```



```
do so (now or later) by using -c with the switch command. Example:
git switch -c <new-branch-name>

Or undo this operation with:
git switch -

Turn off this advice by setting config variable advice.detachedHead to false

Cloning into 'rospkg'...
fatal: Remote branch 0.5.2 not found in upstream origin
grooot@grooot-VirtualBox:~/ros_noetic_base$ cd catkin_ws/src/ros_comm
git apply --ignore-whitespace ros_comm.patch

cd ../roscpp
git apply --ignore-whitespace roscpp.patch
bash: cd: catkin_ws/src/ros_comm: No such file or directory
error: can't open patch '-': No such file or directory
bash: cd: ../roscpp: No such file or directory
error: can't open patch 'roscpp.patch': No such file or directory
grooot@grooot-VirtualBox:~/ros_noetic_base$ FROM: ubuntu:22.04

RUN apt-get update && \
  apt-get install -y \
    cmake \
    build-essential \
    python3 \
    pip
FROM: command not found
RUN: command not found
grooot@grooot-VirtualBox:~/ros_noetic_base$ sudo docker build -t ros_noetic_base .
sudo docker run -it --rm -v ~/ros_noetic_base:ros_noetic_base bash
cd /ros_noetic_base/catkin_pkg && python3 setup.py install
cd /ros_noetic_base/rospkg && python3 setup.py install
cd /ros_noetic_base/catkin_ws
./src/catkin/bin/catkin_make_isolated \
  -DCMAKE_BUILD_TYPE=Release \
  -DPYTHON_EXECUTABLE=/usr/bin/python3
sudo: docker: command not found
bash: cd: /ros_noetic_base/catkin_pkg: No such file or directory
bash: cd: /ros_noetic_base/rospkg: No such file or directory
bash: cd: /ros_noetic_base/catkin_ws: No such file or directory
bash: ./src/catkin/bin/catkin_make_isolated: No such file or directory
grooot@grooot-VirtualBox:~/ros_noetic_base$
```

Pertanyaan

1. Protokol Komunikasi antar Node yang Didukung oleh ROS

ROS mendukung beberapa protokol komunikasi antar node, yang paling umum digunakan adalah ROS Publisher-Subscriber dan ROS Service. Dalam Publisher-Subscriber, node dapat mengirim dan menerima data secara asinkron melalui topik (topics). Sedangkan dalam ROS Service, node dapat menyediakan dan memanggil layanan secara sinkron melalui panggilan prosedural. Selain itu, ROS 2 juga mendukung DDS (Data Distribution Service) sebagai protokol komunikasi dasar yang mendukung komunikasi waktu nyata dan lebih canggih.

2. Perbedaan antara Perintah rosrn dan roslaunch

- Rosrun

Perintah ini digunakan untuk menjalankan satu atau beberapa node ROS. Penggunaannya sederhana dan biasanya digunakan untuk menjalankan satu node tunggal.

- roslaunch

Digunakan untuk meluncurkan file konfigurasi XML yang dapat menjalankan beberapa node sekaligus dengan konfigurasi yang lebih kompleks. Ini sangat berguna untuk meluncurkan sistem yang melibatkan beberapa node atau memerlukan konfigurasi khusus.

3. Perbedaan antara ROS Topics dan Services dalam Operasionalnya

- ROS Topics

Digunakan untuk komunikasi asinkron antara node. Node dapat mengirim dan menerima data melalui topik (topics) tanpa mengetahui atau memerlukan keberadaan node lainnya. Ini sering digunakan untuk mentransmisikan data seperti sensor reading, status robot, dll.

- ROS Services

Digunakan untuk komunikasi sinkron antara node. Node yang menyediakan layanan (service provider) menanggapi permintaan (request) dari node yang memanggil layanan (service client). Services biasanya digunakan untuk melakukan tugas yang memerlukan respons khusus atau komputasi yang lebih rumit.

4. Perbedaan antara ROS Services dan Actionlib dalam Operasionalnya

- ROS Services

Bersifat sinkron, artinya node pemanggil (client) harus menunggu hingga node yang menyediakan layanan (server) menyelesaikan tugas dan memberikan respons.

- Actionlib

Memberikan fungsionalitas yang lebih kompleks dan fleksibel daripada layanan. Actions memungkinkan untuk menangani tugas yang membutuhkan umpan balik (feedback) selama eksekusi dan pembatalan tugas. Actions lebih cocok untuk tugas yang memerlukan kendali dan umpan balik yang lebih baik.