

**Electrical and Computer Engineering, Purdue University Northwest**  
**Big Data (ECE49500/ECE59500)**  
**Hands-on Assignment 1**

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**Task 0 [0 points].** Create an Ubuntu virtual machine (VM) and submit the screenshot for it. Please note that I am fine if you want to use Windows for Docker installation, but you have to manage it by yourself. Download VMWare workstation player from-

<https://www.vmware.com/products/workstation-player/workstation-player-evaluation.html>.

You may refer [1] for installation.

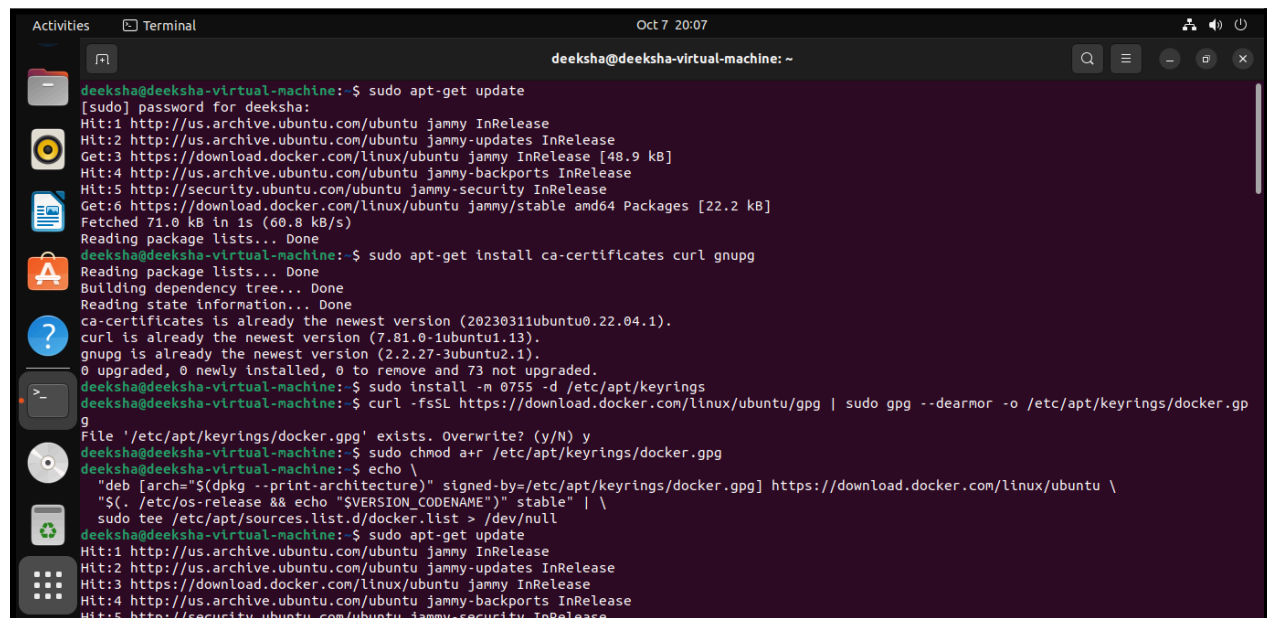
Download Ubuntu image from-

[https://releases.ubuntu.com/22.04.3/ubuntu-22.04.3-desktop-amd64.iso?\\_ga=2.208698834.1557579542.1695500113-1796876152.1695500113](https://releases.ubuntu.com/22.04.3/ubuntu-22.04.3-desktop-amd64.iso?_ga=2.208698834.1557579542.1695500113-1796876152.1695500113). You may Refer [2] for creating an Ubuntu VM.

**Task 1 [5 points].** Follow the steps mentioned below for Docker installation. Provide screenshots as much as possible for credits. Please watch videos from [4] and [5] to learn Docker and its useful commands. Open the terminal pressing Alt + Ctrl + t.

Screenshots for steps for docker installation

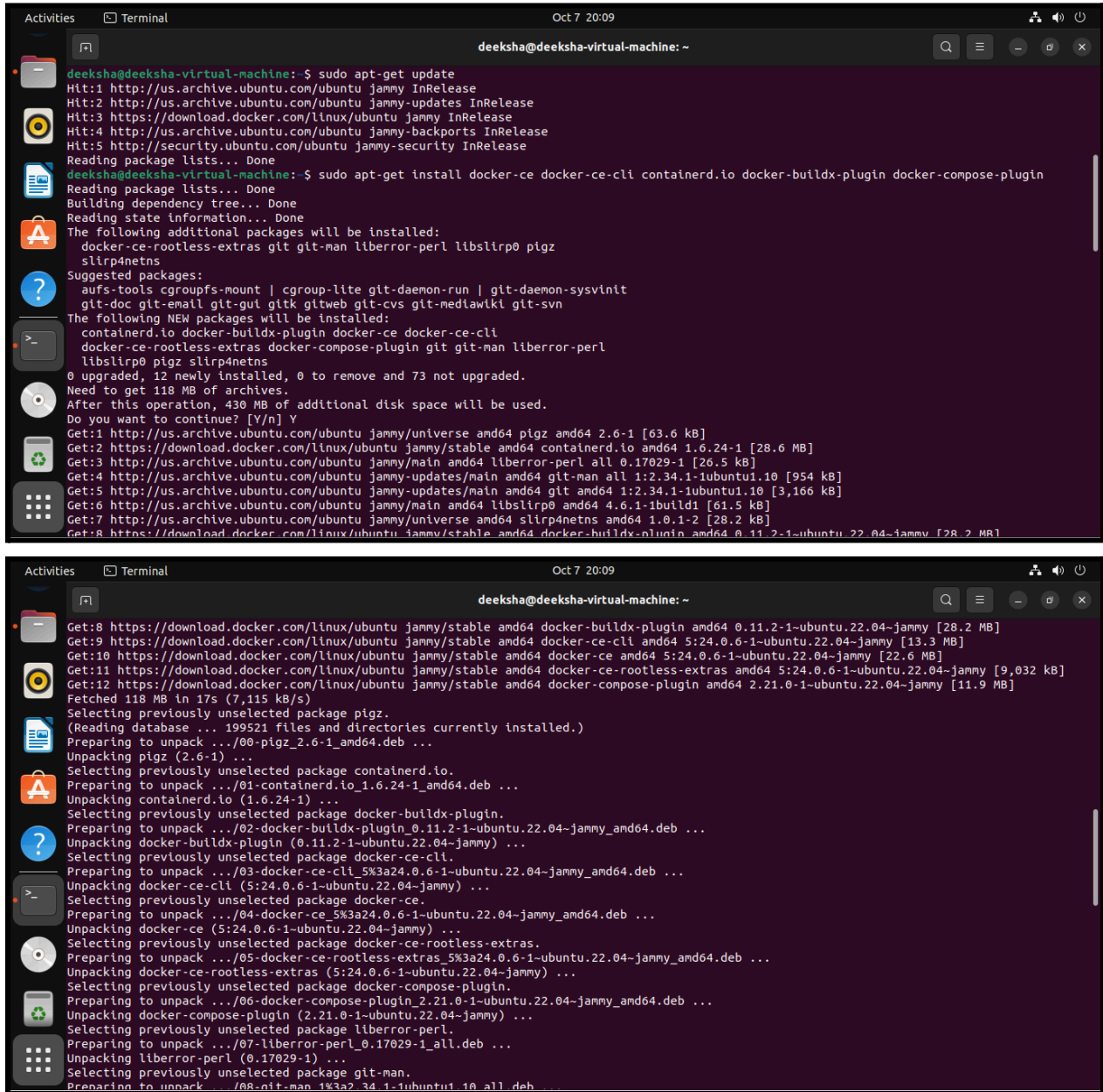
- sudo apt-get update
- sudo apt-get install ca-certificates curl gnupg
- sudo install -m 0755 -d /etc/apt/keyrings
- curl -fsSL <https://download.docker.com/linux/ubuntu/gpg> | sudo gpg --dearmor -o /etc/apt/keyrings/docker.gpg
- sudo chmod a+r /etc/apt/keyrings/docker.gpg
- echo \
- sudo apt-get update



```
deeksha@deeksha-virtual-machine: ~  
deeksha@deeksha-virtual-machine:~$ sudo apt-get update  
[sudo] password for deeksha:  
Hit:1 http://us.archive.ubuntu.com/ubuntu jammy InRelease  
Hit:2 http://us.archive.ubuntu.com/ubuntu jammy-updates InRelease  
Get:3 https://download.docker.com/linux/ubuntu jammy InRelease [48.9 kB]  
Hit:4 http://us.archive.ubuntu.com/ubuntu jammy-backports InRelease  
Hit:5 http://security.ubuntu.com/ubuntu jammy-security InRelease  
Get:6 https://download.docker.com/linux/ubuntu jammy/stable amd64 Packages [22.2 kB]  
Fetched 71.0 kB in 1s (60.8 kB/s)  
Reading package lists... Done  
deeksha@deeksha-virtual-machine:~$ sudo apt-get install ca-certificates curl gnupg  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
ca-certificates is already the newest version (20230311ubuntu0.22.04.1).  
curl is already the newest version (7.81.0-1ubuntu1.13).  
gnupg is already the newest version (2.2.27-3ubuntu2.1).  
0 upgraded, 0 newly installed, 0 to remove and 73 not upgraded.  
deeksha@deeksha-virtual-machine:~$ sudo install -m 0755 -d /etc/apt/keyrings  
deeksha@deeksha-virtual-machine:~$ curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo gpg --dearmor -o /etc/apt/keyrings/docker.gpg  
File '/etc/apt/keyrings/docker.gpg' exists. Overwrite? (y/N) y  
deeksha@deeksha-virtual-machine:~$ sudo chmod a+r /etc/apt/keyrings/docker.gpg  
deeksha@deeksha-virtual-machine:~$ echo \  
"deb [arch=$(dpkg --print-architecture)] signed-by=/etc/apt/keyrings/docker.gpg https://download.docker.com/linux/ubuntu \  
$(. /etc/os-release && echo "$VERSION_CODENAME") stable" | \  
sudo tee /etc/apt/sources.list.d/docker.list > /dev/null  
deeksha@deeksha-virtual-machine:~$ sudo apt-get update  
Hit:1 http://us.archive.ubuntu.com/ubuntu jammy InRelease  
Hit:2 http://us.archive.ubuntu.com/ubuntu jammy-updates InRelease  
Hit:3 https://download.docker.com/linux/ubuntu jammy InRelease  
Hit:4 http://us.archive.ubuntu.com/ubuntu jammy-backports InRelease  
Hit:5 http://security.ubuntu.com/ubuntu jammy-security InRelease
```

## Command -

- `sudo apt-get update`
- `sudo apt-get install docker-ce docker-ce-cli containerd.io docker-buildx-plugin docker-compose-plugin`



```
deeksha@deeksha-virtual-machine: ~  
$ sudo apt-get update  
Hit:1 http://us.archive.ubuntu.com/ubuntu jammy InRelease  
Hit:2 http://us.archive.ubuntu.com/ubuntu jammy-updates InRelease  
Hit:3 https://download.docker.com/linux/ubuntu jammy InRelease  
Hit:4 http://us.archive.ubuntu.com/ubuntu jammy-backports InRelease  
Hit:5 http://security.ubuntu.com/ubuntu jammy-security InRelease  
Reading package lists... Done  
deeksha@deeksha-virtual-machine:~$ sudo apt-get install docker-ce docker-ce-cli containerd.io docker-buildx-plugin docker-compose-plugin  
Reading package lists... Done  
Building dependency tree... Done  
Reading state information... Done  
The following additional packages will be installed:  
  docker-ce-rootless-extras git git-man liberror-perl libslirp0 pigz  
  slirp4netns  
Suggested packages:  
  aufs-tools cgroupfs-mount | cgroup-lite git-daemon-run | git-daemon-sysvinit  
  git-doc git-email git-gui gitk gitweb git-cvs git-mediawiki git-svn  
The following NEW packages will be installed:  
  containerd.io docker-buildx-plugin docker-ce docker-ce-cli  
  docker-ce-rootless-extras docker-compose-plugin git git-man liberror-perl  
  libslirp0 pigz slirp4netns  
0 upgraded, 12 newly installed, 0 to remove and 73 not upgraded.  
Need to get 118 MB of archives.  
After this operation, 430 MB of additional disk space will be used.  
Do you want to continue? [Y/n] Y  
Get:1 http://us.archive.ubuntu.com/ubuntu jammy/universe amd64 pigz amd64 2.6-1 [63.6 kB]  
Get:2 https://download.docker.com/linux/ubuntu jammy/stable amd64 containerd.io amd64 1.6.24-1 [28.6 MB]  
Get:3 http://us.archive.ubuntu.com/ubuntu jammy/main amd64 liberror-perl all 0.17029-1 [26.5 kB]  
Get:4 http://us.archive.ubuntu.com/ubuntu jammy-updates/main amd64 git-man all 1:2.34.1-1ubuntu1.10 [954 kB]  
Get:5 http://us.archive.ubuntu.com/ubuntu jammy-updates/main amd64 git amd64 1:2.34.1-1ubuntu1.10 [3,166 kB]  
Get:6 http://us.archive.ubuntu.com/ubuntu jammy/main amd64 libslirp0 amd64 4.6.1-1build1 [61.5 kB]  
Get:7 http://us.archive.ubuntu.com/ubuntu jammy/universe amd64 slirp4netns amd64 1.0.1-2 [28.2 kB]  
Get:8 https://download.docker.com/linux/ubuntu jammy/stable amd64 docker-buildx-plugin amd64 0.11.2-1-ubuntu.22.04-jammy [28.2 MB]  
Get:9 https://download.docker.com/linux/ubuntu jammy/stable amd64 docker-ce-cli amd64 5:24.0.6-1-ubuntu.22.04-jammy [13.3 MB]  
Get:10 https://download.docker.com/linux/ubuntu jammy/stable amd64 docker-ce amd64 5:24.0.6-1-ubuntu.22.04-jammy [22.6 MB]  
Get:11 https://download.docker.com/linux/ubuntu jammy/stable amd64 docker-ce-rootless-extras amd64 5:24.0.6-1-ubuntu.22.04-jammy [9,032 kB]  
Get:12 https://download.docker.com/linux/ubuntu jammy/stable amd64 docker-compose-plugin amd64 2.21.0-1-ubuntu.22.04-jammy [11.9 MB]  
Fetched 118 MB in 17s (7,115 kB/s)  
Selecting previously unselected package pigz.  
(Reading database ... 199521 files and directories currently installed.)  
Preparing to unpack .../00-pigz_2.6-1_amd64.deb ...  
Unpacking pigz (2.6-1) ...  
Selecting previously unselected package containerd.io.  
Preparing to unpack .../01-containerd.io_1.6.24-1_amd64.deb ...  
Unpacking containerd.io (1.6.24-1) ...  
Selecting previously unselected package docker-buildx-plugin.  
Preparing to unpack .../02-docker-buildx-plugin_0.11.2-1-ubuntu.22.04-jammy_amd64.deb ...  
Unpacking docker-buildx-plugin (0.11.2-1-ubuntu.22.04-jammy) ...  
Selecting previously unselected package docker-ce-cli.  
Preparing to unpack .../03-docker-ce-cli_5%3a24.0.6-1-ubuntu.22.04-jammy_amd64.deb ...  
Unpacking docker-ce-cli (5:24.0.6-1-ubuntu.22.04-jammy) ...  
Selecting previously unselected package docker-ce.  
Preparing to unpack .../04-docker-ce_5%3a24.0.6-1-ubuntu.22.04-jammy_amd64.deb ...  
Unpacking docker-ce (5:24.0.6-1-ubuntu.22.04-jammy) ...  
Selecting previously unselected package docker-ce-rootless-extras.  
Preparing to unpack .../05-docker-ce-rootless-extras_5%3a24.0.6-1-ubuntu.22.04-jammy_amd64.deb ...  
Unpacking docker-ce-rootless-extras (5:24.0.6-1-ubuntu.22.04-jammy) ...  
Selecting previously unselected package docker-compose-plugin.  
Preparing to unpack .../06-docker-compose-plugin_2.21.0-1-ubuntu.22.04-jammy_amd64.deb ...  
Unpacking docker-compose-plugin (2.21.0-1-ubuntu.22.04-jammy) ...  
Selecting previously unselected package liberror-perl.  
Preparing to unpack .../07-liberror-perl_0.17029-1_all.deb ...  
Unpacking liberror-perl (0.17029-1) ...  
Selecting previously unselected package git-man.  
Preparing to unpack .../08-git-man_1%3a2.34.1-1ubuntu1.10_all.deb ...  
Unpacking git-man (1:2.34.1-1ubuntu1.10) ...
```

```
Activities Terminal Oct 7 20:11
deeksha@deeksha-virtual-machine: ~
Unpacking docker-compose-plugin (2.21.0-1-ubuntu.22.04-jammy) ...
Selecting previously unselected package liberror-perl.
Preparing to unpack .../07-liberror-perl_0.17029-1_all.deb ...
Unpacking liberror-perl (0.17029-1) ...
Selecting previously unselected package git-man.
Preparing to unpack .../08-git-man_1%3a2.34.1-1ubuntu1.10_all.deb ...
Unpacking git-man (1:2.34.1-1ubuntu1.10) ...
Selecting previously unselected package git.
Preparing to unpack .../09-git_1%3a2.34.1-1ubuntu1.10_amd64.deb ...
Unpacking git (1:2.34.1-1ubuntu1.10) ...
Selecting previously unselected package libslirp0:amd64.
Preparing to unpack .../10-libslirp0_4.6.1-1build1_amd64.deb ...
Unpacking libslirp0:amd64 (4.6.1-1build1) ...
Selecting previously unselected package slirp4netns.
Preparing to unpack .../11-slirp4netns_1.0.1-2_amd64.deb ...
Unpacking slirp4netns (1.0.1-2) ...
Setting up liberror-perl (0.17029-1) ...
Setting up docker-buildx-plugin (0.11.2-1-ubuntu.22.04-jammy) ...
Setting up containerd.io (1.6.24-1) ...
Created symlink /etc/systemd/system/multi-user.target.wants/containerd.service → /lib/systemd/system/containerd.service.
Setting up docker-compose-plugin (2.21.0-1-ubuntu.22.04-jammy) ...
Setting up docker-ce-cli (5:24.0.6-1-ubuntu.22.04-jammy) ...
Setting up libslirp0:amd64 (4.6.1-1build1) ...
Setting up pigz (2.6-1) ...
Setting up git-man (1:2.34.1-1ubuntu1.10) ...
Setting up docker-ce-rootless-extras (5:24.0.6-1-ubuntu.22.04-jammy) ...
Setting up slirp4netns (1.0.1-2) ...
Setting up docker-ce (5:24.0.6-1-ubuntu.22.04-jammy) ...
Created symlink /etc/systemd/system/multi-user.target.wants/docker.service → /lib/systemd/system/docker.service.
Created symlink /etc/systemd/system/sockets.target.wants/docker.socket → /lib/systemd/system/docker.socket.
Setting up git (1:2.34.1-1ubuntu1.10) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...
```

## Command -

- `sudo docker run hello-world`

```
Activities Terminal Oct 7 20:11
deeksha@deeksha-virtual-machine: ~
Setting up git (1:2.34.1-1ubuntu1.10) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...
deeksha@deeksha-virtual-machine:~$ sudo docker run hello-world
Unable to find image 'hello-world:latest' locally
latest: Pulling from library/hello-world
719385e32844: Pull complete
Digest: sha256:4f53e2564790c8e7856ec08e384732aa38dc43c52f02952483e3f003afb23db
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.

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/

For more examples and ideas, visit:
https://docs.docker.com/get-started/
deeksha@deeksha-virtual-machine:~$
```

Follow the steps 1-3 mentioned in section Install Using the Apt Repository of Ref. [3].

Once you finish installation of Docker, execute the following commands:

`sudo docker images`

```
deeksha@deeksha-virtual-machine:~$ sudo docker images
[sudo] password for deeksha:
REPOSITORY      TAG         IMAGE ID      CREATED       SIZE
hello-world     latest     9c7a54a9a43c  5 months ago  13.3kB
```

sudo docker ps -a

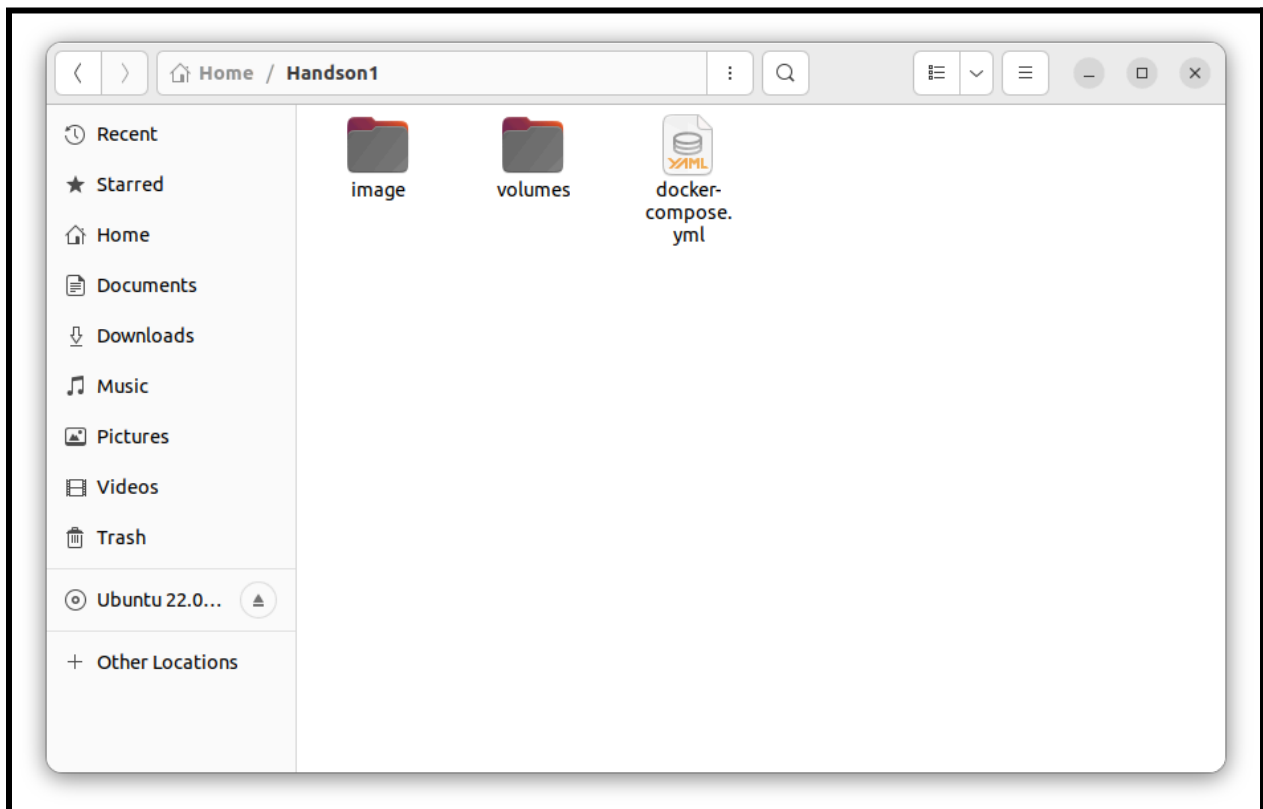
```
deeksha@deeksha-virtual-machine:~$ sudo docker ps -a
CONTAINER ID   IMAGE        COMMAND      CREATED        STATUS        PORTS        NAMES
9a918e46a816   hello-world  "/hello"     21 minutes ago Exited (0) 21 minutes ago          focused_sammet
```

sudo docker network ls

```
deeksha@deeksha-virtual-machine:~$ sudo docker network ls
NETWORK ID     NAME      DRIVER    SCOPE
fa3e335c935f   bridge    bridge    local
87d08010b2f6   host      host      local
16c875099905   none      null      local
```

**Task 2 [7.5 points].** Follow the steps mentioned below for setting-up the Docker container. Provide screenshots as much as possible for credits.

**Download Handson1.zip file in your Ubuntu VM and extract it as Handson1 directory (preferably in your home directory).**



**Go to the extracted directory, you will see two directories-- image and volumes; and docker-compose.yml file inside the directory. Open the docker-compose.yml and review**

its content. Similarly, review the content of DockerFile inside the image directory. Now, open the terminal and go to Handson1 directory. Type the command: `sudo docker compose up -d` to build and start the container.

```
deeksha@deeksha-virtual-machine: ~/Handson1
deeksha@deeksha-virtual-machine:~$ cd Handson1
deeksha@deeksha-virtual-machine:~/Handson1$ sudo docker compose up -d
[sudo] password for deeksha:
[+] Building 139.6s (17/17) FINISHED                                docker:default
=> [ubuntu internal] load .dockerignore                                0.2s
=> == transferring context: 2B                                          0.0s
=> == transferring dockerfile: 629B                                     1.6s
=> [ubuntu internal] load metadata for docker.io/library/ubuntu:focal  6.8s
=> [ubuntu 1/12] FROM docker.io/library/ubuntu:focal@sha256:33a5cc25d22c45900796a1aca487ad7a7cb09f09ea00b779e3b2026b4fc2faba  0.0s
=> == sha256:33a5cc25d22c45900796a1aca487ad7a7cb09f09ea00b779e3b2026b4fc2faba 1.13kB / 1.13kB  0.0s
=> == sha256:3246518d9735254519e1b2ff35f95686e4a5011c90c85344c1f38df7bae9dd37 424B / 424B  0.0s
=> == sha256:6df8940237264d4d0ecf092016c28066391a26f5d40c00b1153e75003465484d 2.30kB / 2.30kB  0.0s
=> == sha256:edaedc954fb53f42a7754a6e2d1b57f091bc9b11063bc445c2e325ea448f8f68 27.51MB / 27.51MB  3.9s
=> == extracting sha256:edaedc954fb53f42a7754a6e2d1b57f091bc9b11063bc445c2e325ea448f8f68 2.5s
=> [ubuntu internal] load build context                                0.0s
=> == transferring context: 177B                                         0.0s
=> [ubuntu 2/12] RUN /bin/bash                                          1.3s
=> [ubuntu 3/12] RUN apt-get update --fix-missing && apt upgrade -y   14.2s
=> [ubuntu 4/12] RUN apt install -y net-tools                         4.3s
=> [ubuntu 5/12] RUN apt-get install -y lptutils-ping                 5.0s
=> [ubuntu 6/12] RUN apt install -y python3                            9.9s
=> [ubuntu 7/12] RUN apt install -y python3-pip                      44.4s
=> [ubuntu 8/12] RUN pip3 install jupyter                             41.4s
=> [ubuntu 9/12] RUN apt-get clean                                     0.8s
=> [ubuntu 10/12] RUN mkdir -p /root/.jupyter && echo "c.NotebookApp.notebook_dir = '/volumes'" >> /root/.jupyter/jupyter_notebook_con  0.7s
=> [ubuntu 11/12] COPY start.sh /                                      0.7s
=> [ubuntu 12/12] RUN chmod +x /start.sh                               0.7s
=> [ubuntu] exporting to image                                          7.9s
=> == exporting layers                                                  7.9s
=> == writing image sha256:88dd0bc4f4acab14b1ec3817e6a125d4bd7d7fc90571b394b807508a8bc746fb 0.0s
=> == naming to docker.io/library/handson1-ubuntu                     0.0s
[+] Running 2/2
✔ Network mynet Created                                               0.2s
✔ Container ubuntu Started                                             0.2s
```

Type the command: `sudo docker ps -a` to see the information for the container process, e.g. container ID, command, ports, etc.

```
deeksha@deeksha-virtual-machine:~/Handson1$ sudo docker ps -a
CONTAINER ID   IMAGE          COMMAND                  CREATED        STATUS        PORTS          NAMES
0dd508a32ebf   handson1-ubuntu "/start.sh"            7 minutes ago   Up 7 minutes   8888/tcp       ubuntu
9a918e46a816   hello-world    "/hello"                4 hours ago    Exited (0) 4 hours ago                                focused_sammet
```

Open another terminal in a separate tab using `Ctrl+Shift+t`. Type command: `sudo docker exec -it <first few digits of CONTAINER ID retrieved from docker ps command> /bin/bash` to launch the container's shell. Once the shell is launched, type the command: `ls /volumes` inside container's shell to see the content of `/volumes` directory.

Do you see `.ipynb` files?

```
root@0dd508a32ebf: /
deeksha@deeksha-virtual-machine:~$ cd Handson1
deeksha@deeksha-virtual-machine:~/Handson1$ sudo docker exec -it 0dd508a32ebf /bin/bash
[sudo] password for deeksha:
root@0dd508a32ebf:/# ls /volumes
Python_Task_1.ipynb      Python_Tutorial_2.ipynb  logs.dat
Python_Task_2.ipynb      Python_Tutorial_3.ipynb  pima-indians-diabetes.csv
Python_Tutorial_1.ipynb  iris.data                records.txt
```

Type the command: `ifconfig` in container's shell to know the IP address of the container.

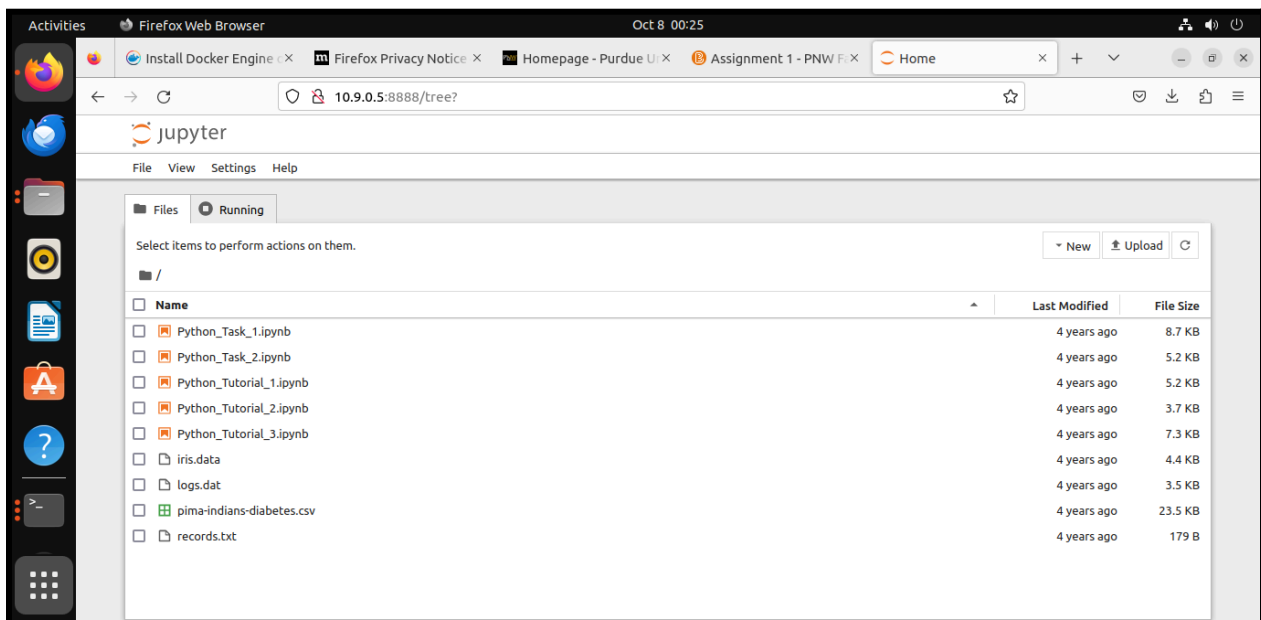
```
root@odd508a32ebf:/# ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.9.0.5 netmask 255.255.255.0 broadcast 10.9.0.255
    ether 02:42:0a:09:00:05 txqueuelen 0 (Ethernet)
    RX packets 76 bytes 13033 (13.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    loop txqueuelen 1000 (Local Loopback)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

Type another command in container's shell: `jupyter notebook list` to check the running Jupyter notebook processes inside the container. Please note down the token value that will be needed to access the Jupyter notebooks for tutorials and programming assignments.

```
root@odd508a32ebf:/# jupyter notebook list
Currently running servers:
http://odd508a32ebf:8888/?token=32ce626be7573c5b9e04f77ad25453217db8874feb1b5d9c :: /volumes
```

Launch the Firefox browser in your Ubuntu VM and provide this URL: `<IP address>:8888`. It will launch the Jupyter in your browser. Enter the token value that you noted down earlier if it is being asked. Do you see all the `.ipynb` files here that you can see in `/volumes` directory of the container?



Now, you can work on Task 3 and 4. Once you are done with your assignments, you can close the browser, exit the container's shell, and stop the container.

**Task 3 [12.5 points]. Complete the programming tasks given in Python\_Task\_1.ipynb and submit the file for credits.**

File submitted.

**Task 4 [10 points]. Complete the programming tasks given in Python\_Task\_2.ipynb and submit the file for credits.**

File submitted.