

Experiment 10

Aim: To study and implement Containerization using Docker.

Requirements: Docker

Theory:

What is Docker?

Docker is an open-source tool designed to create, deploy and run applications with ease by using containers. Docker fits in the deployment phase of the DevOps pipeline. DevOps can be defined as a culture that primarily focuses on improved collaboration, communication and integration between Development and Operations teams.

DevOps improves collaboration and productivity by:

- Automating infrastructure provision
- Automating workflows for building, testing and deploying applications
- Continuously measuring application performances

What is a Container?

A Container is a package which has everything except the Operating System to run the software application.

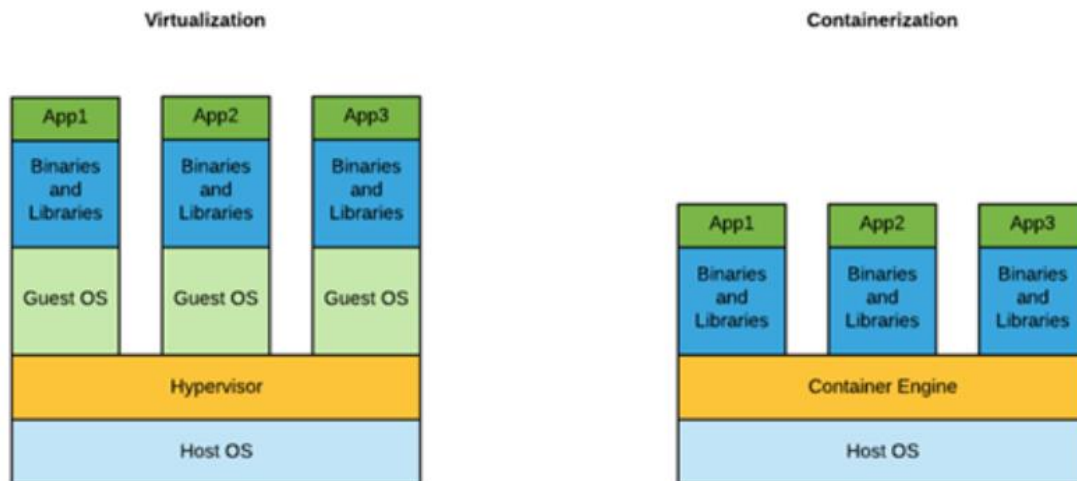
Containers versus Virtual Machines (VM):

Every Virtual Machine has its own Operating System which is the reason why the boot up process takes a longer time. Virtual Machines share the host's hardware with other VMs on the same host.

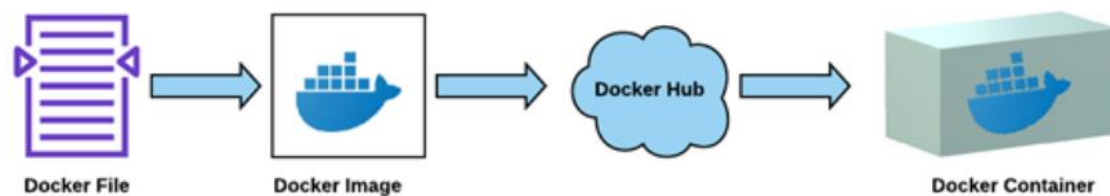
Containers, virtualize the Operating System – every container has its own CPU, memory, block I/O, network stack and uses the host's Operating System.

Containers have a short boot up process. They offer increased efficiency, better utilization and are portable.

Containers versus Virtual Machines (VM):



Docker Architecture:



Docker File:

A Docker file is a text document that contains all the commands a user could call on the command line to assemble an image. Every time, we are going to pick up a base image and build on top of that image.

For example, in the below Docker File, we are taking the base image “tomcat” and adding our web application war file.

From tomcat

ADD LeaveManagementApp.war /usr/local/tomcat/webapps

CMD “catalina.sh” “run”

EXPOSE 8080

Docker Image:

Docker Image is built from the Docker File. Docker Images are made up of multiple layers which are a read only file system A layer is created for each instruction in the Docker File and placed on top of previous layer

`docker build -t LeaveManagementImage:1.0`

Using the Docker build command, a Docker Image can be created.

Docker Hub:

Once the Docker Image is build, it can be stored or shared through Docker Hub. Just like GitHub, we can create an account in Docker Hub, create public or private repositories and maintain the Docker Images. Using the command below, we can set the Docker Hub configuration to our image:

`docker tag LeaveManagementImage:1.0 myrepo/LeaveManagementImage:1.0`

And then finally push the image to Docker Hub:

`docker push myrepo/LeaveManagementImage:1.0`

Now that the image is available on Docker Hub, you’ll be able to run it anywhere. If you try to use it on a new machine that doesn’t have it yet, the Docker client will automatically try and download it from Docker Hub.

Docker Containers: Docker Containers are sort of encapsulated environments in which you run applications. A Container is defined by the image and only have access to resources that are defined in the image.

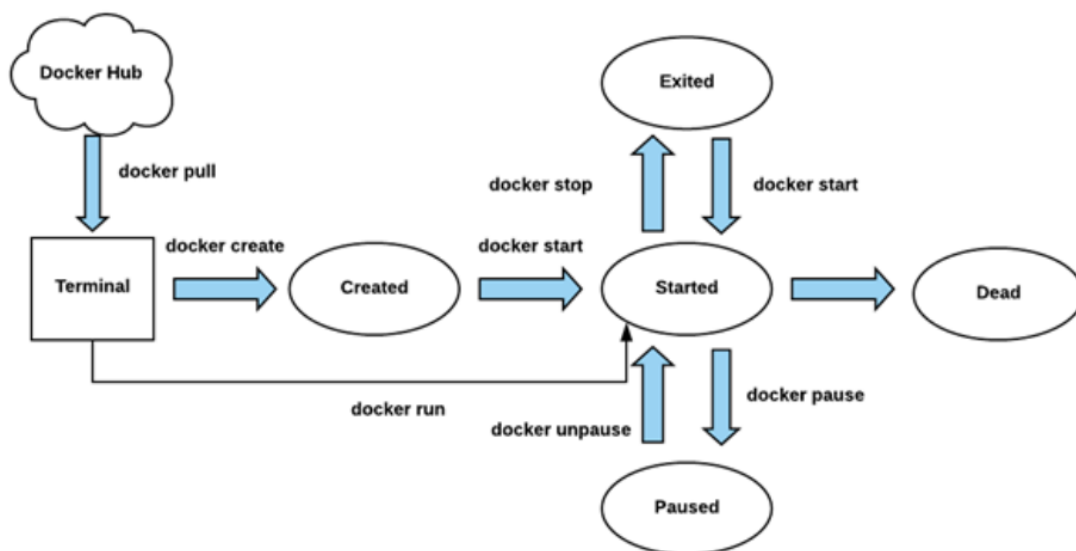
The machine where the container has to run should have a Docker client installed so that Docker commands can be executed. You can use the Docker pull command to get the image from Docker hub to local machine

docker pull LeaveManagementImage

Use Docker run command to fetch the image as well as create a new container from that image

docker run -itd LeaveManagementImage

Once the container is created or has started using the run command, the container can be stopped, paused or started based on the requirement.



Another good use case of Docker is when you want to experiment with different database servers in your development environment. Instead of installing multiple database servers on your computer, simply use Docker containers to run each database server.

Output:

Installing Docker:

```

slowgamer@adnan-System-Product-Name:~$ sudo apt-get install \
> ca-certificates \
> curl \
> gnupg \
> lsb-release
Reading package lists... Done
Building dependency tree
Reading state information... Done
lsb-release is already the newest version (11.1.0ubuntu2).
ca-certificates is already the newest version (20210119-20.04.2).
curl is already the newest version (7.68.0-1ubuntu2.7).
gnupg is already the newest version (2.2.19-3ubuntu2.1).
The following packages were automatically installed and are no longer required:
  libfwpuplugin1 linux-headers-5.13.0-37-generic
  linux-hwe-5.13-headers-5.13.0-37 linux-image-5.13.0-37-generic
  linux-modules-5.13.0-37-generic linux-modules-extra-5.13.0-37-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 22 not upgraded.
slowgamer@adnan-System-Product-Name:~$ curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo gpg --dearmor -o /usr/share/keyrings/docker-archive-keyring.gpg
File '/usr/share/keyrings/docker-archive-keyring.gpg' exists. Overwrite? (y/N) y
slowgamer@adnan-System-Product-Name:~$ sudo apt-get update
> "deb [arch=$(dpkg --print-architecture) signed-by=/usr/share/keyrings/docker-archive-keyring.gpg] https://download.docker.com/linux/ubuntu \
> $(lsb_release -cs) stable" | sudo tee /etc/apt/sources.list.d/docker.list > /dev/null
slowgamer@adnan-System-Product-Name:~$ sudo apt-get update
Hit:1 https://download.docker.com/linux/ubuntu focal InRelease
Hit:2 http://in.archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://in.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:4 http://in.archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:5 http://ppa.launchpad.net/swi-prolog/stable/ubuntu focal InRelease
Get:6 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Hit:7 https://dl.google.com/linux/chrome/deb stable InRelease
Fetched 114 kB in 1s (144 kB/s)
Reading package lists... Done
slowgamer@adnan-System-Product-Name:~$ sudo apt-get install docker-ce docker-ce-cli containerd.io
Reading package lists... Done
Building dependency tree
Reading state information... Done
containerd.io is already the newest version (1.5.11-1).
docker-ce-cli is already the newest version (5:20.10.14-3-0-ubuntu-focal).
docker-ce is already the newest version (5:20.10.14-3-0-ubuntu-focal).
The following packages were automatically installed and are no longer required:
  libfwpuplugin1 linux-headers-5.13.0-37-generic
  linux-hwe-5.13-headers-5.13.0-37 linux-image-5.13.0-37-generic
  linux-modules-5.13.0-37-generic linux-modules-extra-5.13.0-37-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 22 not upgraded.
slowgamer@adnan-System-Product-Name:~$ sudo apt-get update
Hit:1 https://download.docker.com/linux/ubuntu focal InRelease
Hit:2 http://in.archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://in.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:4 http://in.archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:5 https://dl.google.com/linux/chrome/deb stable InRelease
Hit:6 http://ppa.launchpad.net/swi-prolog/stable/ubuntu focal InRelease
Get:7 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Fetched 114 kB in 1s (144 kB/s)
Reading package lists... Done

```

```

Hit:2 http://in.archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://in.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:4 http://in.archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:5 http://ppa.launchpad.net/swi-prolog/stable/ubuntu focal InRelease
Get:6 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Hit:7 https://dl.google.com/linux/chrome/deb stable InRelease
Fetched 114 kB in 1s (144 kB/s)
Reading package lists... Done
slowgamer@adnan-System-Product-Name:~$ sudo apt-get install docker-ce docker-ce-cli containerd.io
Reading package lists... Done
Building dependency tree
Reading state information... Done
containerd.io is already the newest version (1.5.11-1).
docker-ce-cli is already the newest version (5:20.10.14-3-0-ubuntu-focal).
docker-ce is already the newest version (5:20.10.14-3-0-ubuntu-focal).
The following packages were automatically installed and are no longer required:
  libfwpuplugin1 linux-headers-5.13.0-37-generic
  linux-hwe-5.13-headers-5.13.0-37 linux-image-5.13.0-37-generic
  linux-modules-5.13.0-37-generic linux-modules-extra-5.13.0-37-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 22 not upgraded.
slowgamer@adnan-System-Product-Name:~$ sudo apt-get update
Hit:1 https://download.docker.com/linux/ubuntu focal InRelease
Hit:2 http://in.archive.ubuntu.com/ubuntu focal InRelease
Hit:3 http://in.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:4 http://in.archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:5 https://dl.google.com/linux/chrome/deb stable InRelease
Hit:6 http://ppa.launchpad.net/swi-prolog/stable/ubuntu focal InRelease
Get:7 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Fetched 114 kB in 1s (144 kB/s)
Reading package lists... Done
slowgamer@adnan-System-Product-Name:~$ sudo 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.
    (and4)
 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/
slowgamer@adnan-System-Product-Name:~$

```

Installing Docker GUI:

```

slowgamer@adnan-System-Product-Name:~$ curl https://desktop-stage.docker.com/linux/main/amd64/77103/docker-desktop.deb --output docker-desktop.deb
% Total % Received % Xferd Average Speed Time Time Time Current
Dload Upload Total Spent Left Speed
100 369M 100 369M 0 2239k 0 0:02:48 0:02:48 --:--:-- 2364k
slowgamer@adnan-System-Product-Name:~$ sudo apt install ./docker-desktop.deb
Reading package lists... Done
Building dependency tree
Reading state information... Done
Note, selecting 'docker-desktop' instead of './docker-desktop.deb'
The following packages were automatically installed and are no longer required:
libfwpupdpkg linux-headers-5.13.0-37-generic linux-hwe-5.13.0-37 linux-image-5.13.0-37-generic linux-modules-5.13.0-37-generic linux-modules-extra-5.13.0-37-generic
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
libverbs-providers ipxe-qemu ipxe-qemu-256k-compat-efi-roms libaio libcacard0 libfdt1 libibverbs1 libiscsi7 libpnm1 libqrencode4 librados2 librbdi librdnacm1 libslirp0 libspice-server1 libusbredirparser1
libvirglrenderer1 ovmf pass qemu-block-extra qemu-system-common qemu-system-data qemu-system-gut qemu-system-x86 qemu-utils qrencode seabios sharutils tree xcllp
Suggested packages:
gstreamer1.0-plugins-ugly python libxml-stempler-perl ruby samba vde2 debootstrap sharutils-doc bsd-mailx | mailx
The following NEW packages will be installed:
docker-desktop libverbs-providers ipxe-qemu ipxe-qemu-256k-compat-efi-roms libaio libcacard0 libfdt1 libibverbs1 libiscsi7 libpnm1 libqrencode4 librados2 librbdi librdnacm1 libslirp0 libspice-server1
libusbredirparser1 libvirglrenderer1 ovmf pass qemu-block-extra qemu-system-common qemu-system-data qemu-system-gut qemu-system-x86 qemu-utils qrencode seabios sharutils tree xcllp
0 upgraded, 31 newly installed, 0 to remove and 22 not upgraded.
Need to get 19.8 MB/487 MB of archives.
After this operation, 82.8 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libaio amd64 0.3.112-5 [7,184 B]
Get:2 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libcacard0 amd64 1.2.6-1-1 [32.4 kB]
Get:3 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libfdt1 amd64 1.5.1-1 [18.8 kB]
Get:4 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libibverbs1 amd64 28.0-1ubuntu1 [53.6 kB]
Get:5 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libpnm1 amd64 1.8-1ubuntu1 [63.8 kB]
Get:6 http://in.archive.ubuntu.com/ubuntu focal/main amd64 librdnacm1 amd64 28.0-1ubuntu1 [64.9 kB]
Get:7 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 libslirp0 amd64 4.1.0-2ubuntu2.2 [54.4 kB]
Get:8 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 libspice-server1 amd64 0.14.2-4ubuntu3.1 [343 kB]
Get:9 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libusbredirparser1 amd64 0.8.0-1 [14.1 kB]
Get:10 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 libvirglrenderer1 amd64 0.8.2-1ubuntu1.1 [163 kB]
Get:11 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libiscsi7 amd64 1.18.0-2 [63.9 kB]
Get:12 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 librados2 amd64 15.2.14-0ubuntu0.20.04.2 [3,212 kB]
Get:13 /home/slowgamer/docker-desktop.deb docker-desktop amd64 4.8.0-77103 [387 MB]
Get:14 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 librbdi amd64 15.2.14-0ubuntu0.20.04.2 [1,623 kB]
Get:15 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 qemu-block-extra amd64 1:4.2-3ubuntu6.21 [54.8 kB]
Get:16 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 qemu-system-common amd64 1:4.2-3ubuntu6.21 [1,056 kB]
Get:17 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 qemu-system-data all 1:4.2-3ubuntu6.21 [563 kB]
Get:18 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 ipxe-qemu-256k-compat-efi-roms all 1.0.0+git-20150424.a25a16d-0ubuntu4 [552 kB]
Get:19 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 seabios all 1.13.0-1ubuntu1.1 [138 kB]
Get:20 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 ipxe-qemu all 1.0.0+git-20190109.133f4c4-0ubuntu3.2 [930 kB]
Get:21 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 qemu-system-x86 amd64 1:4.2-3ubuntu6.21 [6,726 kB]
Get:22 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 tree amd64 1.8.0-1 [43.0 kB]
Get:23 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 pass all 1.7.3-2 [37.6 kB]
Get:24 http://in.archive.ubuntu.com/ubuntu focal/main amd64 libverbs-providers amd64 28.0-1ubuntu1 [232 kB]
Get:25 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 libqrencode4 amd64 4.0.2-2 [23.6 kB]
Get:26 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 qemu-system-gut amd64 1:4.2-3ubuntu6.21 [40.7 kB]
Get:27 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 qemu-utils amd64 1:4.2-3ubuntu6.21 [976 kB]
Get:28 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 qrencode amd64 4.0.2-2 [24.0 kB]
Get:29 http://in.archive.ubuntu.com/ubuntu focal/main amd64 sharutils amd64 1:4.15.2-4build1 [155 kB]
Get:30 http://in.archive.ubuntu.com/ubuntu focal/universe amd64 xcllp amd64 0:13-1 [18.4 kB]
Get:31 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 ovmf all 0-20191122.bd85bf54-2ubuntu3.3 [2,490 kB]
Fetched 19.8 MB in 18s (7.03k B/s)

```

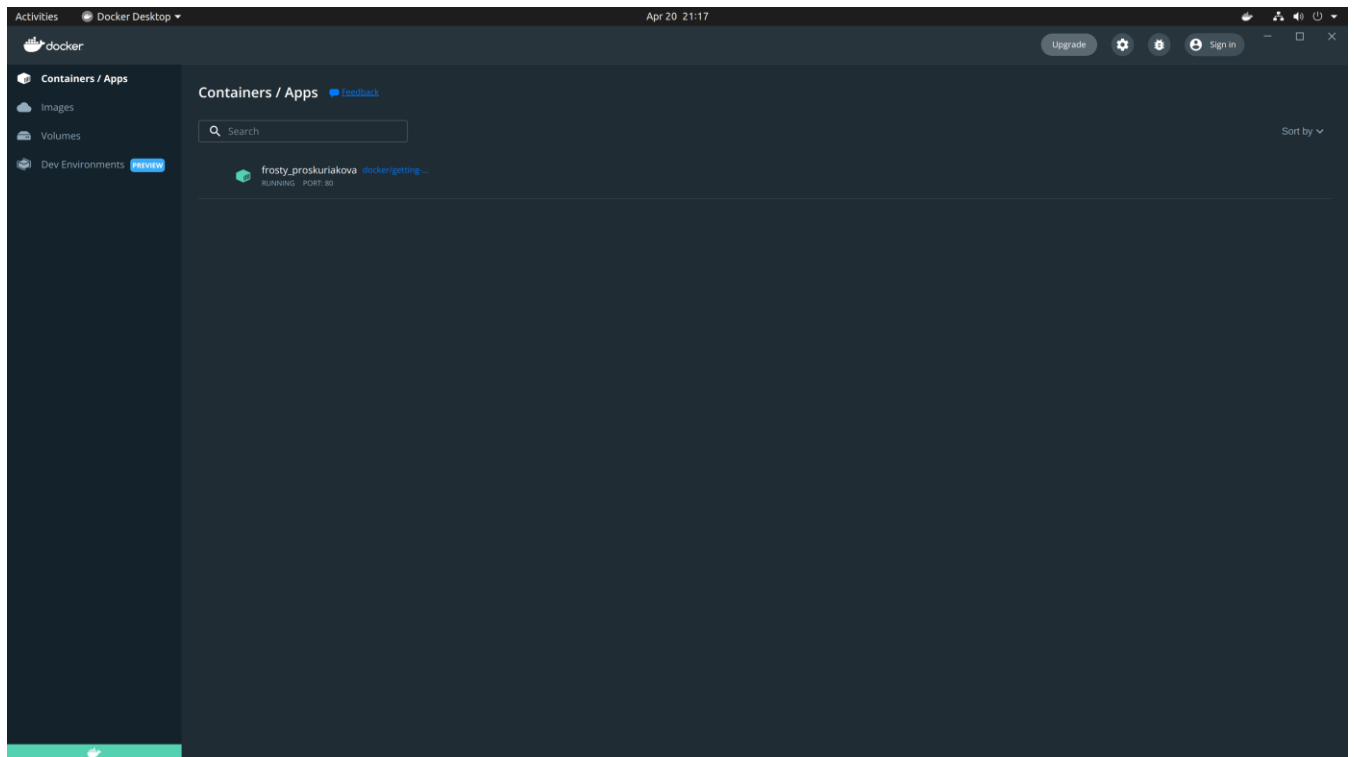
Running first container:

```

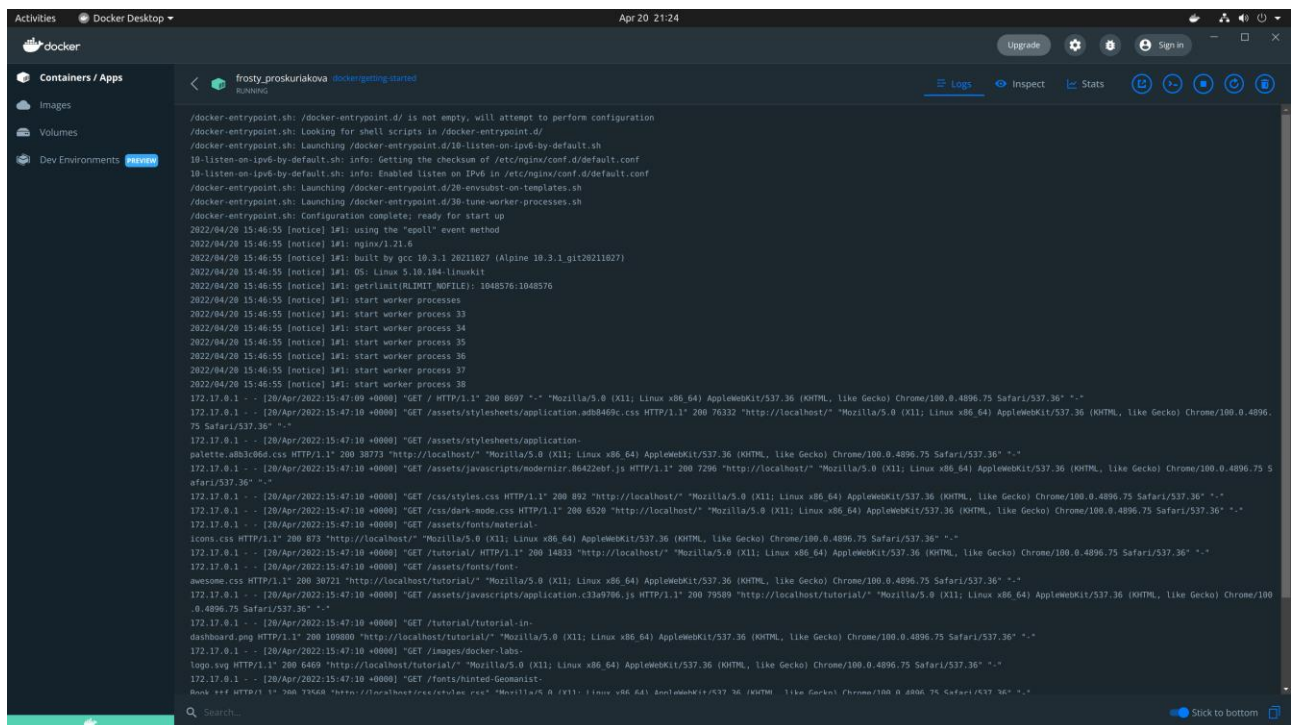
slowgamer@adnan-System-Product-Name:~$ docker run -dp 80:80 docker/getting-started
docker: Got permission denied while trying to connect to the Docker daemon socket at unix:
connect: permission denied.
See 'docker run --help'.
slowgamer@adnan-System-Product-Name:~$ sudo docker run -dp 80:80 docker/getting-started
Unable to find image 'docker/getting-started:latest' locally
latest: Pulling from docker/getting-started
df9b9388f04a: Pull complete
5867cba5fcb4: Pull complete
4b639e65cb3b: Pull complete
061ed9e2b976: Pull complete
bc19f3e8eeb1: Pull complete
4071be97c256: Pull complete
79b586f1a54b: Pull complete
0c9732f525d6: Pull complete
Digest: sha256:b558be874169471bd4e65bd6eac8c303b271a7ee8553ba47481b73b2bf597aee
Status: Downloaded newer image for docker/getting-started:latest
856d3916e2d67f360a7aa4b4c242940512c54e0eefa13b021e16d396f503ae4
slowgamer@adnan-System-Product-Name:~$

```

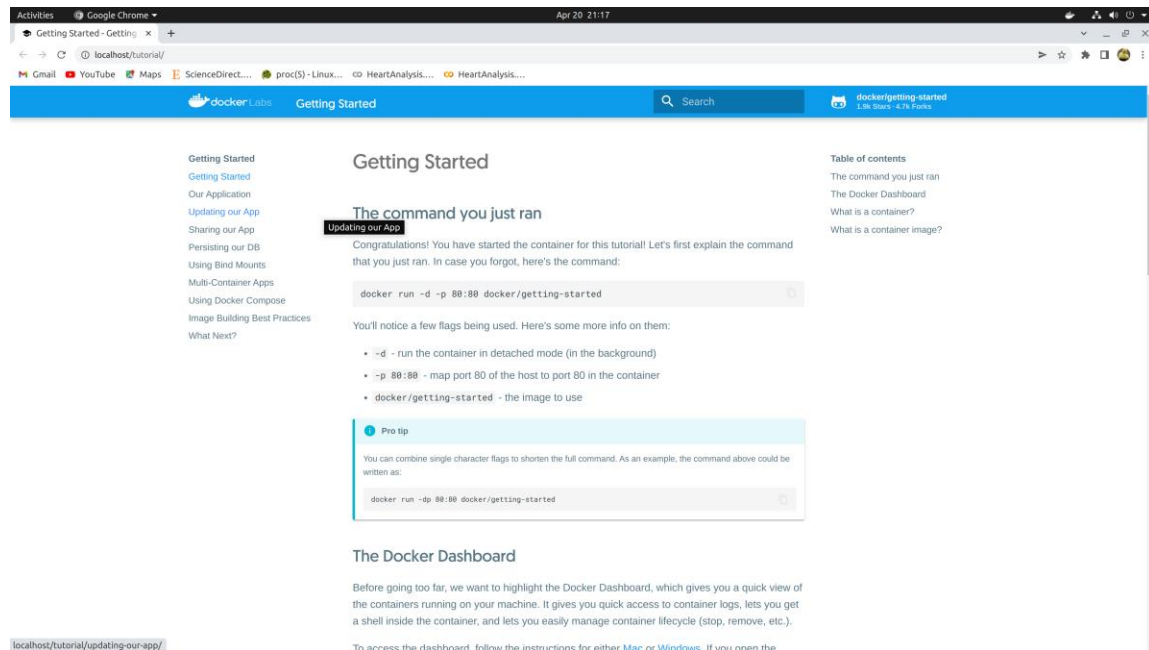
Container in Docker GUI:



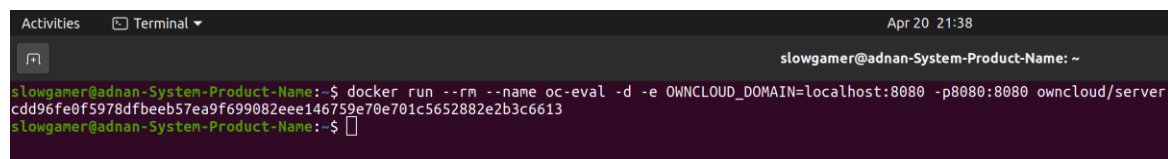
Container log:



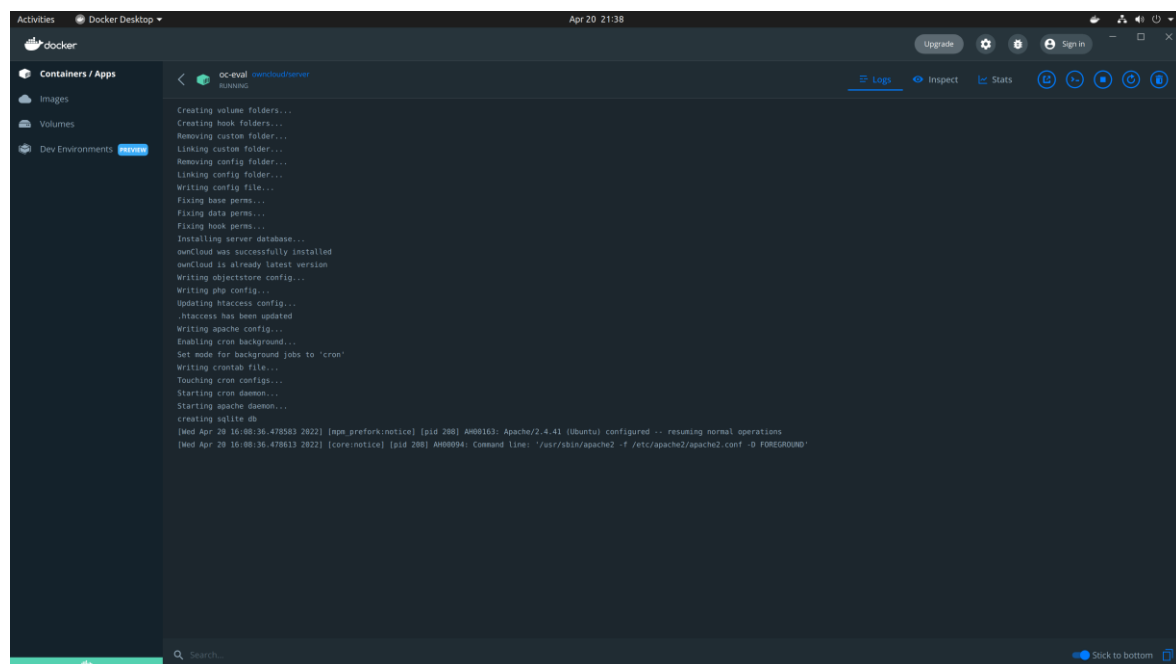
Container app running on port 80:



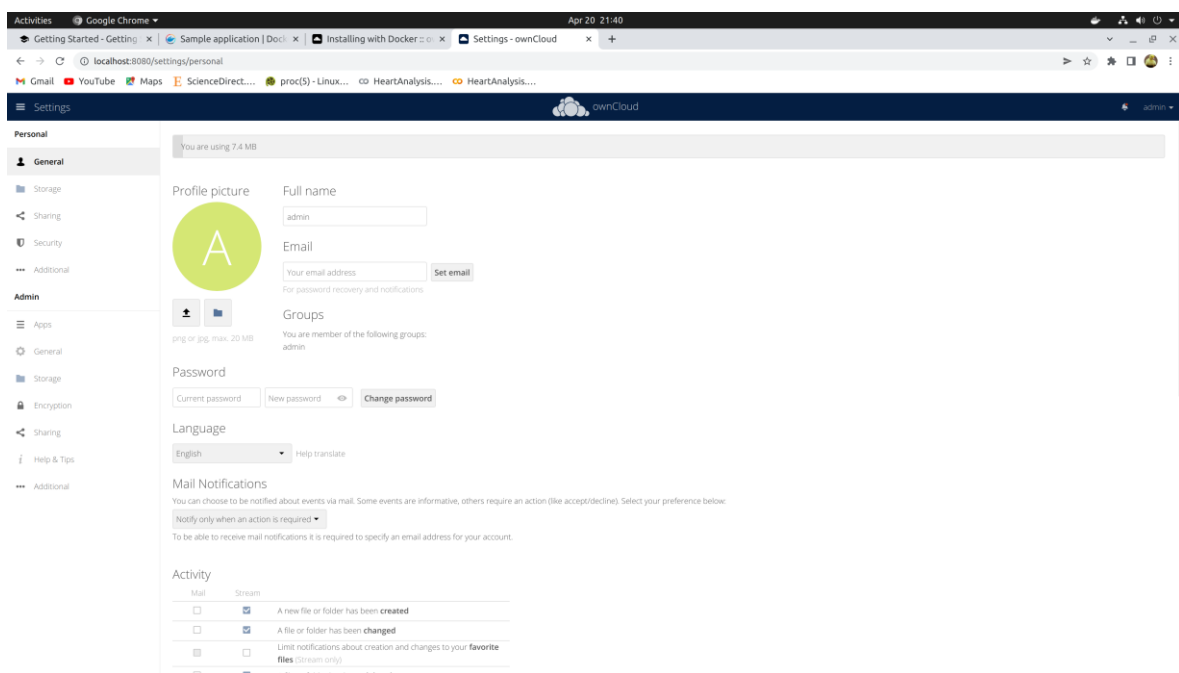
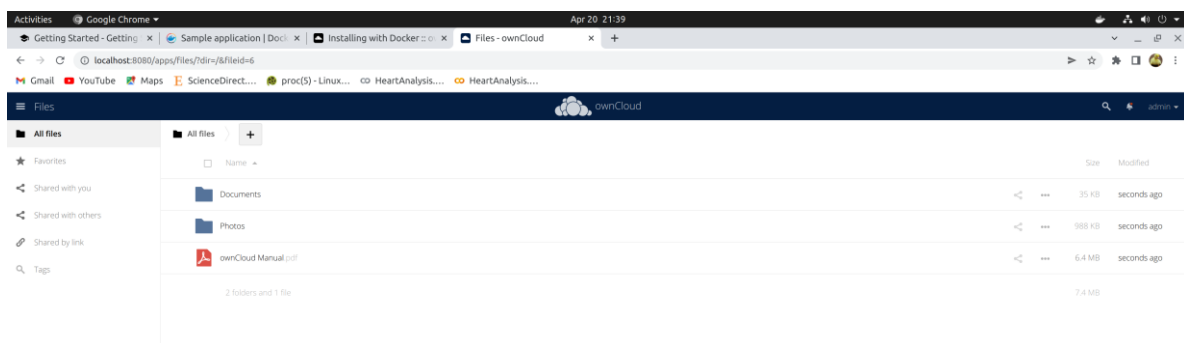
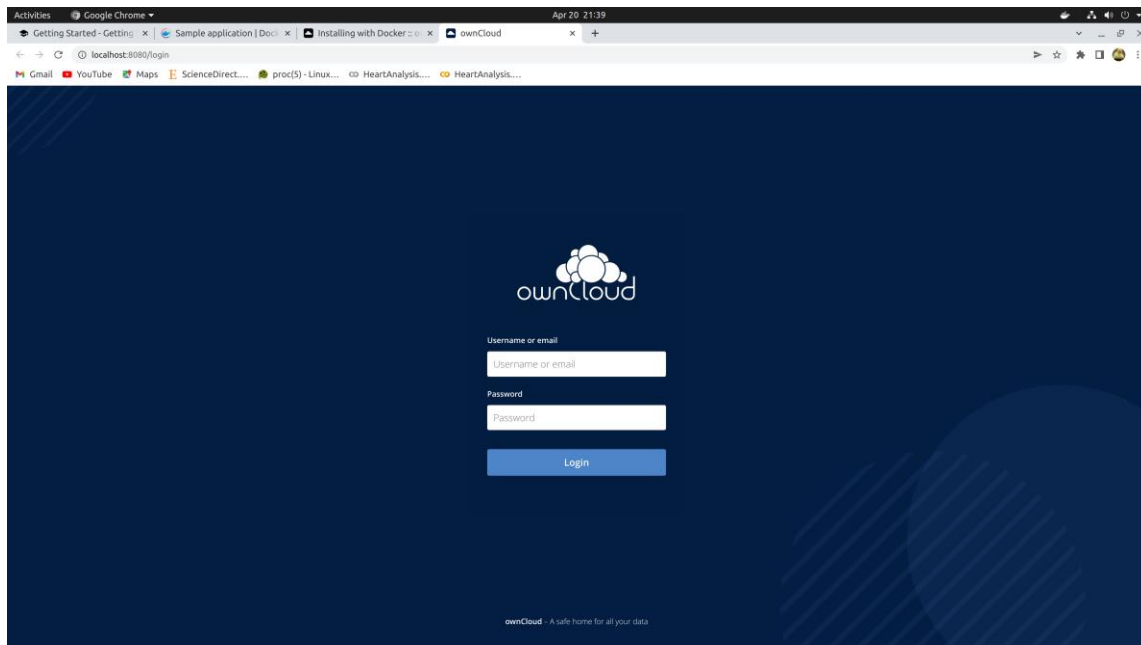
Installing and running container:

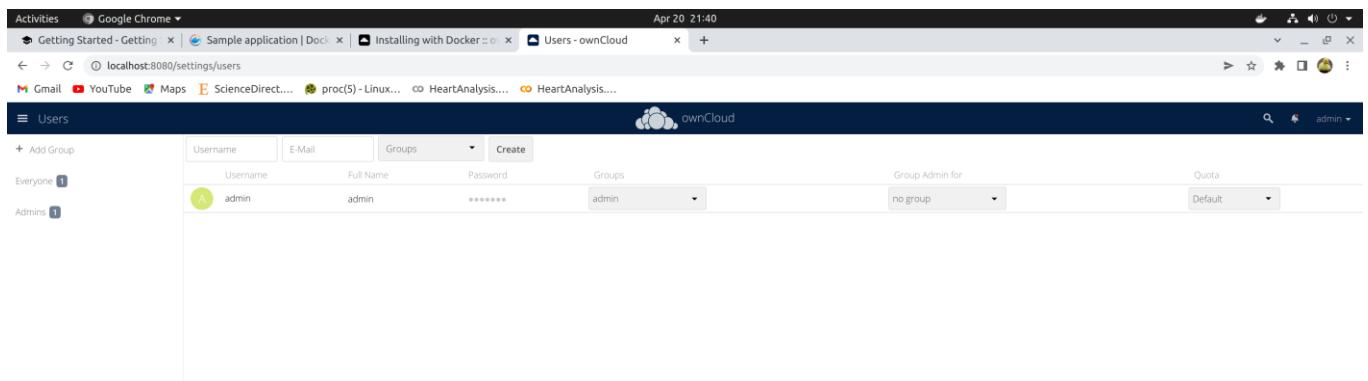


Container log in GUI:



Container app running on port 8080:





Some Docker commands to list container and to list and remove Images:

```

slowgamer@adnan-System-Product-Name:~$ docker ps -a
CONTAINER ID   IMAGE          COMMAND                  CREATED        STATUS        PORTS                    NAMES
cdd96fe8f597   owncloud/server   "/usr/bin/entrypoint..."  2 minutes ago   Up 2 minutes   0.0.0.0:8080->8080/tcp    oc-eval
ad42649cc1a1   docker/getting-started   "/docker-entrypoint..."  40 minutes ago   Exited (255) 4 minutes ago   0.0.0.0:80->80/tcp        frosty_proskuriakova

slowgamer@adnan-System-Product-Name:~$ docker images
REPOSITORY    TAG       IMAGE ID       CREATED        SIZE
owncloud/server   latest   800aa7ec9048   8 hours ago    1.17GB
docker/getting-started   latest   cb90f98fd791   9 days ago     28.8MB

slowgamer@adnan-System-Product-Name:~$ docker rmi cb90f98fd791
Command 'dock' not found, did you mean:
  command 'dbck' from deb lyskom-server (2.1.2-16)
  command 'doc8' from deb python3-doc8 (0.8.0-4)
  command 'duck' from deb duck (0.13)
Try: sudo apt install <deb name>

slowgamer@adnan-System-Product-Name:~$ docker rmi cb90f98fd791
Error response from daemon: conflict: unable to delete cb90f98fd791 (must be forced) - image is being used by stopped container ad42649cc1a1
slowgamer@adnan-System-Product-Name:~$ docker rmi -f cb90f98fd791
Untagged: docker/getting-started:latest
Deleted: sha256:cb90f98fd791dd49f09903cef3eb2245646bd476b093825ea78e0f7bb8fb3403
slowgamer@adnan-System-Product-Name:~$ docker ps -a
CONTAINER ID   IMAGE          COMMAND                  CREATED        STATUS        PORTS                    NAMES
cdd96fe8f597   owncloud/server   "/usr/bin/entrypoint..."  4 minutes ago   Up 4 minutes   0.0.0.0:8080->8080/tcp    oc-eval
ad42649cc1a1   cb90f98fd791     "/docker-entrypoint..."  43 minutes ago   Exited (255) 6 minutes ago   0.0.0.0:80->80/tcp        frosty_proskuriakova

WARNING! This will remove all images without at least one container associated to them.
Are you sure you want to continue? [y/N] y
Total reclaimed space: 8B

slowgamer@adnan-System-Product-Name:~$ docker ps -a
CONTAINER ID   IMAGE          COMMAND                  CREATED        STATUS        PORTS                    NAMES
cdd96fe8f597   owncloud/server   "/usr/bin/entrypoint..."  5 minutes ago   Up 5 minutes   0.0.0.0:8080->8080/tcp    oc-eval
ad42649cc1a1   cb90f98fd791     "/docker-entrypoint..."  43 minutes ago   Exited (255) 7 minutes ago   0.0.0.0:80->80/tcp        frosty_proskuriakova

slowgamer@adnan-System-Product-Name:~$ docker image prune
REPOSITORY    TAG       IMAGE ID       CREATED        SIZE
owncloud/server   latest   800aa7ec9048   8 hours ago    1.17GB
slowgamer@adnan-System-Product-Name:~$

```

Conclusion: We have successfully implemented Containerization using Docker.