PRACTICAL 5

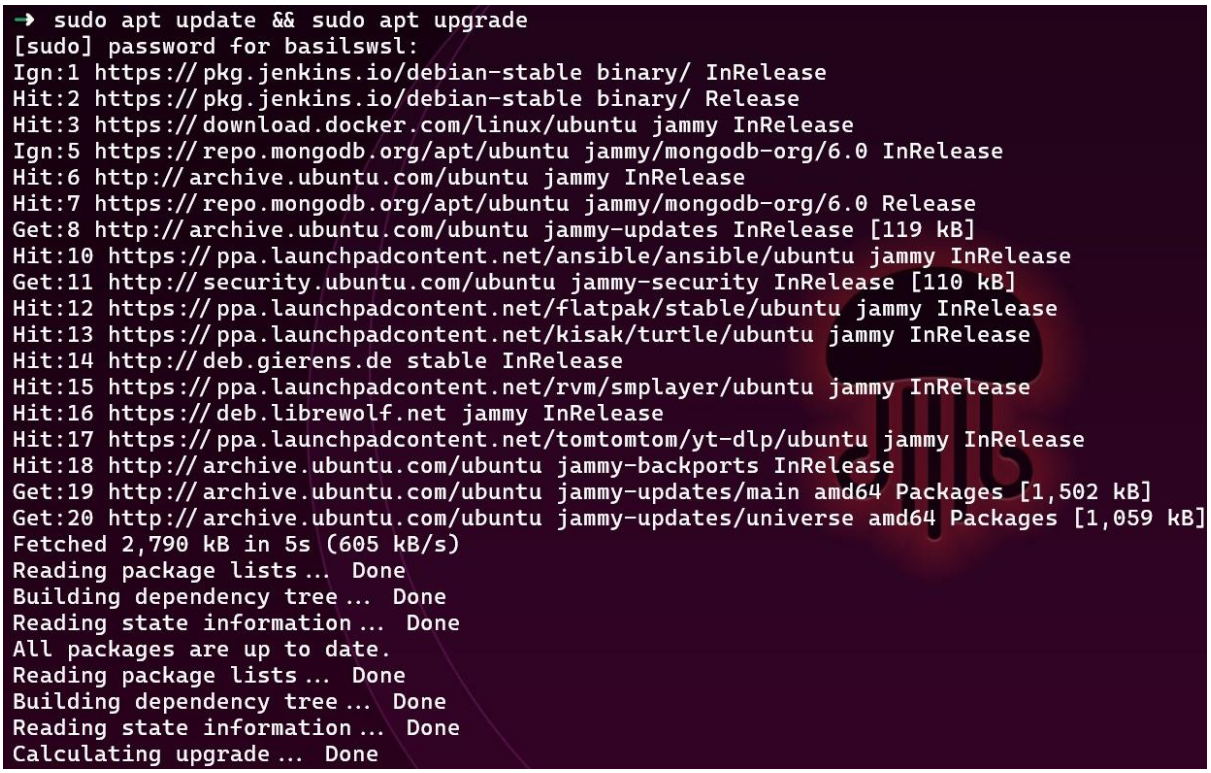
TITLE : Containerization using Docker.

TOOLS REQUIRED : Ubuntu Linux, Git, VSCode (or any other text editor) and Docker.

Docker is an open platform for developing, shipping and running applications, enabling us to separate applications from an infrastructure that can deliver software quickly. This helps to reduce delay between writing the code and running it in production.

I. STEPS TO INSTALL DOCKER :

1. Ensure that all software repositories are updated and upgraded.



2. Make sure that there is no prior installation of Docker. Command to uninstall existing docker installation – sudo apt purge docker.io

3. Install Docker and its packages in Ubuntu.

```
➜ sudo apt 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
containerd.io is already the newest version (1.6.28-2).
docker-buildx-plugin is already the newest version (0.13.1-1~ubuntu.22.04~jammy).
docker-ce-cli is already the newest version (5:26.0.0-1~ubuntu.22.04~jammy).
docker-ce is already the newest version (5:26.0.0-1~ubuntu.22.04~jammy).
docker-compose-plugin is already the newest version (2.25.0-1~ubuntu.22.04~jammy).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

4. After installation, start docker service. In order to start docker from boot, enable Docker service.

```
➜ sudo systemctl enable docker
Synchronizing state of docker.service with SysV service script with /lib/systemd/systemd-sysv-install.
Executing: /lib/systemd/systemd-sysv-install enable docker
```

5. Check version details to verify the Docker version number.

```
➜ docker version
Client: Docker Engine - Community
 Version:           26.0.0
 API version:       1.45
 Go version:        go1.21.8
 Git commit:        2ae903e
 Built:             Wed Mar 20 15:17:48 2024
 OS/Arch:           linux/amd64
 Context:           default

Server: Docker Engine - Community
 Engine:
  Version:          26.0.0
  API version:      1.45 (minimum version 1.24)
  Go version:       go1.21.8
  Git commit:       8b79278
  Built:            Wed Mar 20 15:17:48 2024
  OS/Arch:          linux/amd64
  Experimental:     false
 containerd:
  Version:          1.6.28
  GitCommit:        ae07eda36dd25f8a1b98dfbf587313b99c0190bb
 runc:
  Version:          1.1.12
  GitCommit:        v1.1.12-0-g51d5e94
 docker-init:
  Version:          0.19.0
  GitCommit:        de40ad0
```

II. BASIC COMMANDS OF DOCKER

- Command to pull and download image from Docker Hub –

```
➜ docker pull fedora:40
40: Pulling from library/fedora
e467d19c2ec3: Pull complete
Digest: sha256:bd0b8ed03d00b53d8cefab42c6a9ffac4b90a72f8934355a009ac5fb1258040b
Status: Downloaded newer image for fedora:40
docker.io/library/fedora:40
```

- Command used to list images downloaded –

```
➜ docker images
REPOSITORY                TAG                  IMAGE ID       CREATED          SIZE
alpine                    edge                 7f9cc4fcfea4   7 days ago       7.39MB
ubuntu                    latest               ca2b0f26964c   3 weeks ago      77.9MB
fedora                    40                   6e6c42dab266   4 weeks ago      175MB
bael2k3/myfirstrepo       python-test          d0f72f3abfaa   5 weeks ago      125MB
python                    3.13.0a4-slim-bookworm 2c536ef849ef   5 weeks ago      125MB
alpine                    <none>               9198849dd7f6   3 months ago     7.38MB
gcc                       latest               30a3603487b7   4 months ago     1.38GB
bael2k3/myfirstrepo       latest               d2c94e258dcb   10 months ago    13.3kB
hello-world               latest               d2c94e258dcb   10 months ago    13.3kB
sergiolepore/christbashtree latest             fbf66f206bf5   6 years ago      9.67MB
```

- Command to remove docker image –

```
➜ docker rmi 6e6c42dab266
Untagged: fedora:40
Untagged: fedora@sha256:bd0b8ed03d00b53d8cefab42c6a9ffac4b90a72f8934355a009ac5fb1258040b
Deleted: sha256:6e6c42dab266231e045d787e39b7cf6651aa10ec9de4a052deb066f5e660ada9
Deleted: sha256:bc4e6b0ee8fa0dc59c486a31b5807f366eb592fdc4d7c87f29796840db4ca962
```

```
➜ docker images
REPOSITORY                TAG                  IMAGE ID       CREATED          SIZE
alpine                    edge                 7f9cc4fcfea4   7 days ago       7.39MB
ubuntu                    latest               ca2b0f26964c   3 weeks ago      77.9MB
bael2k3/myfirstrepo       python-test          d0f72f3abfaa   5 weeks ago      125MB
python                    3.13.0a4-slim-bookworm 2c536ef849ef   5 weeks ago      125MB
alpine                    <none>               9198849dd7f6   3 months ago     7.38MB
gcc                       latest               30a3603487b7   4 months ago     1.38GB
bael2k3/myfirstrepo       latest               d2c94e258dcb   10 months ago    13.3kB
hello-world               latest               d2c94e258dcb   10 months ago    13.3kB
sergiolepore/christbashtree latest             fbf66f206bf5   6 years ago      9.67MB
```

- Commands to run any container –

```
➜ docker run rockylinux:9.3
Unable to find image 'rockylinux:9.3' locally
9.3: Pulling from library/rockylinux
489e1be6ce56: Pull complete
Digest: sha256:c944604c0c759f5d164ffbdf0bbab2fac582b739938937403c067ab634a0518a
Status: Downloaded newer image for rockylinux:9.3
```

```
➜ docker run -it -d rockylinux:9.3
ead183903cba773386effd78a3134e23a6c8afbd39784eb49cd0883f6e5f652c
```

```
➜ docker run -it rockylinux:9.3
[root@f6ab71ab695a /]#
```

- Commands to view running/stopped containers –

```
➜ docker ps
CONTAINER ID   IMAGE           COMMAND       CREATED          STATUS          PORTS     NAMES
ead183903cba   rockylinux:9.3  "/bin/bash"   41 seconds ago   Up 40 seconds             vigilant_beaver
```

```
➜ docker ps -a
CONTAINER ID   IMAGE           COMMAND                  CREATED          STATUS                      PORTS     NAMES
f6ab71ab695a   rockylinux:9.3  "/bin/bash"              35 seconds ago   Exited (0) 5 seconds ago              tender_gould
ead183903cba   rockylinux:9.3  "/bin/bash"              43 seconds ago   Up 43 seconds                         vigilant_beaver
8513f37244c1   rockylinux:9.3  "/bin/bash"              2 minutes ago    Exited (0) 2 minutes ago              nifty_allen
8a8a122c490a   9198849dd7f6    "/usr/bin/entrypoint…"   2 months ago     Exited (255) 9 hours ago              alpine
```

- Command to start container –

```
✗ docker start f6ab71ab695a
f6ab71ab695a
```

- Command to execute running container with command or shell –

```
➜ docker exec -it f6ab71ab695a cat /etc/rocky-release
Rocky Linux release 9.3 (Blue Onyx)
```

- Command to stop container –

```
➜ docker stop ead183903cba
ead183903cba
```

- Command to remove container –

```
➜ docker rm 8513f37244c1
8513f37244c1
➜ docker ps -a
CONTAINER ID   IMAGE            COMMAND                  CREATED         STATUS                          PORTS     NAMES
f6ab71ab695a   rockylinux:9.3   "/bin/bash"              3 minutes ago   Exited (0) 3 minutes ago                  tender_gould
ead183903cba   rockylinux:9.3   "/bin/bash"              3 minutes ago   Exited (137) About a minute ago           vigilant_beaver
8a8a122c490a   9198849dd7f6     "/usr/bin/entrypoint…"   2 months ago    Exited (255) 9 hours ago                  alpine
```

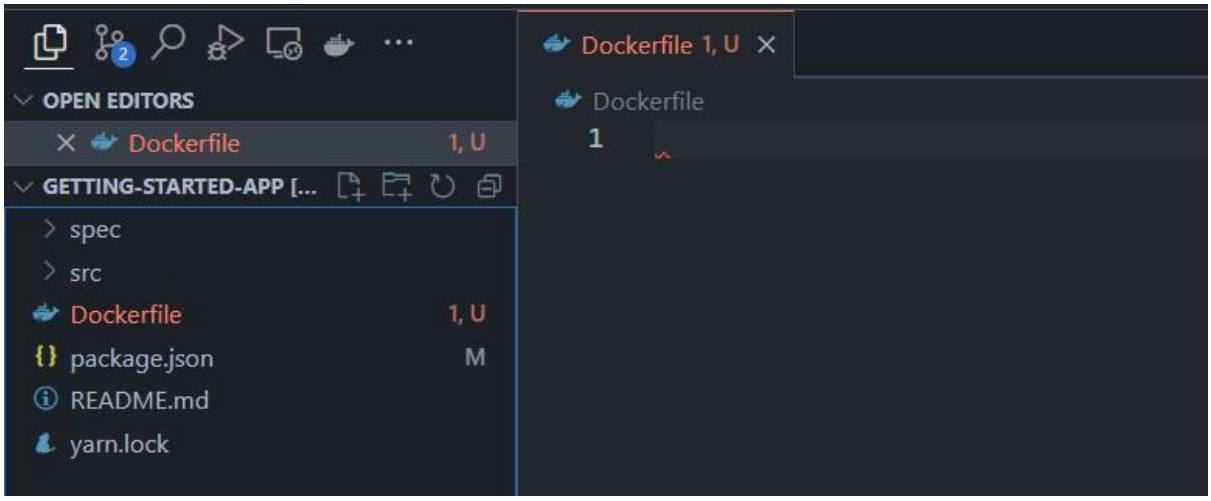
III. CASE STUDY

1. Clone the Git repository ‘getting-started’.

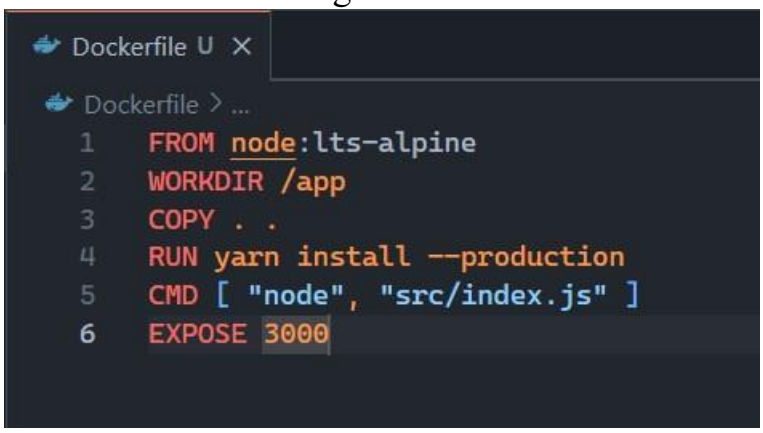
```
➜ git clone https://github.com/docker/getting-started-app.git
Cloning into 'getting-started-app' ...
remote: Enumerating objects: 68, done.
remote: Counting objects: 100% (37/37), done.
remote: Compressing objects: 100% (27/27), done.
remote: Total 68 (delta 12), reused 10 (delta 10), pack-reused 31
Receiving objects: 100% (68/68), 1.75 MiB | 3.87 MiB/s, done.
Resolving deltas: 100% (12/12), done.
➜ cd getting-started-app/
```

2. Open VSCode from the termainal and create an empty file named ‘Dockerfile’.

```
➜ code .
```



3. Enter following contents in ‘Dockerfile’.

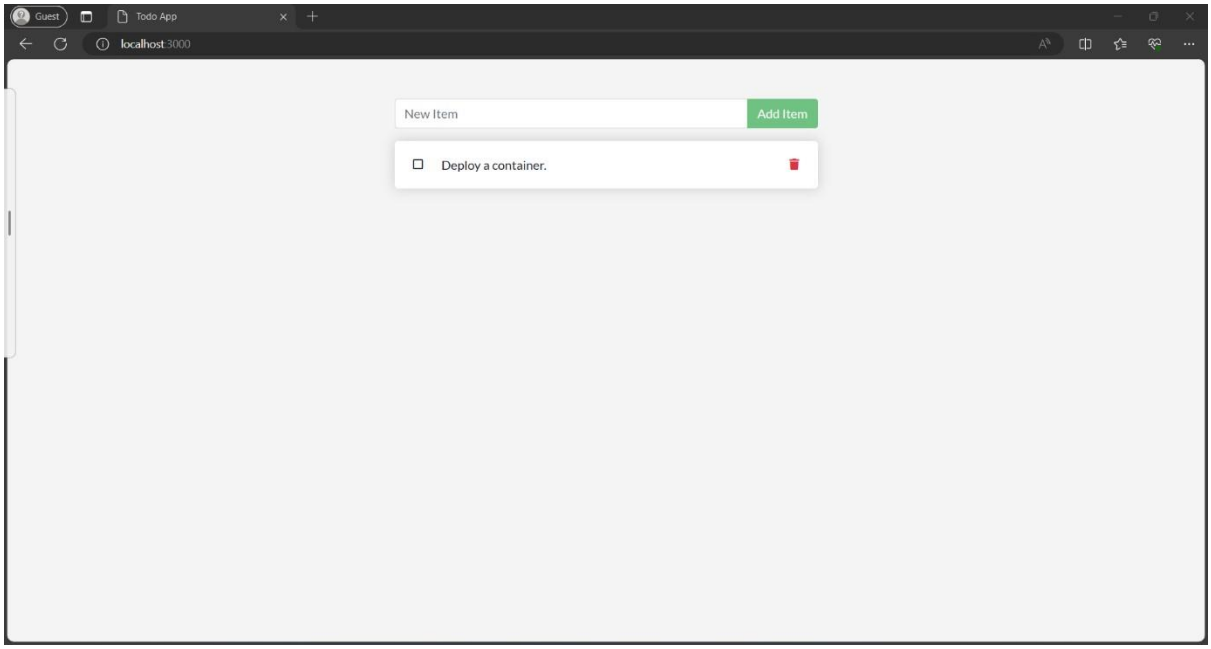


4. Build the image.

Semester: II Class: FYMCA
Course Code:MC520 Course Name: DevOps

5. Run the container.

6. Open localhost:3000 in web browser.



7. Make changes on line 56 at ‘src/static/js/app.js’.

```
56                <p className="text-center">To do list is empty! Please add one above.</p>
```

8. Build the updated version of the image.

```
➜ docker build -t getting-started .
[+] Building 54.2s (10/10) FINISHED                                                                    docker:default
 => [internal] load build definition from Dockerfile                                                          0.0s
 => => transferring dockerfile: 152B                                                                          0.0s
 => [internal] load metadata for docker.io/library/node:lts-alpine                                           38.2s
 => [auth] library/node:pull token for registry-1.docker.io                                                   0.0s
 => [internal] load .dockerignore                                                                             0.0s
 => => transferring context: 2B                                                                               0.0s
 => [1/4] FROM docker.io/library/node:lts-alpine@sha256:bf77dc26e48ea95fca9d1aceb5acfa69d2e546b765ec2abfb502975f1a2d4def   0.0s
```


9. When attempted to run the updated container, we get the following error.

```
➜ docker run -dp 127.0.0.1:3000:3000 getting-started
ba2027360ca0c8229adae790dfde7b5581f312b7df8a36d3e38b8f51d375cc4a
docker: Error response from daemon: driver failed programming external connectivity on endpoint distracted_jones (31ff0e3d4db177db02ec
be83822063dd4f3f98ac7985453d68bbf6e0ebb9cc0d): Bind for 127.0.0.1:3000 failed: port is already allocated.
```

10. To resolve above error, stop and remove the old container.

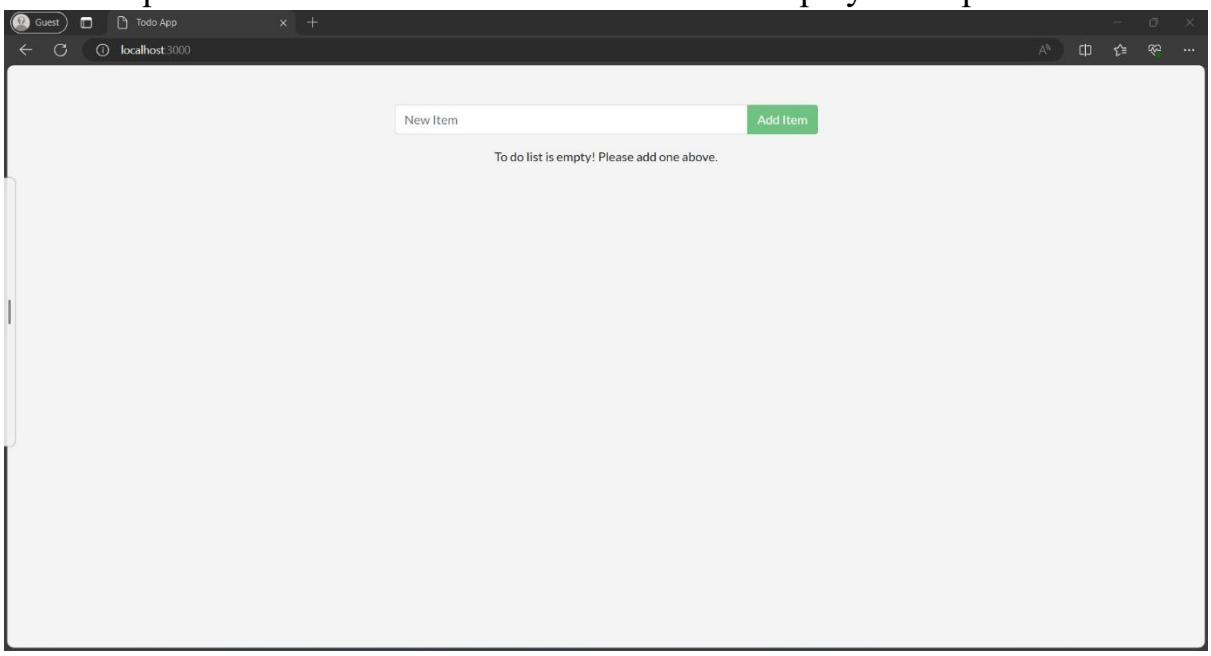
```
➜ docker stop 06311e21cd7e
06311e21cd7e
```

```
➜ docker rm 06311e21cd7e
06311e21cd7e
```

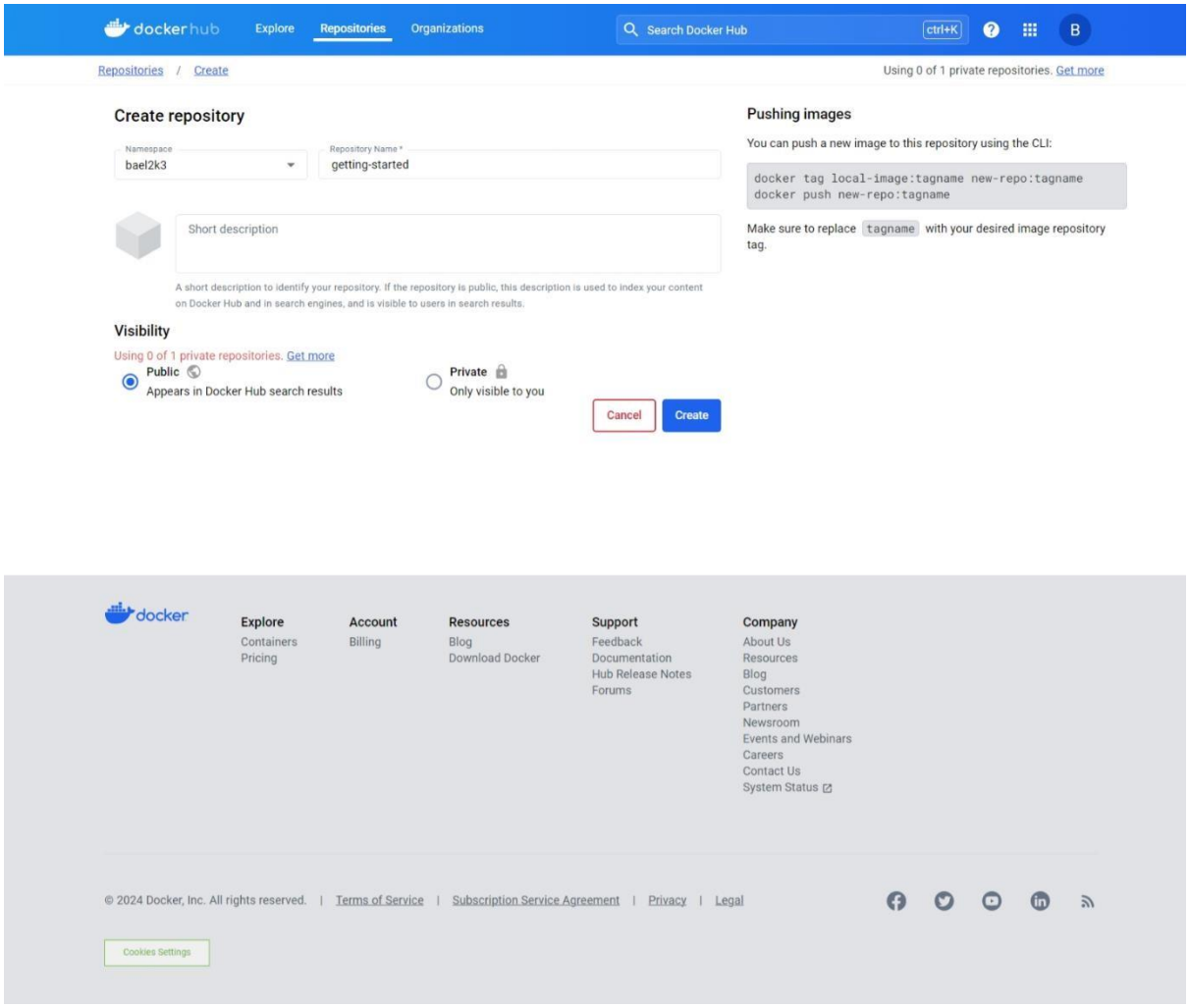
11. Start the updated container.

```
➜ docker run -dp 127.0.0.1:3000:3000 getting-started
7c7f23df5fb3abfcfff1a2eecde5f156a7620e4f4dac2926fae89df2c167ef0d
```

12. Open localhost:3000 in web browser. This displays the updated text.



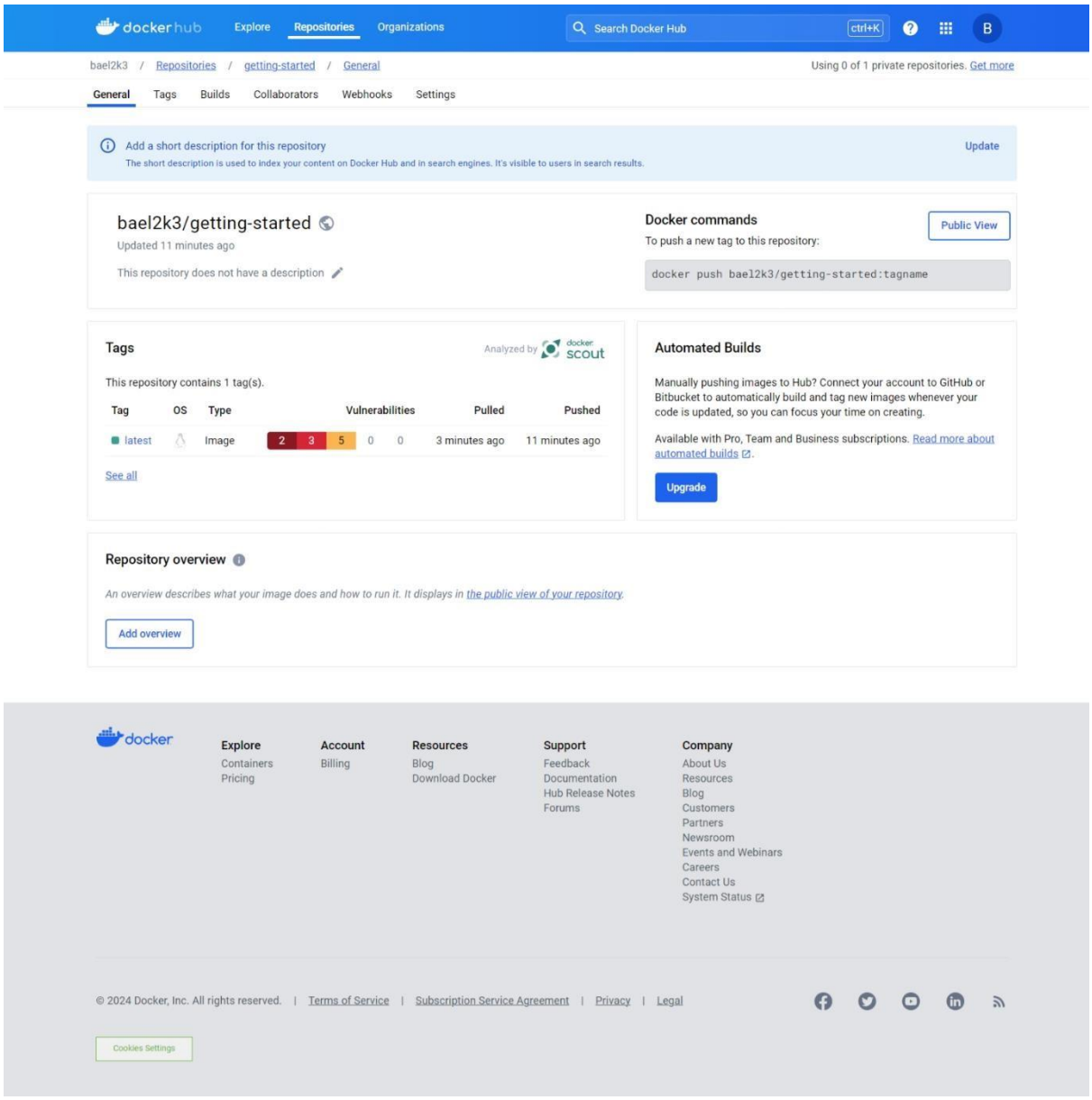
13. Create a repository in Docker Hub setting visibility as public.



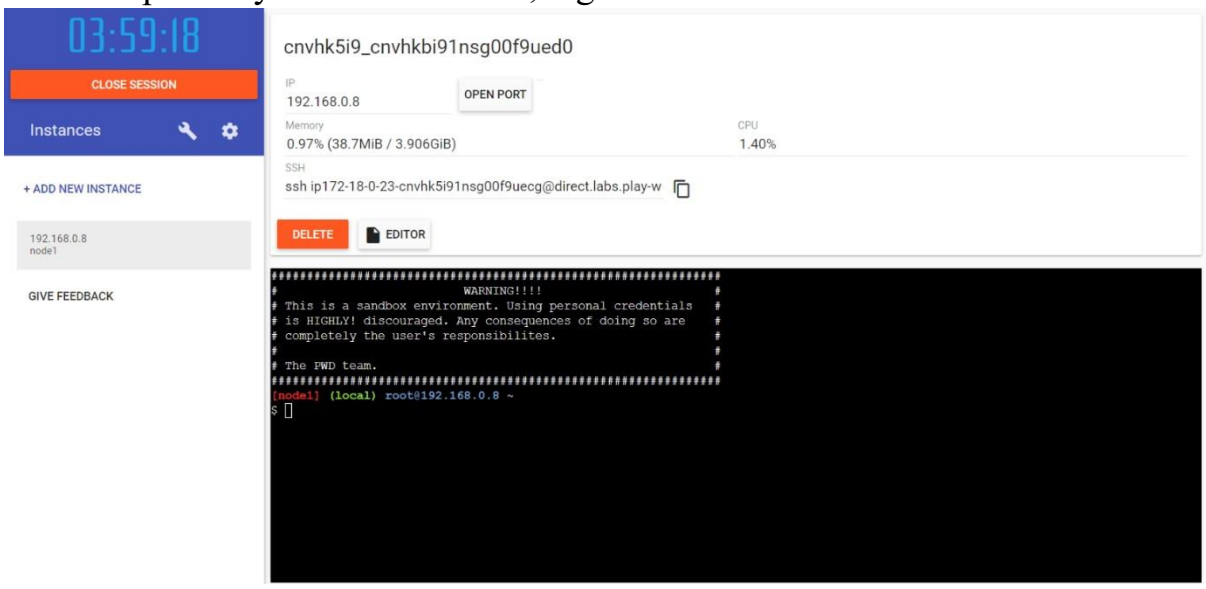
14. Login with docker hub credentials.

15. Push contents into the repository

```
→ docker push bael2k3/getting-started
Using default tag: latest
The push refers to repository [docker.io/bael2k3/getting-started]
f33f924e2d77: Pushed
bc27c0bf1dc4: Pushed
4e1aeb88a9e8: Pushed
468d581477ea: Mounted from library/node
b4770ab48df1: Mounted from library/node
f6810059c632: Mounted from library/node
d4fc045c9e3a: Mounted from library/node
latest: digest: sha256:f5e1d3da025b7b6af118d04feb57ac65c269149d3d86cc416e93cab0b208230a size: 1787
4e1aeb88a9e8: Pushed
468d581477ea: Mounted from library/node
b4770ab48df1: Mounted from library/node
f6810059c632: Mounted from library/node
d4fc045c9e3a: Mounted from library/node
latest: digest: sha256:f5e1d3da025b7b6af118d04feb57ac65c269149d3d86cc416e93cab0b208230a size: 1787
```



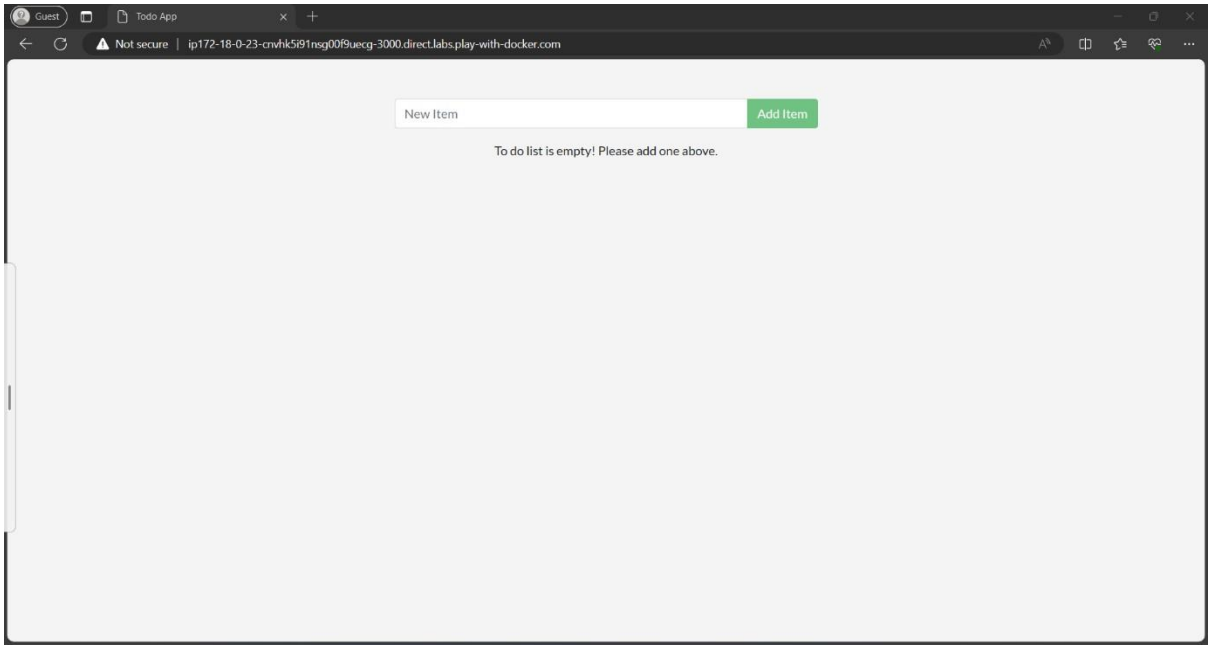
16. Open Play with Docker site, login and create new instance.



17. In the terminal, run the container.

```
[node1] (local) root@192.168.0.8 ~
$ docker run -dp 0.0.0.0:3000:3000 bael2k3/getting-started
Unable to find image 'bael2k3/getting-started:latest' locally
latest: Pulling from bael2k3/getting-started
4abcf2066143: Pull complete
9f16480e2ff5: Pull complete
092226d52cac: Pull complete
0493dfb2ff9c: Pull complete
44110a613a3f: Pull complete
d9037ae090e4: Pull complete
1ba131071ffd: Pull complete
Digest: sha256:f5e1d3da025b7b6af118d04feb57ac65c269149d3d86cc416e93cab0b208230a
Status: Downloaded newer image for bael2k3/getting-started:latest
85573fb1b143c94339bcaa3bafd9e6f8af1d4dcca561e4d97d50bc37a3bd7629
[node1] (local) root@192.168.0.8 ~
$
```

18. Click on port 3000 and open the app.



19. Create the network.

```
➜ docker network create todo-app
e70de2195eecf77a6f5a628841ec33821b0a10aacab27d5406164de445f6cfb6
```

20. Start MariaDB container and attach it to the network. Add environment variables for password and database.

```
➜ docker run -d \
    --network todo-app --network-alias mariadb \
    -v todo-mariadb-data:/var/lib/mysql \
    -e MARIADB_ROOT_PASSWORD=root \
    -e MARIADB_DATABASE=todos \
    mariadb:lts
Unable to find image 'mariadb:lts' locally
lts: Pulling from library/mariadb
bccd10f490ab: Already exists
d9d8e1823c6f: Pull complete
84f2e2edb76d: Pull complete
4df97d18a516: Pull complete
79fe85183306: Pull complete
b891b67a5cf8: Pull complete
ac1d0cb433aa: Pull complete
c29a5135f832: Pull complete
Digest: sha256:3e20b48362476fb535da8b001cfa4d007fe9db0cac915b0487112644276 27fb8
Status: Downloaded newer image for mariadb:lts
ab1ee3398d8407e8f4c73ca18238ceb4523ac5ae9ff6159a791d72e7bead53ed
```


21. To verify if created database exists, open mariadb by executing container and list databases.

```
➜ docker exec -it ab1ee3398d84 mysql -u root -p
Enter password:
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MariaDB connection id is 3
Server version: 10.11.7-MariaDB-1:10.11.7+maria~ubu2204 mariadb.org binary distribution

Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

MariaDB [(none)]> SHOW DATABASES;
+--------------------+
| Database           |
+--------------------+
| information_schema |
| mysql              |
| performance_schema |
| sys                |
| todos              |
+--------------------+
5 rows in set (0.004 sec)

MariaDB [(none)]>
```

22. After exiting container, start new container using nicolaka/netshoot image.

```
➜ docker run -it --network todo-app nicolaka/netshoot
Unable to find image 'nicolaka/netshoot:latest' locally
latest: Pulling from nicolaka/netshoot
661ff4d9561e: Pull complete
995df079f4e4: Pull complete
dd60ddc09193: Pull complete
db21b8384e68: Pull complete
0c4b97b7a9f6: Pull complete
ab55214c6c7f: Pull complete
605fbab30112: Pull complete
4f4fb700ef54: Pull complete
ccf5fa44d580: Pull complete
bd3e8b5a2d54: Pull complete
76daa6c53003: Pull complete
f32b561aa773: Pull complete
b72ad7310ef5: Pull complete
a06bebda965d: Pull complete
a1436cccfd44: Pull complete
Digest: sha256:b569665f0c32391b93f4de344f07bf6353ddff9d8c801ac3318d996db848a64c
Status: Downloaded newer image for nicolaka/netshoot:latest
                    dP            dP                               dP
                    88            88                               88
88d888b. .d8888b. d8888P .d8888b. 88d888b. .d8888b. .d8888b. d8888P
88'  `88 88ooood8   88   Y8ooooo. 88'  `88 88'  `88 88'  `88   88
88    88 88.  ...   88         88 88    88 88.  .88 88.  .88   88
dP    dP `88888P'   dP   `88888P' dP    dP `88888P' `88888P'   dP

Welcome to Netshoot! (github.com/nicolaka/netshoot)
Version: 0.12
```


23. Check ip address of hostname mariadb.

```
7816d6f1fcae ~ dig mariadb

; <<>> DiG 9.18.21 <<>> mariadb
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 6093
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 0

;; QUESTION SECTION:
;mariadb.                       IN      A

;; ANSWER SECTION:
mariadb.                600     IN      A       172.18.0.2

;; Query time: 0 msec
;; SERVER: 127.0.0.11#53(127.0.0.11) (UDP)
;; WHEN: Sat Mar 23 18:34:40 UTC 2024
;; MSG SIZE  rcvd: 48
```

24. Connect container to app network.

```
➜ docker run -dp 127.0.0.1:3000:3000 \
  -w /app -v "$(pwd):/app" \
  --network todo-app \
  -e MARIADB_HOST=mariadb \
  -e MARIADB_USER=root \
  -e MARIADB_PASSWORD=root \
  -e MARIADB_DB=todos \
  node:lts-alpine \
  sh -c "yarn install && yarn run dev"
505ece93f4e980eb489467f369b8e5978e9212573b271ce40d16c18c9363ede2
```

25. Connect to MariaDB database.

```
➜ docker exec -it ab1ee3398d84 mysql -p todos
Enter password:
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MariaDB connection id is 8
Server version: 10.11.7-MariaDB-1:10.11.7+maria~ubu2204 mariadb.org binary distribution

Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

MariaDB [todos]>
```

Name: Durgesh Mandge UCID: 2023510032

CONCLUSION

In this practical, we have learnt how to containerize applications using Docker. In Docker, we learnt to pull images, create containers by running images, starting containers, running containers, stopping containers and deleting images. We learnt how to create Dockerfiles used to build local containers and push to the Docker Hub. We can run and deploy multiple containers and establish connection between containers.