

## 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.

```
→ sudo apt update && sudo apt upgrade
[sudo] password for basilsWSL:
Ign:1 https://pkg.jenkins.io/debian-stable binary/ InRelease
Hit:2 https://pkg.jenkins.io/debian-stable binary/ Release
Hit:3 https://download.docker.com/linux/ubuntu jammy InRelease
Ign:5 https://repo.mongodb.org/apt/ubuntu jammy/mongodb-org/6.0 InRelease
Hit:6 http://archive.ubuntu.com/ubuntu jammy InRelease
Hit:7 https://repo.mongodb.org/apt/ubuntu jammy/mongodb-org/6.0 Release
Get:8 http://archive.ubuntu.com/ubuntu jammy-updates InRelease [119 kB]
Hit:10 https://ppa.launchpadcontent.net/ansible/ansible/ubuntu jammy InRelease
Get:11 http://security.ubuntu.com/ubuntu jammy-security InRelease [110 kB]
Hit:12 https://ppa.launchpadcontent.net/flatpak/stable/ubuntu jammy InRelease
Hit:13 https://ppa.launchpadcontent.net/kisak/turtle/ubuntu jammy InRelease
Hit:14 http://deb.gierens.de stable InRelease
Hit:15 https://ppa.launchpadcontent.net/rvm/smplayer/ubuntu jammy InRelease
Hit:16 https://deb.librewolf.net jammy InRelease
Hit:17 https://ppa.launchpadcontent.net/tomtomtom/yt-dlp/ubuntu jammy InRelease
Hit:18 http://archive.ubuntu.com/ubuntu jammy-backports InRelease
Get:19 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 Packages [1,502 kB]
Get:20 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 Packages [1,059 kB]
Fetched 2,790 kB in 5s (605 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
All packages are up to date.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
```

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](https://hub.docker.com/) –

```
→ docker pull fedora:40
40: Pulling from library/fedora
e467d19c2ec3: Pull complete
Digest: sha256:bd0b8ed03d00b53d8cef4b42c6a9ffac4b90a72f8934355a009ac5fb1258040b
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:c944604c0c759f5d164ffbfdbf0bbab2fac582b739938937403c067ab634a0518a
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 –

```
X 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
```

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

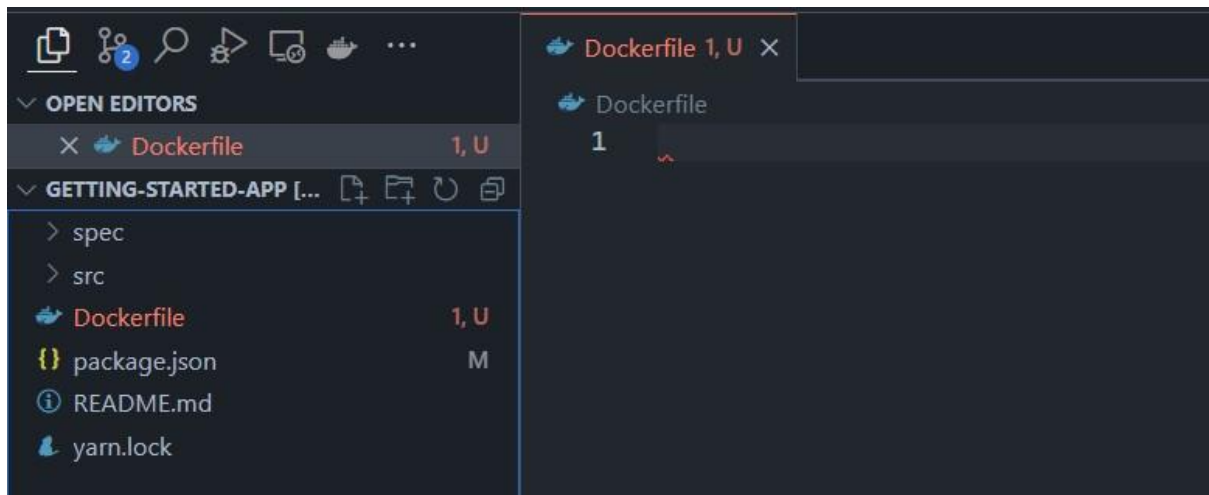
### III. CASE STUDY

1. Clone the Git repository 'getting-started'.

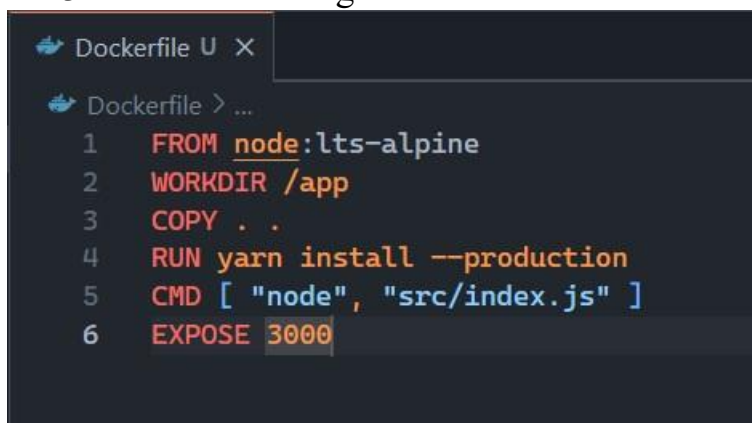
```
→ git clone https://github.com/docker/getting-started-app.git  
Cloning into 'getting-started-app' ...  
remote: Enumerating objects: 68, done.  
remote: Counting objects: 100% (37/37), done.  
remote: Compressing objects: 100% (27/27), done.  
remote: Total 68 (delta 12), reused 10 (delta 10), pack-reused 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 terminal and create an empty file named 'Dockerfile'.

```
→ code .
```



3. Enter following contents in 'Dockerfile'.



4. Build the image.

```
➔ docker build -t getting-started .
[+] Building 103.3s (10/10) FINISHED
=> [internal] load build definition from Dockerfile
=> => transferring dockerfile: 152B
=> [internal] load metadata for docker.io/library/node:lts-alpine
=> [auth] library/node:pull token for registry-1.docker.io
=> [internal] load .dockerignore
=> transferring context: 2B
=> [1/4] FROM docker.io/library/node:lts-alpine@sha256:b777dc26e48ea95fca9d1aceb5acfa69d2e546b765ec2abfb502975f1a2d4def
=> resolve docker.io/library/node:lts-alpine@sha256:b777dc26e48ea95fca9d1aceb5acfa69d2e546b765ec2abfb502975f1a2d4def
```

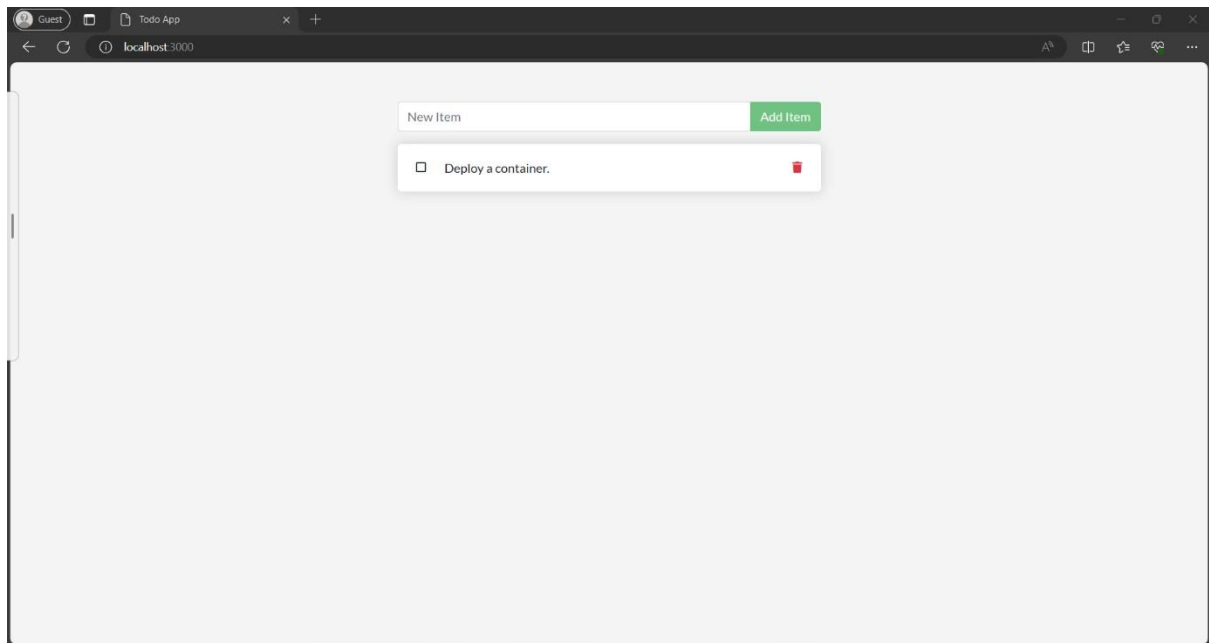
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Course Code:MC520

Class: FYMCA  
Course Name: DevOps

5. Run the container.

```
➔ docker run -dp 127.0.0.1:3000:3000 getting-started
06311e21cd7e3cccbeafec2b5e19ef9d379ee6d055266e630b5d7de1ed003da1
```

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

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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 (31ff0e3d4db177db02ecbe83822063dd4f3f98ac7985453d68bbf6e0ebb9cc0d): 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

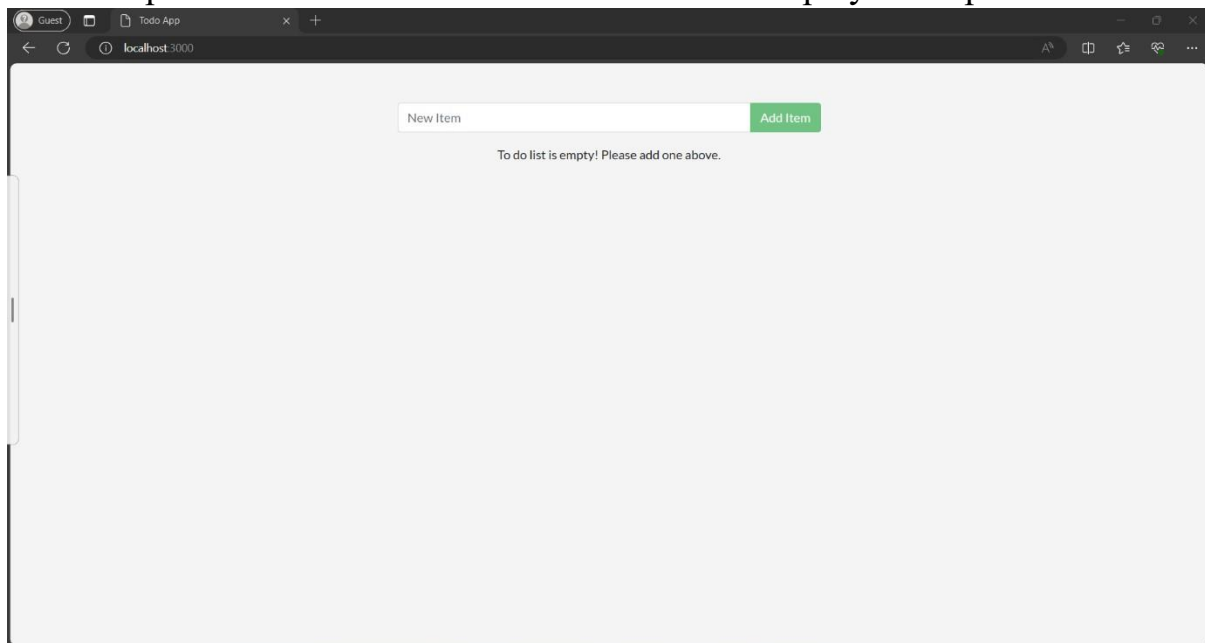
➔ docker rm 06311e21cd7e
06311e21cd7e
```



11. Start the updated container.

```
→ docker run -dp 127.0.0.1:3000:3000 getting-started  
7c7f23df5fb3abfcfff1a2eecd5f156a7620e4f4dac2926fae89df2c167ef0d
```

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



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13. Create a repository in [Docker Hub](https://hub.docker.com/) setting visibility as public.



**Create repository**

Namespace: **bael2k3** Repository Name: **getting-started**

Short description

Visibility: **Public** (Using 0 of 1 private repositories. [Get more](#))

Pushing images: `docker tag local-image:tagname new-repo:tagname`  
`docker push new-repo:tagname`

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14. Login with docker hub credentials.

```
➔ docker login
Authenticating with existing credentials ...
Login Succeeded
```

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
```

dockerhub

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B

bael2k3 / Repositories / getting-started / General

Using 0 of 1 private repositories. [Get more](#)

General

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Settings

Add a short description for this repository

The short description is used to index your content on Docker Hub and in search engines. It's visible to users in search results.

Update

bael2k3/getting-started

Updated 11 minutes ago

This repository does not have a description

Docker commands

To push a new tag to this repository:

docker push bael2k3/getting-started:tagname

Public View

Tags

Analyzed by docker scout

This repository contains 1 tag(s).

Tag	OS	Type	Vulnerabilities	Pulled	Pushed
latest		Image	<div><div>2</div><div>3</div><div>5</div></div> <div>0</div> <div>0</div>	3 minutes ago	11 minutes ago

See all

Automated Builds

Manually pushing images to Hub? Connect your account to GitHub or Bitbucket to automatically build and tag new images whenever your code is updated, so you can focus your time on creating.

Available with Pro, Team and Business subscriptions. [Read more about automated builds](#)

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Repository overview

An overview describes what your image does and how to run it. It displays in [the public view of your repository](#).

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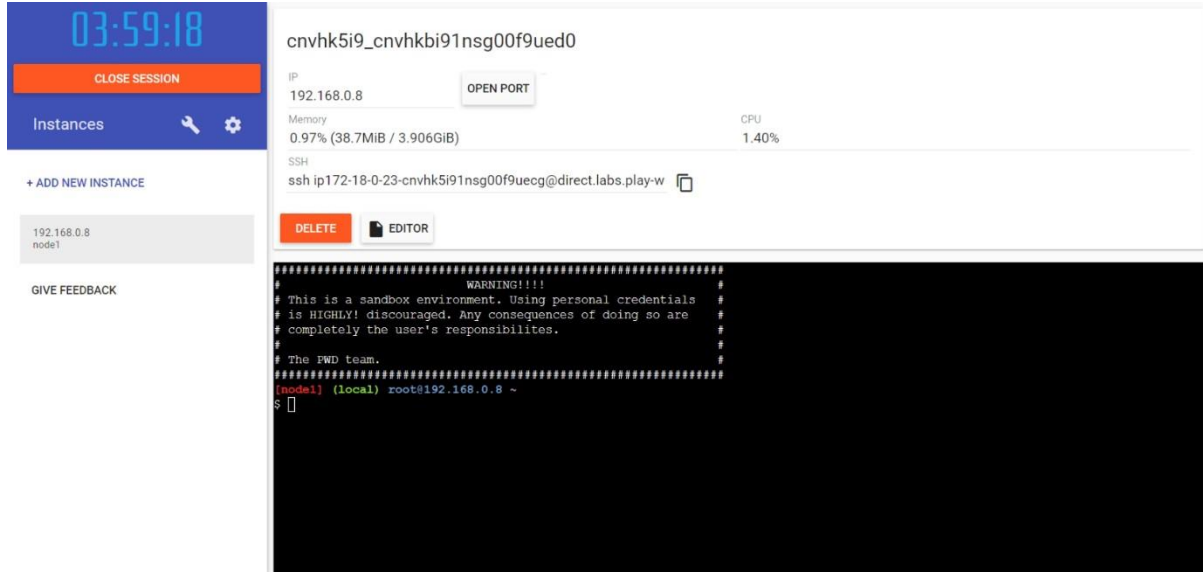
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System Status

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Cookies Settings

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

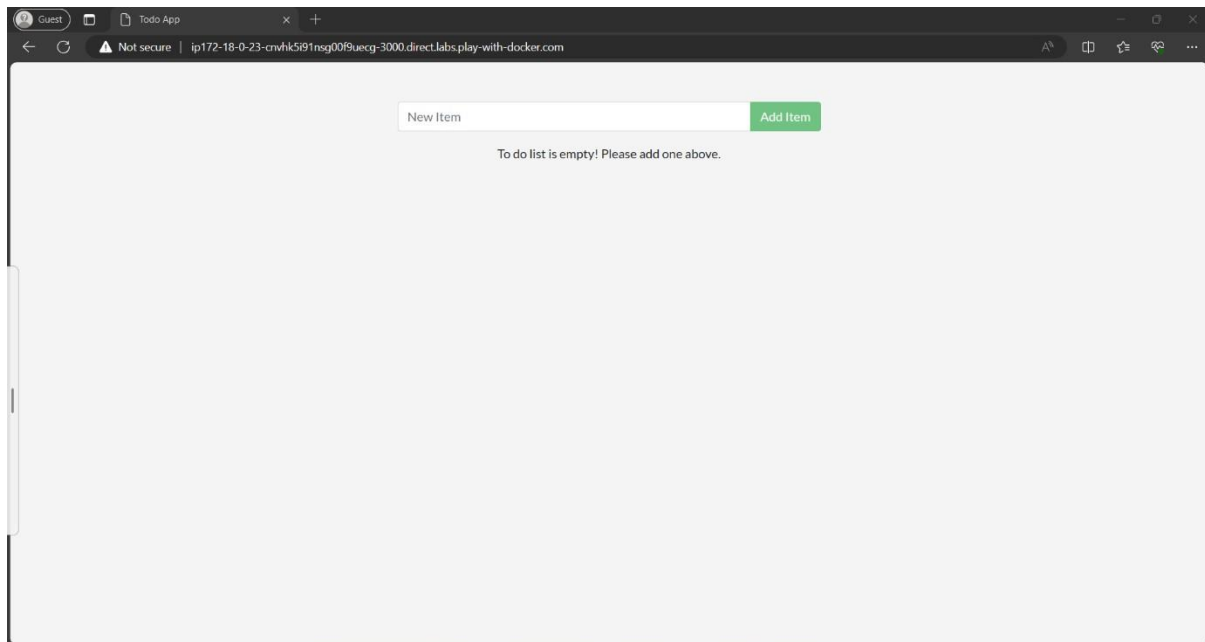


The screenshot shows the Play with Docker web interface. On the left sidebar, there's a clock showing 03:59:18, a 'CLOSE SESSION' button, and a section for 'Instances' with a '+ ADD NEW INSTANCE' button and a 'GIVE FEEDBACK' link. The main area displays details for an instance named 'node1' with IP 192.168.0.8. It includes buttons for 'OPEN PORT', 'DELETE', and 'EDITOR'. Below this is a terminal window showing a warning message and the prompt '[node1] (local) root@192.168.0.8 ~'.

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: sha256:3e20b48362476fb535da8b001cfa4d007fe9db0cac915b048711264427627fb8  
Status: Downloaded newer image for mariadb:lts  
ab1ee3398d8407e8f4c73ca18238ceb4523ac5ae9ff6159a791d72e7bead53ed
```

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



```

→ docker exec -it ablee3398d84 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
a06bebdba965d: Pull complete
a1436cccf44: 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 88oooo8 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

```

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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]> █
```

## 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.