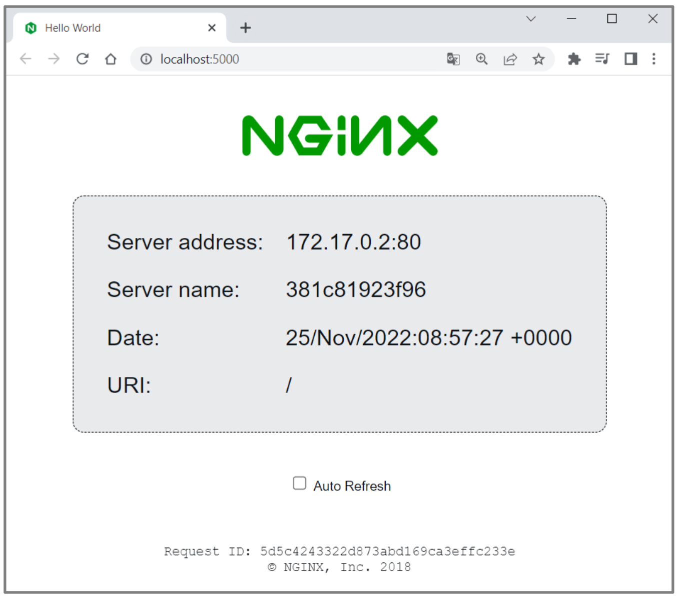
Lab: Containers and Docker

Lab for the "Containers and Clouds" course @ SoftUni

1. NGINX Server Container

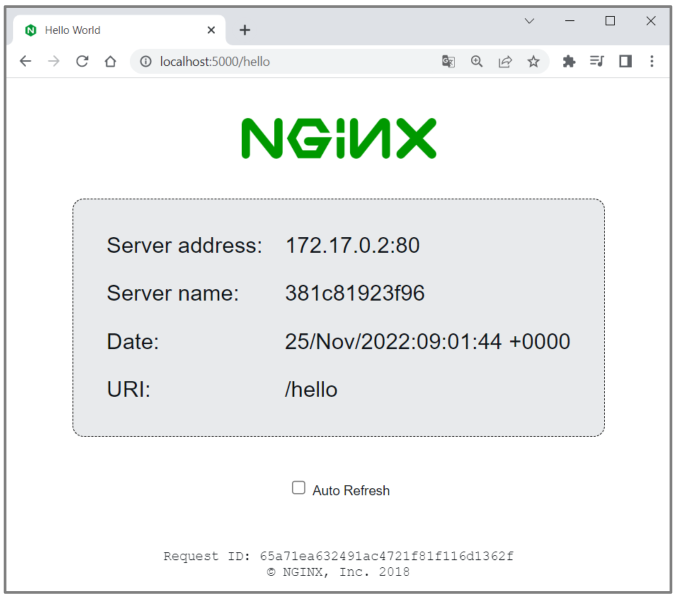
In this task, we will run a **simple NGINX server** in a **Docker container**. The **server** only returns **some server information**:



Server address: 172.17.0.2:80
Server name: 381c81923f96
Date: 25/Nov/2022:08:57:27 +0000
URI: /

☐ Auto Refresh

```
Request ID: 5d5c4243322d873abd169ca3effc233e
© NGINX, Inc. 2018
```



Server address: 172.17.0.2:80
Server name: 381c81923f96
Date: 25/Nov/2022:09:01:44 +0000
URI: /hello

☐ Auto Refresh

```
Request ID: 65a71ea632491ac4721f81f116d1362f
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```
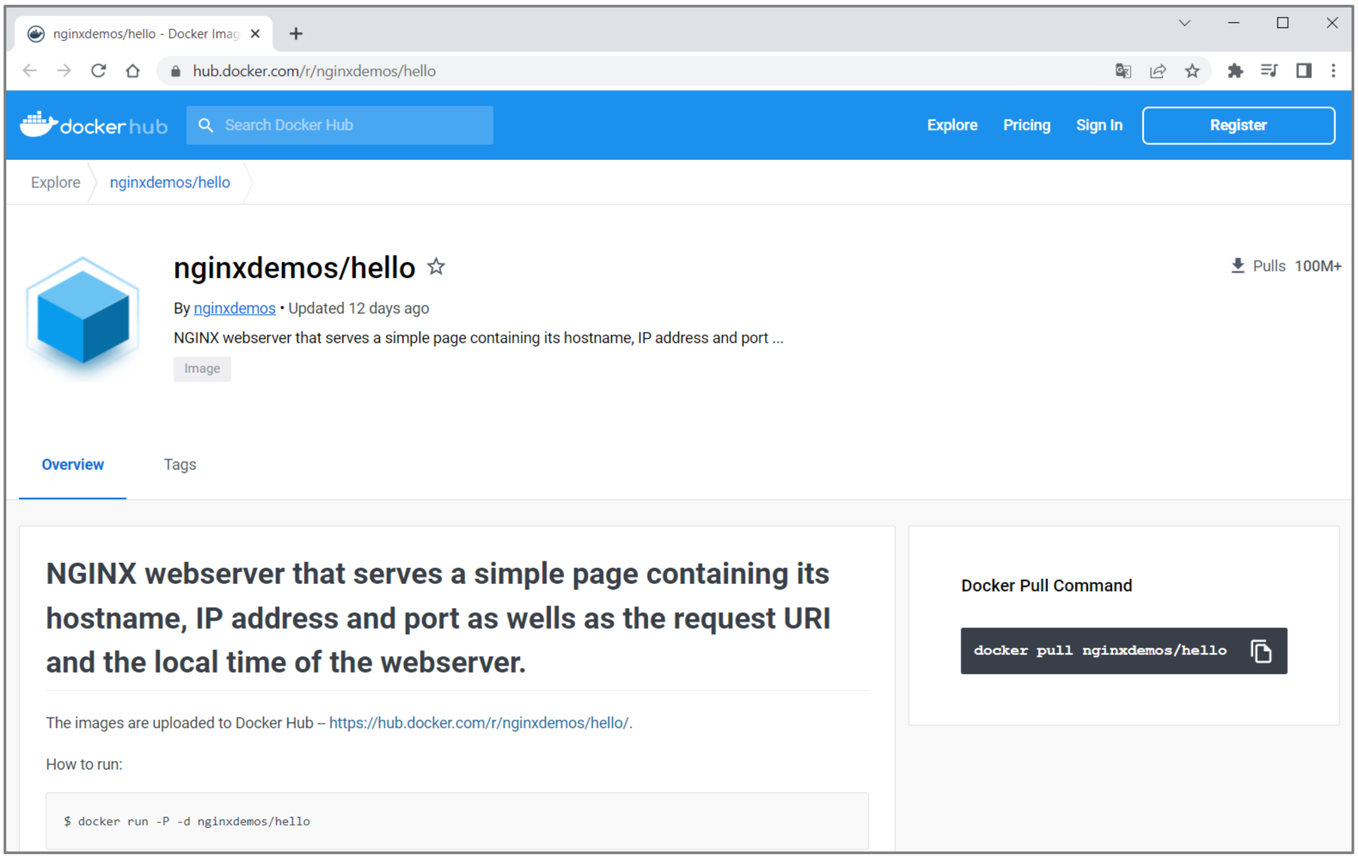

Download Image

To create a **NGINX server container**, we shall first **pull the NGINX server image** from Docker Hub. You can find the image documentation on **Docker Hub here**: https://hub.docker.com/r/nginxdemos/hello. You can always **refer to the documentation** to get instructions on how to pull, build and run the image:



nginxdemos/hello

By nginxdemos • Updated 12 days ago

NGINX webserver that serves a simple page containing its hostname, IP address and port ...

NGINX webserver that serves a simple page containing its hostname, IP address and port as wells as the request URI and the local time of the webserver.

The images are uploaded to Docker Hub – https://hub.docker.com/r/nginxdemos/hello/.

How to run:

```
$ docker run -P -d nginxdemos/hello
```

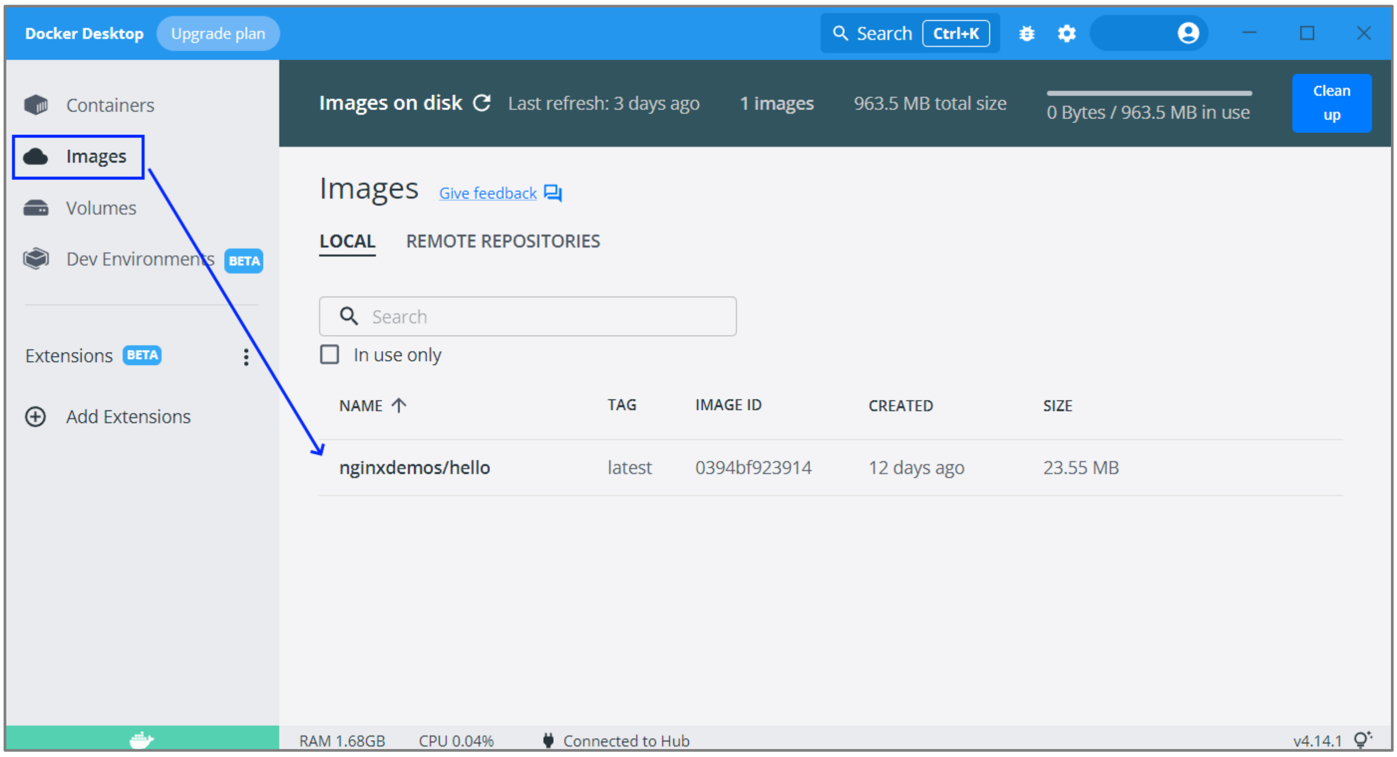
```
docker pull nginxdemos/hello
```

Open a **CLI**, for example, **`PowerShell`** or **`Windows Terminal`** or **`Command Prompt`** (**`PowerShell`** is recommended), and let's first **pull the Docker image** of the server. You should just use the **`pull` command** from the documentation:

```
PS C:\Users\PC> docker pull nginxdemos/hello
Using default tag: latest
latest: Pulling from nginxdemos/hello
ca7dd9ec2225: Already exists
76a48b0f5898: Already exists
2f12a0e7c01d: Already exists
1a7b9b9bbef6: Already exists
b704883c57af: Already exists
4342b1ab302e: Already exists
56b66d0c752b: Pull complete
b53a553ce476: Pull complete
04050cb56f56: Pull complete
Digest: sha256:0c9ae07ff186e92e8ee5b94b42266504f0ad4139a0f548ab29cd72ca089af49e
Status: Downloaded newer image for nginxdemos/hello:latest
docker.io/nginxdemos/hello:latest
```

You can see that the **latest image is downloaded by default**. In addition, some of the **image layers** existed from before (from other installations), so they **were not downloaded again** – this is the advantage of Docker image layers.

You can look at your **downloaded images** in **Docker Desktop**, in the **[Images] tab**:



NAME	TAG	IMAGE ID	CREATED	SIZE
nginxdemos/hello	latest	0394bf923914	12 days ago	23.55 MB

You can also use the command below to **display a list of all images** you have:

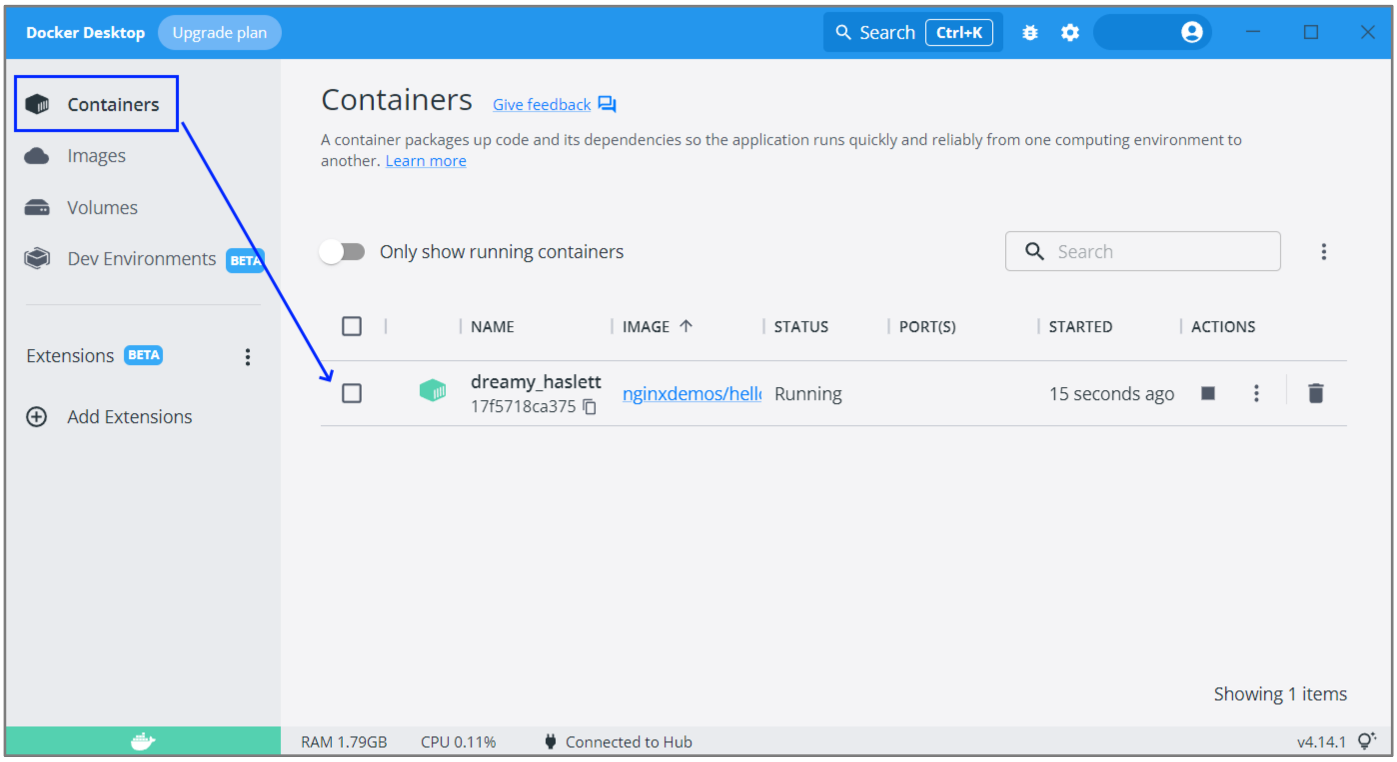
```
PS C:\Users\PC> docker images
REPOSITORY          TAG        IMAGE ID       CREATED        SIZE
nginxdemos/hello    latest     0394bf923914   12 days ago    23.6MB
```

Run a Container

Now we want to **run a container** with the **NGINX server image**, which is already downloaded from Docker Hub to our local machine. Use the **docker run** command and try this way:

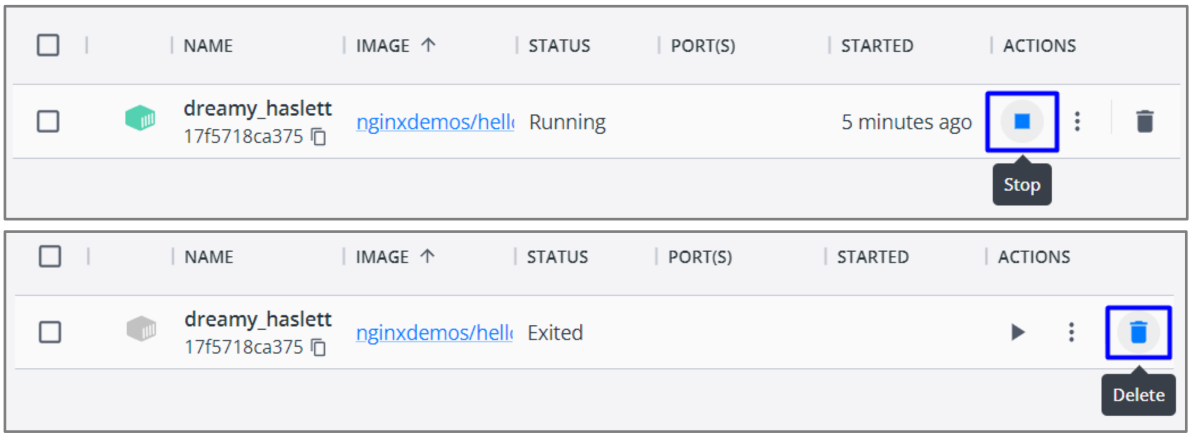
```
PS C:\Users\PC> docker run nginxdemos/hello
/docker-entrypoint.sh: /docker-entrypoint.d/ is not empty, will attempt to perform configuration
/docker-entrypoint.sh: Looking for shell scripts in /docker-entrypoint.d/
/docker-entrypoint.sh: Launching /docker-entrypoint.d/10-listen-on-ipv6-by-default.sh
10-listen-on-ipv6-by-default.sh: info: /etc/nginx/conf.d/default.conf is not a file or does not
exist
/docker-entrypoint.sh: Launching /docker-entrypoint.d/20-envsubst-on-templates.sh
```

Now we have a **running container** with a **random name**, as we did not set it explicitly. We can see it in **Docker Desktop**, in the **[Containers]** tab:



However, you can see that the "**PORT(S)**" **column is empty**, which means that **our container cannot be accessed** through the Internet, as it is isolated.

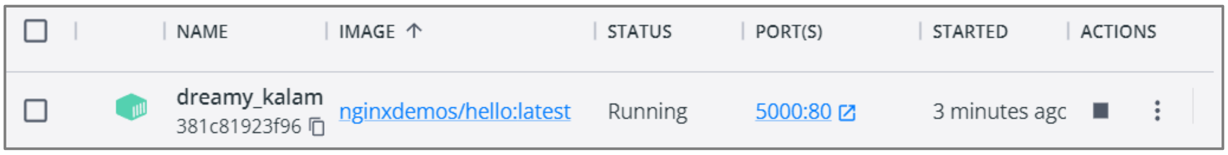
To fix this, we should **expose a port from the container**. But first, let's **stop and delete the container**, which we already have, by **clicking on the buttons** in **Docker Desktop**, as shown below:



Let's **create another container** and **publish its port to the host**. This is done with the **-p option**. After it, we shall add the **port we want the server to be on our machine** (it can be any free port, but let's use **5000**) and the **internal port the server uses** – in our case **80**. Do it like this:

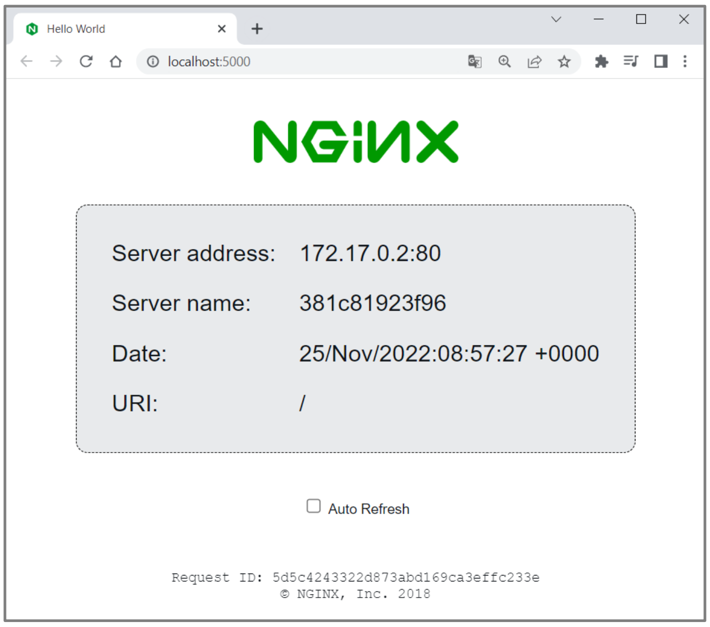
```
PS C:\Users\PC> docker run -p 5000:80 nginxdemos/hello
/docker-entrypoint.sh: /docker-entrypoint.d/ is not empty, will attempt to perform configuration
/docker-entrypoint.sh: Looking for shell scripts in /docker-entrypoint.d/
/docker-entrypoint.sh: Launching /docker-entrypoint.d/10-listen-on-ipv6-by-default.sh
10-listen-on-ipv6-by-default.sh: info: /etc/nginx/conf.d/default.conf is not a file or does not
exist
/docker-entrypoint.sh: Launching /docker-entrypoint.d/20-envsubst-on-templates.sh
```

Now the **container is exposed**:



	NAME	IMAGE ↑	STATUS	PORT(S)	STARTED	ACTIONS
☐	dreamy_kalam 381c81923f96	nginxdemos/hello:latest	Running	5000:80	3 minutes agc	■ ⋮

So, you can go to http://localhost:5000 and **access the working server**:



Server address: 172.17.0.2:80
Server name: 381c81923f96
Date: 25/Nov/2022:08:57:27 +0000
URI: /

Request ID: 5d5c4243322d873abd169ca3effc233e
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Stop and delete the container again and let's do one more thing.

Run a Named Container in Detached Mode

This time, we want to **run a container** with a **name** and **in detached mode** (the container will be running in the background). To do this, use the **`--name` option** with the **container name you want**, and the **`-d` option** for **detached mode**:

```
PS C:\Users\PC> docker run -p 5000:80 -d --name code_it_up nginxdemos/hello
e33b27fefae6a98cef1e6af689de1752609a5844c316644e17e8c33efdc94d66
```

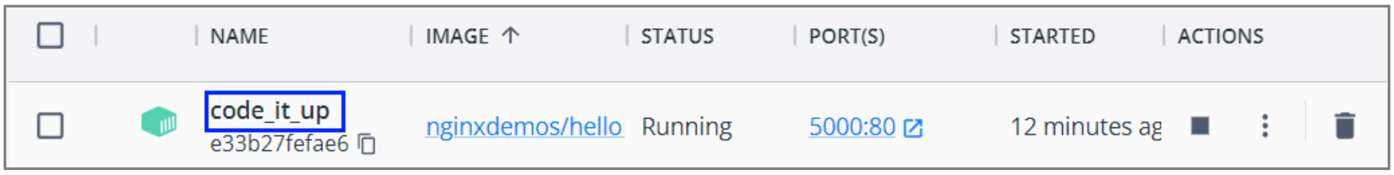
As you can see, now we have only the **container id** returned in the terminal and the **container logs are now shown** (because of the **detached mode**). However, you can **see the logs** with **`docker logs`** and the **container id or name**:

```
PS C:\Users\PC> docker logs e33b27fefae6a98cef1e6af689de1752609a5844c316644e17e8c33efdc94d66
/docker-entrypoint.sh: /docker-entrypoint.d/ is not empty, will attempt to perform configuration
/docker-entrypoint.sh: Looking for shell scripts in /docker-entrypoint.d/
/docker-entrypoint.sh: Launching /docker-entrypoint.d/10-listen-on-ipv6-by-default.sh
10-listen-on-ipv6-by-default.sh: info: /etc/nginx/conf.d/default.conf is not a file or does not
exist
/docker-entrypoint.sh: Launching /docker-entrypoint.d/20-envsubst-on-templates.sh
/docker-entrypoint.sh: Launching /docker-entrypoint.d/30-tune-worker-processes.sh
/docker-entrypoint.sh: Configuration complete; ready for start up
```

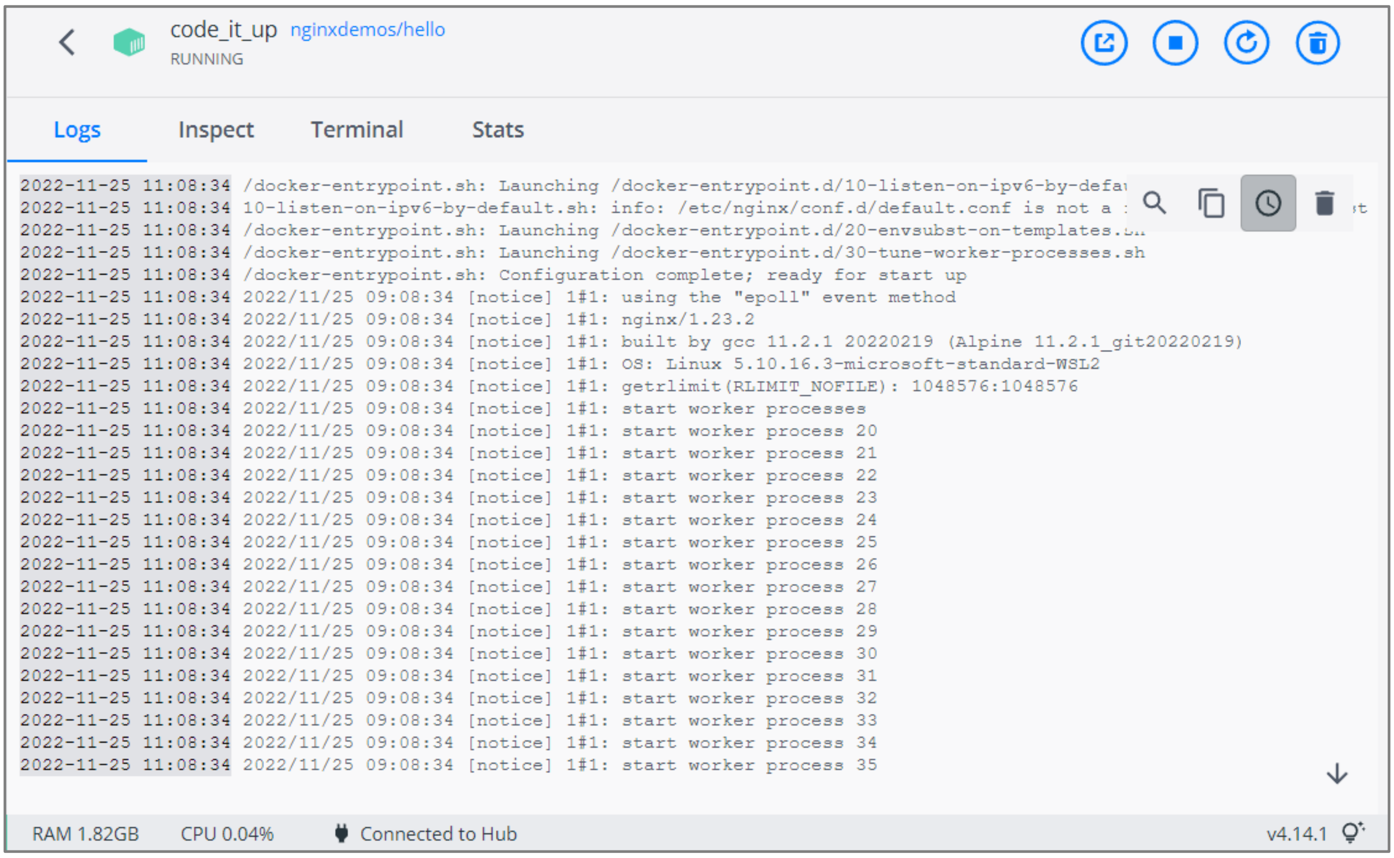
You can also use only the **first two symbols of the container's id**, not the whole one when they are unique (we have no other container with the same first symbols):

```
PS C:\Users\PC> docker logs e3
```

Or you can see them directly from **`Docker Desktop`** when you **click on the container's name**:



	NAME	IMAGE	STATUS	PORT(S)	STARTED	ACTIONS
	code_it_up e33b27fefae6	nginxdemos/hello	Running	5000:80	12 minutes ag	



```
2022-11-25 11:08:34 /docker-entrypoint.sh: Launching /docker-entrypoint.d/10-listen-on-ipv6-by-defa
2022-11-25 11:08:34 10-listen-on-ipv6-by-default.sh: info: /etc/nginx/conf.d/default.conf is not a
2022-11-25 11:08:34 /docker-entrypoint.sh: Launching /docker-entrypoint.d/20-envsubst-on-templates.
2022-11-25 11:08:34 /docker-entrypoint.sh: Launching /docker-entrypoint.d/30-tune-worker-processes.sh
2022-11-25 11:08:34 /docker-entrypoint.sh: Configuration complete; ready for start up
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: using the "epoll" event method
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: nginx/1.23.2
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: built by gcc 11.2.1 20220219 (Alpine 11.2.1_git20220219)
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: OS: Linux 5.10.16.3-microsoft-standard-WSL2
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: getrlimit(RLIMIT_NOFILE): 1048576:1048576
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker processes
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 20
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 21
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 22
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 23
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 24
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 25
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 26
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 27
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 28
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 29
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 30
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 31
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 32
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 33
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 34
2022-11-25 11:08:34 2022/11/25 09:08:34 [notice] 1#1: start worker process 35
```

Notice that the **name of our container** is how we explicitly set it to be.

Examine and Delete Container and Image

We can **see all containers** we have like this:

```
PS C:\Users\PC> docker ps -a
CONTAINER ID  IMAGE            COMMAND                  CREATED         STATUS          PORTS
e33b27fefae6  nginxdemos/hello "/docker-entrypoint.…"  18 minutes ago  Up About a minute  0.0.0.0:5000->80/tcp
```

To **see all running containers**, use:

```
PS C:\Users\PC> docker ps
CONTAINER ID  IMAGE            COMMAND                  CREATED         STATUS          PORTS
e33b27fefae6  nginxdemos/hello "/docker-entrypoint.…"  18 minutes ago  Up About a minute  0.0.0.0:5000->80/tcp
```

In our case, we have a **single running container** and we have the **same output** from the two commands.

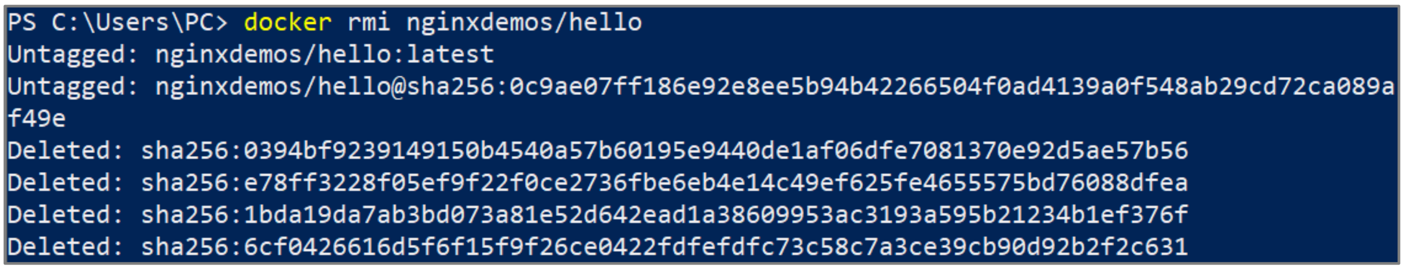
Now let's use the terminal to **stop and delete our container**. Use the following commands with the **container id** or **container name**:

```
PS C:\Users\PC> docker stop e3
e3
```

```
PS C:\Users\PC> docker rm e3
e3
```

Both commands return the **id or the name of the container**.

Finally, we can also **delete the NGINX server image**:



```
PS C:\Users\PC> docker rmi nginxdemos/hello
Untagged: nginxdemos/hello:latest
Untagged: nginxdemos/hello@sha256:0c9ae07ff186e92e8ee5b94b42266504f0ad4139a0f548ab29cd72ca089a
f49e
Deleted: sha256:0394bf9239149150b4540a57b60195e9440de1af06dfe7081370e92d5ae57b56
Deleted: sha256:e78ff3228f05ef9f22f0ce2736fbe6eb4e14c49ef625fe4655575bd76088dfea
Deleted: sha256:1bda19da7ab3bd073a81e52d642ead1a38609953ac3193a595b21234b1ef376f
Deleted: sha256:6cf0426616d5f6f15f9f26ce0422fdfefdfc73c58c7a3ce39cb90d92b2f2c631
```

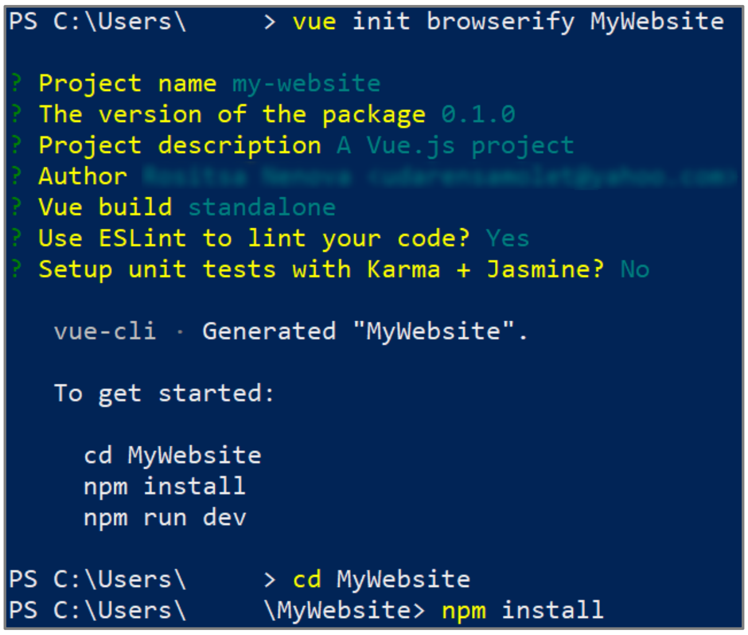
That's how we are supposed to work with **Docker images and containers** at a basic level.

2. Vue.js App in Container

Now we will see how to run a **Vue.js app** in a **Docker container**. We will **create an app just for the demo**.

Create and Set Up a Vue.js App

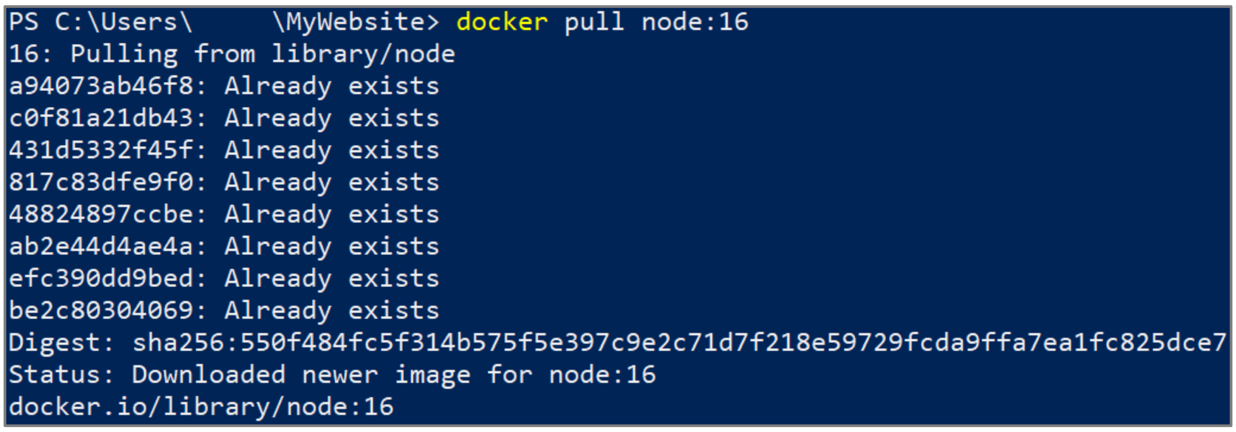
Let's use Terminal to create an app called **`MyWebsite`**, in a folder you choose:



```
PS C:\Users\     > vue init browserify MyWebsite

? Project name my-website
? The version of the package 0.1.0
? Project description A Vue.js project
? Author [redacted]
? Vue build standalone
? Use ESLint to lint your code? Yes
? Setup unit tests with Karma + Jasmine? No

   vue-cli · Generated "MyWebsite".

   To get started:

     cd MyWebsite
     npm install
     npm run dev

PS C:\Users\     > cd MyWebsite
PS C:\Users\     \MyWebsite> npm install
```

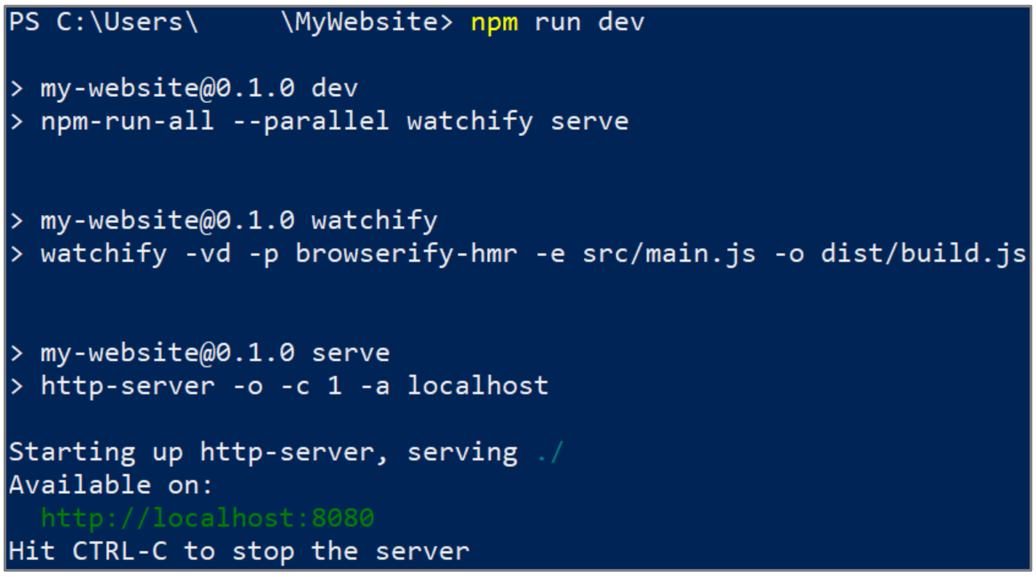
Let's now **pull the image** we will need to run the app – **`NodeJs`**.

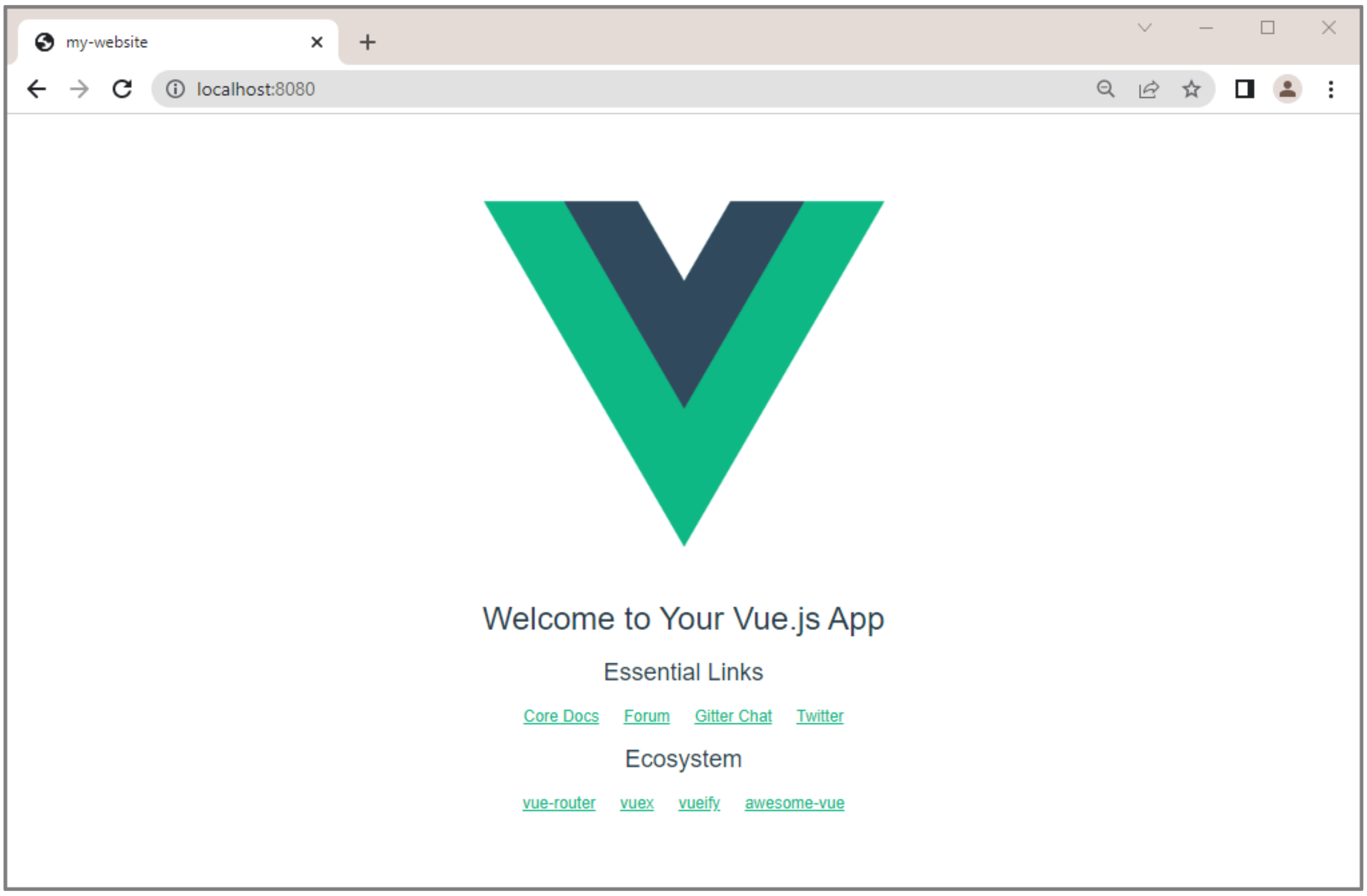
(https://hub.docker.com/_/node). Note that the **image version** should be **the same** as the **app's Node version**:



```
PS C:\Users\     \MyWebsite> docker pull node:16
16: Pulling from library/node
a94073ab46f8: Already exists
c0f81a21db43: Already exists
431d5332f45f: Already exists
817c83dfe9f0: Already exists
48824897ccbe: Already exists
ab2e44d4ae4a: Already exists
efc390dd9bed: Already exists
be2c80304069: Already exists
Digest: sha256:550f484fc5f314b575f5e397c9e2c71d7f218e59729fcda9ffa7ea1fc825dce7
Status: Downloaded newer image for node:16
docker.io/library/node:16
```

Now let's **run the application locally** in the standard way to check if **everything works as expected**:


```
PS C:\Users\      \MyWebsite> npm run dev

> my-website@0.1.0 dev
> npm-run-all --parallel watchify serve


> my-website@0.1.0 watchify
> watchify -vd -p browserify-hmr -e src/main.js -o dist/build.js


> my-website@0.1.0 serve
> http-server -o -c 1 -a localhost

Starting up http-server, serving ./
Available on:
  http://localhost:8080
Hit CTRL-C to stop the server
```



Welcome to Your Vue.js App

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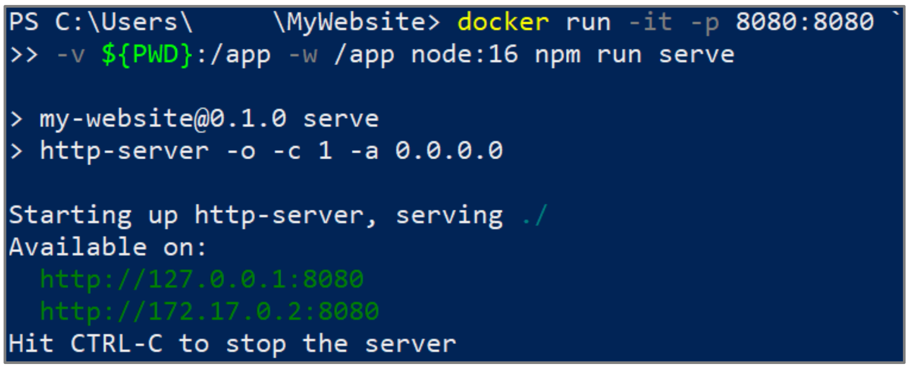
Now we should **modify the app's `package.json` file**, so that the **app runs on the IP we want**. **Open the file** in any editor and **change the `scripts` section settings** like this:

```
"scripts": {
  "watchify": "watchify -vd -p browserify-hmr -e src/main.js -o dist/build.js",
  "serve": "http-server -o -c 1 -a 0.0.0.0",
  "dev": "npm-run-all --parallel watchify serve",
  "lint": "eslint --ext .js,.vue src",
  "build": "cross-env NODE_ENV=production browserify -g envify -p [ vueify/plugins/extract-css -o dist/build.css ]
},
```

Run the App in a Container

To run the Vue.js **app in a container**, we will need to **create a container** with an **exposed port**, a **volume** and an **interactive shell**, so that we can **run the app inside the container** with the **`docker run`** command.

To do so, execute the following command:

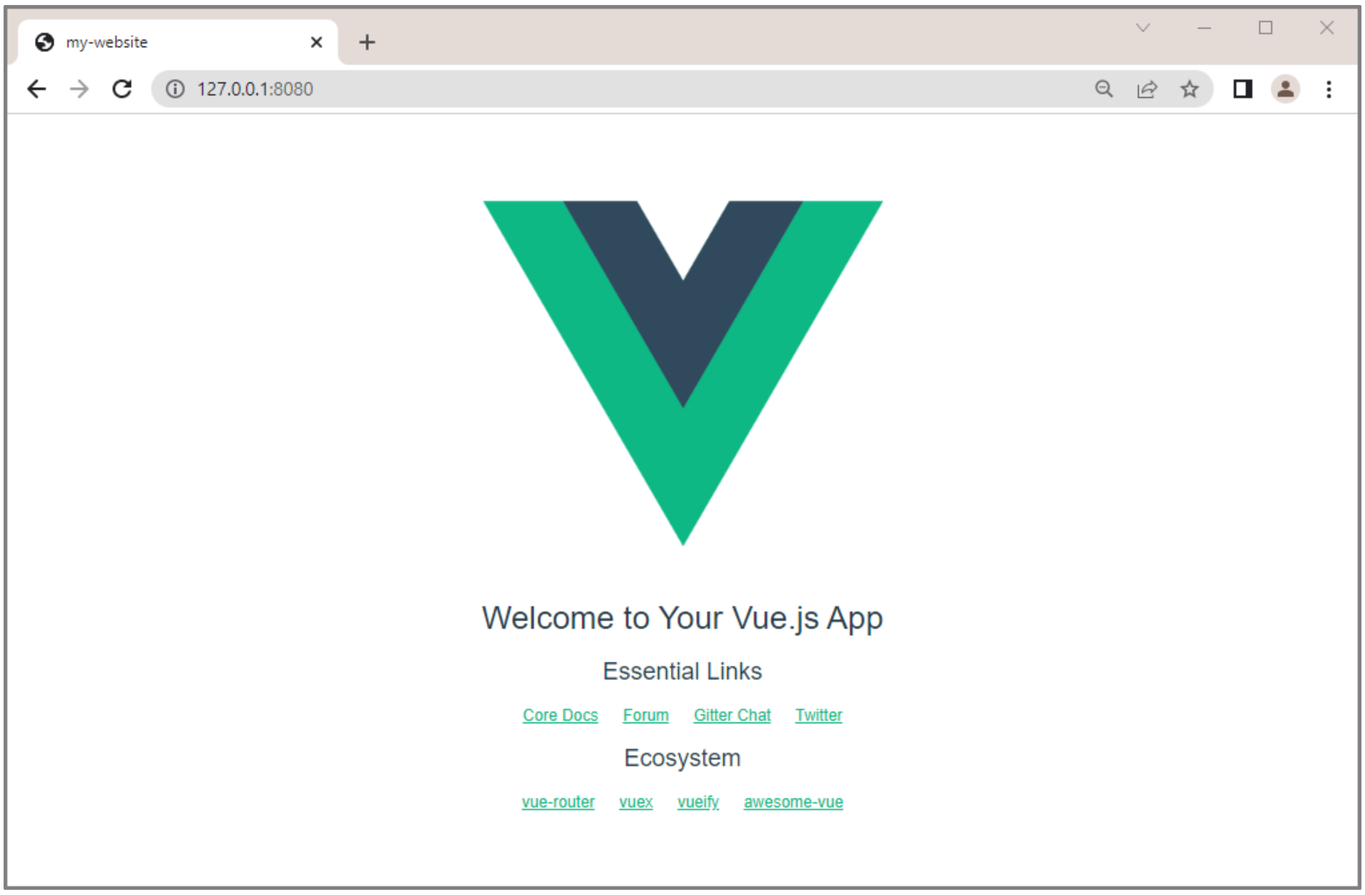


```
PS C:\Users\      \MyWebsite> docker run -it -p 8080:8080 `
>> -v ${PWD}:/app -w /app node:16 npm run serve

> my-website@0.1.0 serve
> http-server -o -c 1 -a 0.0.0.0

Starting up http-server, serving ./
Available on:
  http://127.0.0.1:8080
  http://172.17.0.2:8080
Hit CTRL-C to stop the server
```

Access the app at **`http://127.0.0.1:8080`** to validate that the app is running:



Welcome to Your Vue.js App

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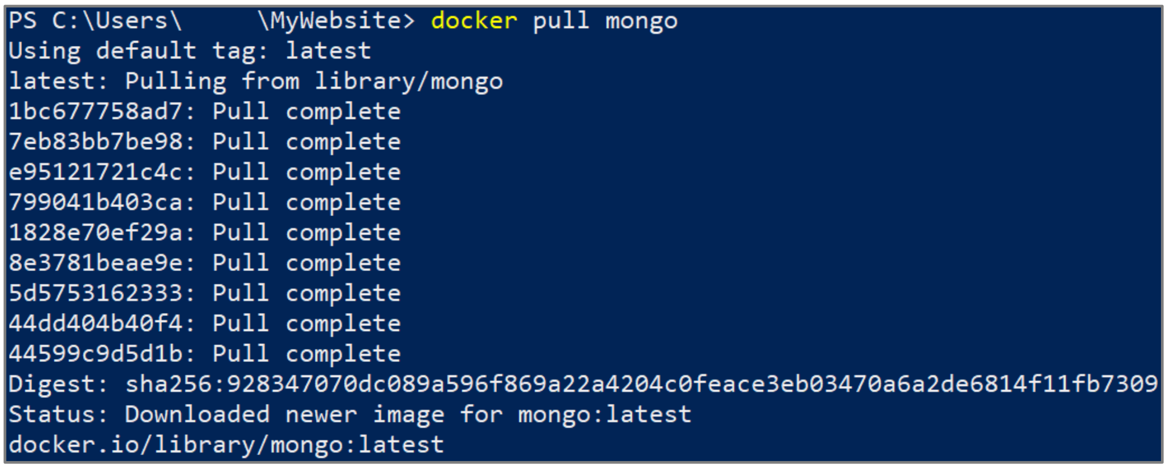
3. MongoDB in Container

Our next task is to **run a container** with a **Mongo database** in it. To do this, we will need the **following image** from **Docker Hub**: https://hub.docker.com/_/mongo

You can look at the "**How to use `this` Image**" **section** to learn how to **run the database container**. However, we will also **show and explain** the process step by step.

Create the Container

First, pull the latest MongoDB image with the **`docker pull mongo`** command:

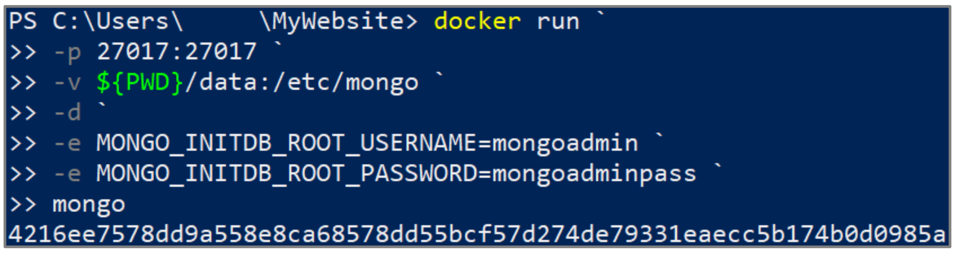


```
PS C:\Users\      \MyWebsite> docker pull mongo
Using default tag: latest
latest: Pulling from library/mongo
1bc677758ad7: Pull complete
7eb83bb7be98: Pull complete
e95121721c4c: Pull complete
799041b403ca: Pull complete
1828e70ef29a: Pull complete
8e3781beae9e: Pull complete
5d5753162333: Pull complete
44dd404b40f4: Pull complete
44599c9d5d1b: Pull complete
Digest: sha256:928347070dc089a596f869a22a4204c0feace3eb03470a6a2de6814f11fb7309
Status: Downloaded newer image for mongo:latest
docker.io/library/mongo:latest
```

You can examine the **documentation** on how to use the image: https://hub.docker.com/_/mongo

Run a Database Container

Our next step is to **run** the container, using the following command:



```
PS C:\Users\      \MyWebsite> docker run `
>> -p 27017:27017 `
>> -v ${PWD}/data:/etc/mongo `
>> -d `
>> -e MONGO_INITDB_ROOT_USERNAME=mongoadmin `
>> -e MONGO_INITDB_ROOT_PASSWORD=mongoadminpass `
>> mongo
4216ee7578dd9a558e8ca68578dd55bcf57d274de79331eaecc5b174b0d0985a
```

- **`docker run`** → starts a new Docker container;
- **`-p 27017:27017`** → sets the external and internal ports to **`27017`**, so that we can access the MongoDB from outside the container;
- **`-v ${PWD}/data:/etc/mongo`**
  - `${PWD}` → the host directory;
  - **`/etc/mongo`** → the container directory;
- **`-d`** → runs the container in detached mode (it will run in the background);
- **`-e MONGO_INITDB_ROOT_USERNAME=mongoadmin`** → sets the admin username;
- **`-e MONGO_INITDB_ROOT_PASSWORD=mongoadminpass`** → sets the admin password;
- **`mongo`** → specifies the image.

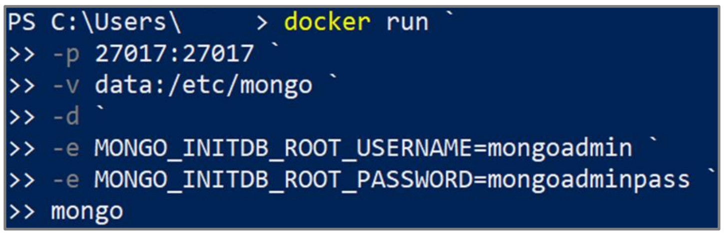
You should disable host's MongoDB Server instances or use another port!

Admin password should always follow the rules from the documentation.

When MongoDB Server container is started, other apps can log in to it and use the database.

Run a Database Container with Volume

To persist data after container is stopped, **create a volume, using the following command:**

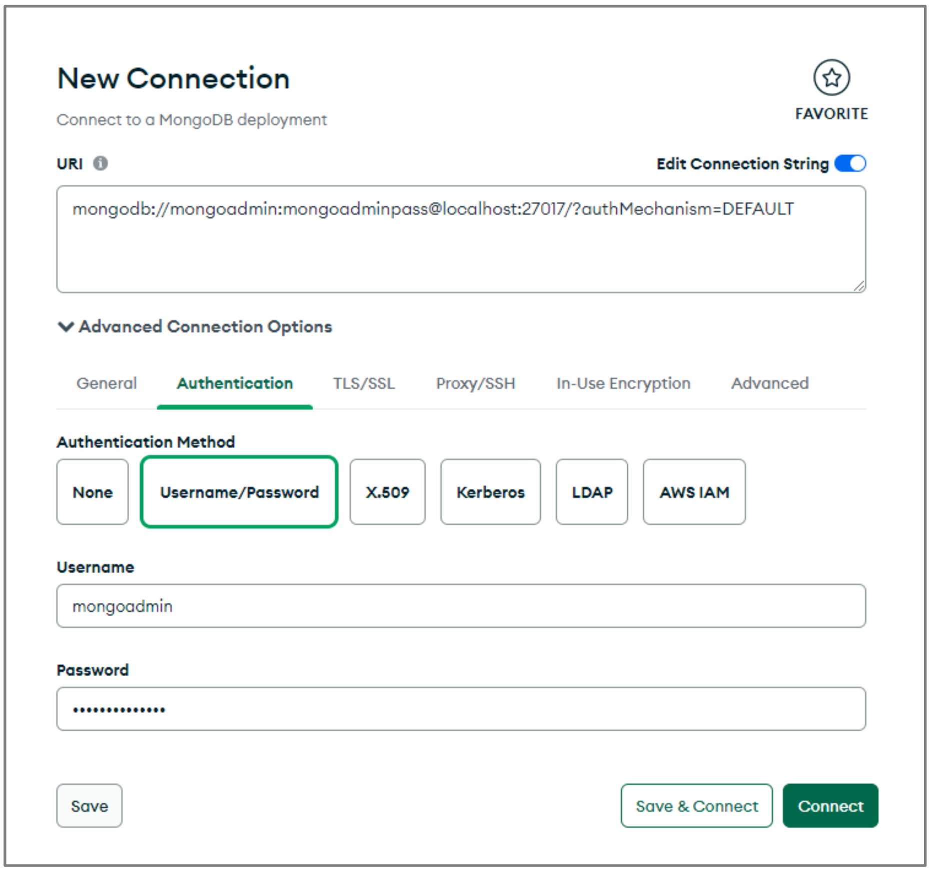


```
PS C:\Users\      > docker run `
>> -p 27017:27017 `
>> -v data:/etc/mongo `
>> -d `
>> -e MONGO_INITDB_ROOT_USERNAME=mongoadmin `
>> -e MONGO_INITDB_ROOT_PASSWORD=mongoadminpass `
>> mongo
```

You can then easily **backup** or **restore** the **data** from the volume.

Connect to the Database Container through MongoDB Compass

You can connect to the container database in **MongoDB Compass,** using the **username** and password that we created in the **previous** step:



New Connection

Connect to a MongoDB deployment

URI

Edit Connection String

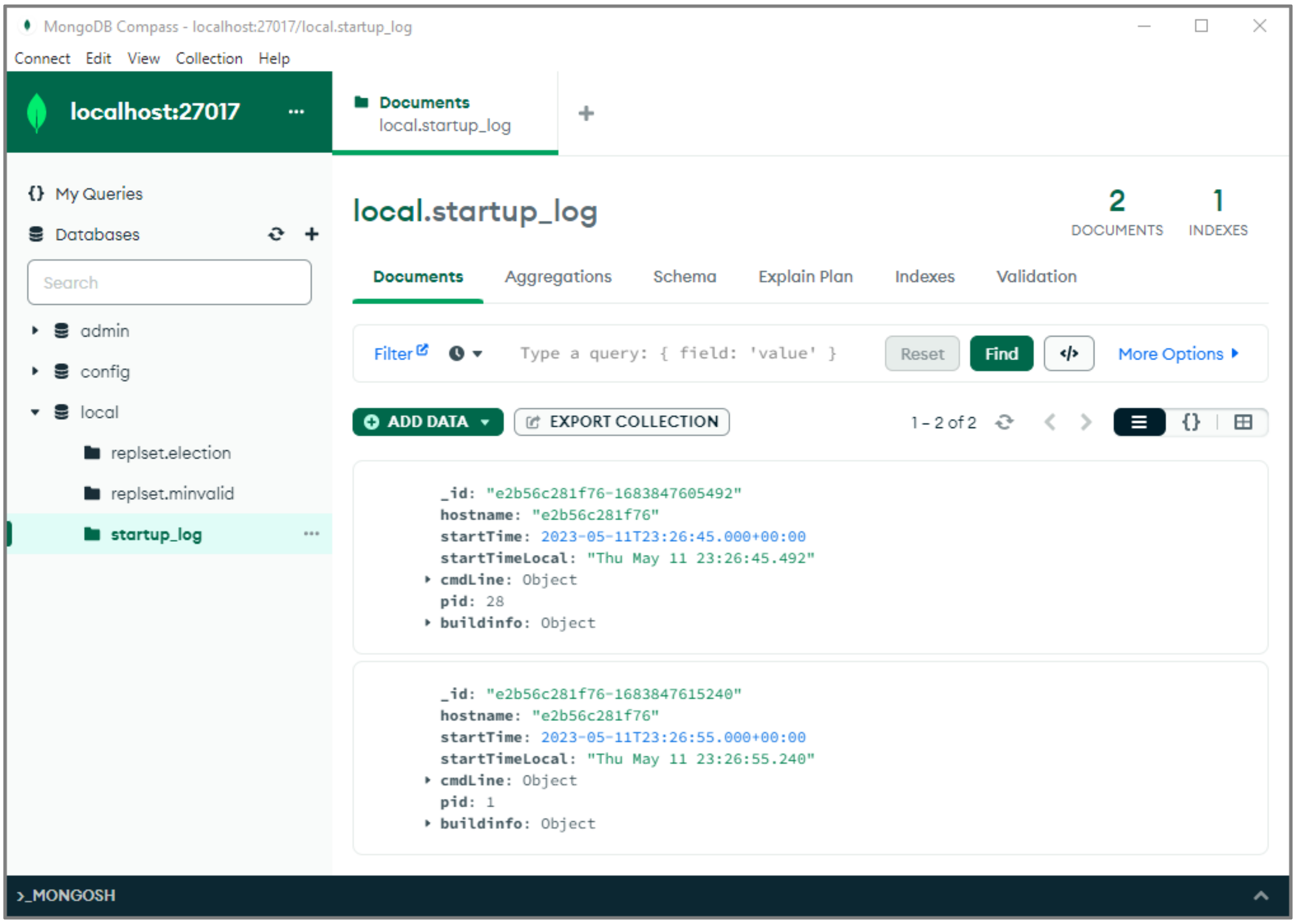
```
mongodb://mongoadmin:mongoadminpass@localhost:27017/?authMechanism=DEFAULT
```

Advanced Connection Options

Authentication Method: Username/Password

Username: mongoadmin

Password: ••••••••••••••



```
_id: "e2b56c281f76-1683847605492"
hostname: "e2b56c281f76"
startTime: 2023-05-11T23:26:45.000+00:00
startTimeLocal: "Thu May 11 23:26:45.492"
▸ cmdLine: Object
pid: 28
▸ buildinfo: Object
```

```
_id: "e2b56c281f76-1683847615240"
hostname: "e2b56c281f76"
startTime: 2023-05-11T23:26:55.000+00:00
startTimeLocal: "Thu May 11 23:26:55.240"
▸ cmdLine: Object
pid: 1
▸ buildinfo: Object
```