

Docker Training

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Please note this Tutorial will be run on Linux

(Windows users please remove the sudo statement in front of all the commands)

1 Creating Docker Files to create Docker Images

example 1 : Hello World Without Arguments

Step 1 : Create a folder for your Docker Image and open this folder:

```
hello-cpp0/
```

Step 2: Inside this folder create a file called: Dockerfile with this content:

```
FROM amytabb/docker_ubuntu16_essentials
COPY HelloWorld /HelloWorld
WORKDIR /HelloWorld/
RUN g++ -o HelloWorld helloworld.cpp
CMD ["/HelloWorld"]
```

Step 3: Inside this folder create a folder called HelloWorld

step 4: Inside this folder create a C++ file : helloworld.cpp with this content:

```
#include <iostream>
using namespace std;

int main()
{
    cout << "Hello world 0!" << endl;
    return 0;
}
```

Step 6: Run the following commands to create the Docker Image:

```
sudo docker pull amytabb/docker_ubuntu16_essentials
```

```
sudo docker build -t hello-cpp0 .
```

Step 7: Launch the Docker Image using Docker:

```
sudo docker run -it hello-cpp0
```

Example 2 : Hello World With Arguments

Step 1: Create a folder for your Docker Image and open this folder:

hello1/

Step 2: create a file called: Dockerfile with this content:

```
FROM amytabb/docker_ubuntu16_essentials
ENV NAME VAR1
ENV NAME VAR2
ENV NAME VAR3
COPY run_hello1.sh /run_hello1.sh
COPY HelloWorld /HelloWorld
WORKDIR /HelloWorld/
RUN g++ -o HelloWorld1 helloworld1.cpp
WORKDIR /
CMD ["/bin/sh", "/run_hello1.sh"]
```

Step 3: Inside this folder create a folder called HelloWorld

Step 4: Inside this folder create a C++ file : helloworld.cpp with this content:

```
#include <iostream>
#include <string>
using namespace std;

int main(int argc, char **argv)
{
    cout << "Hello world 1, with arguments!" << endl;

    string val;
    for (int i = 1; i < argc; i++){
        val = argv[i];
        cout << "Argument " << i << " " << val << endl;
    }
    return 0;
}
```

Step 5: Inside this folder create a shell script file: run_hello1.sh with this content:

```
#!/bin/sh
./HelloWorld/HelloWorld1 $VAR1 $VAR2 $VAR3
```

Step 6: Inside this folder run the following command:

```
chmod 775 run_hello1.sh
```

Step 7: Inside this folder run the following command:

```
cd ../
```

Step 8: Run the following commands to create the Docker Image:

```
sudo docker build -t hello1 .
sudo docker run -it -e VAR1='23' hello1
```

Example 3: Simple Java Hellow World

Step 1: Create a folder for your Docker Image and open this folder:

hello-java/

Step 2: Inside this folder create a Java file : HelloWorld.java with this content:

```
public class HelloWorld {  
    public static void main(String[] args) {  
        System.out.println("Hello, World");  
    }  
}
```

Step 3: Inside this folder run the following command to compile this Class:

```
javac HelloWorld.java
```

Step 4: Inside this folder run the following command to Pull the Alpine Docker Image from the Docker Repository

```
sudo docker pull alpine:latest
```

Step 5: Inside this folder create a file called: Dockerfile with this content:

```
FROM alpine:latest  
ADD HelloWorld.class HelloWorld.class  
RUN apk --update add openjdk8-jre  
ENTRYPOINT ["java", "-Djava.security.egd=file:/dev/./urandom", "HelloWorld"]
```

Step 6: Inside this folder run the following commands to create the Docker Image:

```
sudo docker pull alpine:latest  
sudo docker build --tag "docker-hello-world:latest" .
```

Step 7: Inside this folder run the following command to launch the Docker Image:

```
sudo docker run docker-hello-world:latest
```

Example 4 : Hello World Apache Webserver

Step 1: create a folder for your Docker Image and open this folder:

helloweb/

Step 2: Inside this folder create a HTML file : Index.html with this content:

```
<html>
<body>
<h1>Hellow World</h1>
</body>
</html>
```

Step 3: Inside this folder create a file called: Dockerfile with this content:

```
FROM centos:latest
MAINTAINER NewstarCorporation
RUN yum -y install httpd
COPY index.html /var/www/html/
CMD ["/usr/sbin/httpd", "-D", "FOREGROUND"]
EXPOSE 80
```

Step 4: Inside this folder run the following commands to create the Docker Image:

```
sudo docker pull centos:latest
sudo docker build -t webserver:v1 .
```

Step 5: Inside this folder run the following commands to launch the Docker Image using :

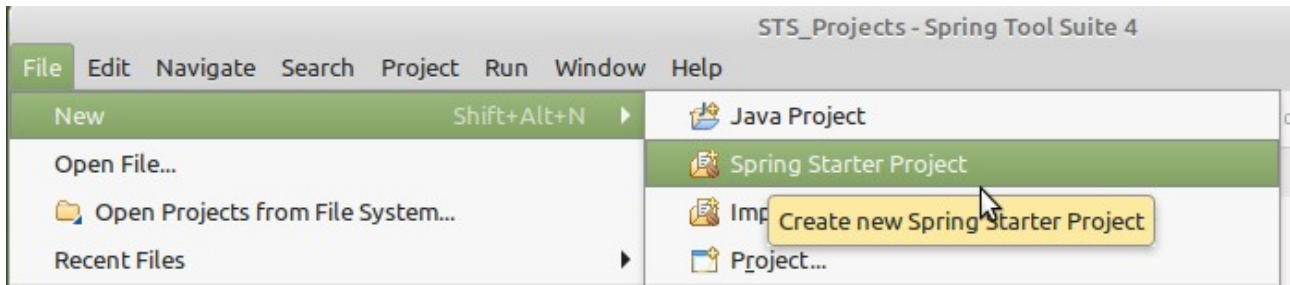
```
sudo docker run -dit -p 1234:80 webserver:v1
```

Step 6: Open your browser to :

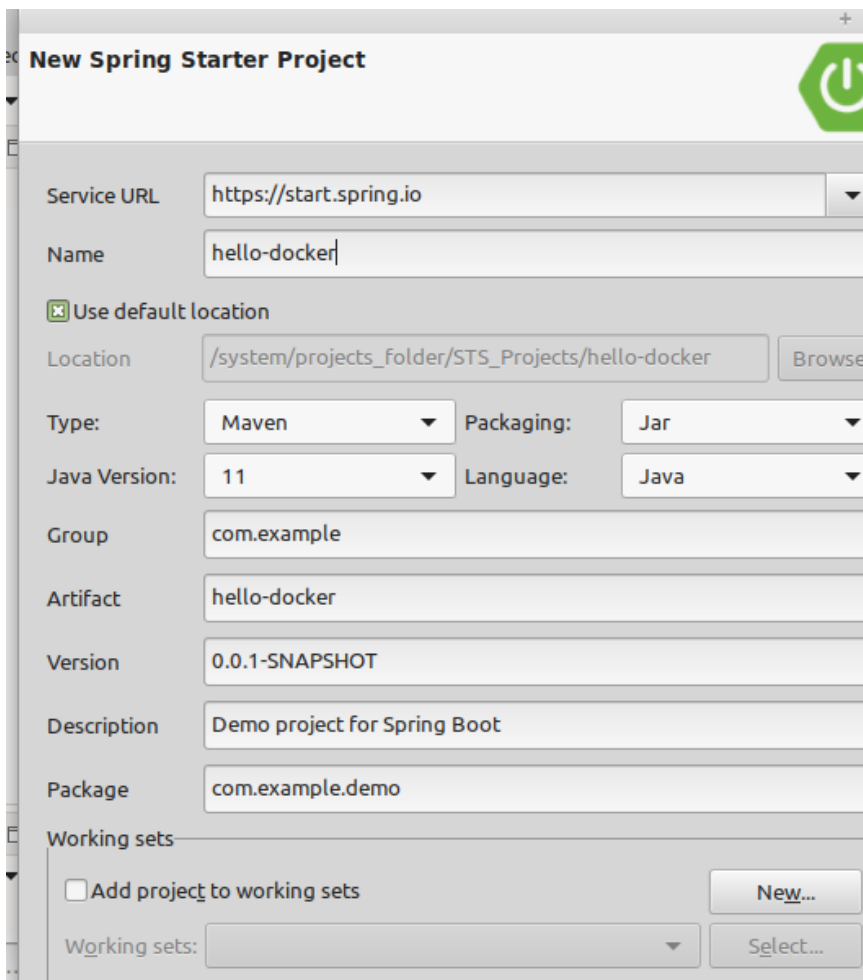
<http://localhost:1234>

Example 5: Java Spring Boot Microservice

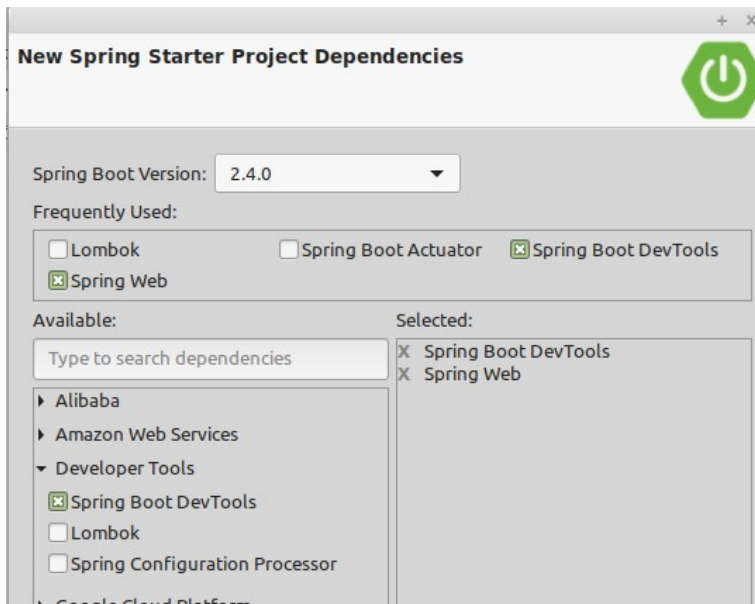
**Step 1 : create a Spring Boot project that will generate JAR file:
hello-docker.jar**



and name it hello-docker and press the Next button



Select the Spring Boot version required
Expand Web and select SpringWeb and expand
DeveloperTools and select Spring Boot devTools
and press the Next button and then the Finish Button



Step 2 : Adding the Java code

Create a package : `com.example.demo.controllers`

In this package create a class `HelloDockerController` and use the following Java Code:

```
package com.example.demo.controllers;

import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RestController;

@RestController
public class HelloDockerController {

    @RequestMapping("/greet")
    public String getGreeting() {
        return "HelloDocker";
    }
}
```

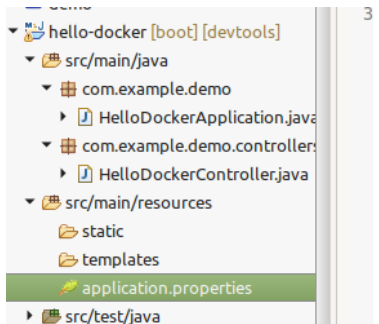
Step 3 : Make the following changes to the POM file:

```
<dependencies>
  <!-- needed to fix issue with missing/invalid enum values -->
  <dependency>
    <groupId>com.sun.xml.bind</groupId>
    <artifactId>jaxb-impl</artifactId>
    <version>2.2.4</version>
  </dependency>
  <dependency>
    <groupId>org.apache.commons</groupId>
    <artifactId>commons-lang3</artifactId>
    <!-- <version>3.3.2</version> -->
  </dependency>
  <dependency>
    <groupId>commons-codec</groupId>
    <artifactId>commons-codec</artifactId>
    <version>1.11</version>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-tomcat</artifactId>
    <scope>provided</scope>
  </dependency>

  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-devtools</artifactId>
    <scope>runtime</scope>
    <optional>true</optional>
  </dependency>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
  </dependency>
</dependencies>

<build>
  <finalName>${project.artifactId}</finalName>
  <plugins>
    <plugin>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-maven-plugin</artifactId>
    </plugin>
  </plugins>
</build>
```

Step 4: In the resources folder edit the applications.properties file

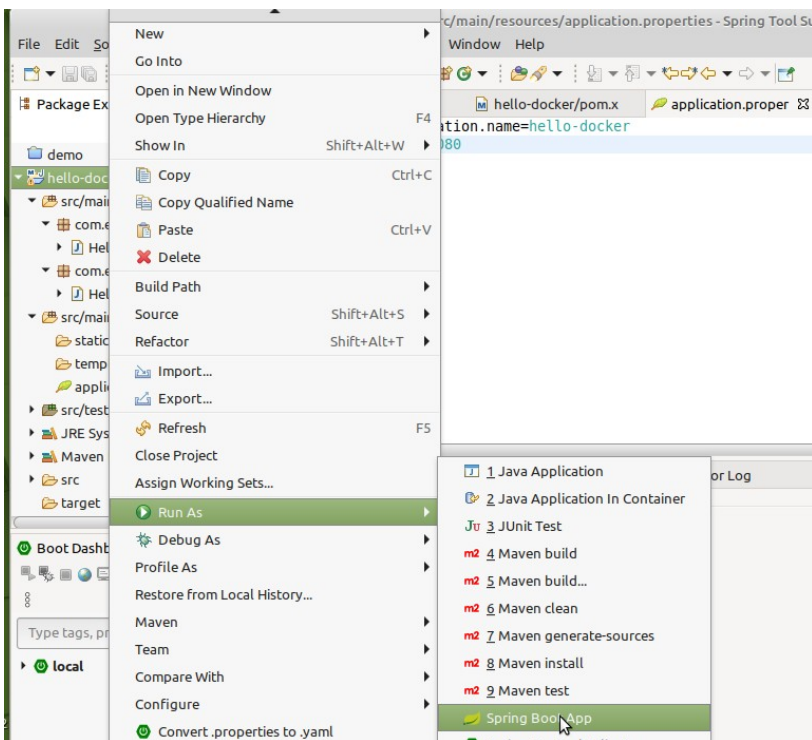


Now add this code there:

spring.application.name=hello-docker
server.port=8080

Step 5: Test this project

Right click the project and select **Run As** and select **Spring Boot App**



Open the browser to this URL: <http://localhost:8080/greet>

You should see : HelloDocker

Stop the Server running in the IDE or shut down the IDE

Step 6 Open the folder where your IDE saved this project

Now run the following maven command in a terminal in that folder:

nicm@nm-laptop:/system/projects_folder/STS_Projects/hello-docker\$ mvn clean package

You should find the following file in the target folder : hello-docker.jar

You will need to copy it in the Docker folder in the next steps

Test this jar file : java -jar hello-docker.jar

Open the Browser here : <http://localhost:8080/greet>

Step 7: Building the Docker Project

Create a folder called:

Hellodocker/

Step 8: Inside this folder copy the JAR file from the previous step

Step 9: Inside this folder create a file called: Dockerfile with this content:

```
FROM alpine:latest
WORKDIR /
VOLUME /tmp
ADD hello-docker.jar hello-docker.jar
RUN apk --update add openjdk11-jre
EXPOSE 8080
CMD java -jar hello-docker.jar
```

Step 10: Inside this folder run the following commands to create the Docker Image:

```
sudo docker pull alpine:latest
sudo docker build -t hello-docker:v1 .
```

Step 11: Inside this folder run the following commands to launch the Docker Image using :

```
sudo docker run -it -p 1234:8080 hello-docker:v1
```

Step 12: Open your browser to :

<http://localhost:1234>

You should now see :

HelloDocker

2 Portainer

Portainer is delivered as a Docker Container so it runs on Docker.

There are two versions one manages Docker containers
the other also Manages Kubernetes Clusters

Please look at Chapters 6 for installation instructions and Chapter 7 for operating instructions

3 Getting Familiar with docker commands

Running an Ubuntu Container and accessing it from the terminal

```
sudo docker run -it ubuntu bash
```

Now run these commands from the terminal

```
ls -l  
pwd  
whoami  
more /etc/os-release  
lscpu  
top  
uname -a
```

Listing docker Images

```
sudo docker images
```

Listing All Docker Containers

```
sudo docker container ls -a
```

Starting a listed container

(assuming a container was listed as: 0a0631eeea21)

```
sudo docker start -i 0a0631eeea21
```

Run and Delete a container afterwards

```
sudo docker run --rm -t ubuntu bash
```

Deleting all Docker Containers

(its dangerous but it give you back all the disk space used)

```
sudo docker container prune
```

Pulling (down) Docker containers

```
sudo docker pull ubuntu
sudo docker pull sonarqube
sudo docker pull postgres
sudo docker pull nginx
sudo docker pull ubuntu
sudo docker pull mariadb
sudo docker pull httpd
sudo docker pull centos
```

Show Details of Docker containers

```
sudo docker container ls
```

List all Containers

```
sudo docker container ls -l
sudo docker container ls -a
sudo docker container ls --all
```

List all Images

```
sudo docker images
```

Stopping a container

```
sudo docker stop ubuntu
```

Deleting a container

```
sudo docker stop hello-world
sudo docker rm hello-world
sudo docker stop 724a4081c966
sudo docker rm 724a4081c966
```

Deleting an Image (This is permanent)

```
sudo docker images
sudo docker rmi hello-world
```

Running containers :

```
sudo docker run hello-world  
sudo docker run -it ubuntu bash
```

Launch a container in the interactive mode

```
sudo docker run -i -t ubuntu:latest /bin/bash
```

Attached Mode

In this mode, the console you are using to execute docker run will be attached to standard input, output and error.

That means your console is attached to the container's process.

Detached Mode

In detached mode, you can follow the standard output of your docker container with `docker logs -f <container_ID>`

Running Containers in Attached mode:

```
docker run -rm mongo          ..... Mongo listens to port 27017  
Ctrl C to stop it
```

Running Containers in Detached mode (as a service):

```
sudo docker run -d -p 80:80 gvelrajan/hello-world:v1.0  
sudo docker run -d -p 8080:80 gvelrajan/hello-world:v1.0  
sudo docker ps
```

Run and then delete the container:

```
sudo docker run --rm -t ubuntu bash
```

Running a webserver with internal port 80 and external port 4000 and 4001

```
sudo docker run --rm -it -p 4000:80 simple-webserver  
sudo docker run --rm -it -p 4001:80 simple-webserver
```

You access the following webserver instances from the browser at:

```
http://localhost:4000  
http://localhost:4001
```


Pruning Docker Containers Images and volumes

Pruning unused Docker Containers

The following removes all containers

```
sudo docker container prune
```

The following removes containers created more than 5 minutes ago:

```
sudo docker container prune --force --filter "until=5m"
```

Prune unused Docker Images

```
sudo docker image prune
```

Limiting images pruned to only images created more than 24 hours ago:

```
sudo docker image prune -a --filter "until=24h"
```

Prune Volumes (this is non recoverable)

```
sudo docker volume prune
```

Removing volumes which are not labelled with the keep label:

```
sudo docker volume prune --filter "label!=keep"
```

4 The Dockerfile Syntax

FROM centos // you are specify "Super - Container" usually the O/S web server or Database
MAINTAINER <author's detail>
COPY <src> ... <dst> // to copy files into the Image
ADD <src> ... <dst> // similar to add but handles tar commands
ENV <key> <value>
ENV DEBUG_LVL 3
ENV APACHE_LOG_DIR /var/log/apache
USER <UID>|<UName> // <UID> numerical user ID <UName> :valid user Name
WORKDIR <dirpath>
VOLUME <mountpoint>
EXPOSE <port>[/<proto>] [<port>/<proto>]...]
EXPOSE 7373/udp 8080
RUN <command> // to run a command in the Image
CMD <command> // execute a shell command during launch of the container
ENTRYPOINT <command> // shell command executed during the launch of the container.
ONBUILD <INSTRUCTION>
ONBUILD ADD config /etc/appconfig

And Example of a Dockerfile :

```
#####  
# Dockerfile to build an Apache2 image  
#####  
# Base image is Ubuntu  
FROM ubuntu:14.04  
# Author: James Bond  
MAINTAINER James Bond <james.bond007@gmail.com>  
# Install apache2 package  
RUN apt-get update && \  
apt-get install -y apache2 && \  
apt-get clean
```

Running Containers with a Hard coded port

```
sudo docker container run --name mongo mongo -p 8081:271017 mongo  
sudo docker container rm -f mongo .....manually deletes the container
```

Running Containers with Dynamically allocated port

```
sudo docker container run -d --name mongo -p 271017 mongo
```

Pausing/Unpausing a Docker Container

```
sudo docker run -i -t ubuntu:latest /bin/bash
```

5 Docker Swarms

Difference between Docker and Docker Swarm

As a platform, Docker has revolutionized the manner software was packaged.

Docker Swarm or simply Swarm is an open-source container orchestration platform and is the native clustering engine for and by Docker.

Swarm turns a pool of Docker hosts into a virtual, single host.

Worker Nodes

Worker nodes are also instances of Docker Engine whose sole purpose is to execute containers.

Create Swarm

`docker swarm init`do this on the first node to manage the swarm

Joining a swarm

```
docker swarm join --token SWMTKN-1-4zfe8c7vezompmxgnvr59z9fzj4dop9lggde6qk4qs71nytr97-03cjgmeh8yiun807y7adz6k79 10.154.2.105:2377
```

Creating workers

`docker swarm join-token worker`

.. it will display :

To add a worker to this swarm, run the following command:

```
sudo docker swarm join --token SWMTKN-1-4zfe8c7vezompmxgnvr59z9fzj4dop9lggde6qk4qs71nytr97-2srtr4qxcnvc9bqmr9nn6s76z 10.154.2.105:2377
```

Joining another node as a worker to this swarm

```
sudo docker swarm join --token SWMTKN-1-4zfe8c7vezompmxgnvr59z9fzj4dop9lggde6qk4qs71nytr97-2srtr4qxcnvc9bqmr9nn6s76z 10.154.2.105:2377
```

6. Installing Portainer

6.1 Linux Installation

6.1.1 Preferred Method of installation with Separate YML download

```
cd /data/downloads/portainer
curl -L https://downloads.portainer.io/portainer-agent-stack.yml -o portainer-agent-stack.yml
cd /data/downloads/portainer
docker stack deploy --compose-file=portainer-agent-stack.yml portainer
```

6.1.2 Simple method to install portainer

```
sudo docker volume create portainer_data
sudo docker run -d -p 8000:8000 -p 9000:9000 -v /var/run/docker.sock:/var/run/docker.sock -v
portainer_data:/data portainer/portainer
```

6.1.3 Create a docker Swarm immediately after a Docker installation

```
docker swarm init
```

You will get this instruction in terminal for other Docker servers to join this Swarm you need to save this text as you will not get it again

```
docker swarm join --token SWMTKN-1-
4zfe8c7vezompmxgnvr59z9fzj4dop9lggde6qk4qs71nytr97-03cjgmeh8yiun807y7adz6k79
10.154.2.105:2377
```

6.1.4 The content of the portainer-agent-stack.yml

```
version: '3.2'
services:
  agent:
    image: portainer/agent
    volumes:
      - /var/run/docker.sock:/var/run/docker.sock
      - /var/lib/docker/volumes:/var/lib/docker/volumes
    networks:
      - agent_network
    deploy:
      mode: global
      placement:
        constraints: [node.platform.os == linux]
  portainer:
    image: portainer/Portainer
    command: -H tcp://tasks.agent:9001 --tlsskipverify
    ports:
      - "9000:9000"
      - "8000:8000"
    volumes:
      - portainer_data:/data
    networks:
      - agent_network
    deploy:
      mode: replicated
      replicas: 1
      placement:
        constraints: [node.role == manager]
networks:
  agent_network:
    driver: overlay
    attachable: true
volumes:
  portainer_data:
```

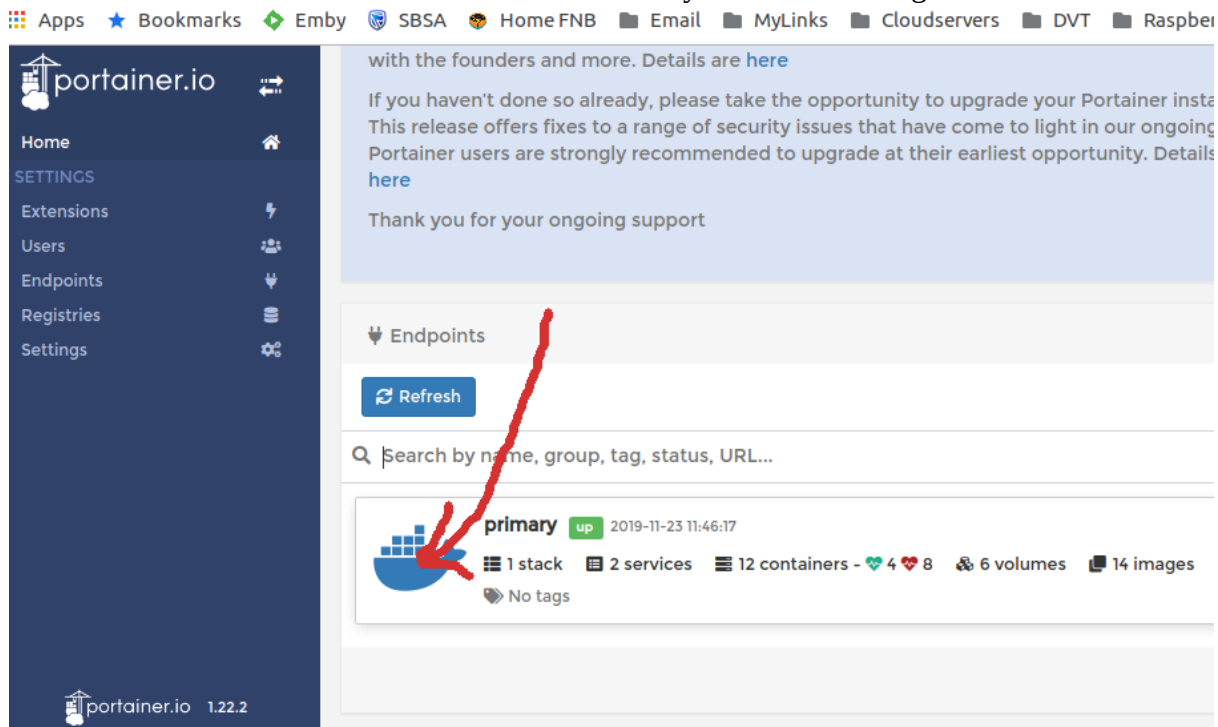
6.2 Windows Installation

It is better to install Ubuntu LTS to run on your Windows 10 Windows Subsystem for Linux Installation Guide for Windows 10
<https://docs.microsoft.com/en-us/windows/wsl/install-win10>

7. Using Portainer

Open your browser to : <http://10.154.2.109:9000>
where 10.154.2.109 is the IP address of your Docker Server
<http://nicoserver.kozow.com:9000>

you will need to create a password of the admin user
if this is not a public server you could use adminadmin as password and you can change it later
Now click on the Docker icon for the Docker server you want to manage



For more information of managing portainer visit these links :

<https://www.youtube.com/watch?v=PFJVhc4CVMo&t=33s>
<https://www.youtube.com/watch?v=MfnxCNpfZg&t=490s>
<https://www.youtube.com/watch?v=ZrEllmXDiwo&t=223s>