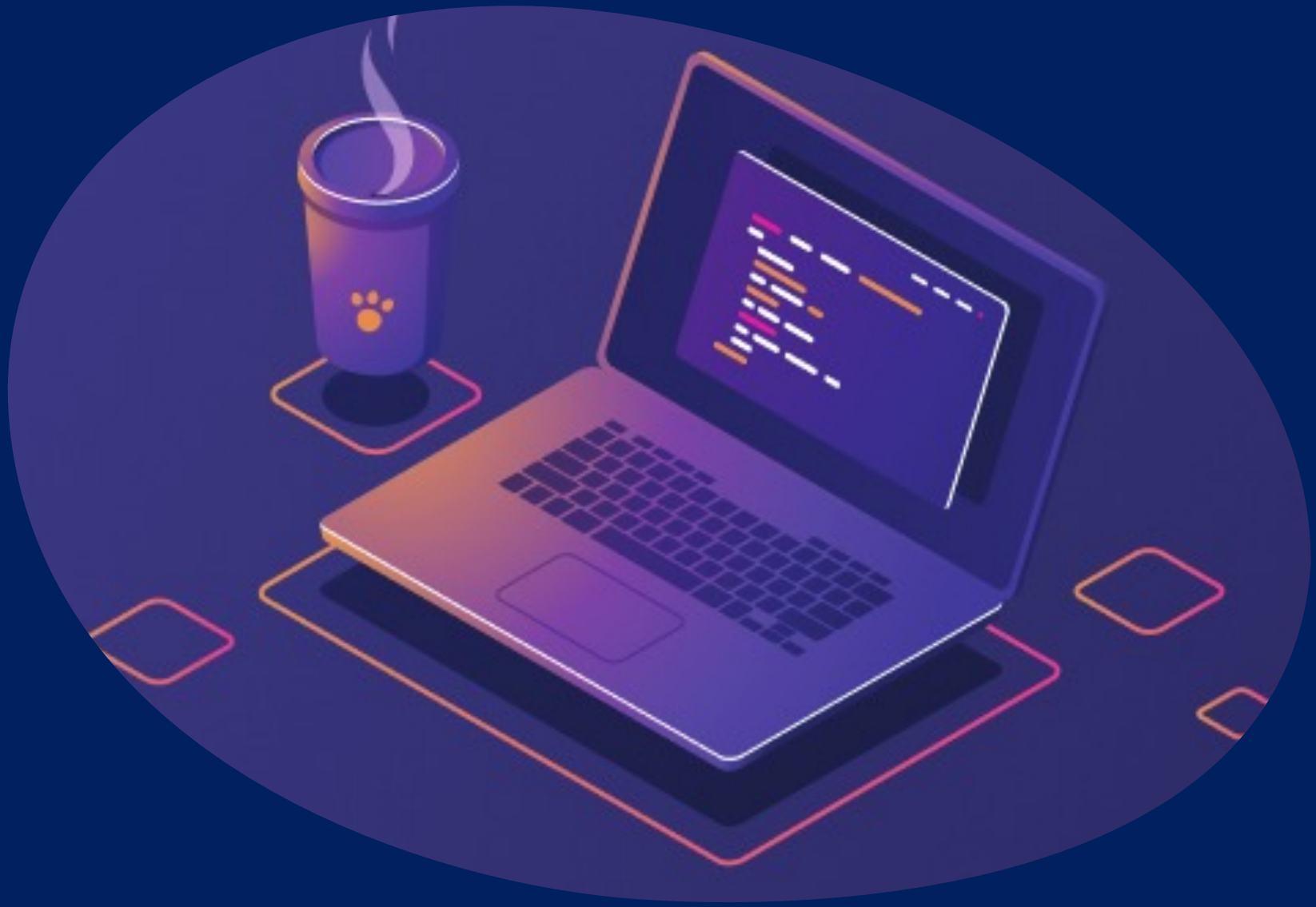
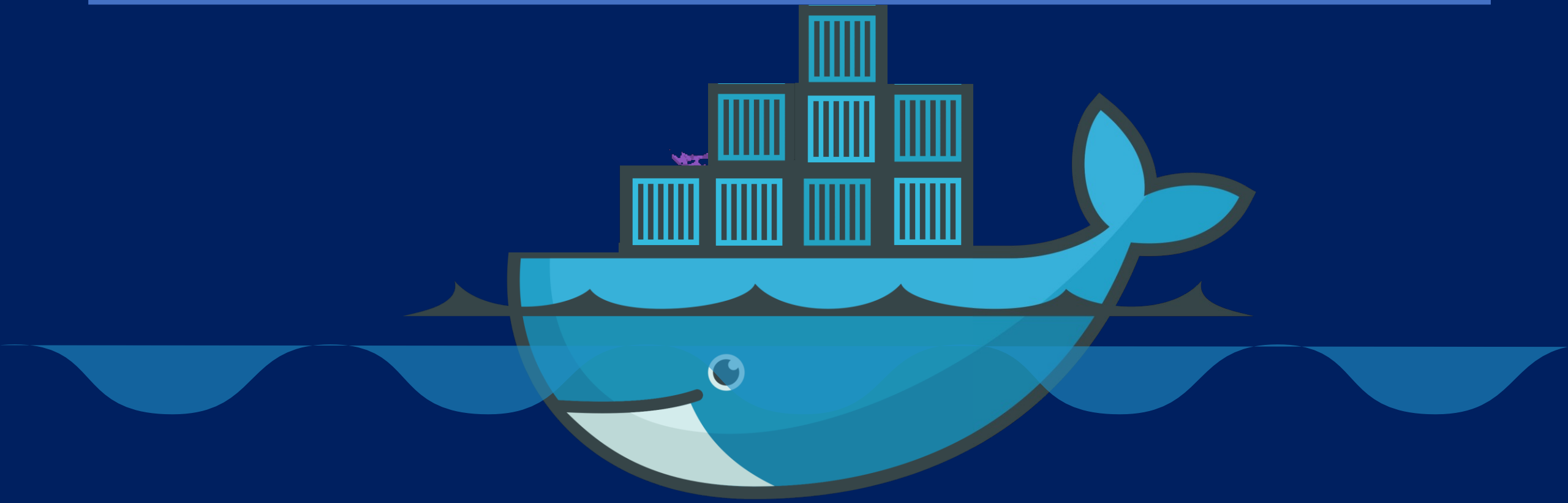


Week 10 : SOFTWARE DEVELOPMENT TOOLS AND ENVIRONMENTS

Dockerfile and Docker Image



Dockerfile

- Dockerfile is instructions to build Docker Image
  - How to run commands
  - Add files or directories
  - Create environment variables
  - What process to run when launching container
- Result from building Dockerfile is Docker Image

Dockerfile

Sample Dockerfile

```
FROM node:14.15.0-alpine3.12
COPY . /nodejs/.
WORKDIR /nodejs
RUN npm install
ENV VERSION 1.0
EXPOSE 8081
CMD ["node", "/nodejs/main.js"]
```

OS + System Packages

Source Code

Library Dependencies

Configuration

Dockerfile reference

FROM <image:tag>	Sets the base image for subsequent instructions.
RUN <command>	Execute any commands in image.
CMD <command> <param1> <param2>	Sets the command to be executed when running the image.
LABEL <key>=<value> ...	Adds metadata to an image.
EXPOSE <port>	Informs Docker that the container listens on the specified network ports at runtime.
ENV <key> <value>	Sets the environment variable.
COPY <src> <dest>	Copies new files from source to the filesystem of the container at the path destinations.
ENTRYPOINT <command> <param1> <param2>	Command line arguments will be appended after all elements in an exec form ENTRYPOINT.
VOLUME ["/data"]	Sets mounted volumes from native host or other containers.
WORKDIR <path>	Sets the working directory for any commands.

How to create my own image?

Dockerfile

```
FROM Ubuntu

RUN apt-get update
RUN apt-get install python

RUN pip install flask
RUN pip install flask-mysql

COPY . /opt/source-code

ENTRYPOINT FLASK_APP=/opt/source-code/app.py flask run
```

1. OS - Ubuntu
2. Update apt repo
3. Install dependencies using apt
4. Install Python dependencies using pip
5. Copy source code to /opt folder
6. Run the web server using “flask” command

```
docker build Dockerfile -t mmumshad/my-custom-app
```

```
docker push mmumshad/my-custom-app
```

Dockerfile

Dockerfile

```
INSTRUCTION ARGUMENT
```

Dockerfile

```
FROM Ubuntu

RUN apt-get update
RUN apt-get install python

RUN pip install flask
RUN pip install flask-mysql

COPY . /opt/source-code

ENTRYPOINT FLASK_APP=/opt/source-code/app.py flask run
```

Start from a base OS or another image

Install all dependencies

Copy source code

Specify Entrypoint

Layered architecture

Dockerfile

```
FROM Ubuntu

RUN apt-get update && apt-get -y install
python

RUN pip install flask flask-
mysql

COPY . /opt/source-
code

ENTRYPOINT FLASK_APP=/opt/source-code/app.py flask run
```

```
docker build Dockerfile -t mmumshad/my-custom-app
```

- Layer 1. Base Ubuntu Layer — 120 MB
- Layer 2. Changes in apt packages — 306 MB
- Layer 3. Changes in pip packages — 6.3 MB
- Layer 4. Source code — 229 B
- Layer 5. Update Entrypoint with “flask” command — 0 B

```
root@osboxes:/root/simple-webapp-docker # docker history mmumshad/simple-webapp
IMAGE               CREATED             CREATED BY                                      SIZE                COMMENT
1a45ba829f10        About an hour ago   /bin/sh -c #(nop)  ENTRYPOINT ["/bin/sh" "...   0B
37d37ed8fe99        About an hour ago   /bin/sh -c #(nop) COPY file:29b92853d73898...   229B
d6aaebf8ded0        About an hour ago   /bin/sh -c pip install flask flask-mysql        6.39MB
e4c055538e60        About an hour ago   /bin/sh -c apt-get update && apt-get insta...   306MB
ccc7a11d65b1        2 weeks ago         /bin/sh -c #(nop)  CMD ["/bin/bash"]            0B
<missing>           2 weeks ago         /bin/sh -c mkdir -p /run/systemd && echo '...   7B
<missing>           2 weeks ago         /bin/sh -c sed -i 's/^#\s*\(deb.*universe\...   2.76kB
<missing>           2 weeks ago         /bin/sh -c rm -rf /var/lib/apt/lists/*          0B
<missing>           2 weeks ago         /bin/sh -c set -xe   && echo '#!/bin/sh' >...   745B
<missing>           2 weeks ago         /bin/sh -c #(nop) ADD file:39d3593ea220e68...   120MB
```

Docker build output

```
root@osboxes:/root/simple-webapp-docker # docker build .
Sending build context to Docker daemon  3.072kB
Step 1/5 : FROM ubuntu
 ---> ccc7a11d65b1
Step 2/5 : RUN apt-get update && apt-get install -y python python-setuptools python-dev
 ---> Running in a7840dbfad17
Get:1 http://archive.ubuntu.com/ubuntu xenial InRelease [247 kB]
Get:2 http://security.ubuntu.com/ubuntu xenial-security InRelease [102 kB]
Get:3 http://archive.ubuntu.com/ubuntu xenial-updates InRelease [102 kB]
Get:4 http://security.ubuntu.com/ubuntu xenial-security/universe Sources [46.3 kB]
Get:5 http://archive.ubuntu.com/ubuntu xenial-backports InRelease [102 kB]
Get:6 http://security.ubuntu.com/ubuntu xenial-security/main amd64 Packages [440 kB]
Step 3/5 : RUN pip install flask flask-mysql
 ---> Running in a4a6c9190ba3
Collecting flask
  Downloading Flask-0.12.2-py2.py3-none-any.whl (83kB)
Collecting flask-mysql
  Downloading Flask_MySQL-1.4.0-py2.py3-none-any.whl
Removing intermediate container a4a6c9190ba3
Step 4/5 : COPY app.py /opt/
 ---> e7cdab17e782
Removing intermediate container faaaaf63c512
Step 5/5 : ENTRYPOINT FLASK_APP=/opt/app.py flask run --host=0.0.0.0
 ---> Running in d452c574a8bb
 ---> 9f27c36920bc
Removing intermediate container d452c574a8bb
Successfully built 9f27c36920bc
```

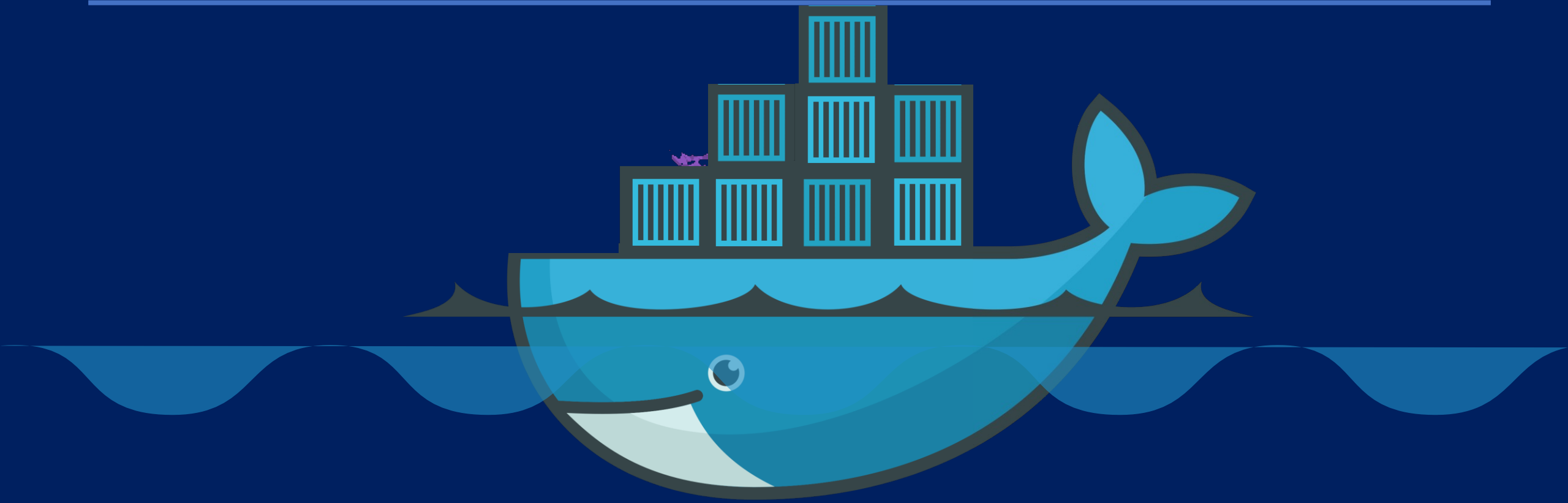
failure

- Layer 1. Base Ubuntu Layer
- Layer 2. Changes in apt packages
- Layer 3. Changes in pip packages
- Layer 4. Source code
- Layer 5. Update Entrypoint with “flask” command

```
docker build Dockerfile -t mmumshad/my-custom-app
```

```
root@osboxes:/root/simple-webapp-docker # docker build .
Sending build context to Docker daemon   5.12kB
Step 1/5 : FROM ubuntu
 ---> ccc7a11d65b1
Step 2/5 : RUN apt-get update && apt-get install -y python python-pip
 ---> Using cache
 ---> e4c055538e60
Step 3/5 : RUN pip install flask
 ---> Running in aacdaccd7403
Collecting flask
  Downloading Flask-0.12.2-py2.py3-none-any.whl (83kB)
Removing intermediate container aacdaccd7403
Step 4/5 : COPY app.py /opt/
 ---> af41ef57f6f3
Removing intermediate container a49cc8befc8f
Step 5/5 : ENTRYPOINT FLASK_APP=/opt/app.py flask run --host=0.0.0.0
 ---> Running in 3d745ff07d5a
 ---> 910416d360b6
Removing intermediate container 3d745ff07d5a
Successfully built 910416d360b6
```

Docker registry



Image

```
docker run nginx
```

Image


```
image:  docker.io/nginx/nginx
```

Registry

User/
Account

Image/
Repository

```
gcr.io/ kubernetes-e2e-test-images/dnsutils
```

Private Registry

```
docker login hub.docker.com
```

```
Login with your Docker ID to push and pull images from Docker Hub. If you don't have a Docker ID, head over to
https://hub.docker.com to create one.
Username: registry-user
Password:
WARNING! Your password will be stored unencrypted in /home/vagrant/.docker/config.json.

Login Succeeded
```

```
docker run private-registry.io/apps/internal-app
```

Deploy Private Registry

```
docker build -t <your-dockerhub-username>/<image_repository_name>:tag  .
```

```
docker push <your-dockerhub-username>/<image_repository_name>:tag
```

```
docker pull <your-dockerhub-username>/<image_repository_name>:tag
```

How to rename image with Docker tag

1. Build a Docker image with a tag:

perl Copy code

```
docker build -t my-lab:1.0 .
```

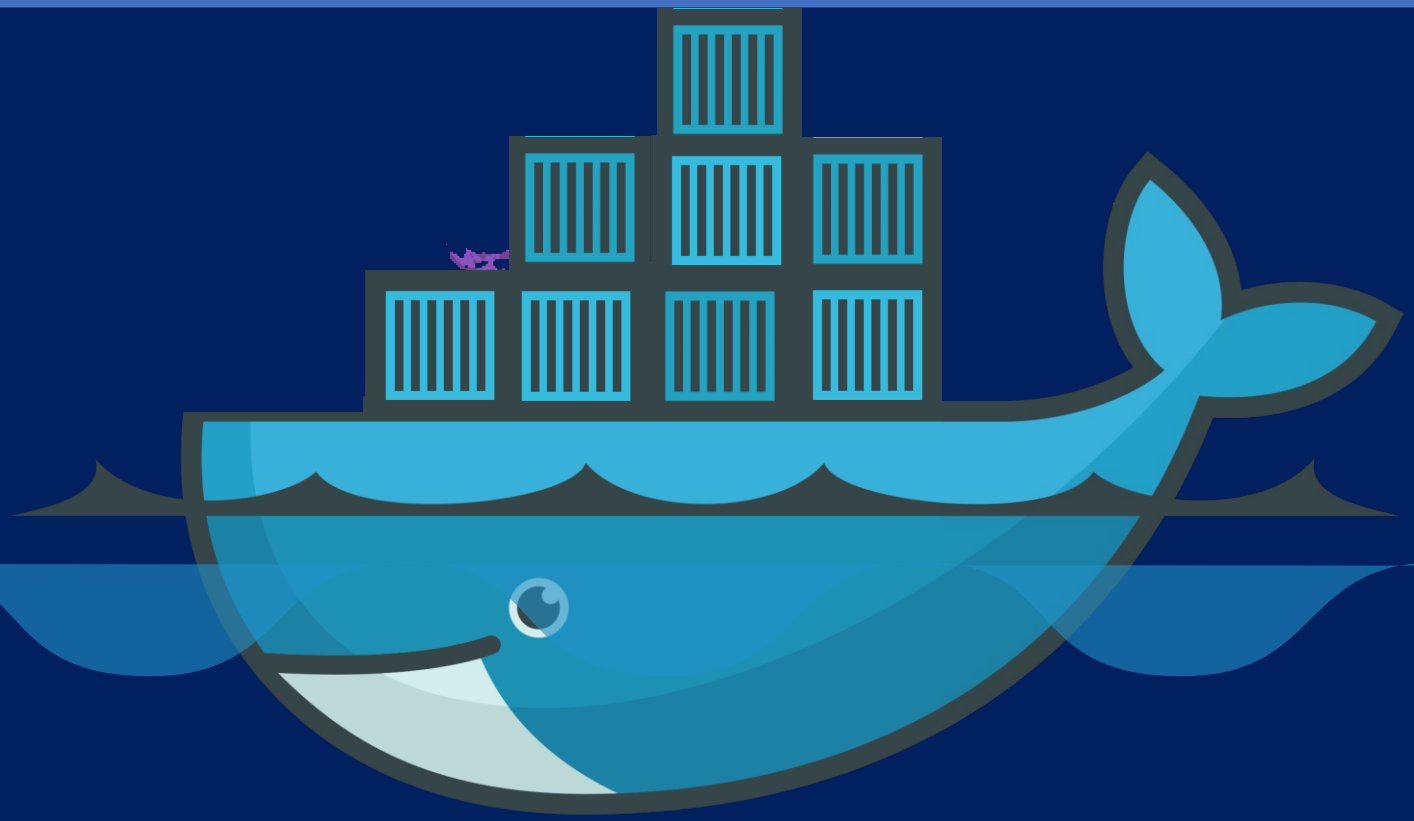
This builds a Docker image with the name `my-lab` and the tag `1.0`.

2. Rename the Docker image with a new tag:

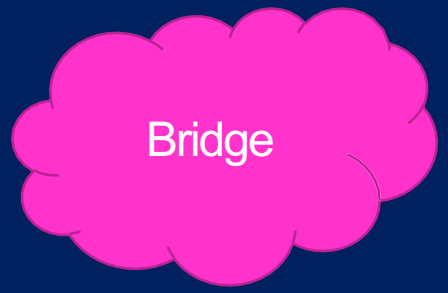
perl Copy code

```
docker tag my-lab:1.0 my-registry/my-lab:latest
```

Docker Network



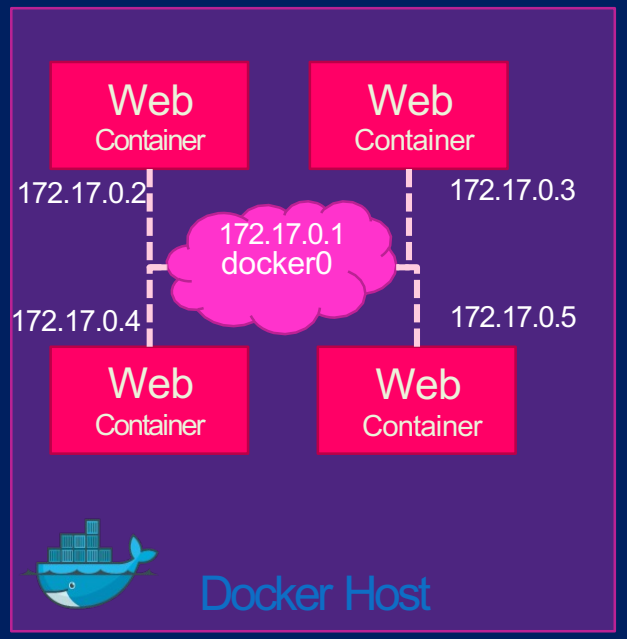
Default networks

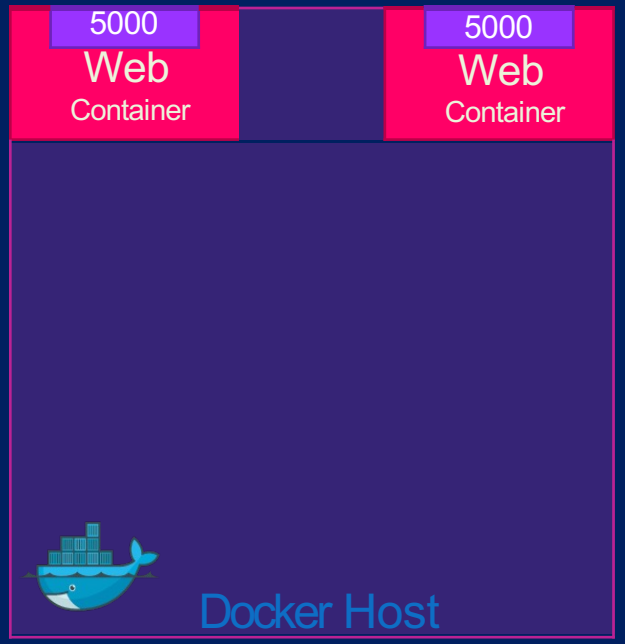



```
docker run ubuntu
```

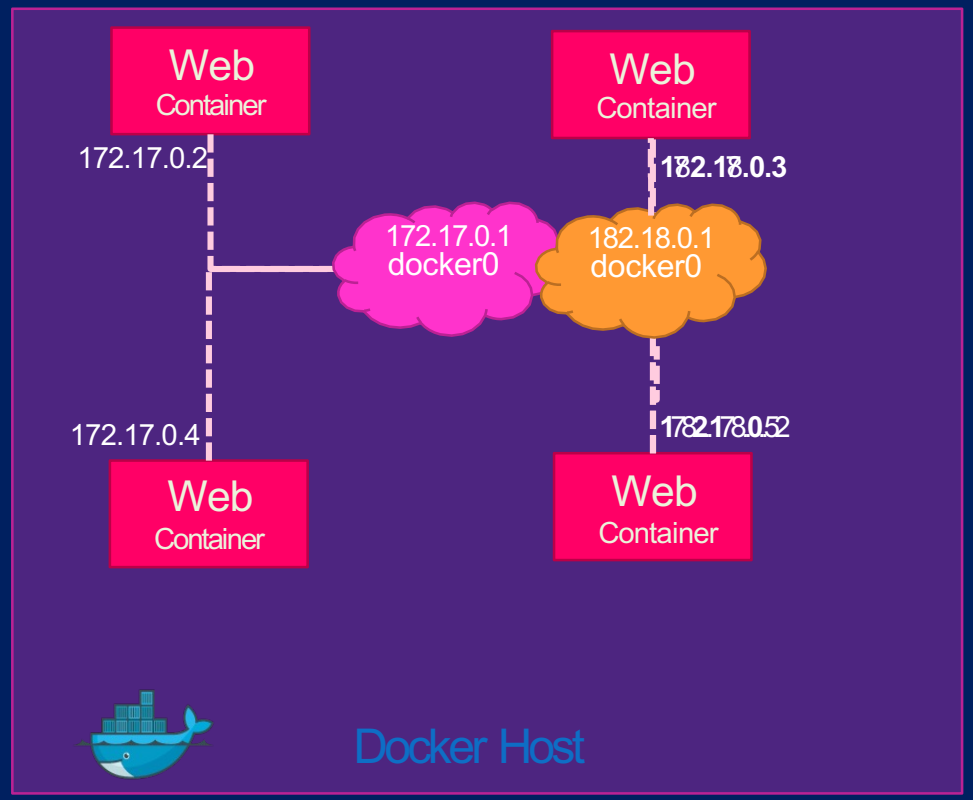
```
docker run Ubuntu --network=none
```

```
docker run Ubuntu --network=host
```





User-defined networks




```
docker network create \
    --driver bridge \
    --subnet 182.18.0.0/16
    custom-isolated-network
```

```
docker network ls
```

```
root@osboxes:/root # docker network ls
NETWORK ID          NAME                          DRIVER              SCOPE
dba0fb9370fe        bridge                        bridge              local
46d476b87cd9        customer-isolated-network     bridge              local
6de685cec1ce        docker_gwbridge               bridge              local
e29d188b4e47        host                          host                local
mmrho7vsb9rm        ingress                       overlay             swarm
d9f11695f0d6        none                          null                local
d371b4009142        simplewebappdocker_default    bridge              local
```

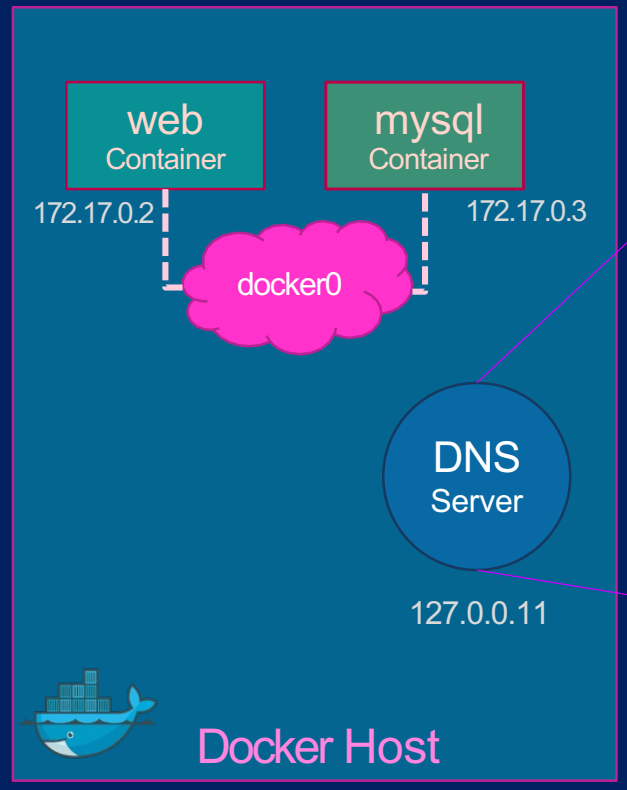
Inspect Network

```
docker inspect blissful_hopper
```

```
[
    {
        "Id": "35505f7810d17291261a43391d4b6c0846594d415ce4f4d0a6ffbf9cc5109048",
        "Name": "/blissful_hopper",
        "NetworkSettings": {
            "Bridge": "",
            "Gateway": "172.17.0.1",
            "IPAddress": "172.17.0.6",
            "MacAddress": "02:42:ac:11:00:06",
            "Networks": {
                "bridge": {
                    "Gateway": "172.17.0.1",
                    "IPAddress": "172.17.0.6",
                    "MacAddress": "02:42:ac:11:00:06",
                }
            }
        }
]
```

Embedded DNS

```
mysql.connect(  mysql      )
```



Host	IP
web	172.17.0.2
mysql	172.17.0.3

Lab Docker Network with Subnet

This guide explains how to create a lab Docker network with a specific subnet using a busybox container.

1. Create a new Docker network named "lab_network" with a specific subnet, e.g., 192.168.100.0/24, using the following command:

```
docker network create --subnet 192.168.100.0/24 lab_network
```

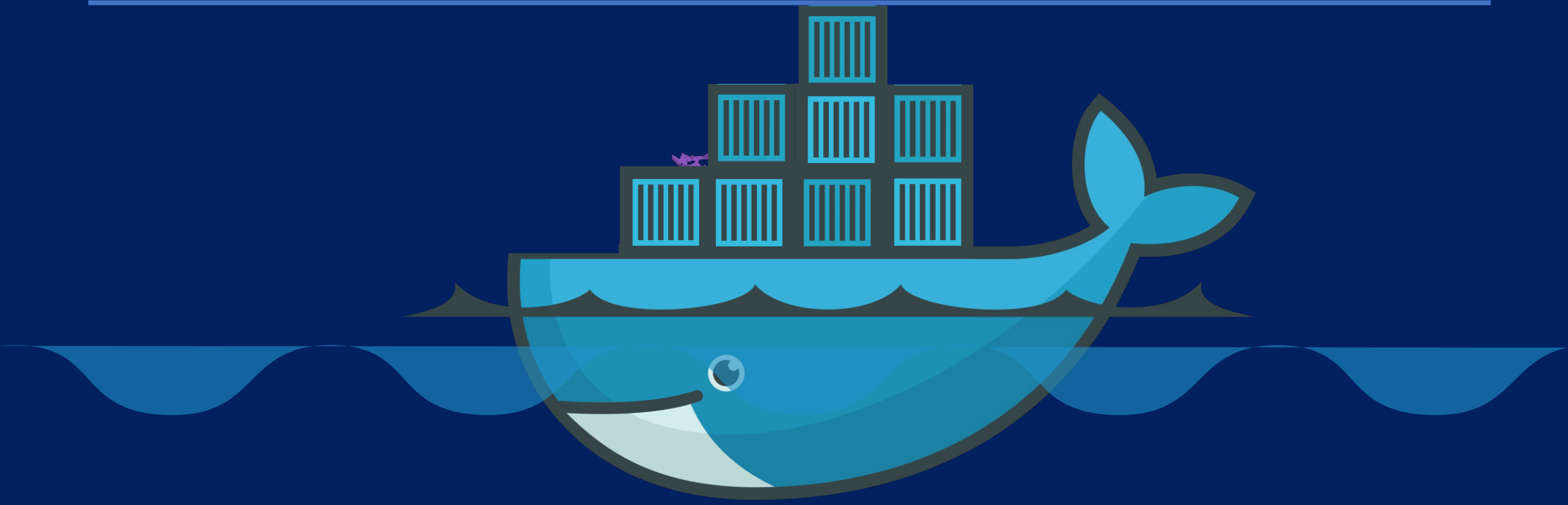
2. To confirm that the "lab_network" has been created and to view its settings, run the following command:

```
docker network inspect lab_network
```

3. Run a new container with the busybox image and connect it to the "lab_network" using the following command:

```
docker run  --name busybox_container --network lab_network busybox
```

Docker compose



Docker compose

```
docker run yourname/simple-webapp
```

```
docker run mongodb
```

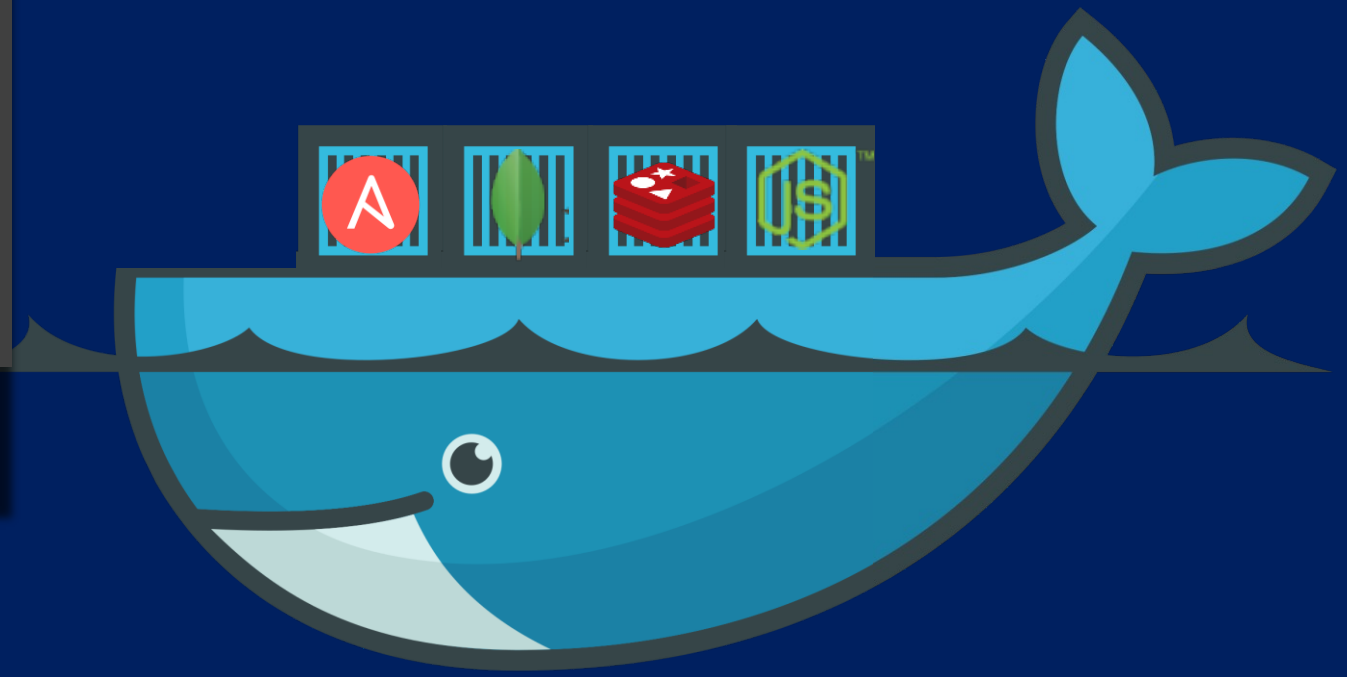
```
docker run redis:alpine
```

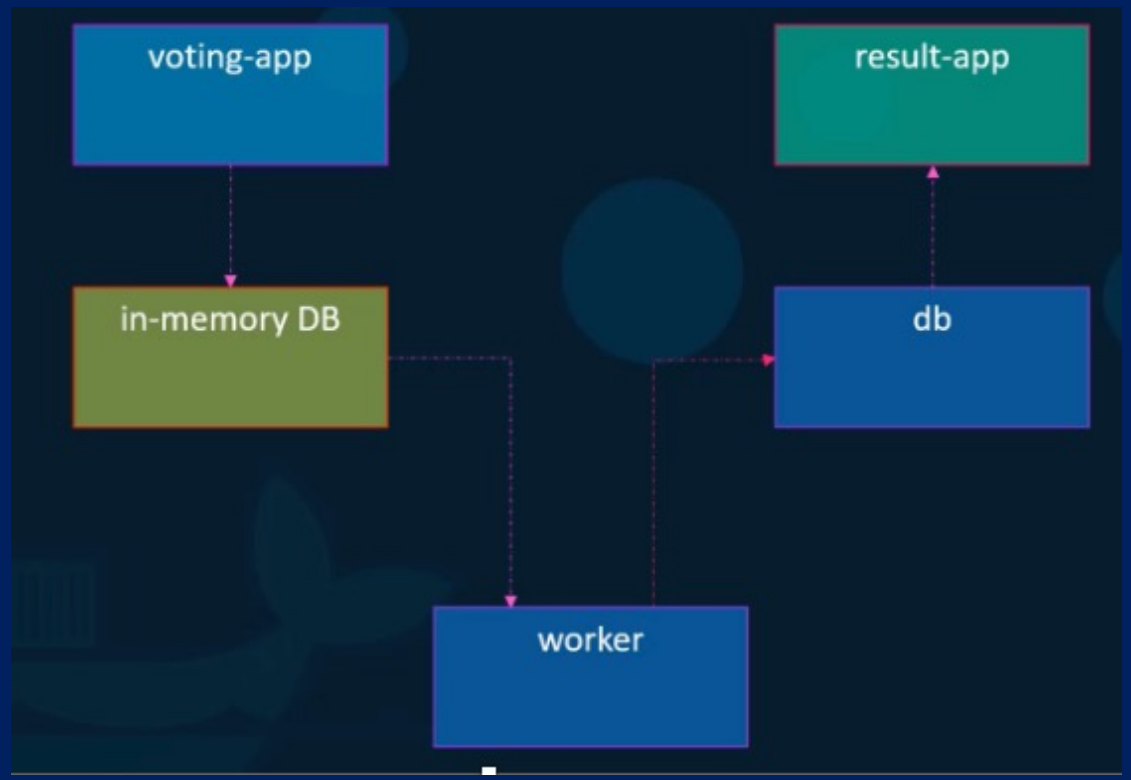
```
docker run ansible
```

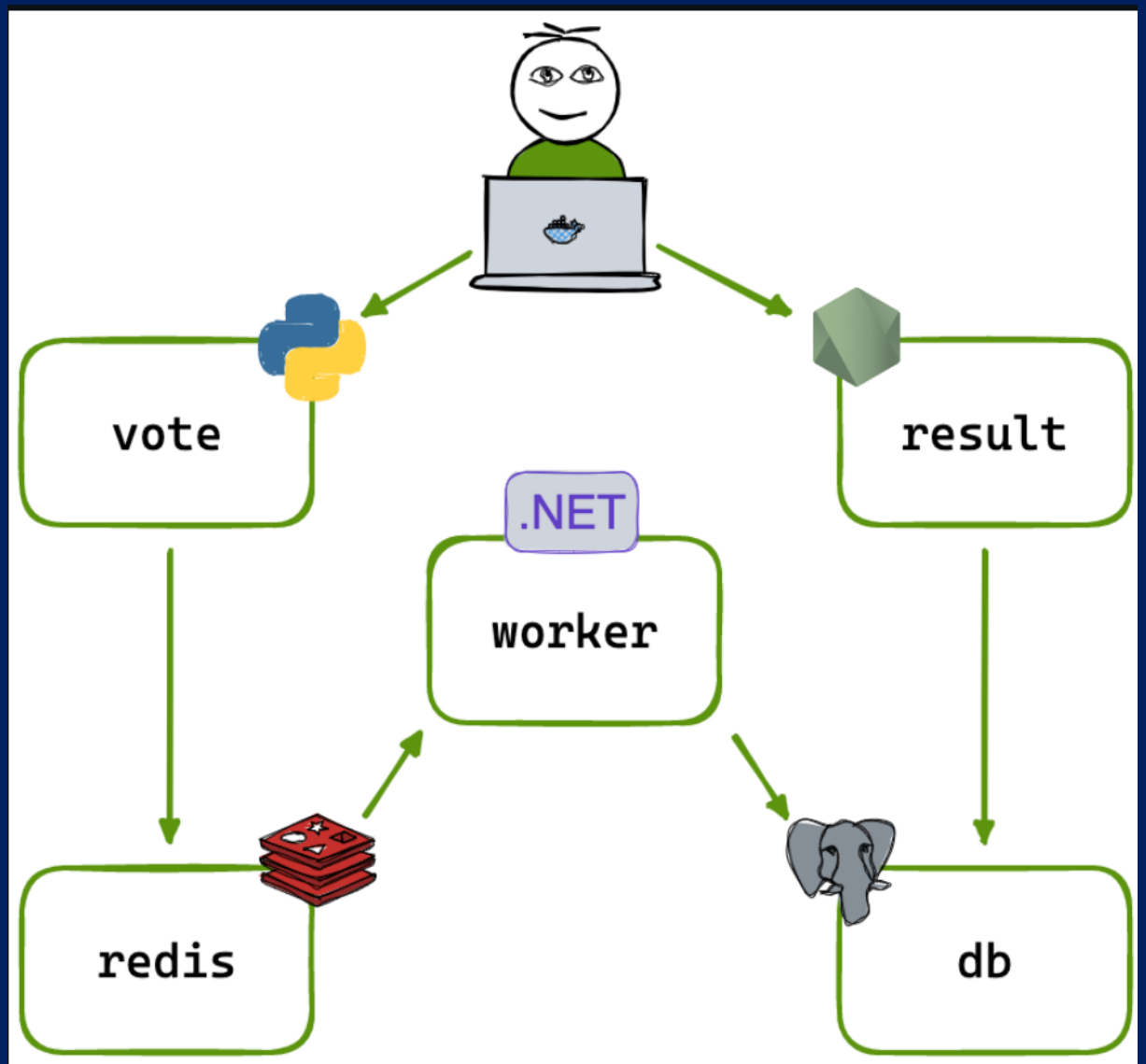
docker-compose.yml

```
services:
     web:
        image: “yourname/simple-webapp"
     database:
        image: “mongodb“
     messaging:
        image: "redis:alpine“
     orchestration:
        image:  “ansible“
```

```
docker-compose up
```

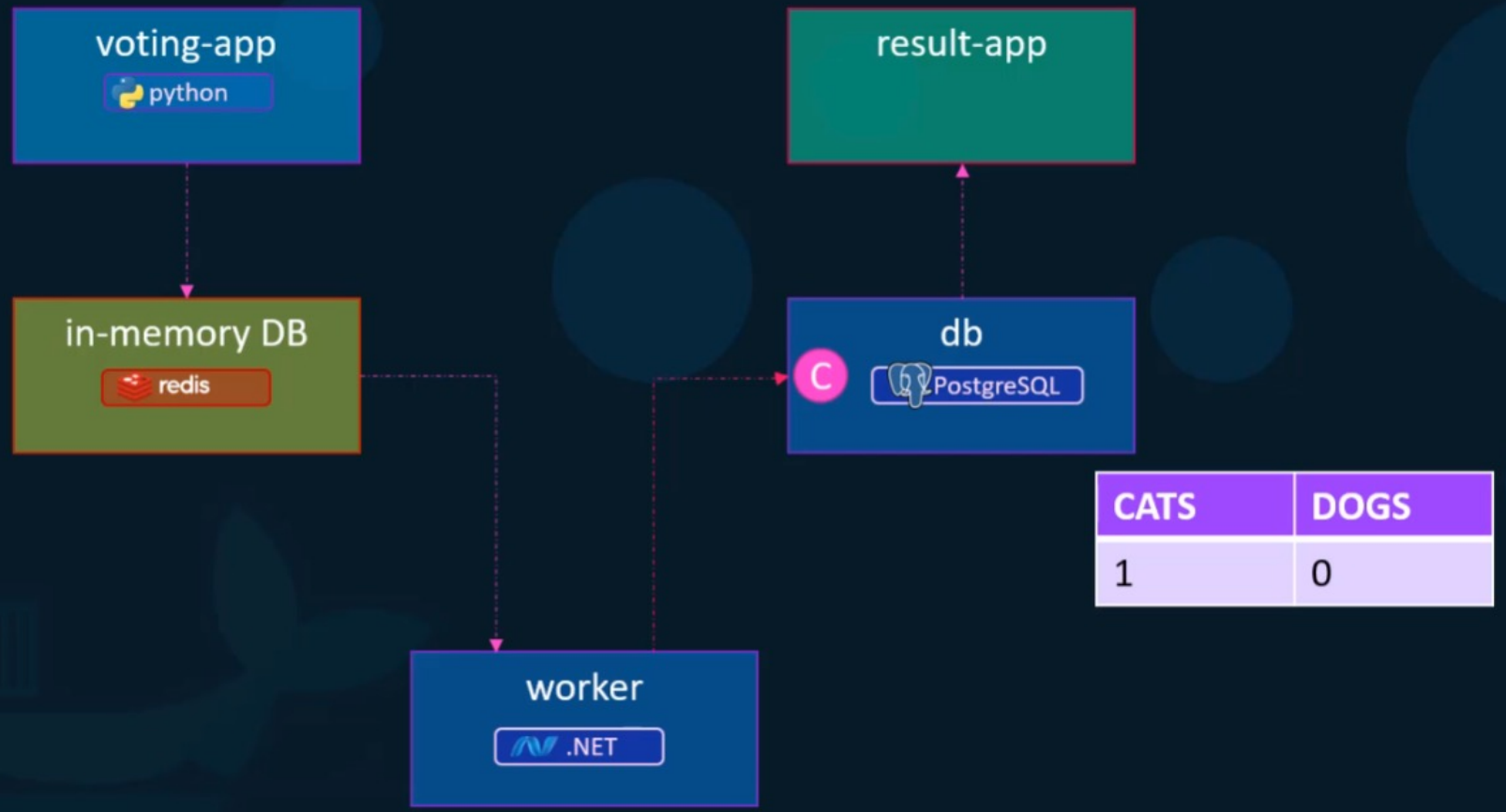






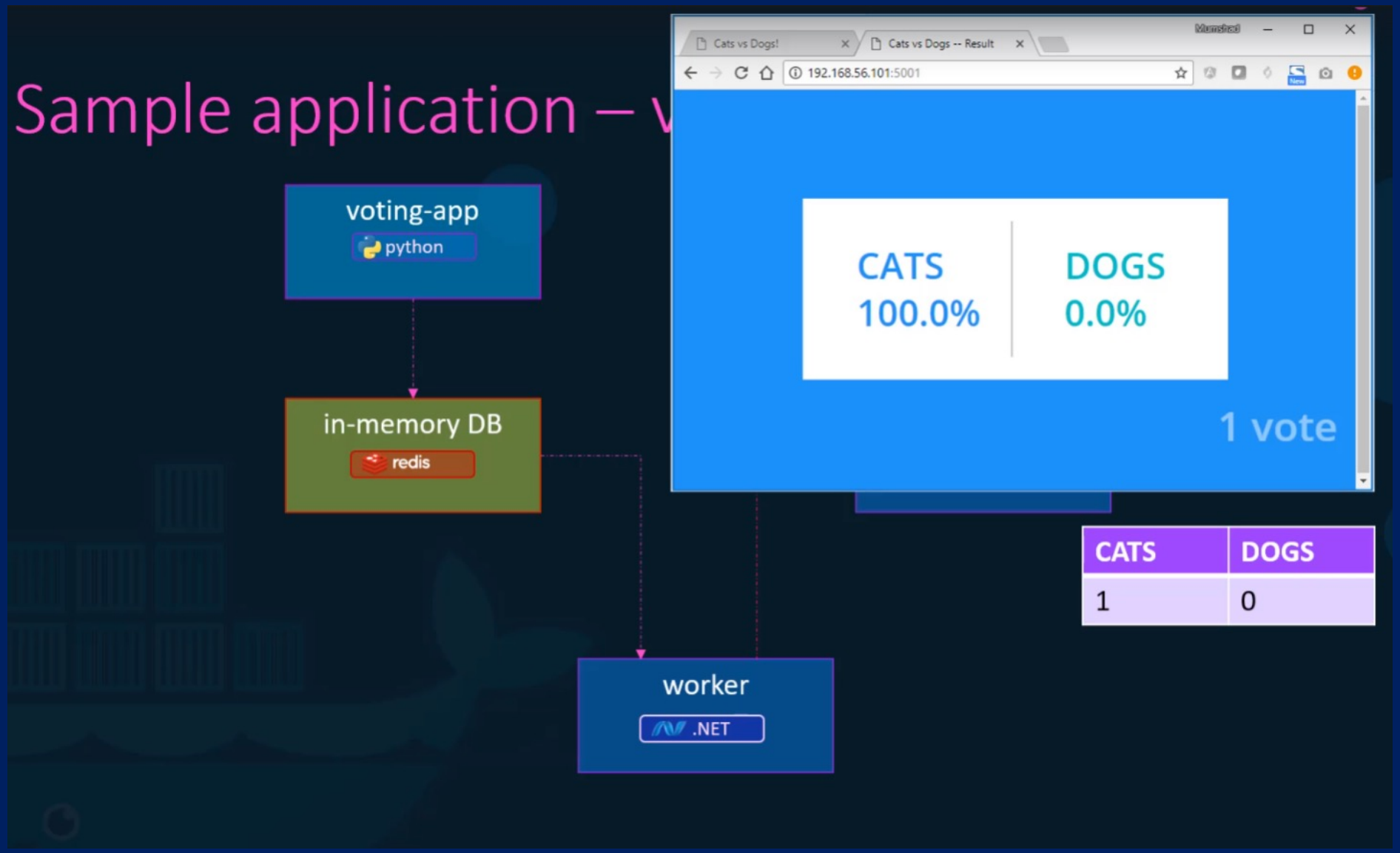
- A front-end web app in Python which lets you vote between two options
- A Redis which collects new votes
- A .NET worker which consumes votes and stores them in...
- A Postgres database backed by a Docker volume
- A Node.js web app which shows the results of the voting in real time

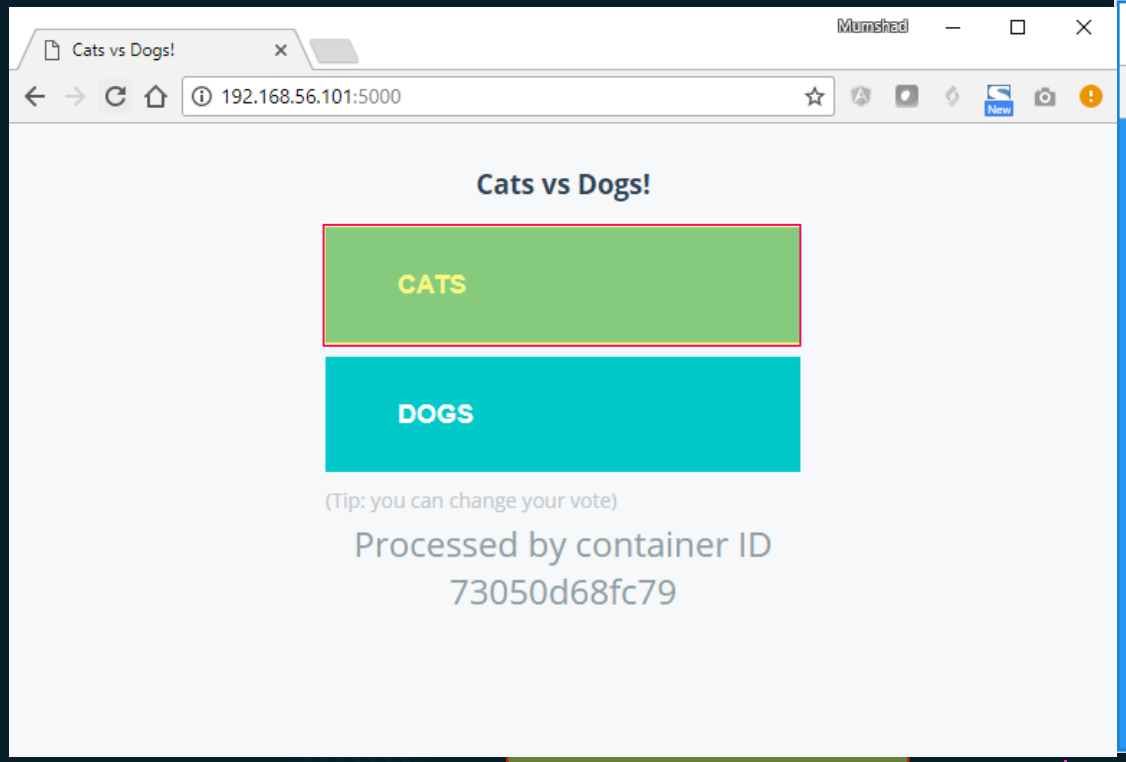
Sample application – voting application

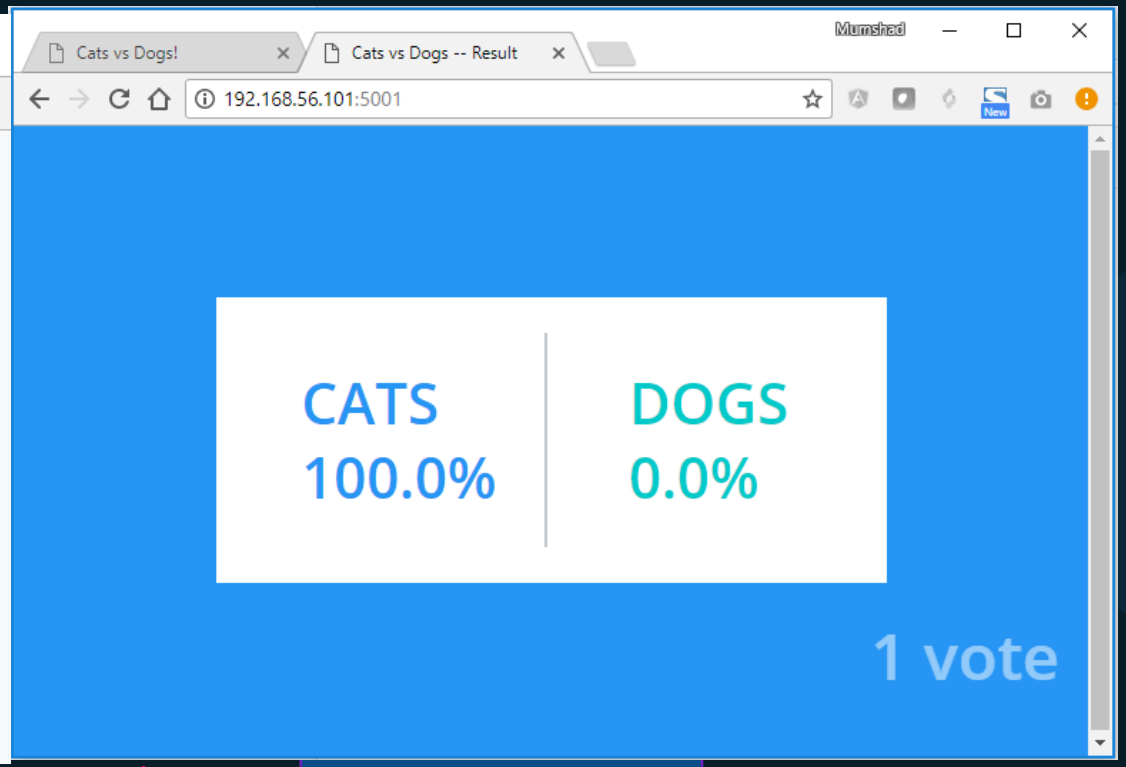


CATS	DOGS
1	0

Sample application – v







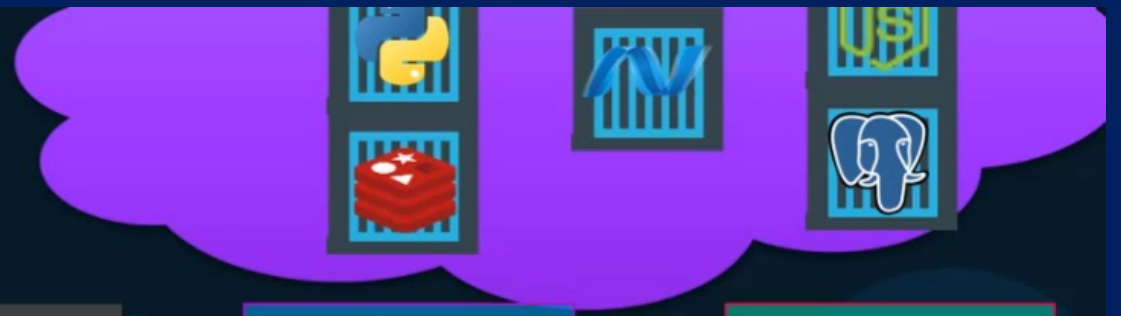
CATS	DOGS
1	0

worker

.NET

docker run

```
docker run -d --name=redis redis
```



voting-app

result-app

in-memory DB

db

worker

docker run

```
docker run -d --name=redis redis
```

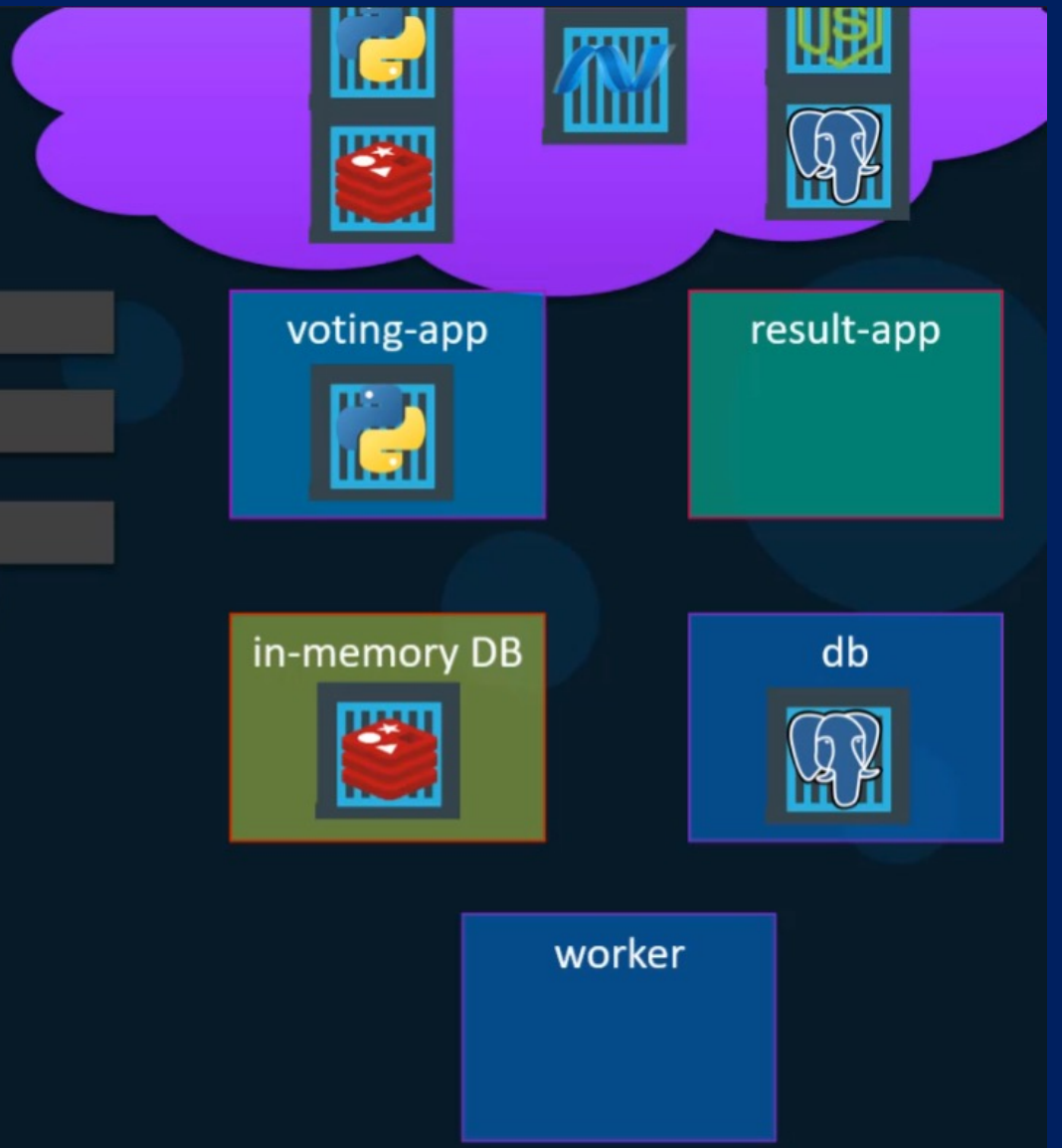
```
docker run -d --name=db postgres
```

docker run

```
docker run -d --name=redis redis
```

```
docker run -d --name=db postgres
```

```
docker run -d --name=vote -p 5000:80  voting-app
```



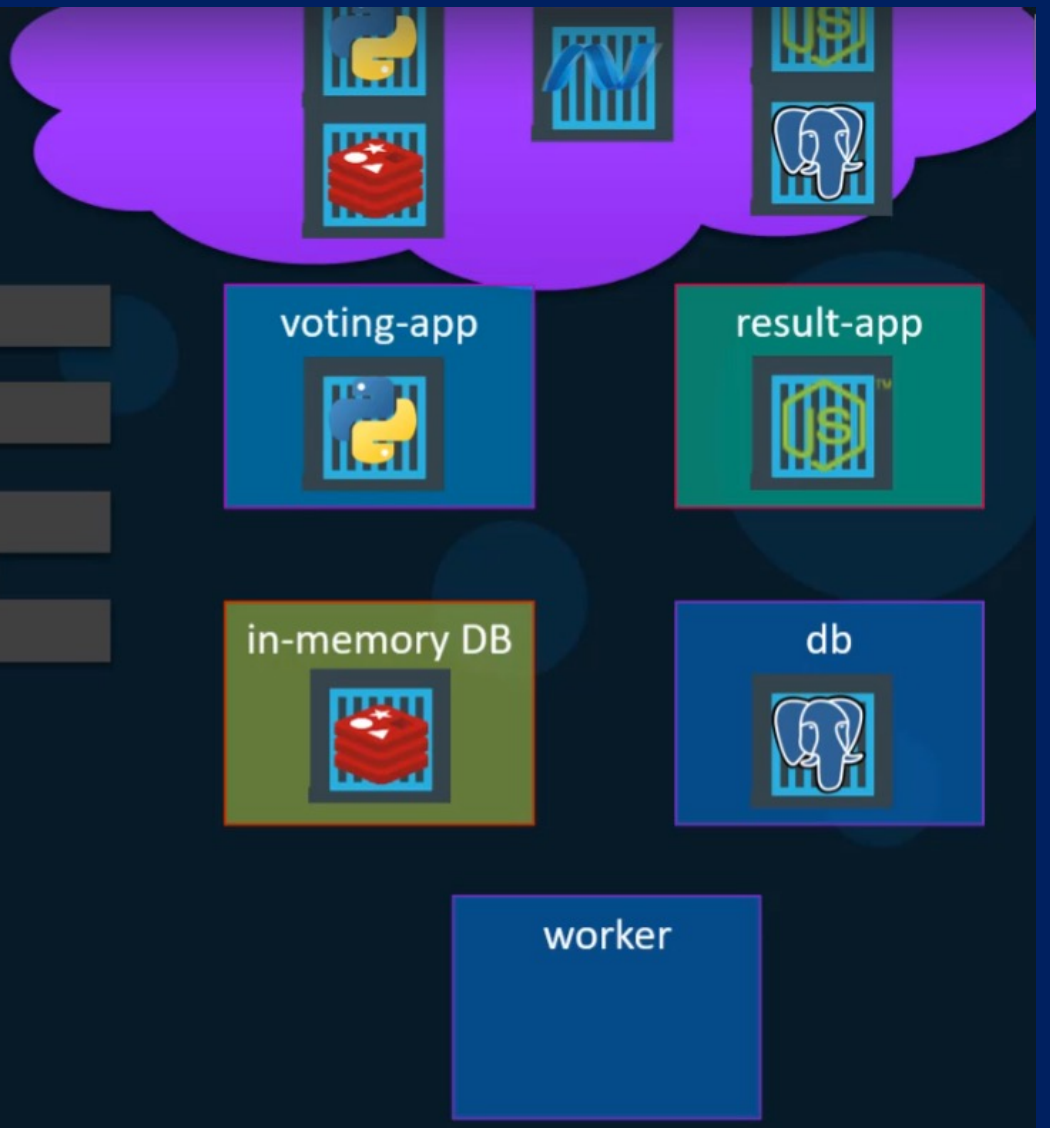
docker run

```
docker run -d --name=redis redis
```

```
docker run -d --name=db postgres
```

```
docker run -d --name=vote -p 5000:80  voting-app
```

```
docker run -d --name=result -p 5001:80  result-app
```



docker run

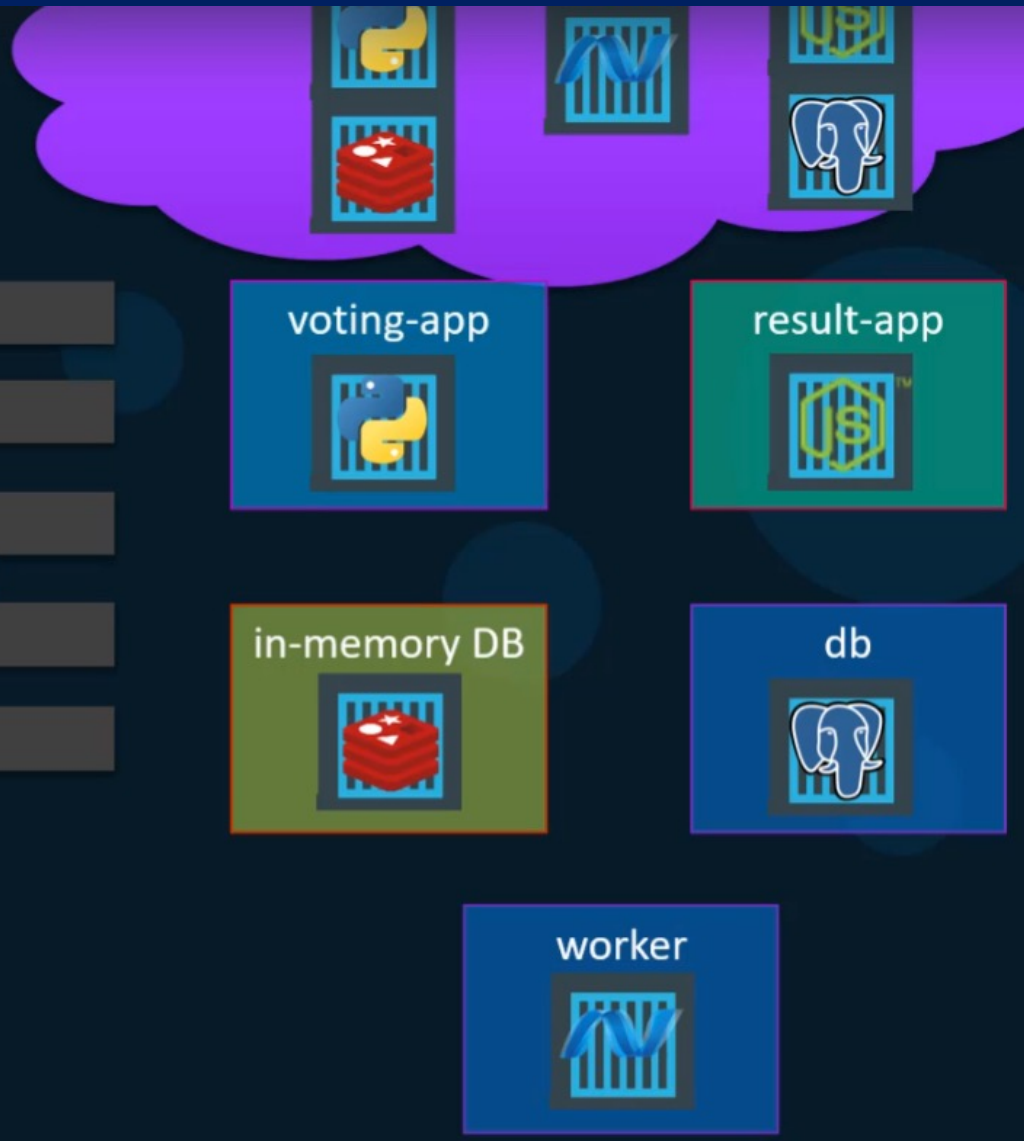
```
docker run -d --name=redis redis
```

```
docker run -d --name=db postgres
```

```
docker run -d --name=vote -p 5000:80  voting-app
```

```
docker run -d --name=result -p 5001:80  result-app
```

```
docker run -d --name=worker  worker
```



docker run

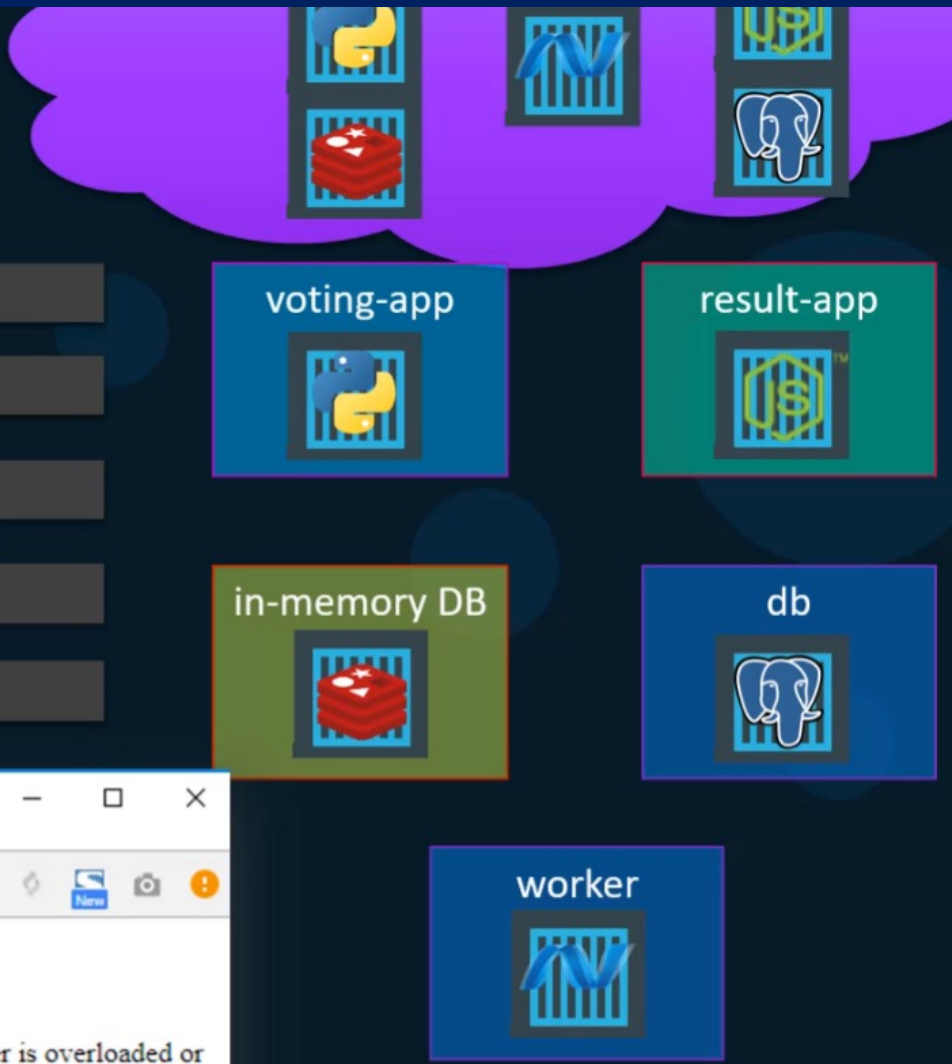
```
docker run -d --name=redis redis
```

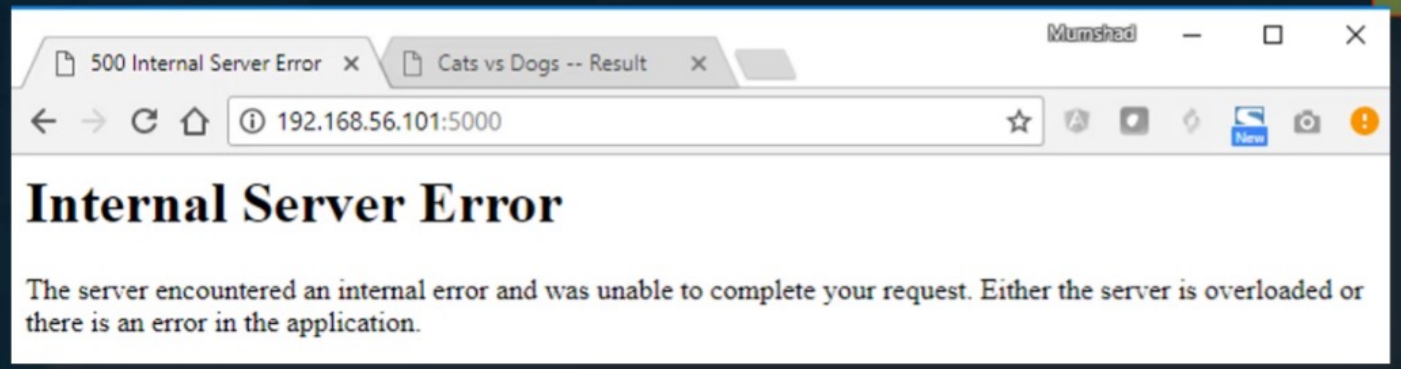
```
docker run -d --name=db postgres
```

```
docker run -d --name=vote -p 5000:80  voting-app
```

```
docker run -d --name=result -p 5001:80  result-app
```

```
docker run -d --name=worker  worker
```





docker run --links

```
docker run -d --name=redis redis
```

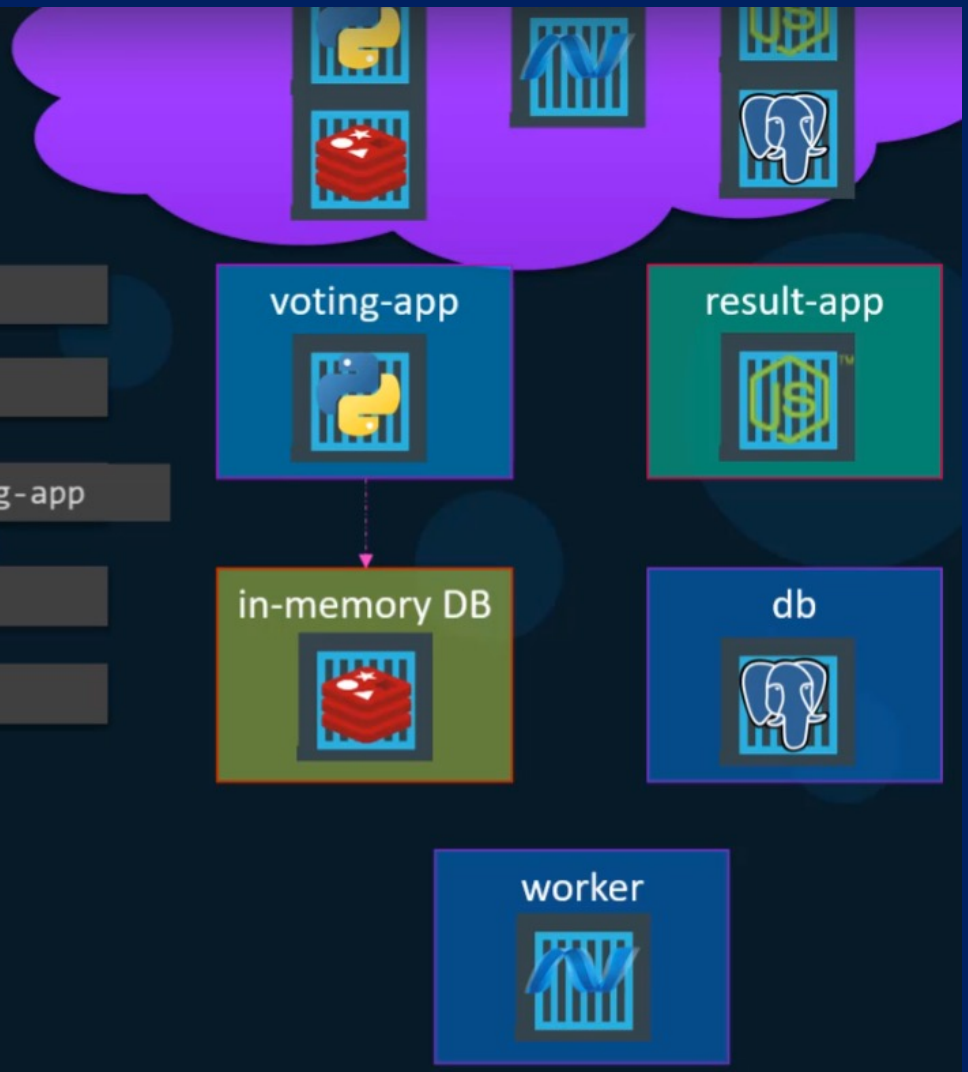
```
docker run -d --name=db postgres
```

```
docker run -d --name=vote -p 5000:80 --link redis:redis voting-app
```

```
docker run -d --name=result -p 5001:80  result-app
```

```
docker run -d --name=worker  worker
```

```
def get_redis():
    if not hasattr(g, 'redis'):
        g.redis = Redis(host="redis", db=0, socket_timeout=5)
    return g.redis
```



docker run --links

```
docker run -d --name=redis redis
```

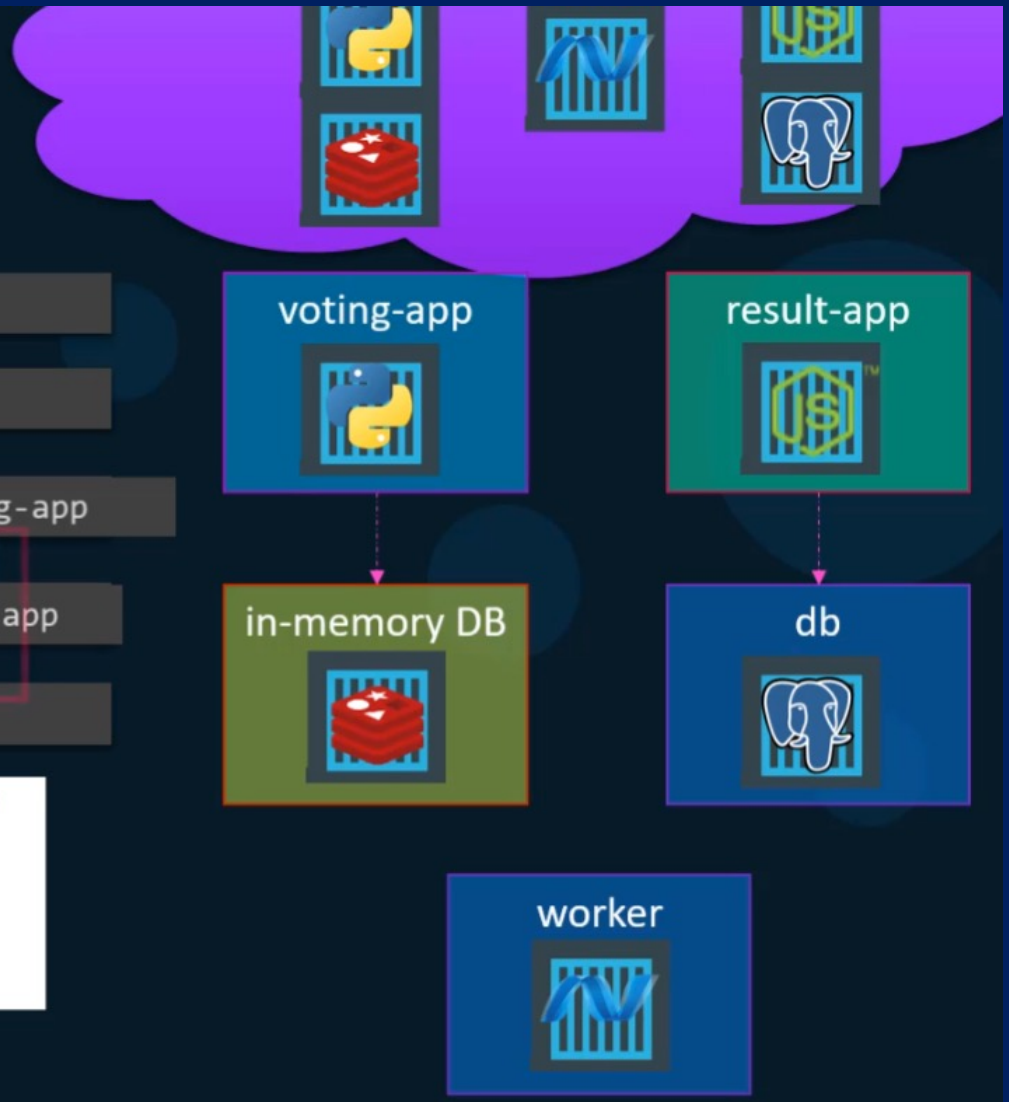
```
docker run -d --name=db postgres
```

```
docker run -d --name=vote -p 5000:80 --link redis:redis voting-app
```

```
docker run -d --name=result -p 5001:80 --link db:db result-app
```

```
docker run -d --name=worker worker
```

```
pg.connect('postgres://postgres@db/postgres', function(err, client, done) {
  if (err) {
    console.error("Waiting for db");
  }
  callback(err, client);
});
```



docker run --links

```
docker run -d --name=redis redis
```

```
docker run -d --name=db postgres
```

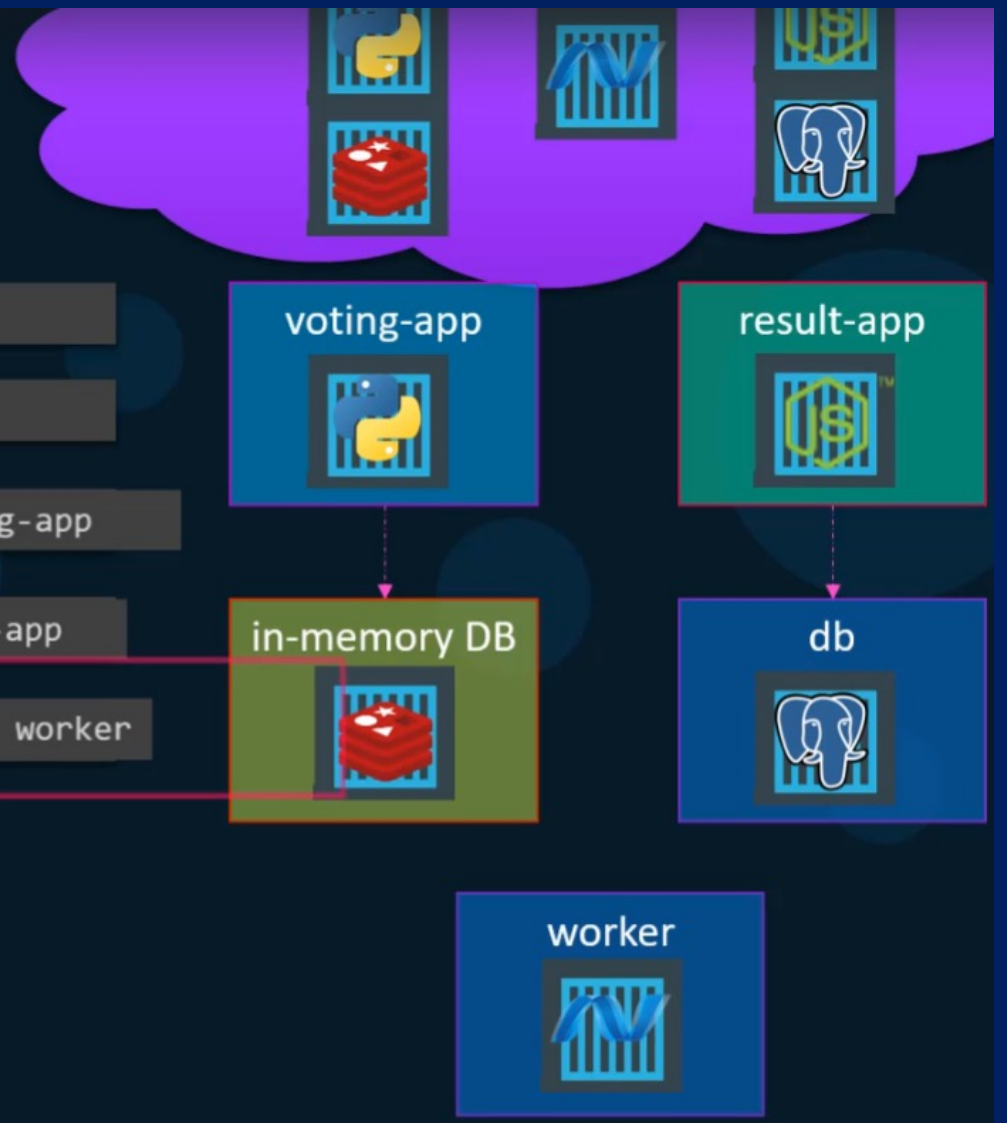
```
docker run -d --name=vote -p 5000:80 --link redis:redis voting-app
```

```
docker run -d --name=result -p 5001:80 --link db:db result-app
```

```
docker run -d --name=worker --link db:db --link redis:redis worker
```

```
try {
  Jedis redis = connectToRedis("redis");
  Connection dbConn = connectToDB("db");

  System.err.println("Watching vote queue");
```



Docker compose

```
docker run -d --name=redis redis
```

```
docker run -d --name=db postgres:9.4
```

```
docker run -d --name=vote -p 5000:80 --link redis:redis voting-app
```

```
docker run -d --name=result -p 5001:80 --link db:db result-app
```

```
docker run -d --name=worker --link db:db --link redis:redis worker
```

docker-compose.yml

```
redis:
  image: redis
db:
  image: postgres:9.4
vote:
  image: voting-app
  ports:
    - 5000:80
  links:
    - redis
result:
  image: result-app
  ports:
    - 5001:80
  links:
    - db
worker:
    image: worker
    links:
      - redis
      - db
```

Docker compose - build

docker-compose.yml

```
redis:
    image: redis
db:
    image: postgres:9.4
vote:
    image: voting-app
    ports:
        - 5000:80
    links:
        - redis
result:
    image: result
    ports:
        - 5001:80
    links:
        - db
worker:
    image: worker
    links:
        - db
        - redis
```

docker-compose.yml

```
redis:
    image: redis
db:
    image: postgres:9.4
vote:
    build: ./vote
    ports:
        - 5000:80
    links:
        - redis
result:
    build: ./result
    ports:
        - 5001:80
    links:
        - db
worker:
    build: ./worker
    links:
        - db
        - redis
```

Docker compose - versions

docker-compose.yml

```
redis:
    image: redis
db:
    image: postgres:9.4
vote:
    image: voting-app
    ports:
        - 5000:80
    links:
        - redis
```

version: 1

docker-compose.yml

```
version: 2
services:
    redis:
        image: redis
    db:
        image: postgres:9.4
    vote:
        image: voting-app
        ports:
            - 5000:80
        depends_on:
            - redis
```

version: 2

docker-compose.yml

```
version: 3
services:
   redis:
       image: redis
   db:
       image: postgres:9.4
   vote:
       image: voting-app
       ports:
           - 5000:80
```

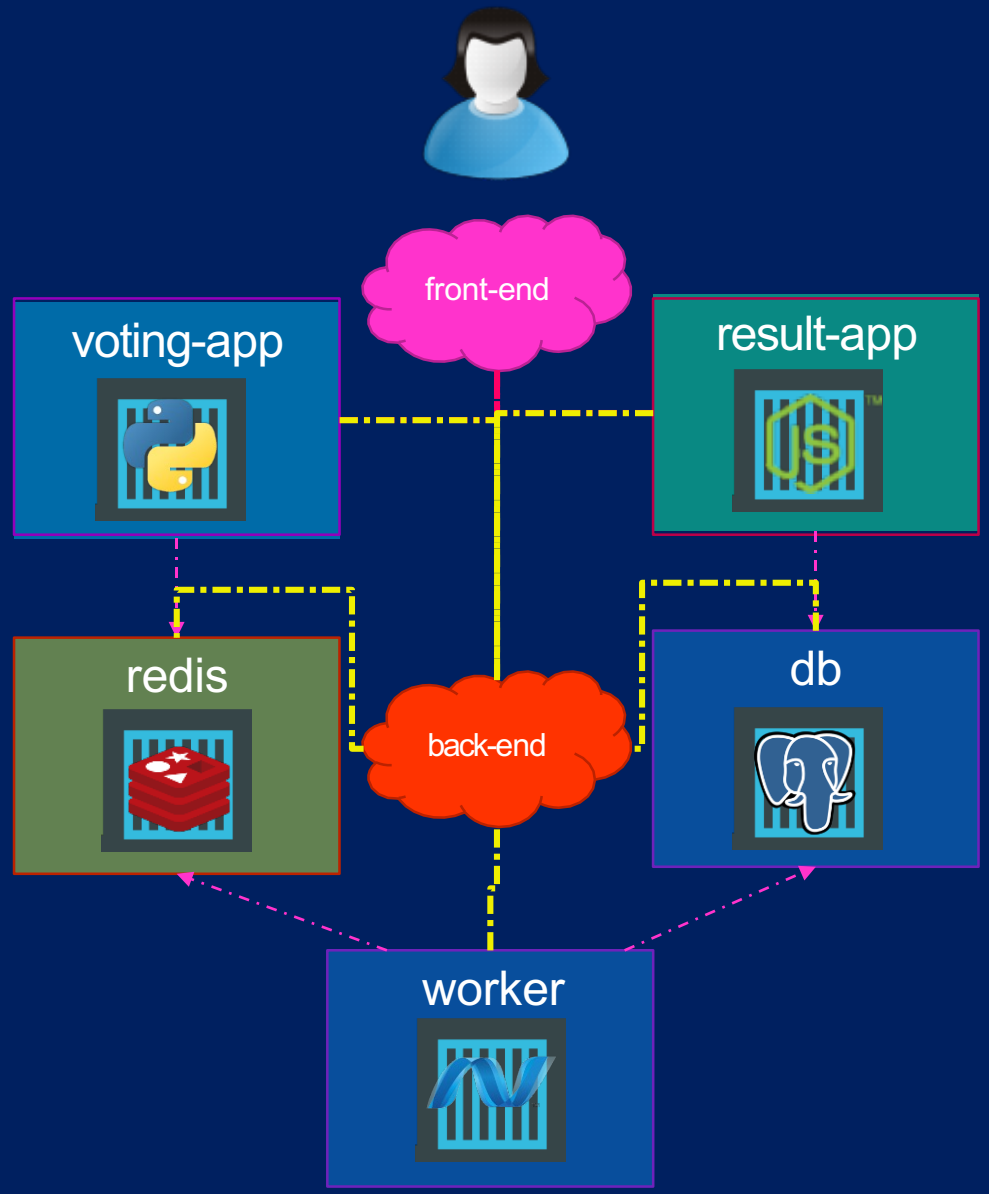
version: 3

Docker compose

docker-compose.yml

```
version: 2
services:
    redis:
        image: redis
        networks:
            - back-end
    db:
        image: postgres:9.4
        networks:
            - back-end
    vote:
        image: voting-app
        networks:
            - front-end
            - back-end
    result:
        image: result
        networks:
            - front-end
            - back-end

networks:
    front-end:
    back-end:
```



```yaml
redis:
  image: redis:alpine
  volumes:
    - "./healthchecks:/healthchecks"
  healthcheck:
    test: /healthchecks/redis.sh
    interval: "5s"
  networks:
    - back-tier

db:
  image: postgres:15-alpine
  environment:
    POSTGRES_USER: "postgres"
    POSTGRES_PASSWORD: "postgres"
  volumes:
    - "db-data:/var/lib/postgresql/data"
    - "./healthchecks:/healthchecks"
  healthcheck:
    test: /healthchecks/postgres.sh
    interval: "5s"
  networks:
    - back-tier
```

```yaml
vote:
  build: ./vote
  # use python rather than gunicorn for local dev
  command: python app.py
  depends_on:
    redis:
      condition: service_healthy
  healthcheck:
    test: ["CMD", "curl", "-f", "http://localhost"]
    interval: 15s
    timeout: 5s
    retries: 3
    start_period: 10s
  volumes:
   - ./vote:/app
  ports:
    - "5000:80"
  networks:
    - front-tier
    - back-tier

result:
  build: ./result
  # use nodemon rather than node for local dev
  entrypoint: nodemon server.js
  depends_on:
    db:
      condition: service_healthy
  volumes:
    - ./result:/app
  ports:
    - "5001:80"
    - "5858:5858"
  networks:
    - front-tier
    - back-tier
```

postgres.sh

```
#!/bin/bash
set -eo pipefail

host="$(hostname -i || echo '127.0.0.1')"
user="${POSTGRES_USER:-postgres}"
db="${POSTGRES_DB:-$POSTGRES_USER}"
export PGPASSWORD="${POSTGRES_PASSWORD:-}"

args=(
        # force postgres to not use the local unix socket (test "external" connectibility)
        --host "$host"
        --username "$user"
        --dbname "$db"
        --quiet --no-align --tuples-only
)

if select="$(echo 'SELECT 1' | psql "${args[@]}")" && [ "$select" = '1' ]; then
        exit 0
fi

exit 1
```

redis.sh

```
1   #!/bin/sh
2   set -eo pipefail
3
4   host="$(hostname -i || echo '127.0.0.1')"
5
6   if ping="$(redis-cli -h "$host" ping)" && [ "$ping" = 'PONG' ]; then
7           exit 0
8   fi
9
10  exit 1
```

You can run a Python script from within a shell script using the `python` command and capture its output using command substitution.

Here's an example:

bash Copy code

```bash
#!/bin/bash

# Run Python script and capture its output
output=$(python my_python_script.py)

# Print the output
echo $output
```

In this example, the shell script runs a Python script called `my_python_script.py` and captures its output into a variable called `output`. The `echo` command then prints the contents of the `output` variable.

You can modify this script to suit your specific needs by replacing `my_python_script.py` with the path to your Python script and modifying the `echo` command to do something else with the output.

docker-compose up

This command is used to start the containers defined in the docker-compose.yml file. If the containers don't exist, they will be created.

```
docker-compose up
```

docker-compose down

This command is used to stop and remove the containers defined in the docker-compose.yml file.

```
docker-compose down
```

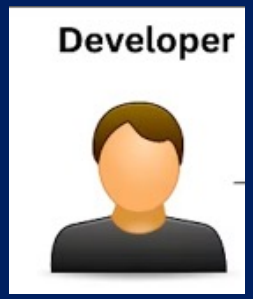
To delete all networks, images, and volumes with Docker Compose, you can use the following commands:

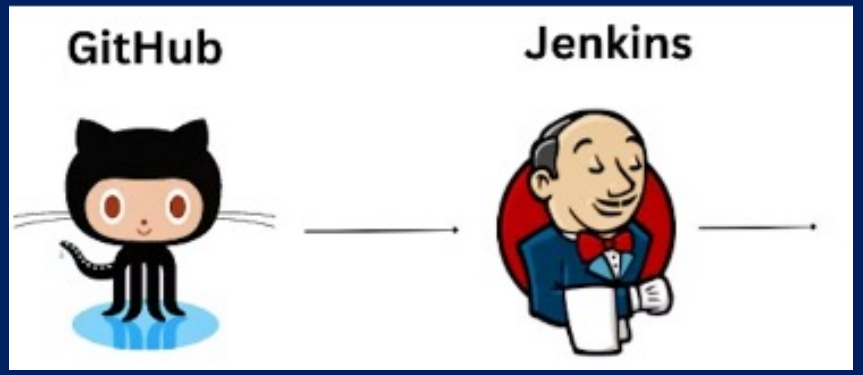
```
docker-compose down --rmi all --volumes --remove-orphans
```

- The --rmi all flag tells Docker to remove all images associated with the containers.
- The --volumes flag tells Docker to remove any volumes associated with the containers.
- The --remove-orphans flag tells Docker to remove any containers that were not defined in the docker-compose.yml file.

```
docker network prune
docker volume prune
```

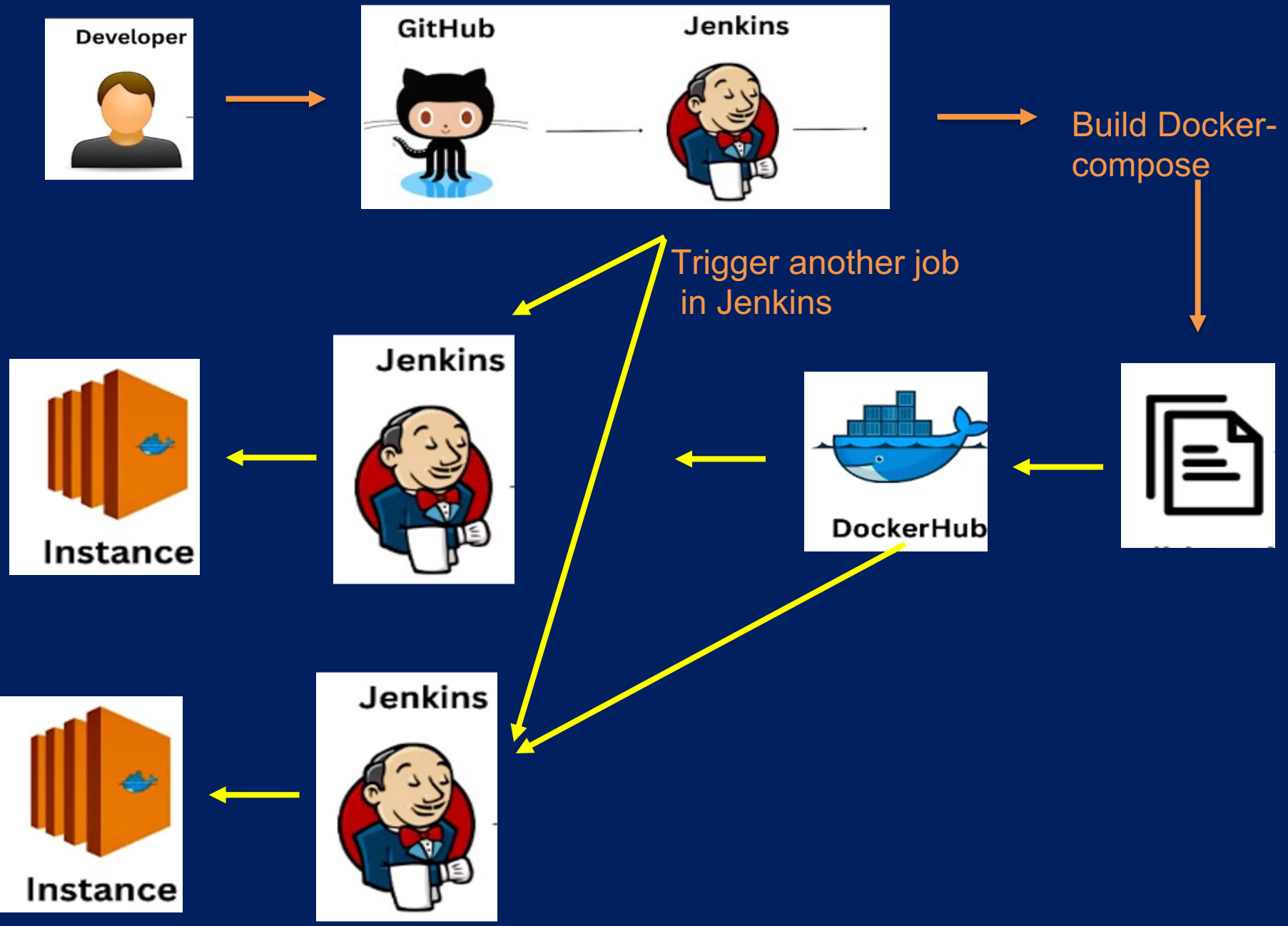
- The second command (docker network prune) will remove any unused networks.
- The third command (docker volume prune) will remove any unused volumes.





Build Docker-compose

Trigger another job
in Jenkins


Developer
GitHub
Jenkins
Build Docker-compose
Trigger another job in Jenkins
Jenkins
Instance
DockerHub
Jenkins
Instance