Introduction to Docker & 12 Factor App Implementation Using Docker

Cemal Ünal

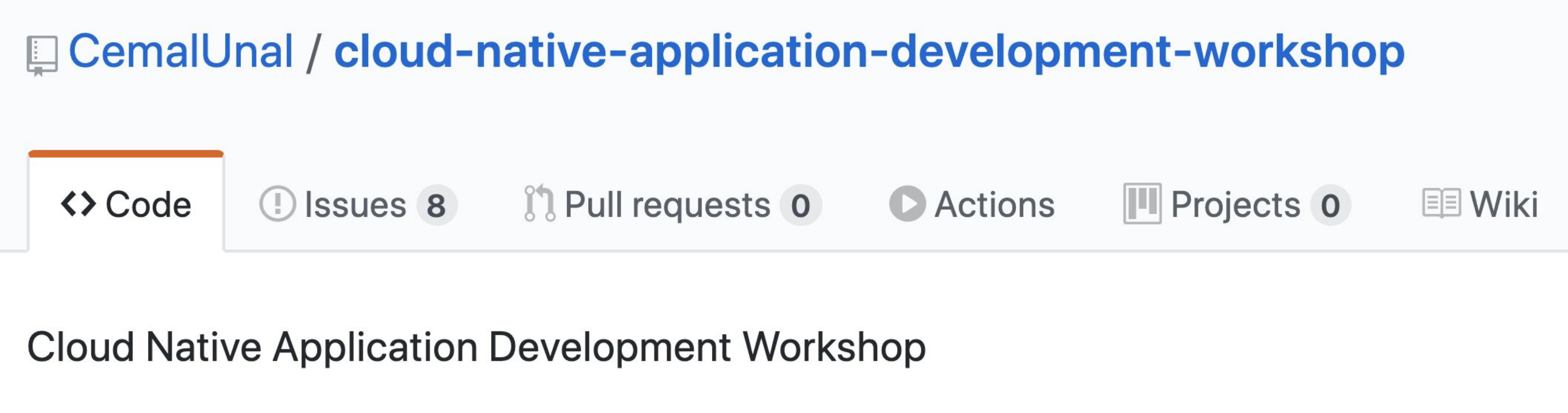
- Software Engineer @ Havelsan Inc.

in cemalunal

GitHub cemalunal

✉ cunal@havelsan.com.tr

Getting Started



CemalUnal / cloud-native-application-development-workshop

Cloud Native Application Development Workshop

```
$ git clone https://github.com/cemalunal/cloud-native-application-development-workshop.git
```

Glossary

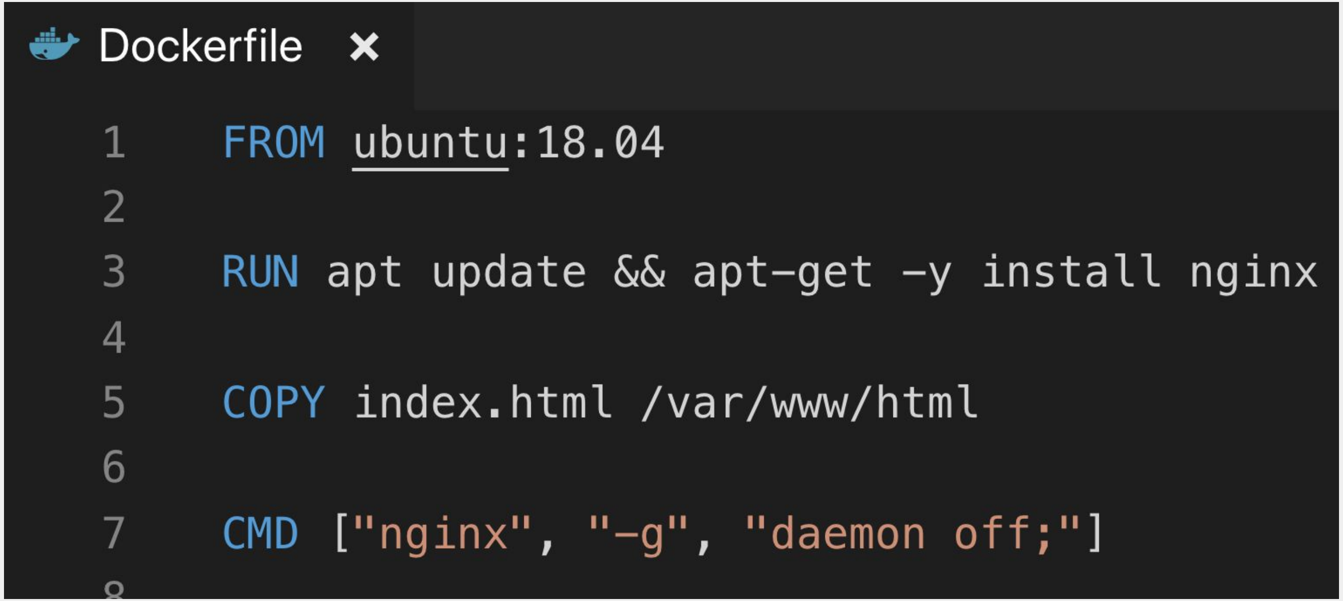
- **Image:** A package that contains the application along with the dependencies that required to run this application.

- **Container:** Running instance of the image

- **Tag:** Convey useful information about a specific image version/variant

- **Registry:** Storage and distribution system for named images

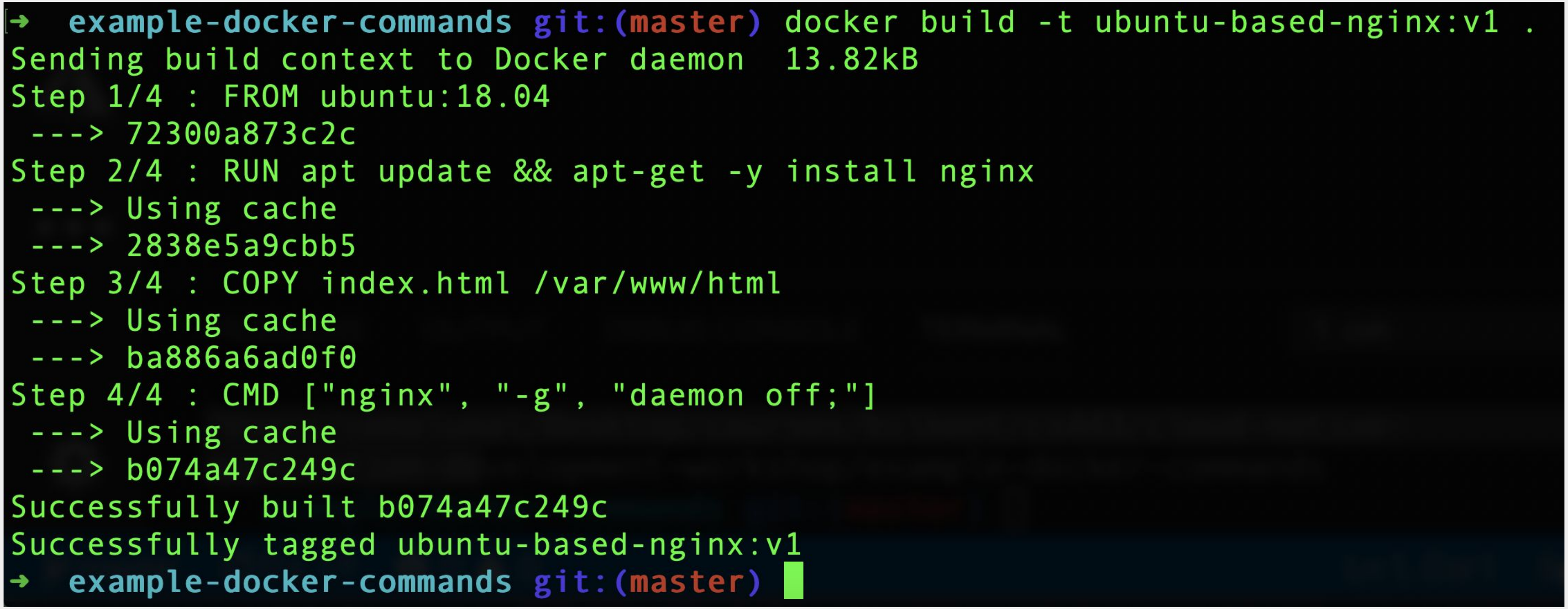
Dockerfile Example



```
FROM ubuntu:18.04

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

COPY index.html /var/www/html

CMD ["nginx", "-g", "daemon off;"]
```

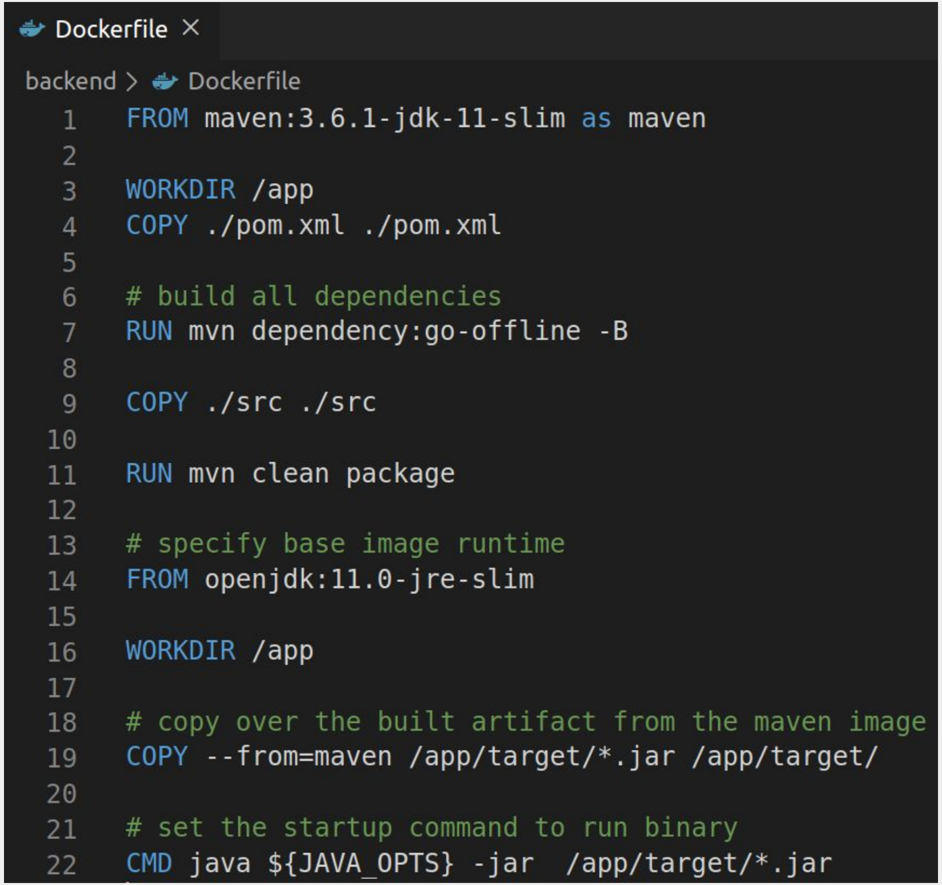
Docker Build Command

- Allows us to build an image using a Dockerfile



```
➜  example-docker-commands git:(master) docker build -t ubuntu-based-nginx:v1 .
Sending build context to Docker daemon  13.82kB
Step 1/4 : FROM ubuntu:18.04
 ---> 72300a873c2c
Step 2/4 : RUN apt update && apt-get -y install nginx
 ---> Using cache
 ---> 2838e5a9cbb5
Step 3/4 : COPY index.html /var/www/html
 ---> Using cache
 ---> ba886a6ad0f0
Step 4/4 : CMD ["nginx", "-g", "daemon off;"]
 ---> Using cache
 ---> b074a47c249c
Successfully built b074a47c249c
Successfully tagged ubuntu-based-nginx:v1
➜  example-docker-commands git:(master) 
```

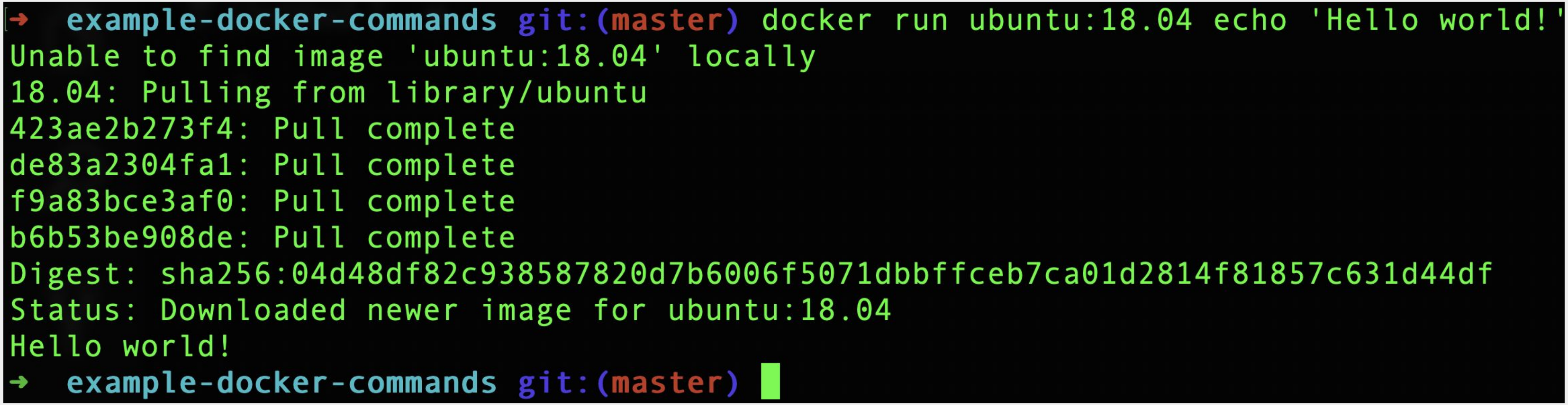
Dockerfile Example of a Java Program



```
FROM maven:3.6.1-jdk-11-slim as maven

WORKDIR /app
COPY ./pom.xml ./pom.xml

# build all dependencies
RUN mvn dependency:go-offline -B

COPY ./src ./src

RUN mvn clean package

# specify base image runtime
FROM openjdk:11.0-jre-slim

WORKDIR /app

# copy over the built artifact from the maven image
COPY --from=maven /app/target/*.jar /app/target/

# set the startup command to run binary
CMD java ${JAVA_OPTS} -jar  /app/target/*.jar
```

Docker Run

- Allows us to create a running instance (container) of an image



```
➜  example-docker-commands git:(master) docker run ubuntu:18.04 echo 'Hello world!'
Unable to find image 'ubuntu:18.04' locally
18.04: Pulling from library/ubuntu
423ae2b273f4: Pull complete
de83a2304fa1: Pull complete
f9a83bce3af0: Pull complete
b6b53be908de: Pull complete
Digest: sha256:04d48df82c938587820d7b6006f5071dbbffceb7ca01d2814f81857c631d44df
Status: Downloaded newer image for ubuntu:18.04
Hello world!
➜  example-docker-commands git:(master) 
```

Docker Volumes

- By default all files created inside a container do not persist when that container no longer exists

- Two options available:
  - Volumes
    - Managed by Docker
    - docker volume create test-volume
    - docker run -v test-volume:/data ....

  - Bind mounts
    - A file or directory on the host machine is mounted into a container
    - The file or directory is referenced by its full path on the host machine
    - docker run -v /full/path/here:/data ....

Docker Volumes Options Use Cases

- Volume
  - Allows storage for container’s data on a remote host or a cloud provider
  - Backup operations are simple
  - When the Docker host is not guaranteed to have a given directory or file structure

- Bind Mount
  - Sharing configuration files from the host machine to containers.
  - When the Docker host is guaranteed to be consistent with the bind mounts the containers require.

Docker Network

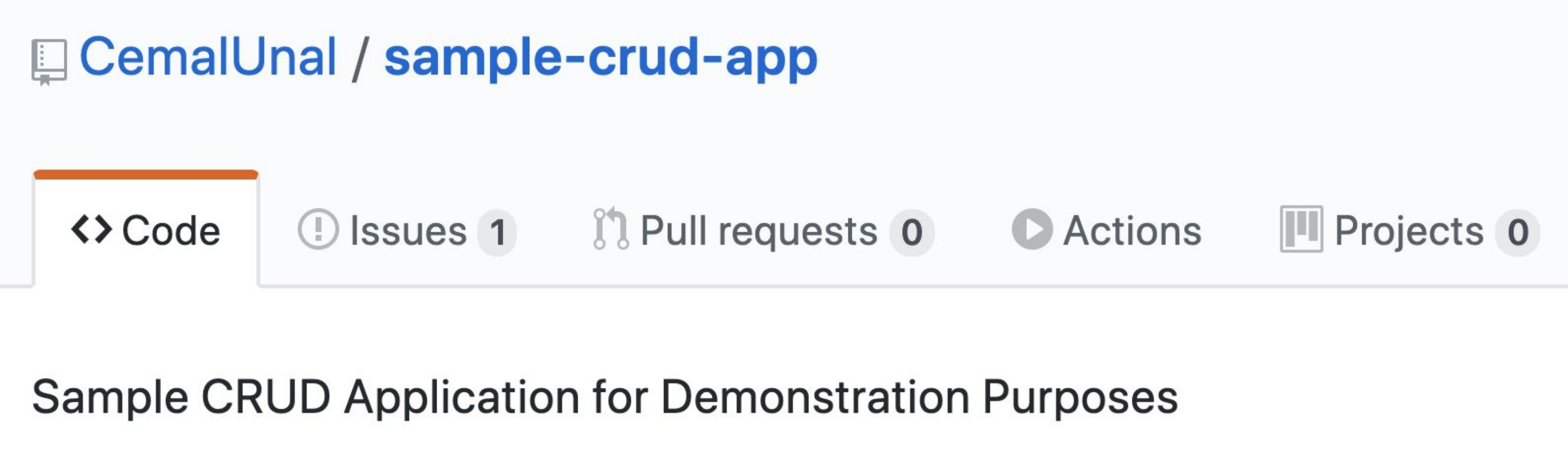
- Provide complete isolation for containers

- Most common docker network drivers:
  - Bridge
    - Default driver
    - Usually used when your applications run in standalone containers that need to communicate

  - Host
    - Remove network isolation between the container and the host
    - Use the host’s networking directly

  - Overlay
    - Connect multiple Docker daemons together and enable swarm services to communicate with each other

12-factor App Implementation

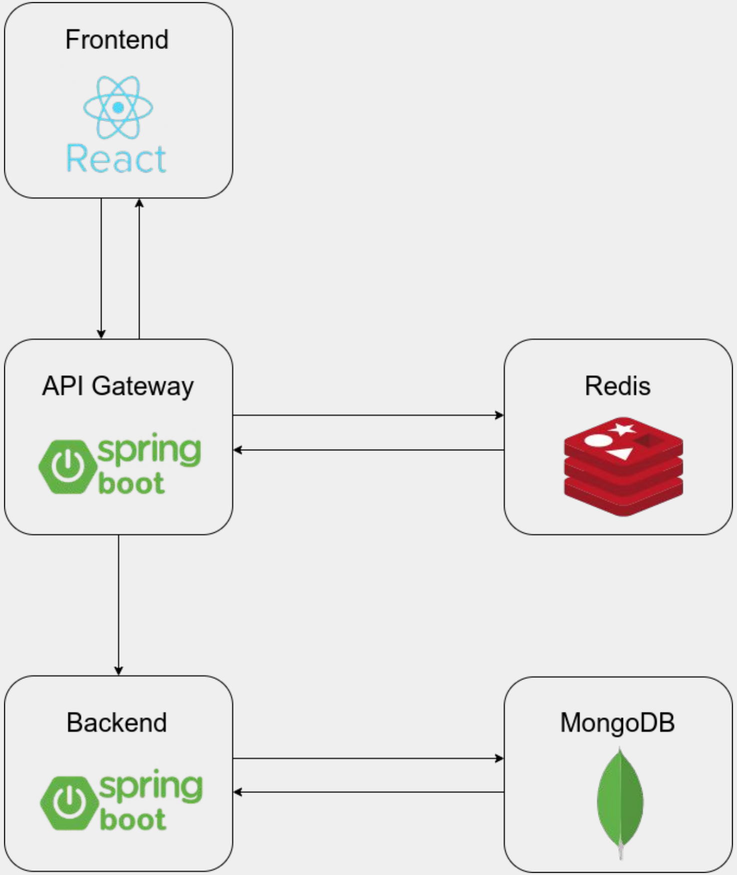


CemalUnal / sample-crud-app

Sample CRUD Application for Demonstration Purposes

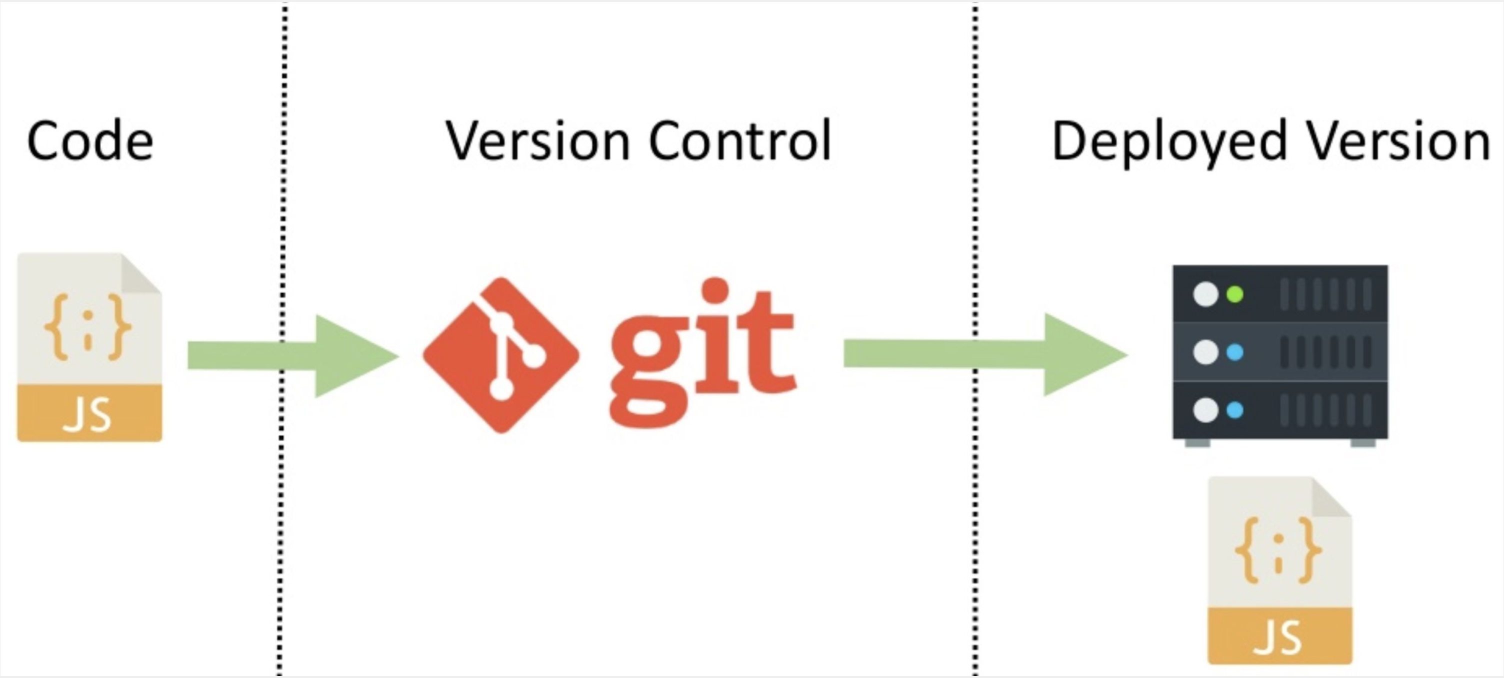
```
$ git clone https://github.com/cemalunal/sample-crud-app.git
```

Architecture Diagram



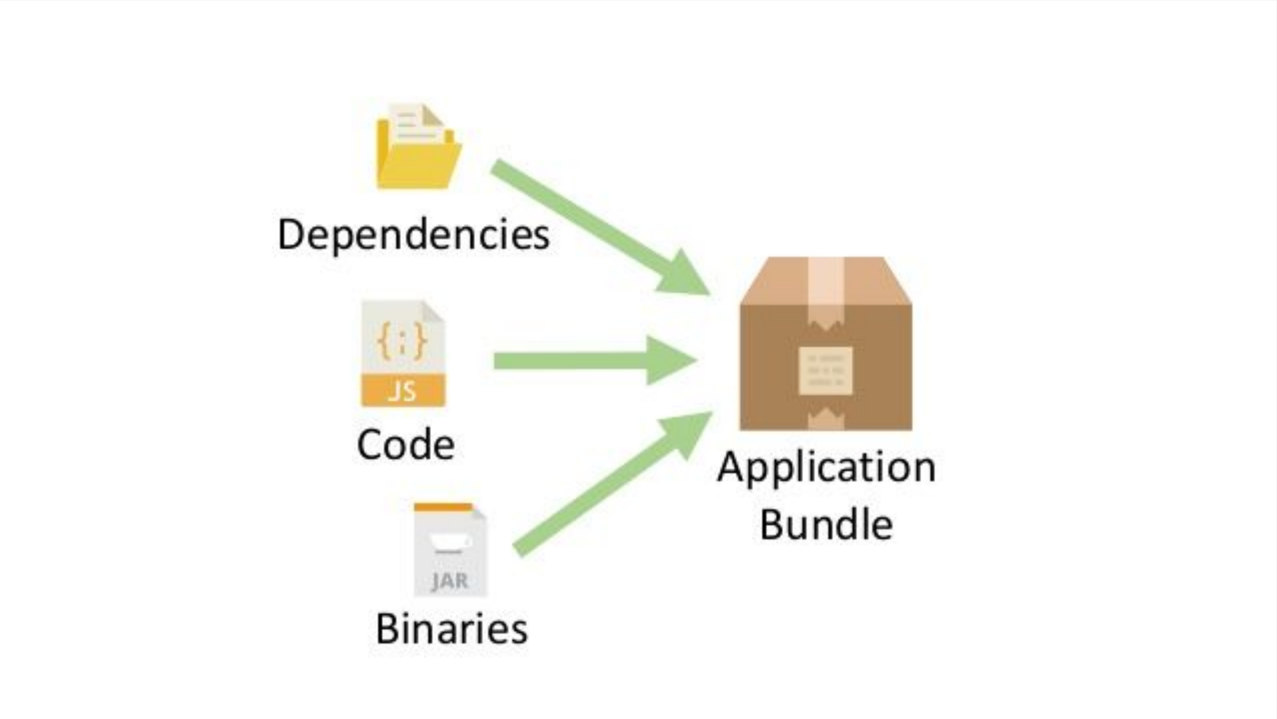
1- Codebase

One codebase tracked in revision control, many deploys



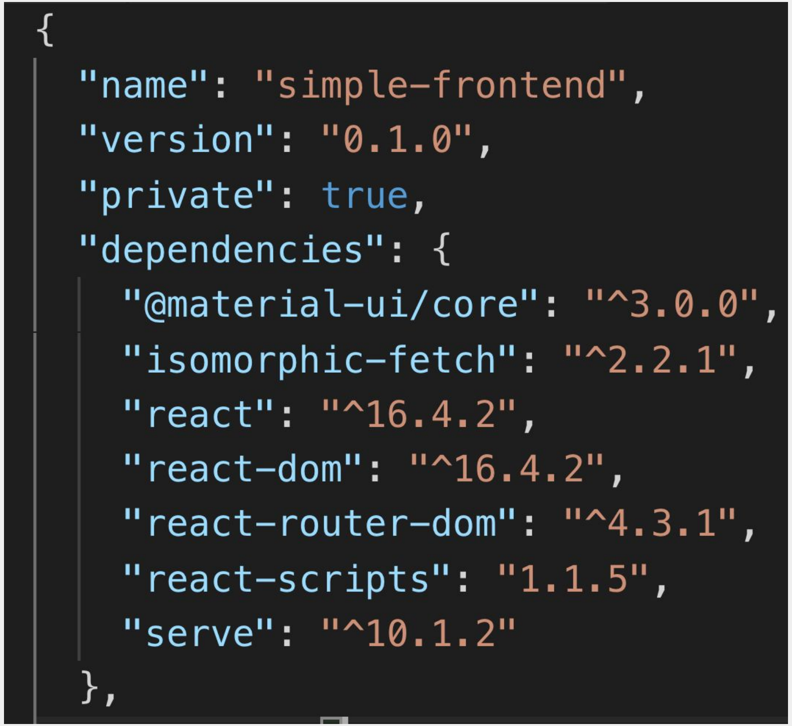
2- Dependencies

Explicitly declare and isolate dependencies



Dependency Declaration - Frontend

package.json

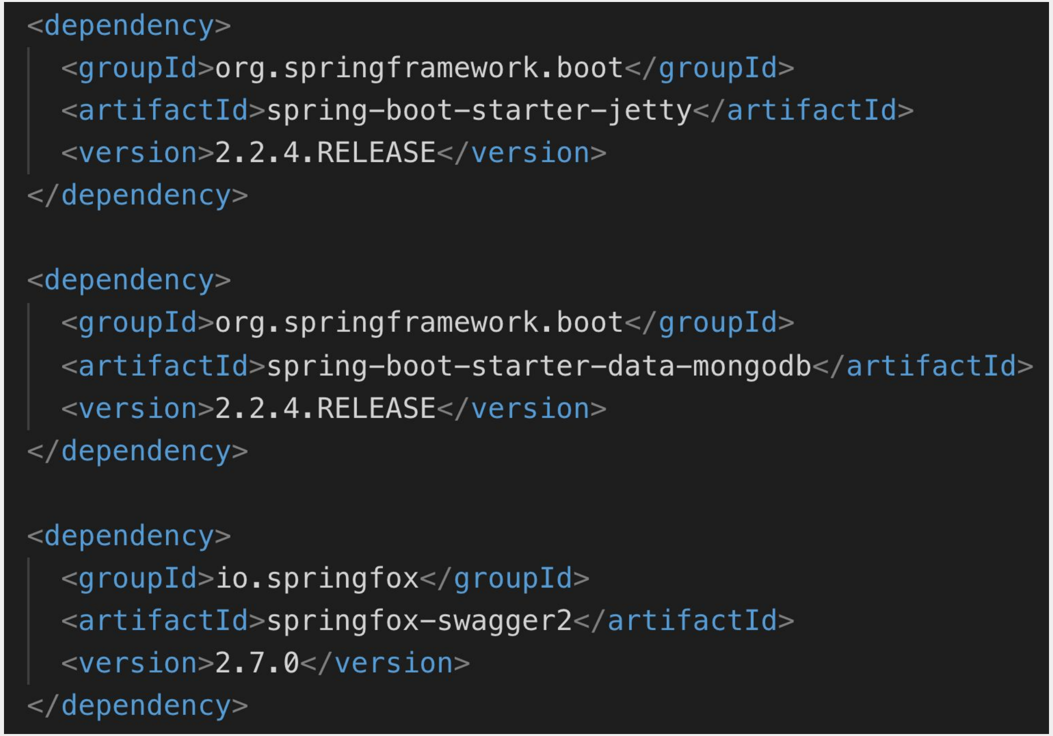


```
{
  "name": "simple-frontend",
  "version": "0.1.0",
  "private": true,
  "dependencies": {
    "@material-ui/core": "^3.0.0",
    "isomorphic-fetch": "^2.2.1",
    "react": "^16.4.2",
    "react-dom": "^16.4.2",
    "react-router-dom": "^4.3.1",
    "react-scripts": "1.1.5",
    "serve": "^10.1.2"
  },
```

$ npm install

Dependency Declaration - Backend & Gateway

pom.xml



```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-jetty</artifactId>
  <version>2.2.4.RELEASE</version>
</dependency>

<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-data-mongodb</artifactId>
  <version>2.2.4.RELEASE</version>
</dependency>

<dependency>
  <groupId>io.springfox</groupId>
  <artifactId>springfox-swagger2</artifactId>
  <version>2.7.0</version>
</dependency>
```

$ mvn install

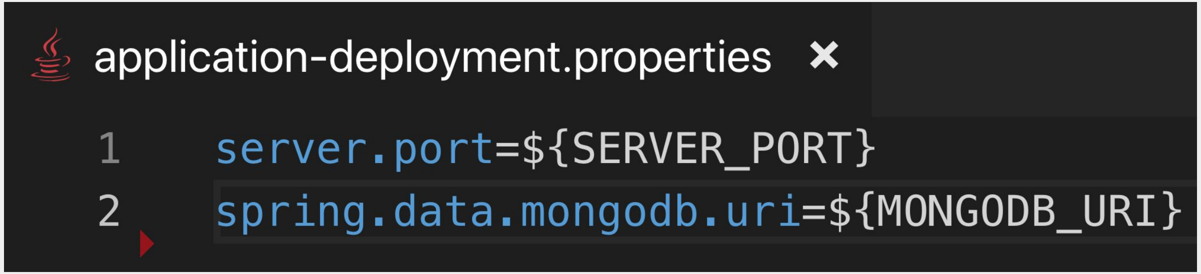
3- Config

Store config in the environment

- Frontend
  - URL of the backend service is stored in environment variables and accessed via **window.env**
    - fetch(`${window.env.REACT_APP_BACKEND_URI}/customers`)

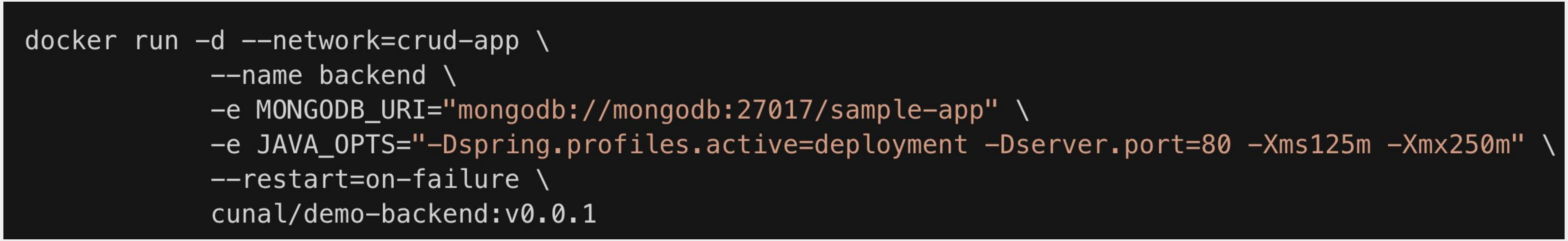
- Backend
  - MongoDB connection URI is stored is stored in environment variables and accessed via application-deployment.properties file
    - spring.data.mongodb.uri=${MONGODB_URI}

Backend container gets config from the environment



application-deployment.properties

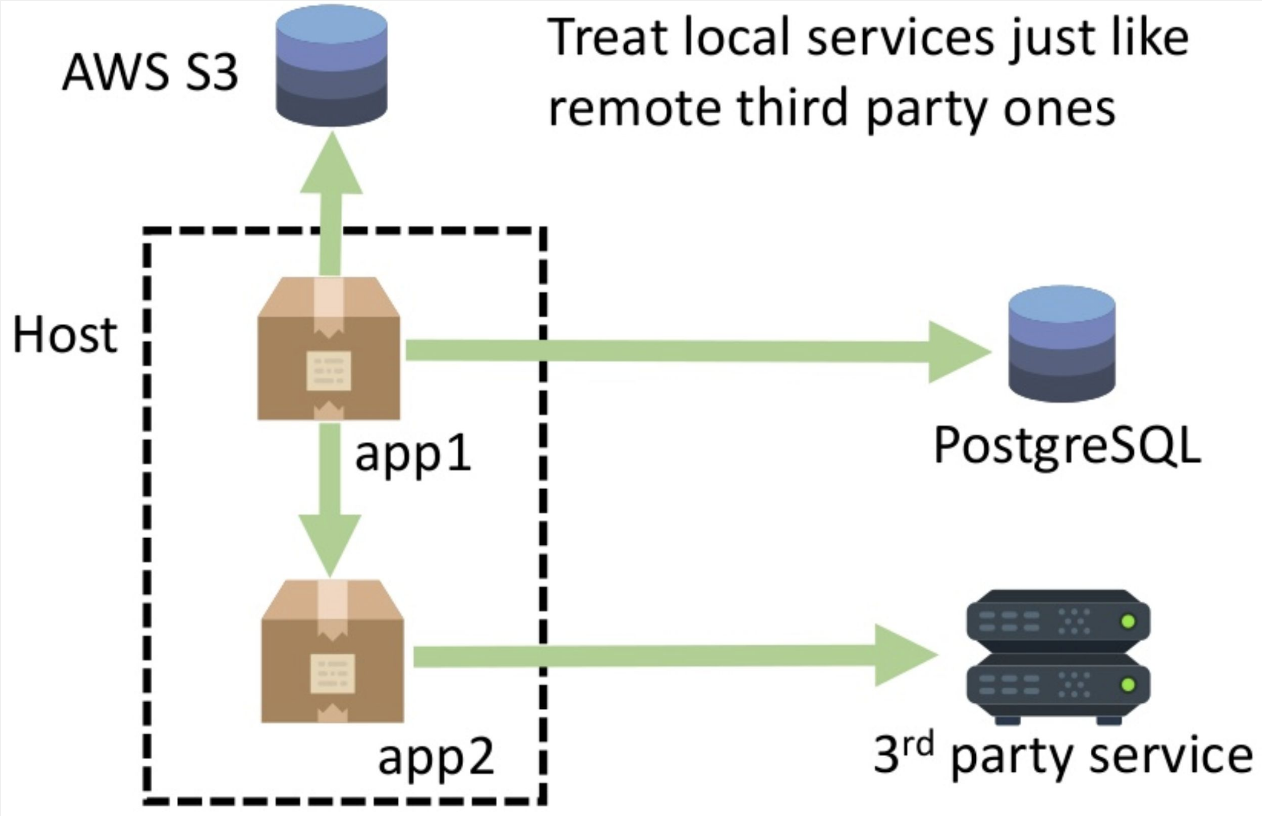
```
server.port=${SERVER_PORT}
spring.data.mongodb.uri=${MONGODB_URI}
```



```
docker run -d --network=crud-app \
            --name backend \
            -e MONGODB_URI="mongodb://mongodb:27017/sample-app" \
            -e JAVA_OPTS="-Dspring.profiles.active=deployment -Dserver.port=80 -Xms125m -Xmx250m" \
            --restart=on-failure \
            cunal/demo-backend:v0.0.1
```

4- Backing Services

Treat backing services as attached resources



MongoDB connection for Backend

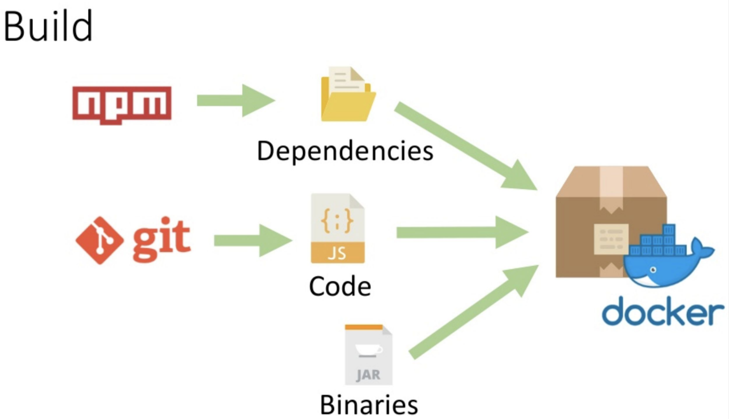
- Think about MongoDB - Connection URI is stored in **MONGODB_URI** environment variable.

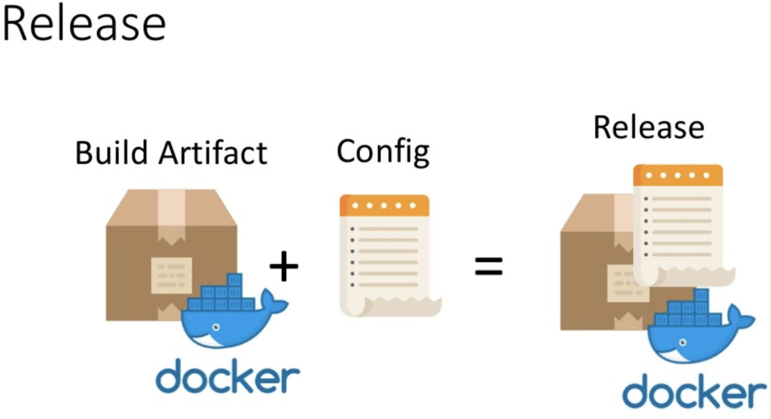
- We can easily switch between local and production MongoDB databases. Or we can even use Azure Cosmos DB by just changing the connection string. Examples:

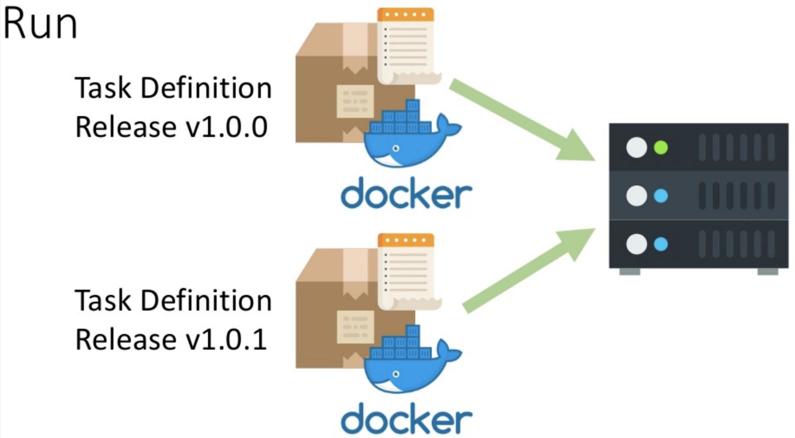
    - mongodb://localhost:27017/sample-app
    - mongodb://mongodb:27017/sample-app
    - mongodb://user:pass@test.documents.azure.com:10255/dbname?ssl=true

5- Build, release, run

Strictly separate build and run stages



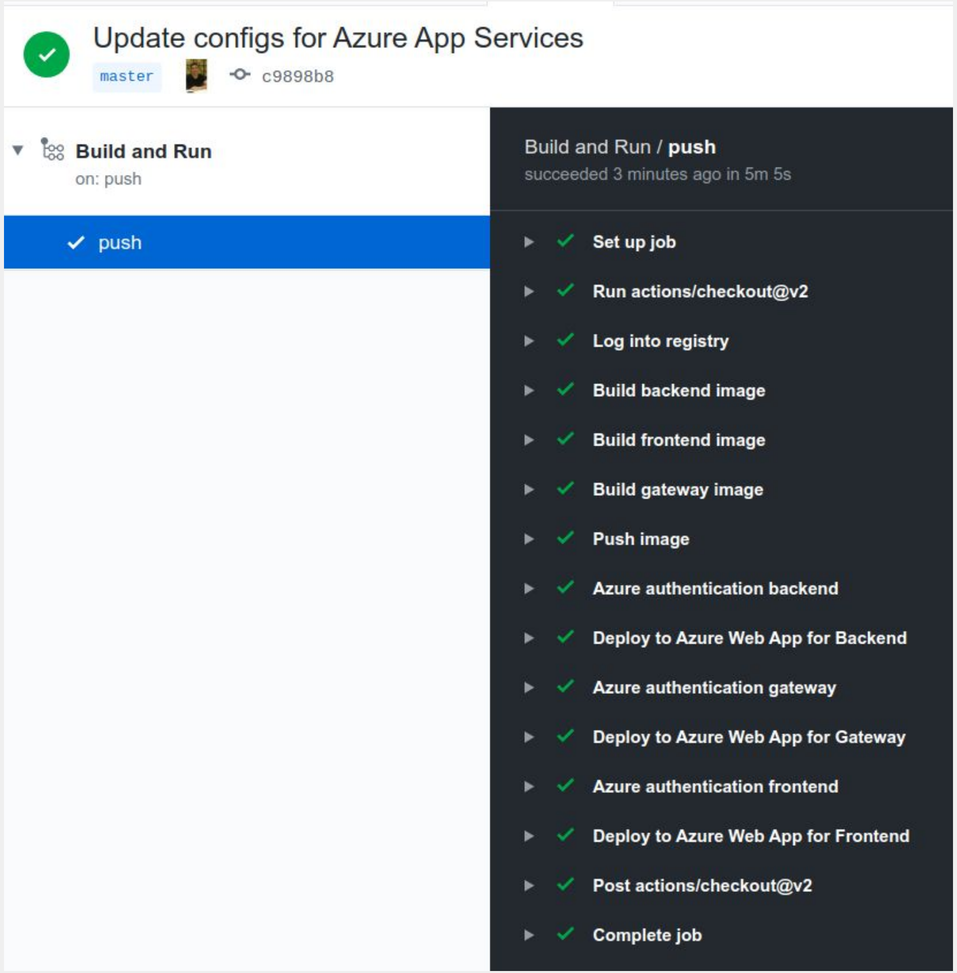




Build - Release

- There are 3 Dockerfiles for each service (frontend, backend and gateway)

- GitHub actions is triggered at each commit on master branch



Update configs for Azure App Services

master c9898b8

Build and Run
on: push

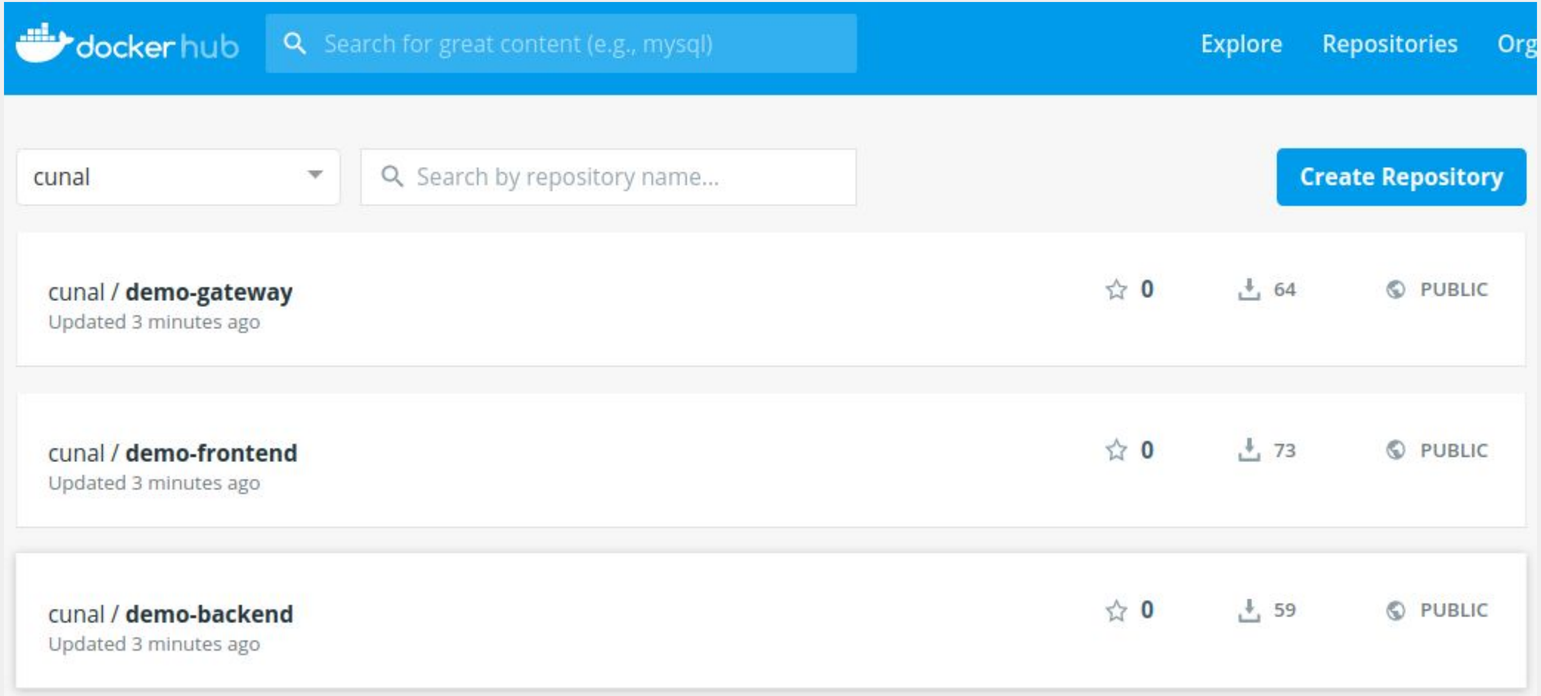
✓ push

Build and Run / **push**
succeeded 3 minutes ago in 5m 5s

- ✓ Set up job
- ✓ Run actions/checkout@v2
- ✓ Log into registry
- ✓ Build backend image
- ✓ Build frontend image
- ✓ Build gateway image
- ✓ Push image
- ✓ Azure authentication backend
- ✓ Deploy to Azure Web App for Backend
- ✓ Azure authentication gateway
- ✓ Deploy to Azure Web App for Gateway
- ✓ Azure authentication frontend
- ✓ Deploy to Azure Web App for Frontend
- ✓ Post actions/checkout@v2
- ✓ Complete job

Build - Release

- Each build artifact is stored in Docker Hub


docker hub
Search for great content (e.g., mysql)
Explore
Repositories
Org
cunal
Search by repository name...
Create Repository

cunal / **demo-gateway**
Updated 3 minutes ago
☆ 0 64 PUBLIC

cunal / **demo-frontend**
Updated 3 minutes ago
☆ 0 73 PUBLIC

cunal / **demo-backend**
Updated 3 minutes ago
☆ 0 59 PUBLIC

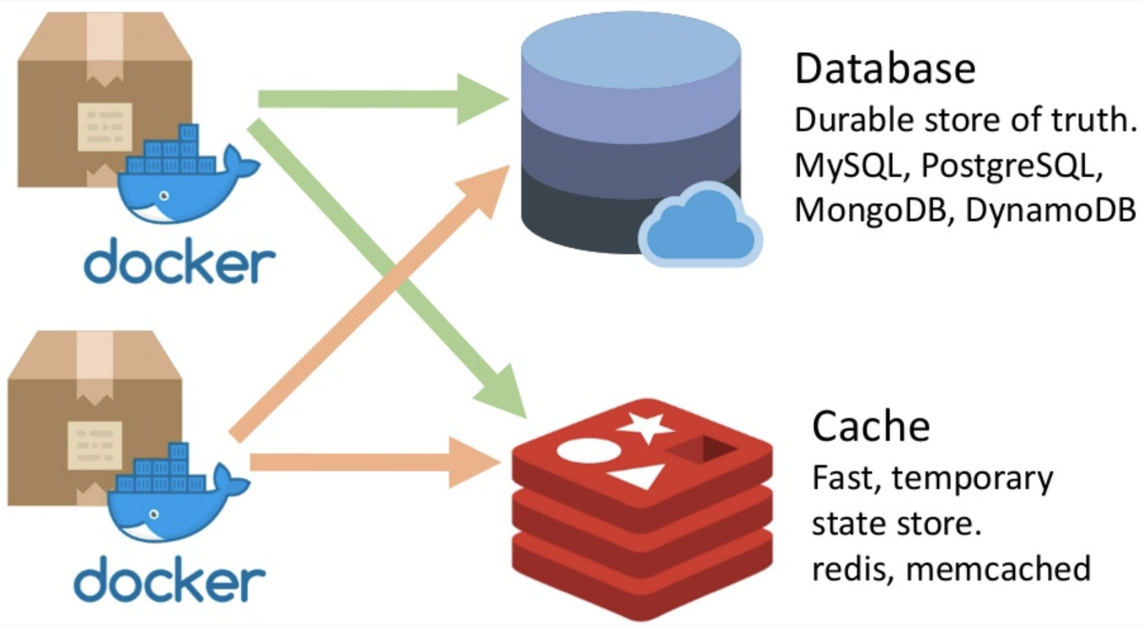
Run

- Azure App Services
  - Allows to run / scale pre built docker image without managing any servers.
- Azure Cosmos DB
  - MongoDB API for backend
- Azure Cache for Redis
  - Rate limiting for gateway

https://azure-demo-frontend.azurewebsites.net/

6- Processes

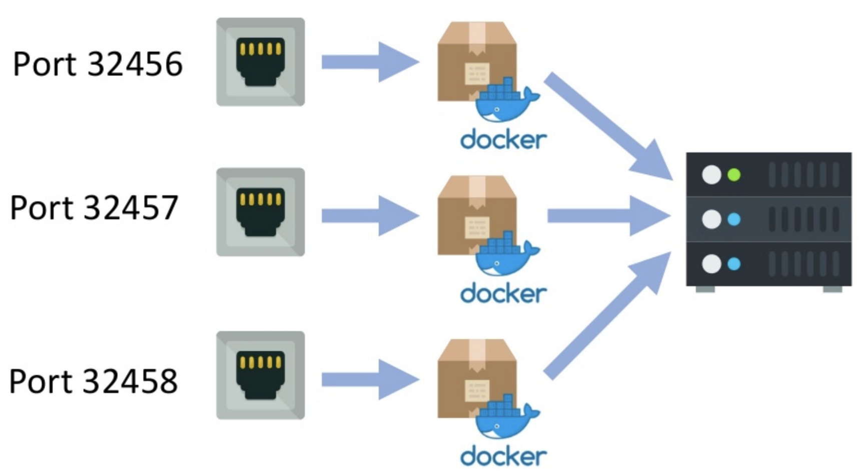
Execute the app as one or more stateless processes



- The application delegates stateful persistence to MongoDB.
- It is easily scalable since it is stateless.

7- Port Binding

Export services via port binding

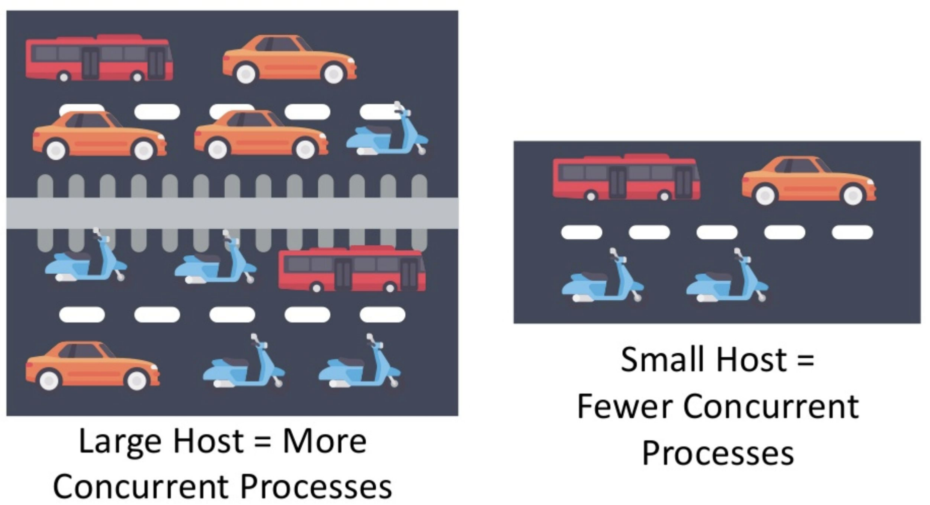


- Backend and Gateway
  - Spring Boot is used along with embedded Jetty server.
  - server.port=80 in application-azure.properties
- Frontend
  - serve npm package is used to serve the static frontend
  - serve -l 80 -s build in startup.sh

8- Concurrency

Scale out via the process model

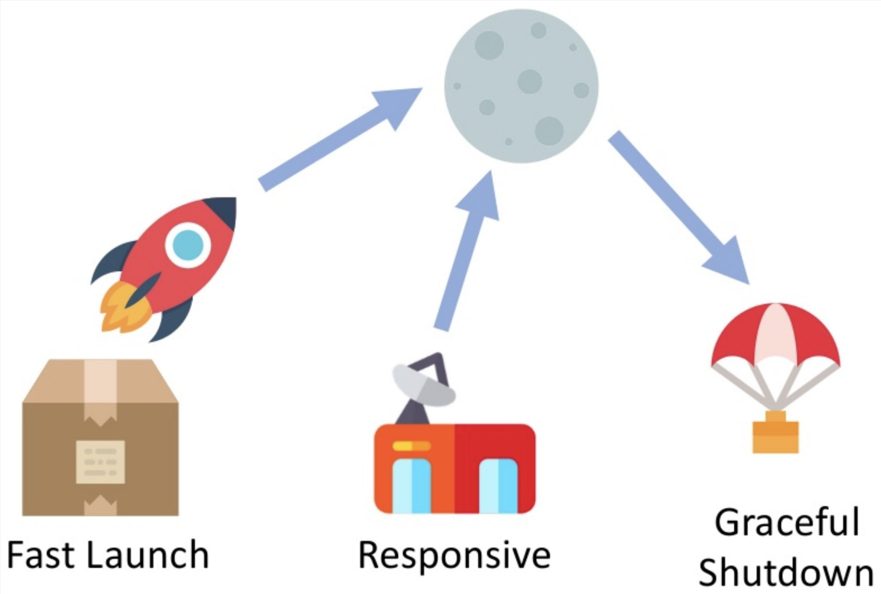
API
Web
Worker


Large Host = More Concurrent Processes
Small Host = Fewer Concurrent Processes

- All components of the application is dockerized
- Launching multiple instances is simple.

9- Disposability

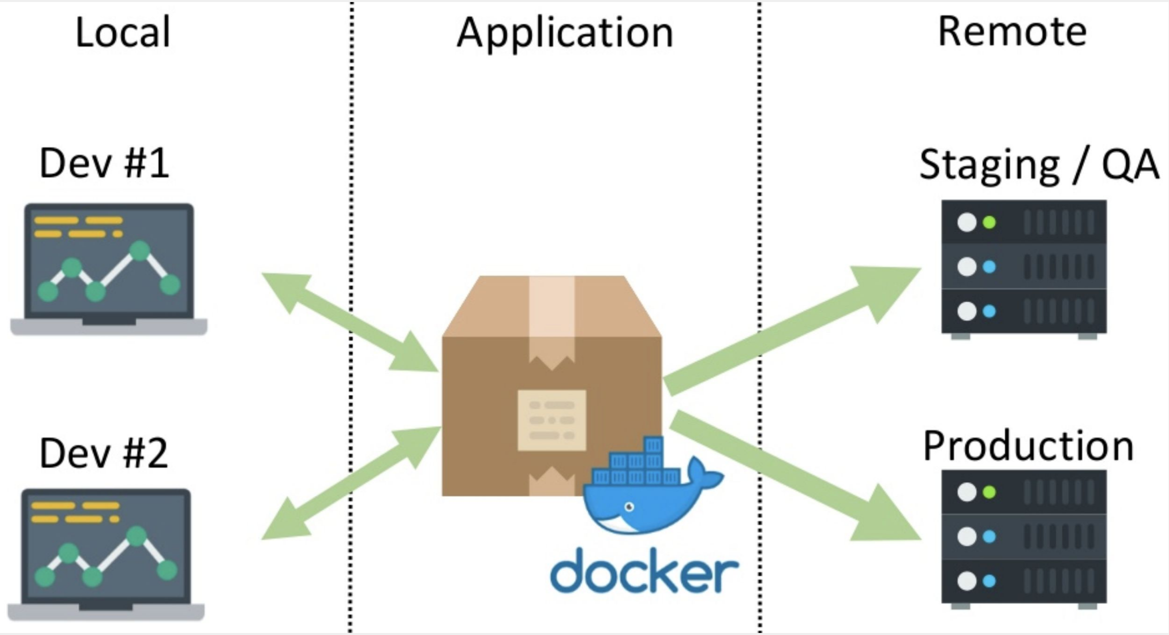
Maximize robustness with fast startup and graceful shutdown



- All components of the sample application are disposable and can be started and stopped quickly
- They shut down gracefully when they receive SIGTERM

10- Dev / prod parity

Keep development, staging, and production as similar as possible

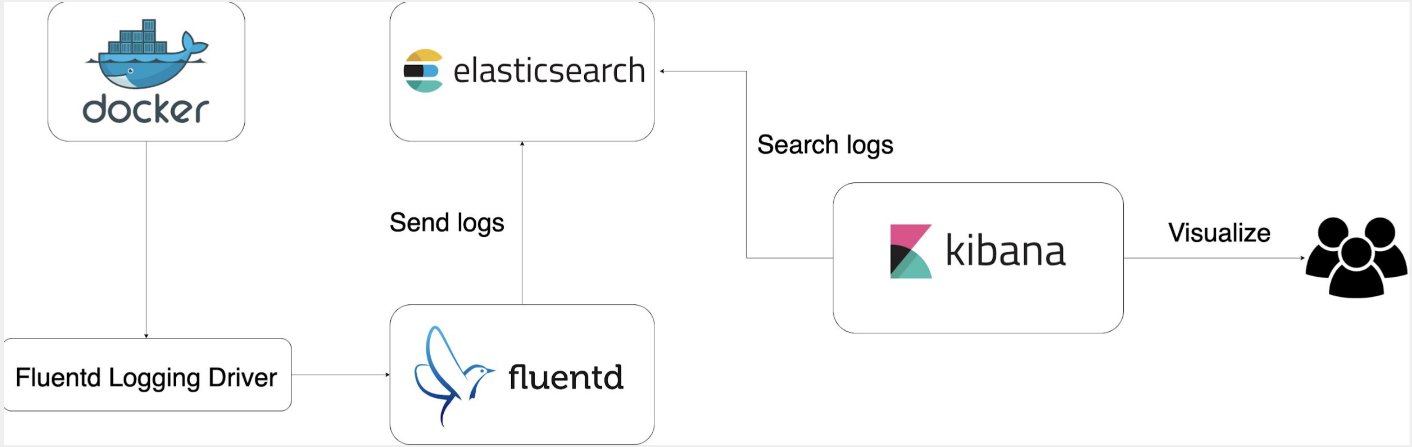


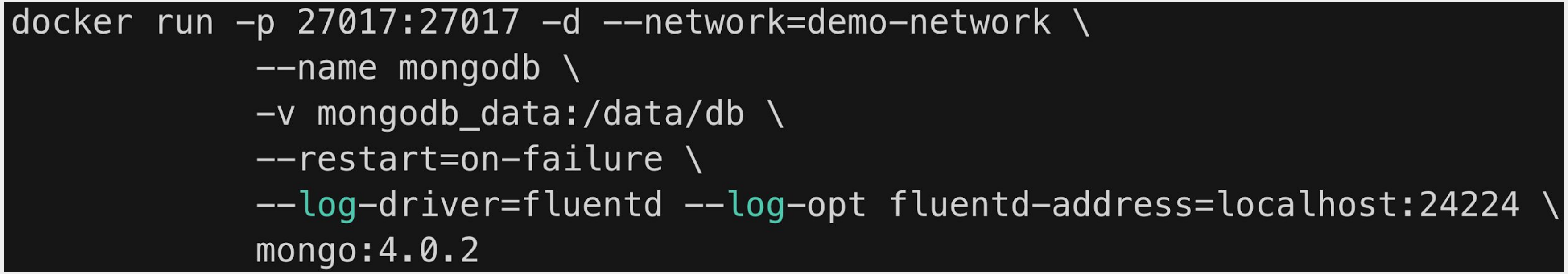
- **Docker** is used to run app components and the third party services.

- **Docker** and **Docker Compose** allow developers to run local environments which closely approximate production environments.

11- Logs

Treat logs as event streams





```
docker run -p 27017:27017 -d --network=demo-network \
            --name mongodb \
            -v mongodb_data:/data/db \
            --restart=on-failure \
            --log-driver=fluentd --log-opt fluentd-address=localhost:24224 \
            mongo:4.0.2
```

12- Admin Processes

Run admin/management tasks as one-off processes

- Running database migrations
- Repair some broken data
- Move old database records to cold storage

Run these admin processes just like other processes.

THANKS!