FE - Docker Containers and Micro-services

This page serves as documentation on Docker and how to implement it with a React application in a Micro-services type of architecture.

Docker Installation Instructions

NOTE: You will have to create a docker account in order to download and use the local docker application on your machine.

- Docker for Mac OSX: Docker Desktop on Mac
- Docker for Windows: Docker Desktop on Windows

TLDR; Single Container Docker Workflow Process

Create Application Directory:

- Create application directory via create-react-app or manually

Create Dockerfile for Different Builds:

- For **DEV**:
    - Create a file called **'dockerfile.dev'** in the root of the application project directory
    - Example File Contents:

```
FROM node:alpine

WORKDIR '/app'

COPY package.json .
RUN npm install
COPY . .

CMD [ "npm", "run", "start" ]
```

- For **PROD**:
  - Create a file called **‘dockerfile’** in the root of the application project directory
    - 1st set of procedures builds the image
    - 2nd set starts NGINX and tells it to expose Port 80 for traffic and to use the build directory generated from the 1st set of procedures
  - Example File Contents:

```
FROM node:alpine as builder
WORKDIR '/app'
COPY package.json .
RUN npm install
COPY . .
RUN npm run build


FROM nginx
EXPOSE 80
COPY --from=builder /app/build /usr/share/nginx/html
```

Create docker-compose.yml file:

- Create a docker-compose.yml file in the root of your project and it should look similar to this:
  - **NOTE:** The **‘tests’** section can be commented out/removed if using the preferred docker-compose method **OPTION 1** in the **‘Commands to run tests’** section that follows

```
version: '3'
services:
    web:
        build:
            context: . # Specifies where we want all files and
folders to be pulled from
            dockerfile: Dockerfile.dev # Name of dockerfile to
be used to build and run container
        ports:
            - "3000:3000"
        volumes:
            - /app/node_modules
            - .:/app
    tests:
       build:
           context: .
           dockerfile: Dockerfile.dev
       volumes:
           - /app/node_modules
           - .:/app
       command: [ "npm", "run", "test" ] # Override our default
"npm run start" starting command to use this instead
```

Commands to run tests:

- Create a new build via **Option 1 (preferred method)** in Testing section that does NOT use a separate ‘tests' service in the docker-compose.yml file:
    - Example docker-compose.yml file:

```
• version: '3'
  services:
      web:
          build:
              context: . # Specifies where we want all files
  and folders to be pulled from
              dockerfile: Dockerfile.dev # Name of
  dockerfile to be used to build and run container
          ports:
              - "3000:3000"
          volumes:
              - /app/node_modules
              - .:/app
```

    - Open a terminal session and type ‘docker-compose up --build’
- Open another terminal session and run ‘docker ps’ get container id run ‘docker exec -it <container id> npm/yarn run test’ to run interactive test runner in this terminal session window

OPTIONAL: Build and Deploy Production Version of Container w/Travis-CI:

- See CI/CD Pipeline section for instructions and **'.travis.yml'** file example

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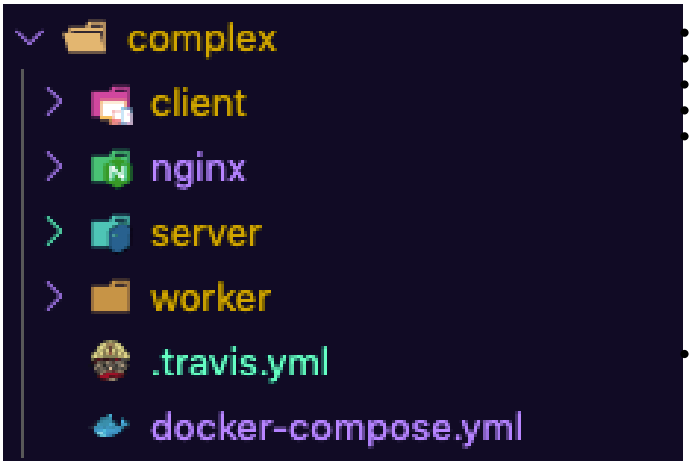
TLDR; Multi-Container Docker Workflow Process:

This is how you would 'dockerize' a project that contains multiple containers.

Create Application Directory:

Given a setup similar to what's shown in this screenshot, each subdirectory is its own service and will be turned into a container using the steps that follow.



- **'complex'**: Project root
- **'client'**: Simple React FE Application
- **'nginx'**: NGINX proxy server
- **'server'**: Node/Express server
- **'worker'**: Redis key/value store server

Create Dockerfiles for each subdirectory:

Each directory will need a **'Dockerfile.dev' file for use in DEV** and also a **'Dockerfile' file for use in PROD**. Customize the contents of each as needed.

- **NOTE:** Some of these files can be identical in some cases and that's perfectly fine. It just depends on what you are trying to do.

Create NGINX Config file(s):

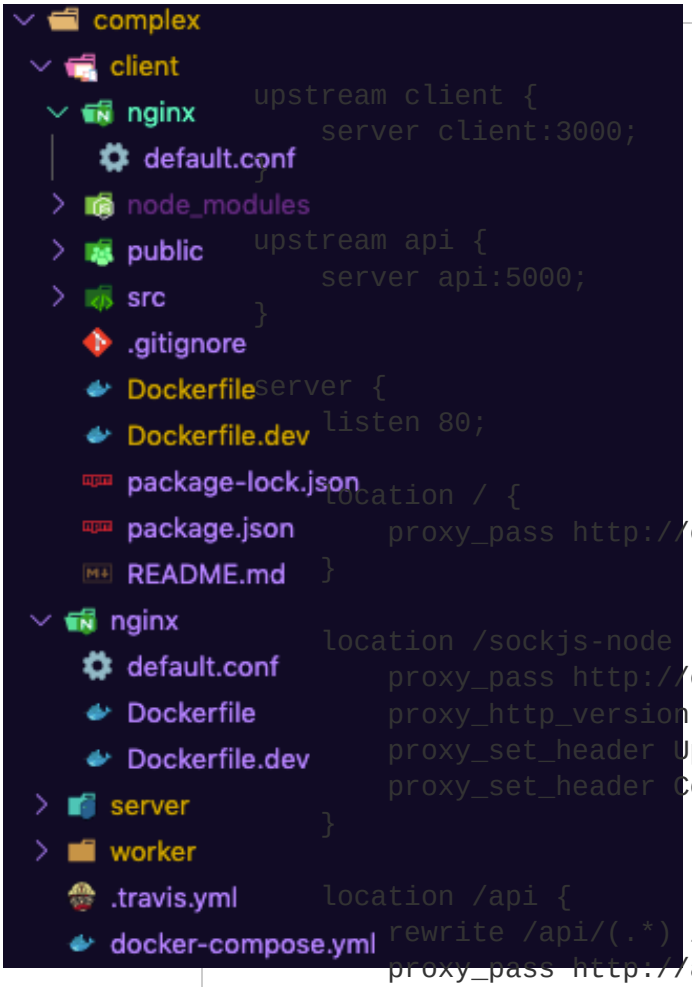
If using NGINX, you'll need to setup a config file for every instance/directory where you plan to run an NGINX server. In this project we have one at the root, but also another one within the 'client' directory.

- client/nginx/**default.conf** file contents:
  - **NOTE:** This NGINX server will be tasked with strictly handling traffic within the client application

```
server {
      listen 3000;

      location / {
          root /usr/share/nginx/html;
          index index.html index.htm;
          try_files $uri $uri/ /index.html;
      }
  }
```

  - Tells the server to listen to the CRA default port of 3000
  - The rest basically says to look for the 'index.html' or 'index.htm' file at the '/' location
- complex/nginx/default.conf file contents:
  - **NOTE**: This NGINX server will be tasked with routing traffic from the between the client, express server, and redis server




```
upstream client {
    server client:3000;
}

upstream api {
    server api:5000;
}

server {
    listen 80;

    location / {
        proxy_pass http://client;
    }

    location /sockjs-node {
        proxy_pass http://client;
        proxy_http_version 1.1;
        proxy_set_header Upgrade $http_upgrade;
        proxy_set_header Connection "Upgrade";
    }

    location /api {
        rewrite /api/(.*) /$1 break;
        proxy_pass http://api;
    }
}
```

- This file contains upstream client ports it will serve traffic between along with more server route configurations
- Consult NGINX docs on docker hub for additional info on configuration files
- **NOTE:** The **'nginx'** directory inside of the **'client'** does **NOT** need a dockerfile of its own.

Create the Docker Compose File for Running The App and Creating the Build:

At this point, the app can be built and run locally once a **'docker-compose.yml'** file is created in the project root.

- **docker-compose.yml** file example:

```
version: '3'
services:
    postgres:
        image: 'postgres:latest'
    redis:
        image: 'redis:latest'
    nginx:
        restart: always
        build:
            dockerfile: Dockerfile.dev
            context: ./nginx
        ports:
            - '3050:80'
    api:
        build:
            dockerfile: Dockerfile.dev
            context: ./server
        volumes:
            - /app/node_modules
            - ./server:/app
        environment:
            - REDIS_HOST=redis
            - REDIS_PORT=6379
            - PGUSER=postgres
            - PGHOST=postgres
            - PGDATABASE=postgres
            - PGPASSWORD=postgres_password
            - PGPORT=5432
    client:
        build:
            dockerfile: Dockerfile.dev
            context: ./client
        volumes:
            - /app/node_modules
            - ./client:/app
    worker:
        build:
            dockerfile: Dockerfile.dev
            context: ./worker
        volumes:
            - /app/node_modules
            - ./worker:/app
```

- **NOTE: ‘api’** was used in place of **‘server’** under the SERVICES as that is standard and less confusing than having the word ‘SERVER’ appearing in so many places
- Build and run the application by typing: **‘docker-compose up --build’**
    - This will build and run the application the first time and to run it after that, just type **‘docker-compose up’**. Only run new builds when necessary.

OPTIONAL: CI/CD Build and Deploy Process w/Travis-CI with Push to DockerHub Repository:

- Consult CI/CD Pipeline section found in this document for specific setup/config info for the '.travis.yml' file and account setup instructions, etc.
    - Example **'.travis.yml'** file content:

```
language: generic
sudo: required
services:
    - docker

before_install:
    - docker build -t oe/react-test -f ./client/Dockerfile.dev
./client

script:
    - docker run -e CI=true oe/react-test npm run test

after_success:
    - docker build -t oe/multi-client ./client
    - docker build -t oe/multi-nginx ./nginx
    - docker build -t oe/multi-server ./server
    - docker build -t oe/multi-worker ./worker
    # LOG IN TO DOCKER CLI
    - echo  "$DOCKER_PASSWORD" | docker login -u "$DOCKER_ID"
--password-stdin
    # TAKE IMAGES AND PUSH THEM TO DOCKER HUB
    - docker push oe/multi-client
    - docker push oe/multi-nginx
    - docker push oe/multi-server
    - docker push oe/multi-worker
```

    - **NOTE:** the **'# LOG IN TO DOCKER CLI'** part is how you get Travis-CI to be able to initiate the login to Docker CLI since it can't actually access the CLI in the terminal like a person can.

Docker CLI Commands

	Description	Command	Example
1	Create and run an image and container(s)	docker run	docker run hello-world
2	Show all Containers as list (current and not running)	docker ps --all	docker ps --all
3	Build and run a container	docker build .	docker build .
4	Build and run a container from a **custom** Docker file (like running a dev version of the Dockerfile named '**Dockerfile.dev**')	docker build -f <custom file name> .	docker build -f Dockerfile.dev .
5	Show running containers	docker ps	docker ps
6	Restarting stopped containers ('-a' flag shows the output of the container)	docker start -a <container id>	docker start a98qu49q6r87q34
7	Remove stopped containers	docker system prune	docker system prune
8	Retrieve log outputs	docker logs <container id>	docker logs 9847r7969fas678

9	Stopping containers (stops but allows cleanup, saving, etc. before killing the container) - **NOTE**: After about 10 seconds, it will automatically run 'docker kill' and automatically kill the container if it hasn't stopped by then.	docker stop <container id>	docker stop 2348768sd786swa5
10	Killing containers (immediately kills container without cleanup or save opportunity)	docker kill <container id>	docker kill 34987faaf78689ag67
11	Execute Commands in Running Containers (**NOTE:** '-it' flag just allows for input and info to be displayed back)	docker exec -it <container id> <command to execute in running container>	docker exec -it 20d98a591d80 redis-cli
12	Accessing a CMD Prompt in a Container via 'exec'	docker exec -it <container id> sh	docker exec -it fss976af8a72jkaf sh
13	Starting with a shell (NOTE: this blocks any other process, but is good to be able to initially look into things on the image)…type "exit" or hit 'ctrl +d' to get out of the shell session	docker run -it <image> sh	docker run -it busybox sh
14	Execute a container in the background and give back access to terminal	docker run -d <container id>	docker run -d busybox
15	Port Mapping (forwards localhost traffic into container)	docker run -p localhostPort:containerPort <image name>	docker run -p 8080:8080 oe/simpleweb
16	Specifying a Working Directory (to avoid adding new files to the root of hte container)	WORKDIR /usr/app (in a linux-based OS, the 'usr' directory is a safe place to specify all user generated content and is ideal)	WORKDIR /usr/ app
17	How to forward input from a terminal directly to a running container (**NOTE:** This only gives you a handle to the **PRIMARY** process and not any subsequent processes that you may want to hook into!!!)	docker attach <container id>	docker- attach <container id>
18	Docker Volumes to create directory mappings between container and local source code	docker run -p 3000:3000 -v /app/node_modules -v "$(pwd):/app" <image id>	docker run -p 3000:3000 -v /app/node_modules -v "$(pwd):/app" oe/simpleweb
19	Live Updating Tests by attaching to a running volumed container	docker exec -it <container id> npm/yarn run test	docker exec -it af08qeqja98a77 npm/yarn run test
20			
21			

Docker Compose Commands

	Description	Command	Example
1	How to start multiple Docker containers at the same time and also how keep from writing tons or repetitive commands with the Docker CLI	docker-compose	docker-compose
2	Run a docker image	docker-compose up	docker-compose up
3	Build and then run a docker image so that you have latest changes	docker-compose up --build	docker-compose up --build
4	Launch containers in background and give back terminal access	docker-compose up -d	docker-compose up -d
5	Stop docker containers with a single command	docker-compose down	docker-compose down
6			
7			

How To Create A Docker Image

- Building a **Dockerfile**:
  - This is a plain text file that will contain configurations for how our container behaves, specifically what it programs it contains and what it does as it starts up as a container and almost always follows this flow:
    - Specify a base image
    - Run some commands to install additional programs

    - Specify a command to run on container startup
- Steps to build the Dockerfile:
    1. Create a directory where you want the Dockerfile to reside on your local machine and create a file called '**Dockerfile**' without any extensions. Docker will pick this file name up by default.
        a. **NOTE:** It is possible to use a **custom dockerfile name**, most likely for development purposes like '**Dockerfile.dev**' for example.
            i. To get docker to use this custom file rather than the default, you have to use the '**docker build -f <custom file name> .**' command
    2. Open the Dockerfile in your text editor and add comments for what we'll need to do:
        a. '# Use an existing docker image as a base'
        b. '# Download and install a dependency;
        c. '# Tell the image what to do when it starts as a container'
    3. Example of #2 for a redis-server:

a.
```
# Use and existing docker image as a base
FROM alpine

# Download and install a dependency
RUN apk add --update redis

# Tell the image what to do when it starts
# as a container
CMD ["redis-server"]
```

- Run Docker command in the CLI to build the Dockerfile:
    - From with directory that contains the Dockerfile, run '**docker build .**' (be sure to include the '.' at the end)
        - Running this command feeds the Dockerfile to the **Docker CLI (Docker Client)** which feeds it to the **Docker Server** which then builds a **Usable Image**
    - After it builds, it will display and id at the end. Copy this id and then run '**docker run <copied id>**' and the expected behavior of the container should work.
- Docker will automatically implement caching **only as long as the order of the operations previously used in the build have not changed** and only new operations are added at the end of the file. Changing these operations around will cause a complete rebuild of the image, thus taking longer when needing to add new things.
- Tagging an Image:
    - To avoid having to constantly copy/paste the id of an image when trying to run them in docker, you can create a custom tag to use instead by doing the following:
        - Based off the convention of **<'your docker id' / 'repo/project name' / 'version'>**, i.e., running '**docker build -t oe/redis:latest .**' will now allow you to run an image using the tag called 'oe/redis'. So you can now run it by typing '**docker run oe/redis**' rather than '**docker run afs98a8f67a1**'

How to Resolve Errors and Base Image Issues

Sometimes when using a base docker image, you will encounter errors such as "npm: not found", etc. (in this example where a NodeJS server is being used and has 'express' as a dependency, but 'alpine' was used as the base) and this is due to the base image being used in the Dockerfile not actually having a specific program installed on it, Node/NPM in this case, and the RUN command in our Dockerfile fails because it can't find 'npm' to run the 'npm install' command.

Options to resolve Dockerfile build errors are as follows:

1. Install another base image that does contain the programs you need in your image (NodeJS in this example):

```
# Use an existing docker image as a base
FROM alpine

# Download and install a dependency
RUN npm install

# Tell the image what to do when it starts
# as a container
CMD [ "npm", "start" ]
```

a. Reference docker hub to search for a base that does include the programs you for sure will need.
b. We can change our 'FROM alpine' in the docker file to be 'FROM node:alpine' to resolve the 'npm: not found' issue because Node contains NPM.

```
# Use an existing docker image as a base
FROM node:alpine

# Download and install a dependency
RUN npm install

# Tell the image what to do when it starts
# as a container
CMD [ "npm", "start" ]
```

i. **NOTE:** 'alpine' is a term for a version of an image that is as small and compact as possible, meaning it won't contain a bunch of additional pre-installed programs.
    1. 'node:alpine' is using the 'alpine' tag specified as available on the NodeJS official image in the docker hub.
    2. Running 'docker build .' at this point will resolve the error, but now shows another commonly seen when doing an 'npm install' where it displays npm WARN messages and ENOENT errors that it can't find '/package.json', etc. (See Copying Build Files section below)

2. Manually install dependencies/programs into the image with multiple RUN commands.

Copying Build files:

To resolve issues where files/directories are not found during the 'docker build .' process that exist in the local directory of your project, you must copy the files using the 'COPY' command, i.e,. 'COPY ./ ./' (**IMPORTANT:** These paths are relative to the current build context). The updated Dockerfile should look like this:

```
# Use an existing docker image as a base
FROM node:alpine

# Download and install a dependency
COPY ./ ./
RUN npm install

# Tell the image what to do when it starts
# as a container
CMD [ "npm", "start" ]
```

- Run the '**docker build -t oe/simpleweb .**' command to rebuild everything correctly and with a tag ('simpleweb', the demo project name for the example) for easy reference.
- Test the image by starting it with '**docker run oe/simpleweb**' and it should run correctly.

Container Port Mapping:

When following the previous steps and then trying to open a browser to 'https://localhost:8080' for example, you'll find that the page will not work or the 'connection refused' error is on the page. This is because the localhost network is different from the network found inside of the container and traffic from the localhost has to be routed to a port inside of the container. NOTE: The container can communicate with the outside world by default without any special instructions, but steps need to be taken to route traffic into the container.

- The solution is a runtime only command:
  - '**docker run -p 8080:8080 oe/webserver**' will now allow your to implement the '-p localhostPort:ContainerPort' flag to route the traffic appropriate to the container. Refreshing the page after running this command will allow it to render correctly without any errors.
  - The ports used do **NOT** have to match, but whatever the port gets changed to that's used by the container needs to also have the port updated in the server file, index.js, to also use the same port.

Specifying a Working Directory:

Without specifying a working directory, copying and adding new files to your container will place the files in the root of the container and could cause potential naming conflicts or other issues when some programs generate files and directories. To avoid this, it's always advised to specify a working directory in the Dockerfile:

```
# Use an existing docker image as a base
FROM node:alpine

WORKDIR /usr/app

# Download and install a dependency
COPY ./ ./
RUN npm install

# Tell the image what to do when it starts
# as a container
CMD [ "npm", "start" ]
```

NOTE: in 'WORKDIR /usr/app', if the 'app' directory doesn't exist, it will be created for you automatically.

- Running a new build and starting the container shell will now automatically start you from the workdir specified.

Minimizing Cache Busting and Rebuilds:

Making a change of any size to the project files that were built into the container will not reflect those changes on refresh in the web browser. In order to see the changes, another build would need to be initiated since the last build was a snapshot of the project and rebuilding and copying the same files repeatedly just to see changes is not good. We can fix this by splitting the COPY operation in the Dockerfile into 2 (or more, depending on your needs) steps in order to avoid unnecessary rebuilds:

```
# Use an existing docker image as a base
FROM node:alpine

WORKDIR /usr/app

# Download and install a dependency
COPY ./package.json ./
RUN npm install
COPY ./ ./

# Tell the image what to do when it starts
# as a container
CMD [ "npm", "start" ]
```

- After running a new build, we are now specifying that we only want to copy changes to the 'package.json' file and then run 'npm install' **o nly when there are changes to those files**. NOTE: At this point the container run command w/port mapping must still be rerun to pick up changes (this will be addressed later- add update here).

Docker Compose

When running multiple containers at the same time that actually depend on processes being run in another container, there are 2 options available.

1. Use **Docker CLI's Networking Features** (as have been the case so far in this documentation), but this becomes cumbersome for any real application. Although it's possible, it's is never actually used as a a solution or standard in a real production application.
2. Use **Docker Compose**!
    a. Docker Compose is a separate CLI tool that gets installed along with Docker and is used to startup multiple Docker containers at the same time that automatically connects them together with networking and also to keep from writing lots of repetitive commands with Docker CLI.
        i. Type '**docker-compose**' to see a list of available options

- Docker Compose will make use of a '**docker-compose.yml**' file that will be run by the docker-compose CLI.
    - This file essentially will combine the commands we've been running in the docker CLI into one, i.e. 'docker build -t oe/simpleweb' and 'docker run -p 8080:8080 oe/simpleweb'
    - Example docker-compose.yml file that runs separate redis and a node js app containers, w/comments at the '#' symbols:

```
version: '3' # Specifies the version of docker compose we want to use to
put together this file
services: # 'service' basically means a type of container
    redis-server: # the name of the service you want to create (could be
anything)
        image: 'redis' # the image you want to use to create this
service/container
    node-app:
        build: . # look in the current directory for a dockerfile and
build from there
        ports:
            - "4001:8081" # ports specified that we want opened up on
this container solely for access on local machine
```

Docker Compose Commands:

- '**docker-compose up**' will run the image
- '**docker-compose up --build**' will build and then run an image with latest changes

Docker Compose - Automatic Container Restarts:

In the event of a crash or other error on the server, we want to give Docker the ability to automatically restart the container. You can do this by specifying a '**Restart Policy**' inside of the **docker-compose.yml** file.

- Restart Policies:

1	"no"	Never attempt to restart this "." container if it stops or crashes
2	always	If this container stops *for any reason*, always attempt to restart it
3	on-failure	Only restart if the container stops with an error code
4	unless-stopped	Always restart unless we (the developers) forcibly stop it

- Updated example docker-compose.yml file implementing restart policies:

```
version: '3'
services:
    redis-server:
        image: 'redis'
    node-app:
        restart: always
        build: .
        ports:
            - "4001:8081"
```

- **NOTE:** The **"no"** restart policy must be surrounded by quotes (single or double) in the docker-compose.yml file, otherwise the file will interpret it as the value of false.

Creating a Production-Grade Workflow

In the full context of developing and making updates to an application, there has to be a set workflow with is commonly implemented. Docker is NOT necessary, but it's a tool that makes this process and workflow much easier if implemented. This section will detail how to add Docker into your Production workflow as well as provide tips to make the process as efficient as possible.

NOTE: These steps are from the perspective of using the default CRA (create-react-app) template as the FE application that needs to have Docker implemented and put into the daily workflow of Git, Testing, Deploying, etc.

React/NPM/Yarn Necessary Commands for Running the FE Application:

- **Run The App:** 'npm run start' or 'yarn run start'
- **Test The App:** 'npm run test' or 'yarn run test'
- **Build The App:** 'npm run build' or 'yarn run build'

NOTE: ****IMPORTANT** To avoid duplicating dependencies when running a docker build, it is safe to **REMOVE the local node_modules file from the React application** as the dependencies are actually on the container as specified by the 'RUN npm install' procedure in the file. If you do NOT remove the local node_modules folder, then the first thing you will see upon running a docker build is a large amount of data that was 'Sending to build context Daemon …. 150+mb'. This data already lives within the container and can safely be removed.

Creating the Dev Dockerfile:

- Docker picks up the name 'Dockerfile' by default within the project structure to use to build the project and due to this, you will need to create a different version of the Dockerfile to use while in development, each using a slightly different set of commands.
- Create a custom dockerfile by creating a file named 'Dockerfile.dev', in the same manner and place in the project structure you would normally create the dockerfile. Add the usual content that you want to use that's required for the dockerfile. Next, you will need to use the

docker command that will allow docker to use the custom file rather than the default one by using this command:

- '**docker build -f <custom file name> .**', i.e. '**docker build -f Dockerfile.dev .**'

Starting the Container:

- Remember to add the '-p' flag along with the port mappings followed by the container id to get it to render from the container in the browser.
  - docker run -p 3000:3000 <container id> …..This will build and run the container with your CRA and set your port mappings so that the container actually renders the app when you go to 'https://localhost:3000'

Getting Source Code Changes to Appear with Stopping and Rebuilding the Container:

The previous section of 'Starting the Container' has one issue, and that's that while the app is running, any changes to the source code of the CRA aren't reflected unless you stop and rebuild the container and then run it again. This can be resolved by implementing Docker Volumes. Docker Volumes are essentially mappings from a folder inside the container to a folder outside of the container (folders on your local machine in the CRA source code). You can think of it as port mappings but for folders so that updates can be fed to the container when made.

- Docker Volumes CLI Command: 'docker run -p 3000:3000 -v /app/node_modules -v "$(pwd):/app" <image id>'
  - This volume mapping says to map create volumes for the node_modules folder in the container '/app' directory and the '$(pwd)' local '/app' directory
  - Doing this will now allow for the **Hot Reloading** feature of CRA.

Using Docker Compose Shorthand:

Rather than using the manual Docker CLI commands such as 'docker run -p 3000:3000 -v /app/node_modules -v "$(pwd):/app" <image id>' in the previous section, we can again avoid this by using Docker Compose like so:

- **Create a 'docker-compose.yml'** file in the same location as the Dockerfile.dev file and it should look like this:

```
version: '3'
services:
    web:
        build:
            context: . # Specifies where we want all files and
folders to be pulled from
            dockerfile: Dockerfile.dev # Name of dockerfile to be
used to build and run container
        ports:
            - "3000:3000"
        volumes:
            - /app/node_modules
            - .:/app
```

- Running **'docker-compose up'** will now execute the same run commands using volumes as discussed in the previous section!

Executing Tests:

You can easily run your unit tests using the commands mentioned previously in this documentation by doing the following:

- Run a new build and get the tag or container id
- Run **'docker run -it <container id> npm/yarn run test'**
  - **NOTE 1**: Make use of the '-it' flag in order to get the normal terminal UI that you can interact with, otherwise it will just run the tests one time and be static.

Running Tests that autorun/update on changes:

Tests won't rerun or update via this alone so you so you have some options to do this:

1. **Attaching to an existing container:** Build and Run your volumed container with docker-compose running in one terminal and in another one, get the container id by running **'docker ps'** and then running **'docker exec -it <container id> npm/yarn run test'**

a. Making changes to test files will now autorun and update them in the terminal session.
b. **NOTE: I prefer this method as I prefer having access to the test suite commands in the terminal and that's only possible w/this approach.**

2. **Adding a new service to the docker-compose.yml file:** You can update your docker-compose.yml file to include another service for testing, 'tests' in this example and then run a new build and run command with **'docker-compose up --build'**:

a.
```
version: '3'
services:
    web:
        build:
            context: . # Specifies where we want all files and
folders to be pulled from
            dockerfile: Dockerfile.dev # Name of dockerfile to
be used to build and run container
        ports:
            - "3000:3000"
        volumes:
            - /app/node_modules
            - .:/app
    tests:
        build:
            context: .
            dockerfile: Dockerfile.dev
        volumes:
            - /app/node_modules
            - .:/app
        command: [ "npm", "run", "test" ] # Override our
default "npm run start" starting command to use this instead
```

b. **NOTE:** It's recommended to run a new build at this point as sometimes running a container after adding a new service is finicky.
c. Unfortunately, this is as good as it gets with docker-compose with testing. You won't ever be able to access the secondary processes in the container via **'docker attach'** or anything else and are just left with the static test output in the terminal that docker-compose is running it. **NOTE:** It still refreshes and autoupdates when there are changes to tests, but you won't be able to use the terminal to run the test suite w/Jest or another test runner commands.

TESTING TLDR;

1. Using option 1 above:
    a. You just need the 'web' service in your docker-compose.yml file:

i.
```
version: '3'
services:
    web:
        build:
            context: . # Specifies where we want all files
and folders to be pulled from
            dockerfile: Dockerfile.dev # Name of
dockerfile to be used to build and run container
        ports:
            - "3000:3000"
        volumes:
            - /app/node_modules
            - .:/app
```

b. Run **'docker compose up'** in one terminal session
c. Open another terminal session and run **'docker ps'** get the **container id** run **'docker exec -it <container id> npm/yarn run test'**
    i. This will run the Jest/Specific test runner suite in the terminal with full access to it's commands

2. Using option 2 above:
    a. You need to create a service for 'tests' in your docker-compose.yml file:

i.
```
version: '3'
services:
    web:
        build:
            context: . # Specifies where we want all files
and folders to be pulled from
            dockerfile: Dockerfile.dev # Name of
dockerfile to be used to build and run container
        ports:
            - "3000:3000"
        volumes:
            - /app/node_modules
            - .:/app
    tests:
        build:
            context: .
            dockerfile: Dockerfile.dev
        volumes:
            - /app/node_modules
            - .:/app
        command: [ "npm", "run", "test" ] # Override our
default "npm run start" starting command to use this
instead
```

b. Run **'docker compose up --build'** to make sure the build is clean since you added a new service in a terminal session
    i. This will run build and run **EVERYTHING** in this terminal session, including test suite results, along with auto-retests on test file changes, but **NOTE: that you won't be able to directly interact with the test suite using this option**

Multi-Step Docker Builds to Run NGINX:

When normally running the build command for your React application, a deployable 'build' directory gets generated. With Docker, we need a way to be able to build this directory and then deploy it's static assets to a webserver that's built for just that and NGINX is the standard. To implement this, we need to create a multi-step build with our Dockerfile that will be used for production. The first step will create our build directory as we normally do and the second step will be the run phase that will copy the 'build' directory over to a container that will initiate the NGINX start command. The process is as follows:

- Create a new dockerfile named 'Dockerfile' in your project root alongside the 'dev' version of the dockerfile:
  - An Example Multi-Step Dockerfile for Prod:

```
FROM node:alpine as builder
WORKDIR '/app'
COPY package.json .
RUN npm install
COPY . .
RUN npm run build


FROM nginx
EXPOSE 80
COPY --from=builder /app/build /usr/share/nginx/html
```

    - The file breaks down as this:
      - The 1st FROM section:
        - We still provide 'node:alpine' as the base but add on 'as builder'. This now tells Docker that everything below this will be referred to as "builder"
        - We specify all of the normal commands that we've previously used, but add an additional 'RUN' command to actually create the production 'build' directory
      - The 2nd FROM section:
        - We now are into the 'run' phase of the multi-step build process and specify that 'nginx' is now the base for this additional container
        - 'EXPOSE' is only used for deployment and specifies the port you want to make available for the hosting service, AWS Elastic Beanstalk (later in this example), to use for traffic
        - We next copy the 'build' directory that was created from the previous 'FROM' section and specify where to get it from '/app/build' (this is where CRA places the 'build' directory) and where we want it copied to in the NGINX container ('/usr/share/nginx/html', this is where the NGINX dockerhub docs specify where nginx would like the static assets to be placed)
- In your terminal project root, run 'docker build .'
  - This will use the new PROD dockerfile to create the build and go through the processes described above and will generate a container id
- In another terminal, copy the container id generated in the previous step and do the following:
  - Type '**docker run -p 8080:80 <container id>**'
    - We have to specify our port mappings since we are now using NGINX (8080 is our localhost port we'll check our app in the browser with and 80 is the port on NGINX we'll use)
    - **NOTE:** You won't see anything in the terminal after entering this command until you open the browser and traffic starts flowing.

CI/CD Pipeline

We can implement simple CI/CD integrations with various services to automate our Docker build, test, and deploy stages of our workflow. We'll use Travis CI in this example, but the process should be similar for any other services that may be preferred.

Travis CI:

Connect Repo to Travis:

- Go to travis-ci.org and link your Github account via Oauth and select the repo from the list of your repos present toggle the switch to automatically have Travis-CI watch the commits on this repo click 'Dashboard' at the top of the page and you can now view all repos setup for Travis-CI that you have actively running on. Clicking on one will show you branches, builds, build history, pull requests, etc.

Create Travis YML File:

- In the root of your project, next to your Dockerfile, create a file called '**.travis.yml**' (you **MUST** include the '**.**' at the start of the file!)
- Example .travis.yml file:

```
language: generic
sudo: required
services:
    - docker

before_install:
    - docker build -t oe/docker-react -f Dockerfile.dev .

script:
    - docker run -e CI=true oe/docker-react npm run test
```

- Breakdown of .travis.yml file:
    - language - Optional but must be added at **top** of .travis.yml file. This example helps fix a build Travis-CI build issue where the build fails with 'rakefile not found' error.
    - sudo: required - This gives Docker and Travis-CI superuser permissions
    - services - A list of services that Travis needs to install, "docker" in this instance
    - before_install - A series of commands that get executed before our tests are ran. Since this process is automated, it's suggested to add a tag for the name, rather than randomly generated id, of your image per docker standard naming conventions (dockername/name-wanted-for-image)
    - script - Commands we want to run in the Docker container
        - **NOTE:** CI=true is used for this test-specific command so as to tell Jest to only run the test once, otherwise Jest will perform it's default behavior and wait around for another command to be issued after it's finished a round of testing.
    - ***OPTIONAL w/Elastic Beanstalk example***:
        - deploy - Configurations to tell Travis-CI how to deploy the application to different services
            - provider - The provider you would like to use to deploy the application. Travis-CI comes preconfigured with many different providers setup for you, i.e. AWS, DigitalOcean, Elastic Beanstalk, etc.
            - region - Depends on the region where you originally created Elasticbeanstalk instance (found in the url generated by Elastic Beanstalk, i.e. 'us-east-2' will be somewhere in the url.
            - app - The exact name you named your Elastic Beanstalk app, i.e, "docker-react"
            - env - The environment Elastic Beanstalk created for you, i.e. "DockerReact-env"
            - bucket_name - The name of the bucket that Travis-CI will copy our zipped application into
                - This is found by clicking on 'Services' in AWS Search for 'S3' Find the bucket that contains the same region for the environment you created in Elastic Beanstalk
                - **NOTE:** This bucket will be reused for pretty much all deployments made with your Elastic Beanstalk account and you will be able to see all deployed projects within this bucket, but **ONLY AFTER** they have been deployed!
            - bucket_path - The name of the path of the bucket, which is the exact same value you entered for 'app', so this one would also be 'docker-react'
            - on - Command to specify when and where to trigger deploys
                - branch - The specific branch you want Travis-CI to watch and deploy when the branch receives new code, i.e. "master"
            - access_key_id - AWS Access Key already stored in Travis-CI env variable (**NOTE:** You have to manually enter your keys from AWS into the Travis-CI project)
            - secret_access_key - AWS Secret Key already stored in Travis-CI env variable (**NOTE:** You have to manually enter your keys from AWS into the Travis-CI project)
- Example of .travis.yml file w/deploy procedures:

```
- language: generic
  sudo: required
  services:
      - docker

  before_install:
      - docker build -t oe/docker-react -f Dockerfile.dev .

  script:
      - docker run -e CI=true oe/docker-react npm run test

  deploy:
      provider: elasticbeanstalk
      region: "us-east-2"
      app: "docker-react"
      env: "DockerReact-env"
      bucket_name: "elasticbeanstalk-us-east-2-0082642098734"
      bucket_path: "docker-react"
      on:
          branch: master
      access_key_id: $AWS_ACCESS_KEY
      secret_access_key: $AWS_SECRET_KEY
```

- **NOTE:** An S3 bucket and AWS keys need to be setup on IAM on AWS and

Docker Links and Resources:

- Docker Official Docs
- Docker Labs Cheatsheet
- Docker Hub
- Travis CI