FullStack Development

CS571: Building User Interfaces

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Today's Warmup

1. Clone today's starter code and run `npm install` in `starter/frontend`, in `starter/backend`, in `solution/frontend`, and in `solution/frontend`.
   a. Consider using pnpm for future development :)
2. Download & install Docker

Announcements

Today's content *will be* on the final exam.

Please complete the end-of-semester survey!

- 🍪 @ 50% participation
- All feedback is welcome! :)

Complete the Final Exam Conflict Form *by tomorrow* at the **absolute latest**.

Announcements

Work **must** be turned in by *Friday, May 3rd @ 11:59 pm*

- HW11
- ICA K
- Bonus Quiz
- Bonus CTF

Bonus Quiz + CTF points added *outside* of Canvas.

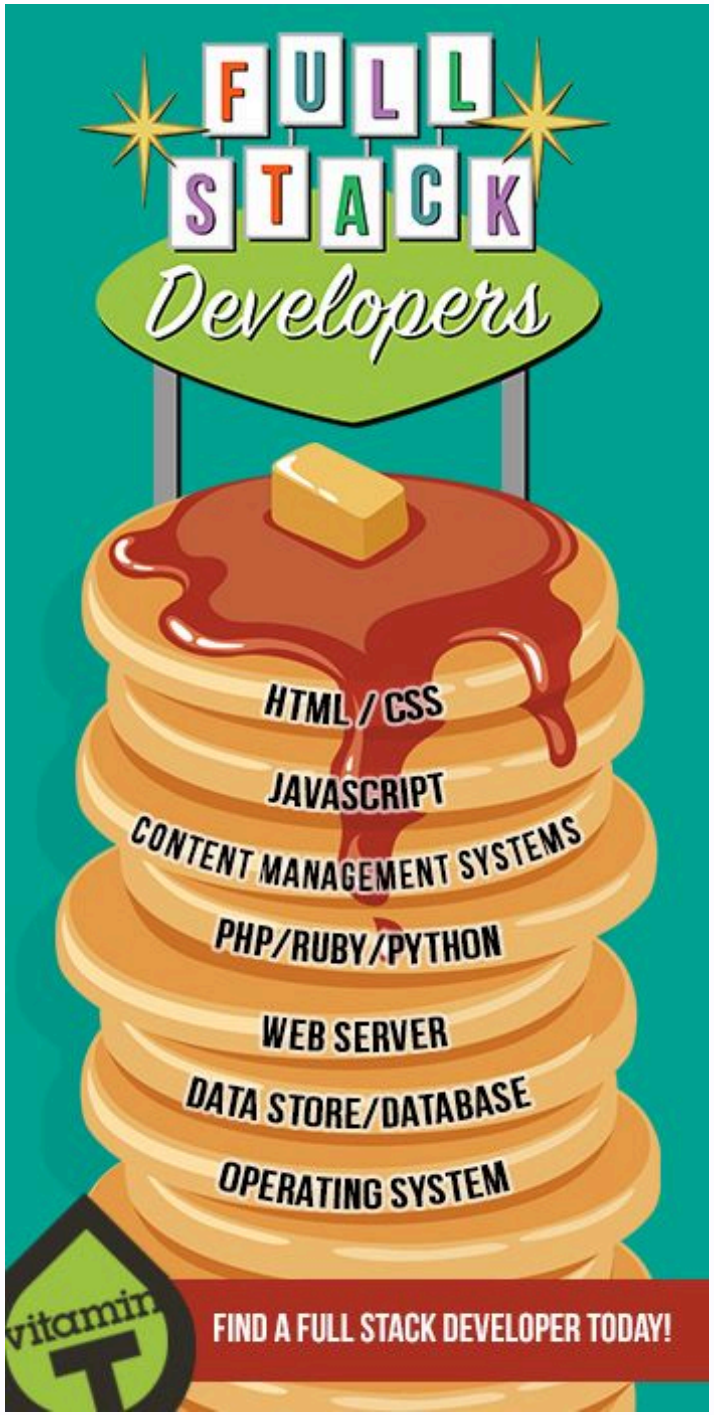
Learning Objectives

1. Be able to define how backend development fits into the software stack.
2. Be able to develop a backend.
3. Be able to persist data.
4. Be able to make other considerations such as containerization.

Software Stack

Think of software like a stack of pancakes...

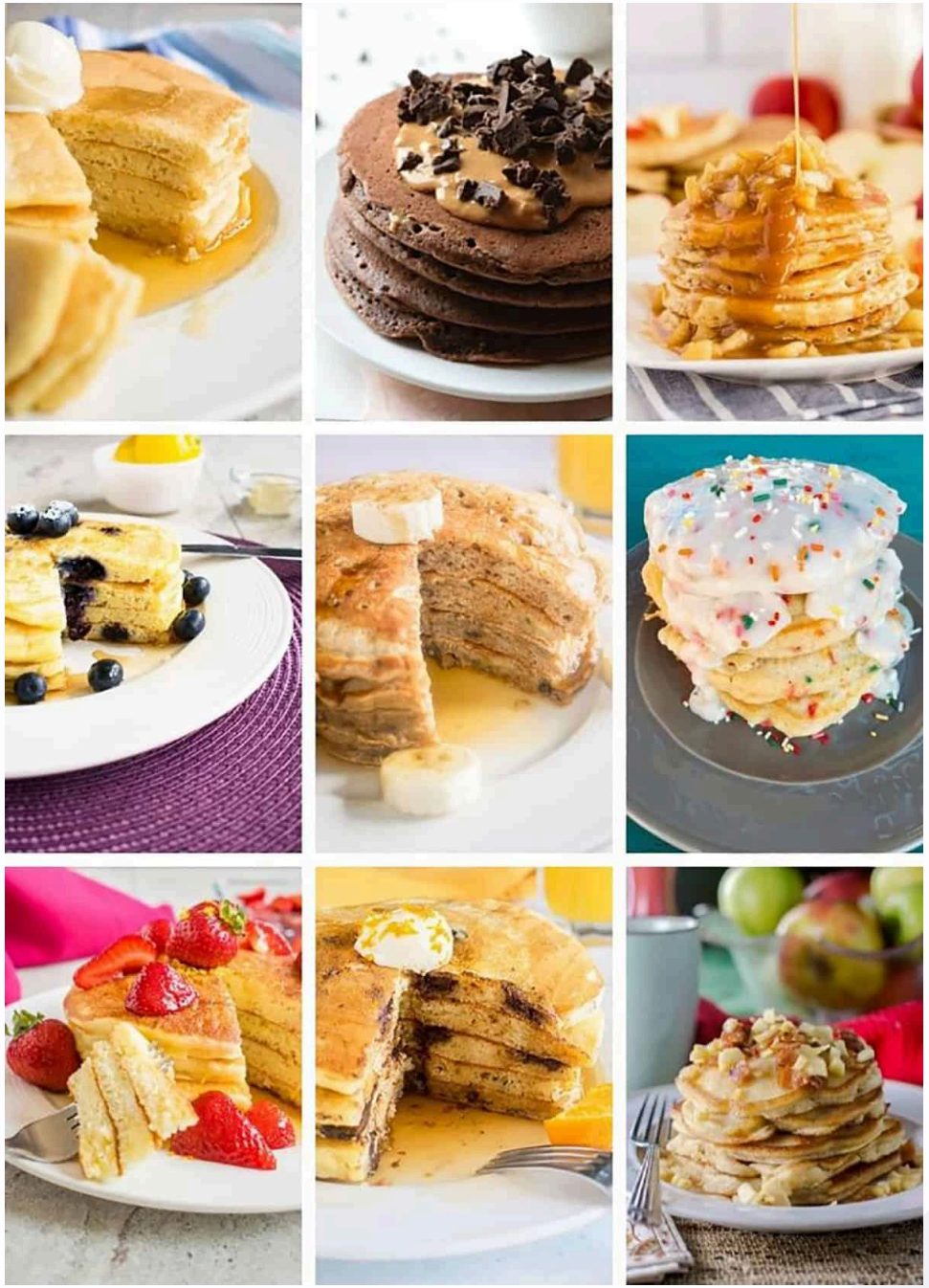
Image Source



Software Stack

... where each pancake can be its own flavor...

Image Source



Software Stack

... and can be cooked its own way...

Image Source

Software Stack

... with as many or as few as we want!

Image Source

Our Software Stack

JavaScript and React for frontend development.

JavaScript and Express for backend development.

When you build your project, you get to choose your software stack!

Creating a Backend Server

Many, many, many options!

- Google Cloud Functions
- AWS Lambdas
- C# & .NET
- Java & Spring
- Python & Flask
- **JavaScript & Express**

```
const express = require('express')
const app = express()
const port = 3000

app.get('/', (req, res) => {
  res.send('Hello World!')
})

app.listen(port, () => {
  console.log(`Example app listening on port ${port}`)
})
```

Taken from ExpressJS

ExpressJS

Define every *endpoint* with a *callback handler*.

```
app.get('/messages', (req, res) => {
  res.send('I should get the messages.')
})
```

```
app.post('/messages', (req, res) => {
  res.send('I should create a message.')
})
```

Notice! We use `res` rather than `return`.

ExpressJS

We prefer JSON! :)

```
app.get('/messages', (req, res) => {
  res.send({msg: 'I should get the messages.'})
})
```

```
app.post('/messages', (req, res) => {
  res.send({msg: 'I should create a message.'})
})
```

ExpressJS

Parameters in `req`, response in `res`.

```
app.get('/messages', (req, res) => {
  const chatroom = req.query.chatroom;
  if (chatrooms.includes(chatroom)) {
    res.status(200).send({msg: `I should get the messages.`})
  } else {
    res.status(404).send({msg: 'Could not find specified chatroom.'})
  }
})
```

ExpressJS

Parameters in `req`, response in `res`.

```
app.get('/messages', (req, res) => {
  const comment = req.body.comment;
  if (comment) {
    res.status(200).send({msg: `I should create this comment.`})
  } else {
    res.status(400).send({msg: 'You must specify a comment.'})
  }
})
```

ExpressJS Middleware

`use` some middleware that can read the `req` and modify the `res` before proceeding to the `next`

```
app.use((req, res, next) => {
    res.header("Access-Control-Allow-Origin", req.headers.origin);
    res.header("Access-Control-Allow-Headers", req.headers["access-control-request-headers"]);
    res.header('Access-Control-Allow-Methods', req.headers["access-control-request-method"]);
    res.header('Access-Control-Allow-Credentials', 'true');
    res.header('Access-Control-Expose-Headers', 'Set-Cookie');
    res.header('Vary', 'Origin, Access-Control-Allow-Headers, Access-Control-Allow-Methods')
    next();
});
```

Applied in the order of `use`

Your Turn!

Build the BadgerChat Nano API.

How to persist data?

Let's use SQLite

SQLite

- SQL, but lite!
- Creates a `.db` file on your machine
- Is not a "hosted" database, but is good for quick projects and hacks!

```
const db = await open({
    filename: "./db.db",
    driver: sqlite3.Database
});
```

SQL 101

Interact with the database via string queries.

```
-- Get all comments.
SELECT * FROM BadgerComment;

-- Get a specific comment.
SELECT * FROM BadgerComment WHERE id = ?;

-- Create a comment and return its id.
INSERT INTO BadgerComment(comment, created) VALUES (?, ?) RETURNING id;

-- Delete a specific comment.
DELETE FROM BadgerComment WHERE id = ?;
```

SQL w/ ExpressJS

Common functions incl. `exec`, `run`, `get`, and `all`.

```
// Run arbitrary queries, disregarding the results.
await db.exec('CREATE TABLE BadgerComment');

// Run a query, disregarding the results.
await db.run('DELETE FROM BadgerComment WHERE id = 4;');

// Get the first row back as an object.
const datum = await db.get('SELECT * FROM BadgerComment WHERE id = 7');

// Get all rows back as a list of objects.
const data = await db.all('SELECT * FROM BadgerComment');
```

Your Turn!

Build the BadgerChat Nano API with a database.

SQL Prepared Statements

Concatenating SQL queries with user input is **very bad**. Prefer to use prepared statements.

```
// Use prepared statements instead!
await db.get('SELECT * FROM BadgerComment WHERE id = ?', 7)
```

`?` is sanitized and interpolated with the arguments following the SQL query.

Your Turn!

Build the BadgerChat Nano API with a database using prepared statements.

This is great but...

...how can we deploy this?

Deployment

Generally accepted: a server is a piece of computer hardware or software that provides functionality for other programs or devices, called "clients". - Wikipedia

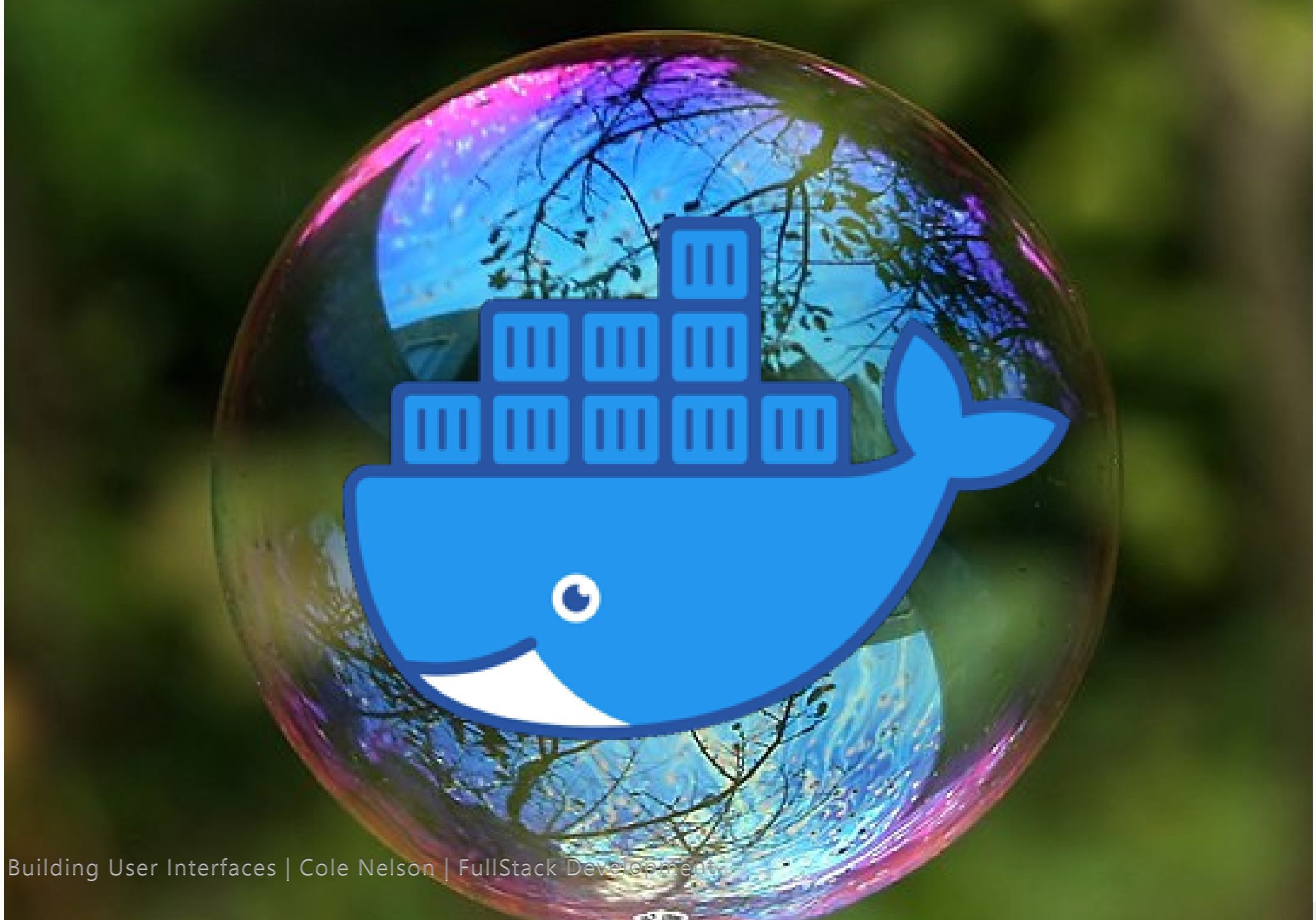
More cynical: a server is just another computer with a bunch of holes in its firewall.

Deployment

Run the setup commands, then...

1. Open the ports on your machine & router (or use a reverse proxy tool like ngrok).
2. Open the ports on a remote machine.

Still... how do we *isolate* ourselves? How do we make the environment *portable*? **Use a VM or a container!**



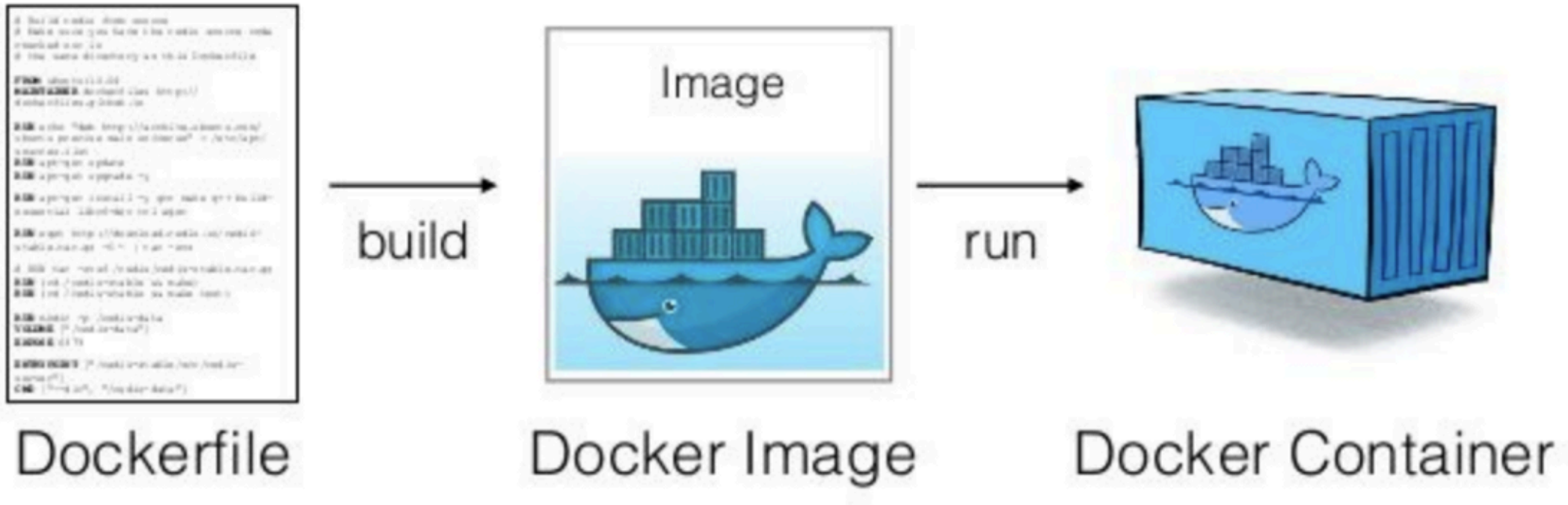


Image Source

Docker Commands

`docker build` builds an image from a given Dockerfile

`docker run` runs a container from a given image

`docker stop` stops a running container

`docker rm` removes a stopped container

`docker push` pushes an image

`docker pull` pulls an image

Demo

Building, pushing, pulling, and running a Docker image as a container on a remote machine.

Source Code

Backend Server Hosting

Not an endorsement of any particular service.

Other Considerations

- Use Jenkins or some other CICD platform to create a build and deploy pipeline.
  - Include testing as an automated step.
- Use HTTPS for a secure HTTP connection.
  - Consider LetsEncrypt.
- Use TypeScript instead of JavaScript!
- Buy a domain name?
  - Completely optional!

Questions?