KATHLEEN JUELL

FROM
CONTAINERS
TO
KUBERNETES

WITH NODE.JS

From Containers to Kubernetes with Node.js

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About DigitalOcean

DigitalOcean is a cloud services platform delivering the simplicity developers love and businesses trust to run production applications at scale. It provides highly available, secure and scalable compute, storage and networking solutions that help developers build great software faster. Founded in 2012 with offices in New York and Cambridge, MA, DigitalOcean offers transparent and affordable pricing, an elegant user interface, and one of the largest libraries of open source resources available. For more information, please visit https://www.digitalocean.com or follow @digitalocean on Twitter.

Preface - Getting Started with this Book

To work with the examples in this book, we recommend that you have a local development environment running Ubuntu 18.04. For examples that model pushing code to production, we recommend that you provision a remote Ubuntu 18.04 server. This will be important as you begin exploring how to deploy to production with containers and SSL certificates.

When working with Kubernetes, we also recommend that you have a local machine or server with the kubectl command line tool installed.

Each chapter of the book will also have clear requirements that pertain to the instructions it covers.

Introduction

About this Book

This book is designed as an introduction to containers and [Kubernetes](#) by way of [Node.js](#). Containers are the basis for distributed, repeatable workflows with orchestrators such as Kubernetes, and they allow developers and operators to develop applications consistently across environments and deploy in a repeatable and predictable fashion.

The examples in this book focus on Node.js, a JavaScript runtime, and demonstrate how to develop an application that communicates with a [MongoDB](#) backend. Though the chapters of the book cover cumulative topics – from how to develop a stateless application, to adding storage, to containerization – they can also be used as independent guides.

Feel free to use the chapters in order, or jump to the discussion that best suits your purpose.

Motivation for this Book

Often, resources on development and deployment are relatively independent of one another: guides on containers and Kubernetes rarely cover application development, and tutorials on languages and frameworks are often focused on languages and other nuances rather than on deployment.

This book is designed to be a full-stack introduction to containers and Kubernetes by way of Node.js application development. It assumes that readers want an introduction not only to the fundamentals of

containerization, but also to the basics of working with Node and a NoSQL database backend.

Learning Goals and Outcomes

The goal for this guide is to serve readers interested in Node application development, as well as readers who would like to learn more about working with containers and container orchestrators. It assumes a shared interest in moving away from highly individuated local environments, in favor of repeatable, reproducible application environments that ensure consistency and ultimately resiliency over time.

[How To Build a Node.js Application with Docker](#)

Written by Kathleen Juell

The first chapter of this book will introduce you to building a Node.js application with the Express framework. Once you have the application built and working locally, you will turn it into an image that you can run with the Docker container engine. From there, you'll learn how to publish the image to Docker Hub so that it can be run as a container on any system that supports Docker images. Finally, you'll use the image from Docker Hub to run your application as a container, which will demonstrate how you can develop a workflow that moves code from a local development environment all the way to a production-ready application that is deployed using containers.

The [Docker](#) platform allows developers to package and run applications as containers. A container is an isolated process that runs on a shared operating system, offering a lighter weight alternative to virtual machines. Though containers are not new, they offer benefits — including process isolation and environment standardization — that are growing in importance as more developers use distributed application architectures.

When building and scaling an application with Docker, the starting point is typically creating an image for your application, which you can then run in a container. The image includes your application code, libraries, configuration files, environment variables, and runtime. Using

an image ensures that the environment in your container is standardized and contains only what is necessary to build and run your application.

In this tutorial, you will create an application image for a static website that uses the [Express](#) framework and [Bootstrap](#). You will then build a container using that image and push it to [Docker Hub](#) for future use. Finally, you will pull the stored image from your Docker Hub repository and build another container, demonstrating how you can recreate and scale your application.

Prerequisites

To follow this tutorial, you will need: - One Ubuntu 18.04 server, set up following this [Initial Server Setup guide](#). - Docker installed on your server, following Steps 1 and 2 of [How To Install and Use Docker on Ubuntu 18.04](#). - Node.js and npm installed, following [these instructions on installing with the PPA managed by NodeSource](#). - A Docker Hub account. For an overview of how to set this up, refer to [this introduction](#) on getting started with Docker Hub.

Step 1 — Installing Your Application Dependencies

To create your image, you will first need to make your application files, which you can then copy to your container. These files will include your application's static content, code, and dependencies.

First, create a directory for your project in your non-root user's home directory. We will call ours **node_project**, but you should feel free to replace this with something else:

```
mkdir node_project
```

Navigate to this directory:

```
cd node_project
```

This will be the root directory of the project.

Next, create a `package.json` file with your project's dependencies and other identifying information. Open the file with `nano` or your favorite editor:

```
nano package.json
```

Add the following information about the project, including its name, author, license, entrypoint, and dependencies. Be sure to replace the author information with your own name and contact details:

```
{

  "name": "nodejs-image-demo",

  "version": "1.0.0",

  "description": "nodejs image demo",

  "author": "Sammy the Shark <sammy@example.com>",

  "license": "MIT",

  "main": "app.js",

  "keywords": [

    "nodejs",

    "bootstrap",

    "express"

  ],

  "dependencies": {

    "express": "^4.16.4"

  }

}
```

This file includes the project name, author, and license under which it is being shared. Npm [recommends](#) making your project name short and descriptive, and avoiding duplicates in the [npm registry](#). We've listed the [MIT license](#) in the license field, permitting the free use and distribution of the application code.

Additionally, the file specifies: - `"main"`: The entrypoint for the application, `app.js`. You will create this file next. - `"dependencies"`: The project dependencies — in this case, Express 4.16.4 or above.

Though this file does not list a repository, you can add one by following these guidelines on [adding a repository to your `package.json` file](). This is a good addition if you are versioning your application.

Save and close the file when you've finished making changes.

To install your project's dependencies, run the following command:

```
npm install
```

This will install the packages you've listed in your `package.json` file in your project directory.

We can now move on to building the application files.

Step 2 — Creating the Application Files

We will create a website that offers users information about sharks. Our application will have a main entrypoint, `app.js`, and a `views` directory that will include the project's static assets. The landing page, `index.html`, will offer users some preliminary information and a link to a page with more detailed shark information, `sharks.html`. In the `views` directory, we will create both the landing page and `sharks.html`.

First, open `app.js` in the main project directory to define the project's routes:

```
nano app.js
```

The first part of the file will create the Express application and Router objects, and define the base directory and port as constants:

```
const express = require('express');

const app = express();

const router = express.Router();


const path = __dirname + '/views/';

const port = 8080;
```

The `require` function loads the `express` module, which we then use to create the `app` and `router` objects. The `router` object will perform the routing function of the application, and as we define HTTP method routes we will add them to this object to define how our application will handle requests.

This section of the file also sets a couple of constants, `path` and `port`: - `path`: Defines the base directory, which will be the `views` subdirectory within the current project directory. - `port`: Tells the app to listen on and bind to port `8080`.

Next, set the routes for the application using the `router` object:

```
...


router.use(function (req,res,next) {

  console.log('/' + req.method);

  next();

});



router.get('/', function(req,res){

  res.sendFile(path + 'index.html');

});



router.get('/sharks', function(req,res){

  res.sendFile(path + 'sharks.html');

});
```

The `router.use` function loads a [middleware function](#) that will log the router's requests and pass them on to the application's routes. These are defined in the subsequent functions, which specify that a GET request to the base project URL should return the `index.html` page, while a GET request to the `/sharks` route should return `sharks.html`.

Finally, mount the `router` middleware and the application's static assets and tell the app to listen on port `8080`:

```
...


app.use(express.static(path));

app.use('/', router);


app.listen(port, function () {

  console.log('Example app listening on port 8080!')

})
```

The finished `app.js` file will look like this:

```javascript
const express = require('express');

const app = express();

const router = express.Router();


const path = __dirname + '/views/';

const port = 8080;


router.use(function (req,res,next) {

  console.log('/' + req.method);

  next();

});


router.get('/', function(req,res){

  res.sendFile(path + 'index.html');

});


router.get('/sharks', function(req,res){

  res.sendFile(path + 'sharks.html');

});


app.use(express.static(path));

app.use('/', router);


app.listen(port, function () {

  console.log('Example app listening on port 8080!')

})
```

Save and close the file when you are finished.

Next, let's add some static content to the application. Start by creating the `views` directory:

```
mkdir views
```

Open the landing page file, `index.html`:

```
nano views/index.html
```

Add the following code to the file, which will import Boostrap and create a [jumbotron](#) component with a link to the more detailed `sharks.html` info page:

~/node_project/views/index.html

```
<!DOCTYPE html>

<html lang="en">


<head>

    <title>About Sharks</title>

    <meta charset="utf-8">

    <meta name="viewport" content="width=device-width, initial-
scale=1">

    <link rel="stylesheet"
href="https://stackpath.bootstrapcdn.com/bootstrap/4.1.3/css/bootst
rap.min.css" integrity="sha384-
MCw98/SFnGE8fJT3GXwEOngsV7Zt27NXFoaoApmYm81iuXoPkFOJwJ8ERdknLPMO"
crossorigin="anonymous">

    <link href="css/styles.css" rel="stylesheet">

    <link href="https://fonts.googleapis.com/css?
family=Merriweather:400,700" rel="stylesheet" type="text/css">

</head>


<body>

    <nav class="navbar navbar-dark bg-dark navbar-static-top
navbar-expand-md">

        <div class="container">

            <button type="button" class="navbar-toggler collapsed"
data-toggle="collapse" data-target="#bs-example-navbar-collapse-1"
aria-expanded="false"> <span class="sr-only">Toggle
navigation</span>
```

```html
            </button> <a class="navbar-brand" href="#">Everything
Sharks</a>

            <div class="collapse navbar-collapse" id="bs-example-
navbar-collapse-1">
                <ul class="nav navbar-nav mr-auto">
                    <li class="active nav-item"><a href="/"
class="nav-link">Home</a>
                    </li>
                    <li class="nav-item"><a href="/sharks"
class="nav-link">Sharks</a>
                    </li>
                </ul>
            </div>
        </div>
    </nav>
    <div class="jumbotron">
        <div class="container">
            <h1>Want to Learn About Sharks?</h1>
            <p>Are you ready to learn about sharks?</p>
            <br>
            <p><a class="btn btn-primary btn-lg" href="/sharks"
role="button">Get Shark Info</a>
            </p>
        </div>
    </div>
    <div class="container">
        <div class="row">
```

```
                <div class="col-lg-6">

                        <h3>Not all sharks are alike</h3>

                        <p>Though some are dangerous, sharks generally do
not attack humans. Out of the 500 species known to researchers,
only 30 have been known to attack humans.
                        </p>

                </div>

                <div class="col-lg-6">

                        <h3>Sharks are ancient</h3>

                        <p>There is evidence to suggest that sharks lived
up to 400 million years ago.
                        </p>

                </div>

            </div>

        </div>

</body>


</html>
```

The top-level [navbar](#) here allows users to toggle between the Home and Sharks pages. In the `navbar-nav` subcomponent, we are using Bootstrap's `active` class to indicate the current page to the user. We've also specified the routes to our static pages, which match the routes we defined in `app.js`:

```
...

<div class="collapse navbar-collapse" id="bs-example-navbar-
collapse-1">

   <ul class="nav navbar-nav mr-auto">

      <li class="active nav-item"><a href="/" class="nav-
link">Home</a>

      </li>

      <li class="nav-item"><a href="/sharks" class="nav-
link">Sharks</a>

      </li>

   </ul>

</div>

...
```

Additionally, we've created a link to our shark information page in our jumbotron's button:

```
...

<div class="jumbotron">

    <div class="container">

        <h1>Want to Learn About Sharks?</h1>

        <p>Are you ready to learn about sharks?</p>

        <br>

        <p><a class="btn btn-primary btn-lg" href="/sharks"

role="button">Get Shark Info</a>

        </p>

    </div>

</div>

...
```

There is also a link to a custom style sheet in the header:

```
...

<link href="css/styles.css" rel="stylesheet">

...
```

We will create this style sheet at the end of this step.

Save and close the file when you are finished.

With the application landing page in place, we can create our shark information page, `sharks.html`, which will offer interested users more information about sharks.

Open the file:

```
nano views/sharks.html
```

Add the following code, which imports Bootstrap and the custom style sheet and offers users detailed information about certain sharks:

```
<!DOCTYPE html>

<html lang="en">


<head>

    <title>About Sharks</title>

    <meta charset="utf-8">

    <meta name="viewport" content="width=device-width, initial-
scale=1">

    <link rel="stylesheet"
href="https://stackpath.bootstrapcdn.com/bootstrap/4.1.3/css/bootst
rap.min.css" integrity="sha384-
MCw98/SFnGE8fJT3GXwEOngsV7Zt27NXFoaoApmYm81iuXoPkFOJwJ8ERdknLPMO"
crossorigin="anonymous">

    <link href="css/styles.css" rel="stylesheet">

    <link href="https://fonts.googleapis.com/css?
family=Merriweather:400,700" rel="stylesheet" type="text/css">

</head>

<nav class="navbar navbar-dark bg-dark navbar-static-top navbar-
expand-md">

    <div class="container">

        <button type="button" class="navbar-toggler collapsed"
data-toggle="collapse" data-target="#bs-example-navbar-collapse-1"
aria-expanded="false"> <span class="sr-only">Toggle
navigation</span>

        </button> <a class="navbar-brand" href="/">Everything
Sharks</a>
```

```
        <div class="collapse navbar-collapse" id="bs-example-
navbar-collapse-1">

            <ul class="nav navbar-nav mr-auto">

                <li class="nav-item"><a href="/" class="nav-
link">Home</a>

                </li>

                <li class="active nav-item"><a href="/sharks"
class="nav-link">Sharks</a>

                </li>

            </ul>

        </div>

    </div>

</nav>

<div class="jumbotron text-center">

    <h1>Shark Info</h1>

</div>

<div class="container">

    <div class="row">

        <div class="col-lg-6">

            <p>

                <div class="caption">Some sharks are known to be
dangerous to humans, though many more are not. The sawshark, for
example, is not considered a threat to humans.

                </div>

                <img
src="https://assets.digitalocean.com/articles/docker_node_image/saw
shark.jpg" alt="Sawshark">
```

```
            </p>

        </div>

        <div class="col-lg-6">

            <p>

                <div class="caption">Other sharks are known to be
friendly and welcoming!</div>

                    <img
src="https://assets.digitalocean.com/articles/docker_node_image/sam
my.png" alt="Sammy the Shark">

            </p>

        </div>

    </div>
</div>


</html>
```

Note that in this file, we again use the `active` class to indicate the current page.

Save and close the file when you are finished.

Finally, create the custom CSS style sheet that you've linked to in `index.html` and `sharks.html` by first creating a `css` folder in the `views` directory:

```
mkdir views/css
```

Open the style sheet:

```
nano views/css/styles.css
```

Add the following code, which will set the desired color and font for our pages:

```css
.navbar {

    margin-bottom: 0;

}


body {

    background: #020A1B;

    color: #ffffff;

    font-family: 'Merriweather', sans-serif;

}


h1,

h2 {

    font-weight: bold;

}


p {

    font-size: 16px;

    color: #ffffff;

}


.jumbotron {

    background: #0048CD;

    color: white;

    text-align: center;

}
```

```
.jumbotron p {

    color: white;

    font-size: 26px;

}


.btn-primary {

    color: #fff;

    text-color: #000000;

    border-color: white;

    margin-bottom: 5px;

}


img,

video,

audio {

    margin-top: 20px;

    max-width: 80%;

}


div.caption: {

    float: left;

    clear: both;

}
```

In addition to setting font and color, this file also limits the size of the images by specifying a `max-width` of 80%. This will prevent them from taking up more room than we would like on the page.

Save and close the file when you are finished.

With the application files in place and the project dependencies installed, you are ready to start the application.

If you followed the initial server setup tutorial in the prerequisites, you will have an active firewall permitting only SSH traffic. To permit traffic to port 8080 run:
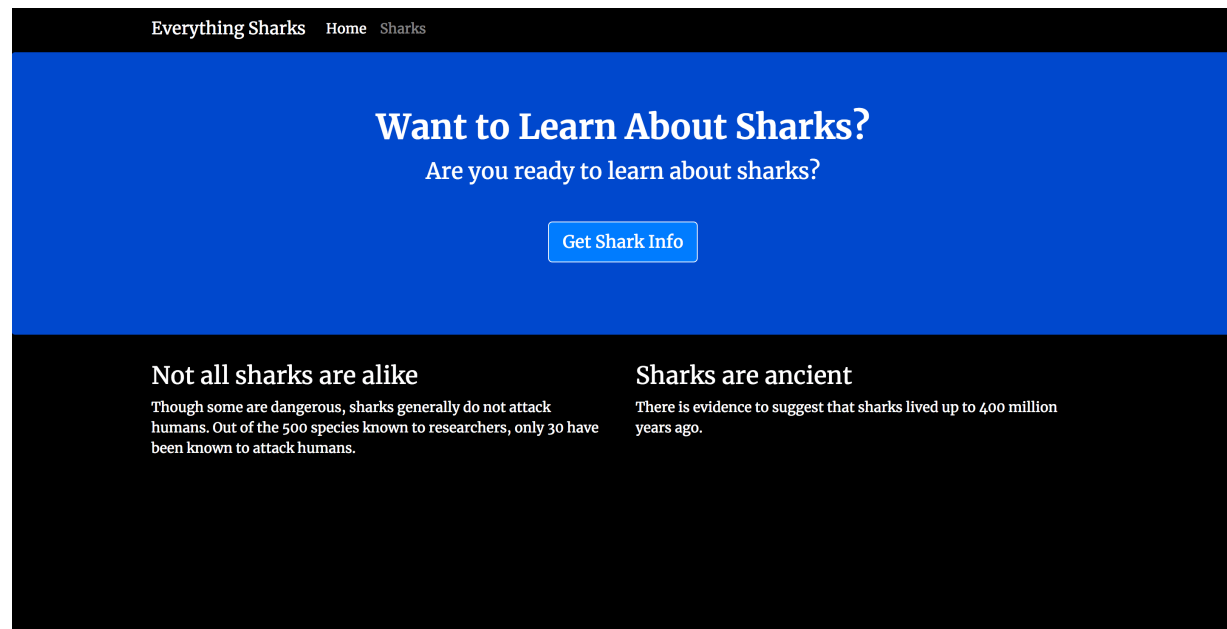
```
sudo ufw allow 8080
```

To start the application, make sure that you are in your project's root directory:

```
cd ~/node_project
```
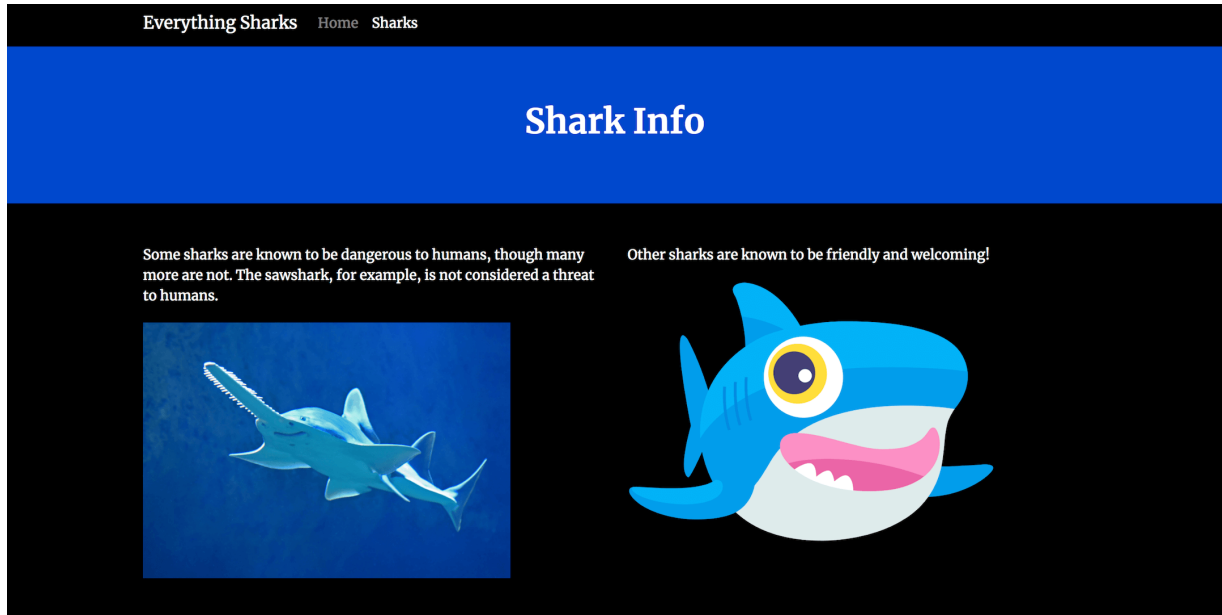
Start the application with `node app.js`:

```
node app.js
```

Navigate your browser to `http://your_server_ip:8080`. You will see the following landing page:

Application Landing Page

Click on the Get Shark Info button. You will see the following information page:

Shark Info Page

You now have an application up and running. When you are ready, quit the server by typing `CTRL+C`. We can now move on to creating the Dockerfile that will allow us to recreate and scale this application as desired.

Step 3 — Writing the Dockerfile

Your Dockerfile specifies what will be included in your application container when it is executed. Using a Dockerfile allows you to define your container environment and avoid discrepancies with dependencies or runtime versions.

Following these guidelines on building optimized containers, we will make our image as efficient as possible by minimizing the number of

image layers and restricting the image's function to a single purpose — recreating our application files and static content.

In your project's root directory, create the Dockerfile:

```
nano Dockerfile
```

Docker images are created using a succession of layered images that build on one another. Our first step will be to add the base image for our application that will form the starting point of the application build.

Let's use the node:**10-alpine** image, since at the time of writing this is the recommended LTS version of Node.js. The `alpine` image is derived from the Alpine Linux project, and will help us keep our image size down. For more information about whether or not the `alpine` image is the right choice for your project, please see the full discussion under the Image Variants section of the Docker Hub Node image page.

Add the following FROM instruction to set the application's base image:

~/node_project/Dockerfile

```
FROM node:10-alpine
```

This image includes Node.js and npm. Each Dockerfile must begin with a FROM instruction.

By default, the Docker Node image includes a non-root node user that you can use to avoid running your application container as root. It is a recommended security practice to avoid running containers as root and to restrict capabilities within the container to only those required to run its processes. We will therefore use the node user's home directory as the working directory for our application and set them as our user inside the

container. For more information about best practices when working with the Docker Node image, see this best practices guide.

To fine-tune the permissions on our application code in the container, let's create the `node_modules` subdirectory in `/home/node` along with the `app` directory. Creating these directories will ensure that they have the permissions we want, which will be important when we create local node modules in the container with `npm install`. In addition to creating these directories, we will set ownership on them to our node user:

~/node_project/Dockerfile

```
...
RUN mkdir -p /home/node/app/node_modules && chown -R node:node
/home/node/app
```

For more information on the utility of consolidating `RUN` instructions, see this discussion of how to manage container layers.

Next, set the working directory of the application to `/home/node/app`:

~/node_project/Dockerfile

```
...
WORKDIR /home/node/app
```

If a `WORKDIR` isn't set, Docker will create one by default, so it's a good idea to set it explicitly.

Next, copy the `package.json` and `package-lock.json` (for npm 5+) files:

```
...
COPY package*.json ./
```

Adding this `COPY` instruction before running `npm install` or copying the application code allows us to take advantage of Docker's caching mechanism. At each stage in the build, Docker will check to see if it has a layer cached for that particular instruction. If we change `package.json`, this layer will be rebuilt, but if we don't, this instruction will allow Docker to use the existing image layer and skip reinstalling our node modules.

To ensure that all of the application files are owned by the non-root node user, including the contents of the `node_modules` directory, switch the user to node before running `npm install`:

```
...
USER node
```

After copying the project dependencies and switching our user, we can run `npm install`:

```
...
RUN npm install
```

Next, copy your application code with the appropriate permissions to the application directory on the container:

~/node_project/Dockerfile

```
...
COPY --chown=node:node . .
```

This will ensure that the application files are owned by the non-root node user.

Finally, expose port 8080 on the container and start the application:

~/node_project/Dockerfile

```
...
EXPOSE 8080

CMD [ "node", "app.js" ]
```

EXPOSE does not publish the port, but instead functions as a way of documenting which ports on the container will be published at runtime. CMD runs the command to start the application — in this case, node app.js. Note that there should only be one CMD instruction in each Dockerfile. If you include more than one, only the last will take effect.

There are many things you can do with the Dockerfile. For a complete list of instructions, please refer to Docker's Dockerfile reference documentation.

The complete Dockerfile looks like this:

```
FROM node:10-alpine

RUN mkdir -p /home/node/app/node_modules && chown -R node:node
/home/node/app

WORKDIR /home/node/app

COPY package*.json ./

USER node

RUN npm install

COPY --chown=node:node . .

EXPOSE 8080

CMD [ "node", "app.js" ]
```

Save and close the file when you are finished editing.

Before building the application image, let's add a .dockerignore file. Working in a similar way to a .gitignore file, .dockerignore specifies which files and directories in your project directory should not be copied over to your container.

Open the .dockerignore file:

```
nano .dockerignore
```

Inside the file, add your local node modules, npm logs, Dockerfile, and `.dockerignore` file:

<div align="center">~/node_project/.dockerignore</div>

```
node_modules

npm-debug.log

Dockerfile

.dockerignore
```

If you are working with [Git](#) then you will also want to add your `.git` directory and `.gitignore` file.

Save and close the file when you are finished.

You are now ready to build the application image using the [docker build](#) command. Using the `-t` flag with `docker build` will allow you to tag the image with a memorable name. Because we are going to push the image to Docker Hub, let's include our Docker Hub username in the tag. We will tag the image as **nodejs-image-demo**, but feel free to replace this with a name of your own choosing. Remember to also replace **your_dockerhub_username** with your own Docker Hub username:

```
docker build -t your_dockerhub_username/nodejs-image-demo .
```

The `.` specifies that the build context is the current directory.

It will take a minute or two to build the image. Once it is complete, check your images:

```
docker images
```

You will see the following output:

```
REPOSITORY                                              TAG
IMAGE ID            CREATED             SIZE
your_dockerhub_username/nodejs-image-demo               latest
1c723fb2ef12        8 seconds ago       73MB
node                                                    10-alpine
f09e7c96b6de        3 weeks ago         70.7MB
```

It is now possible to create a container with this image using <u>docker run</u>. We will include three flags with this command: - `-p`: This publishes the port on the container and maps it to a port on our host. We will use port `80` on the host, but you should feel free to modify this as necessary if you have another process running on that port. For more information about how this works, see this discussion in the Docker docs on <u>port binding</u>. - `-d`: This runs the container in the background. - `--name`: This allows us to give the container a memorable name.

Run the following command to build the container:

```
docker run --name nodejs-image-demo -p 80:8080 -d your_dockerhub_username/nodejs-image-demo
```

Once your container is up and running, you can inspect a list of your running containers with <u>docker ps</u>:

```
docker ps
```

You will see the following output:

Output

```
CONTAINER ID        IMAGE
COMMAND             CREATED         STATUS          PORTS
NAMES
e50ad27074a7        your_dockerhub_username/nodejs-image-demo
"node app.js"       8 seconds ago       Up 7 seconds
0.0.0.0:80->8080/tcp   nodejs-image-demo
```

With your container running, you can now visit your application by navigating your browser to http://**your_server_ip**. You will see your application landing page once again:
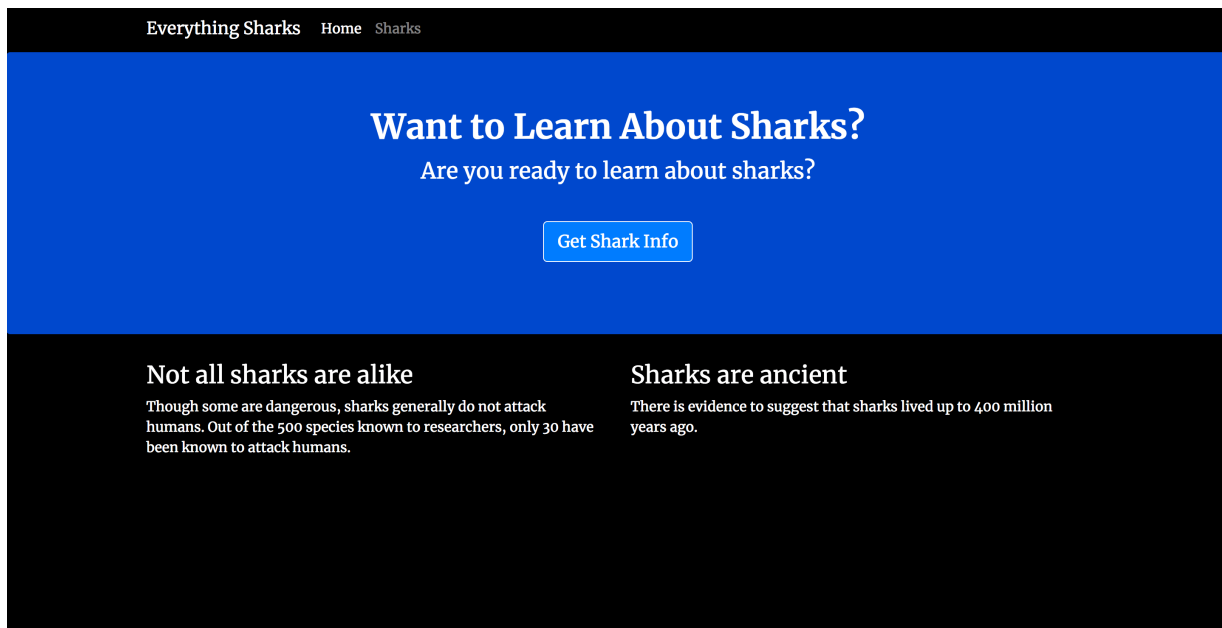
Application Landing Page

Now that you have created an image for your application, you can push it to Docker Hub for future use.

Step 4 — Using a Repository to Work with Images

By pushing your application image to a registry like Docker Hub, you make it available for subsequent use as you build and scale your containers. We will demonstrate how this works by pushing the application image to a repository and then using the image to recreate our container.

The first step to pushing the image is to log in to the Docker Hub account you created in the prerequisites:

```
docker login -u your_dockerhub_username
```

When prompted, enter your Docker Hub account password. Logging in this way will create a `~/.docker/config.json` file in your user's home directory with your Docker Hub credentials.

You can now push the application image to Docker Hub using the tag you created earlier, `your_dockerhub_username/nodejs-image-demo`:

```
docker push your_dockerhub_username/nodejs-image-demo
```

Let's test the utility of the image registry by destroying our current application container and image and rebuilding them with the image in our repository.

First, list your running containers:

```
docker ps
```

You will see the following output:

Output

```
CONTAINER ID        IMAGE
COMMAND             CREATED         STATUS          PORTS
NAMES
e50ad27074a7        your_dockerhub_username/nodejs-image-demo
"node app.js"       3 minutes ago   Up 3 minutes
0.0.0.0:80->8080/tcp   nodejs-image-demo
```

Using the `CONTAINER ID` listed in your output, stop the running application container. Be sure to replace the highlighted ID below with your own `CONTAINER ID`:

`docker stop e50ad27074a7`

List your all of your images with the `-a` flag:

`docker images -a`

You will see the following output with the name of your image, **your_dockerhub_username**/**nodejs-image-demo**, along with the `node` image and the other images from your build:

Output

```
REPOSITORY                                      TAG

IMAGE ID            CREATED          SIZE

your_dockerhub_username/nodejs-image-demo        latest

1c723fb2ef12       7 minutes ago    73MB

<none>                                          <none>

2e3267d9ac02       4 minutes ago    72.9MB

<none>                                          <none>

8352b41730b9       4 minutes ago    73MB

<none>                                          <none>

5d58b92823cb       4 minutes ago    73MB

<none>                                          <none>

3f1e35d7062a       4 minutes ago    73MB

<none>                                          <none>

02176311e4d0       4 minutes ago    73MB

<none>                                          <none>

8e84b33edcda       4 minutes ago    70.7MB

<none>                                          <none>

6a5ed70f86f2       4 minutes ago    70.7MB

<none>                                          <none>

776b2637d3c1       4 minutes ago    70.7MB

node                                            10-alpine

f09e7c96b6de       3 weeks ago      70.7MB
```

Remove the stopped container and all of the images, including unused or dangling images, with the following command:

```
docker system prune -a
```

Type `y` when prompted in the output to confirm that you would like to remove the stopped container and images. Be advised that this will also remove your build cache.

You have now removed both the container running your application image and the image itself. For more information on removing Docker containers, images, and volumes, please see [How To Remove Docker Images, Containers, and Volumes](#).

With all of your images and containers deleted, you can now pull the application image from Docker Hub:

```
docker pull your_dockerhub_username/nodejs-image-demo
```

List your images once again:

```
docker images
```

You will see your application image:

Output

```
REPOSITORY                                      TAG
IMAGE ID            CREATED             SIZE
your_dockerhub_username/nodejs-image-demo       latest
1c723fb2ef12        11 minutes ago      73MB
```

You can now rebuild your container using the command from Step 3:

```
docker run --name nodejs-image-demo -p 80:8080 -d your_dockerhub_username/nodejs-image-demo
```

List your running containers:

```
docker ps
```

Output

```
CONTAINER ID        IMAGE

COMMAND             CREATED             STATUS              PORTS

NAMES

f6bc2f50dff6        your_dockerhub_username/nodejs-image-demo

"node app.js"       4 seconds ago       Up 3 seconds

0.0.0.0:80->8080/tcp   nodejs-image-demo
```

Visit `http://`**`your_server_ip`** once again to view your running application.

Conclusion

In this tutorial you created a static web application with Express and Bootstrap, as well as a Docker image for this application. You used this image to create a container and pushed the image to Docker Hub. From there, you were able to destroy your image and container and recreate them using your Docker Hub repository.

If you are interested in learning more about how to work with tools like Docker Compose and Docker Machine to create multi-container setups, you can look at the following guides: - How To Install Docker Compose on Ubuntu 18.04. - How To Provision and Manage Remote Docker Hosts with Docker Machine on Ubuntu 18.04.

For general tips on working with container data, see: - How To Share Data between Docker Containers. - How To Share Data Between the

Docker Container and the Host.

If you are interested in other Docker-related topics, please see our complete library of Docker tutorials.

How To Integrate MongoDB with Your Node Application

Written by Kathleen Juell

In this chapter, you will continue to build on the Node.js application from the previous chapter by incorporating MongoDB, a database that allows you to store JSON objects. Integrating MongoDB into your application will allow you to structure your code using a Model View Controller (MVC) architecture.

This application structure will help keep your application, data, and presentation logic separate from each other, which will facilitate testing and development as you build more features into the example application. By the end of this chapter, you will have an application that accepts user input, saves it, and displays it as a web page that is retrieved from MongoDB.

As you work with Node.js, you may find yourself developing a project that stores and queries data. In this case, you will need to choose a database solution that makes sense for your application's data and query types.

In this tutorial, you will integrate a MongoDB database with an existing Node application. NoSQL databases like MongoDB can be useful if your data requirements include scalability and flexibility. MongoDB also integrates well with Node since it is designed to work asynchronously with JSON objects.

To integrate MongoDB into your project, you will use the Object Document Mapper (ODM) [Mongoose](#) to create schemas and models for your application data. This will allow you to organize your application code following the [model-view-controller (MVC)](#) architectural pattern, which lets you separate the logic of how your application handles user input from how your data is structured and rendered to the user. Using this pattern can facilitate future testing and development by introducing a separation of concerns into your codebase.

At the end of the tutorial, you will have a working shark information application that will take a user's input about their favorite sharks and display the results in the browser:
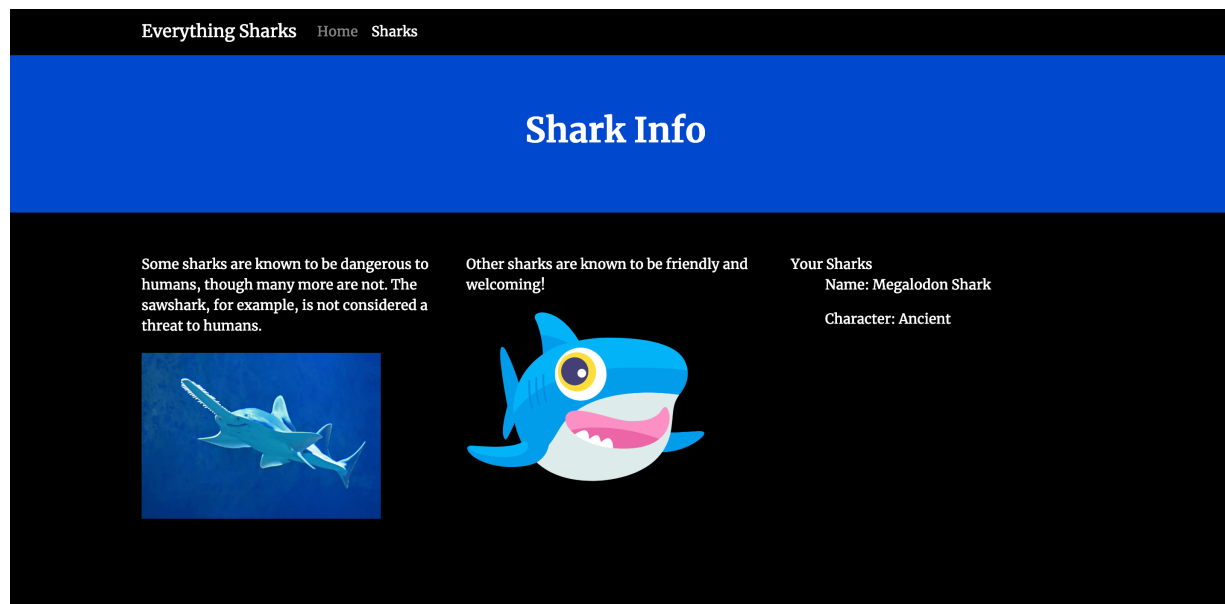
Shark Output

Prerequisites

- A local development machine or server running Ubuntu 18.04, along with a non-root user with `sudo` privileges and an active firewall. For guidance on how to set these up on an 18.04 server, please see this [Initial Server Setup guide](#).
- Node.js and [npm](#) installed on your machine or server, following [these instructions on installing with the PPA managed by NodeSource](#).
- MongoDB installed on your machine or server, following Step 1 of [How To Install MongoDB in Ubuntu 18.04](#).

Step 1 — Creating a Mongo User

Before we begin working with the application code, we will create an administrative user that will have access to our application's database. This user will have administrative privileges on any database, which will give you the flexibility to switch and create new databases as needed.

First, check that MongoDB is running on your server:

```
sudo systemctl status mongodb
```

The following output indicates that MongoDB is running:

Output

```
● mongodb.service - An object/document-oriented database
   Loaded: loaded (/lib/systemd/system/mongodb.service; enabled;
vendor preset: enabled)
   Active: active (running) since Thu 2019-01-31 21:07:25 UTC;
21min ago
...
```

Next, open the Mongo shell to create your user:

```
mongo
```

This will drop you into an administrative shell:

Output

```
MongoDB shell version v3.6.3

connecting to: mongodb://127.0.0.1:27017

MongoDB server version: 3.6.3

...

>
```

You will see some administrative warnings when you open the shell due to your unrestricted access to the `admin` database. You can learn more about restricting this access by reading [How To Install and Secure MongoDB on Ubuntu 16.04](#), for when you move into a production setup.

For now, you can use your access to the `admin` database to create a user with [userAdminAnyDatabase](#) privileges, which will allow password-protected access to your application's databases.

In the shell, specify that you want to use the `admin` database to create your user:

```
use admin
```

Next, create a role and password by adding a username and password with the `db.createUser` command. After you type this command, the shell will prepend three dots before each line until the command is complete. Be sure to replace the user and password provided here with your own username and password:

```
db.createUser(
  {
    user: "sammy",
    pwd: "your_password",
    roles: [ { role: "userAdminAnyDatabase", db:
"admin" } ]
  }
)
```

This creates an entry for the user **sammy** in the `admin` database. The username you select and the `admin` database will serve as identifiers for your user.

The output for the entire process will look like this, including the message indicating that the entry was successful:

Output

```
> db.createUser(

...   {

...      user: "sammy",

...      pwd: "your_password",

...      roles: [ { role: "userAdminAnyDatabase", db: "admin" } ]

...   }

...)

Successfully added user: {

        "user" : "sammy",

        "roles" : [

                {

                        "role" : "userAdminAnyDatabase",

                        "db" : "admin"

                }

        ]

}
```

With your user and password created, you can now exit the Mongo shell:

```
exit
```

Now that you have created your database user, you can move on to cloning the starter project code and adding the Mongoose library, which will allow you to implement schemas and models for the collections in your databases.

Step 2 — Adding Mongoose and Database Information to the Project

Our next steps will be to clone the application starter code and add Mongoose and our MongoDB database information to the project.

In your non-root user's home directory, clone the [nodejs-image-demo repository](#) from the [DigitalOcean Community GitHub account](#). This repository includes the code from the setup described in [How To Build a Node.js Application with Docker](#).

Clone the repository into a directory called **node_project**:

```
git clone https://github.com/do-community/nodejs-image-demo.git node_project
```

Change to the **node_project** directory:

```
cd  node_project
```

Before modifying the project code, let's take a look at the project's structure using the `tree` command.

Tip: `tree` is a useful command for viewing file and directory structures from the command line. You can install it with the following command:

```
sudo apt install tree
```

To use it, `cd` into a given directory and type `tree`. You can also provide the path to the starting point with a command like:

```
tree /home/sammy/sammys-project
```

Type the following to look at the **node_project** directory:

```
tree
```

The structure of the current project looks like this:

Output

```
├── Dockerfile
├── README.md
├── app.js
├── package-lock.json
├── package.json
└── views
    ├── css
    │   └── styles.css
    ├── index.html
    └── sharks.html
```

We will be adding directories to this project as we move through the tutorial, and `tree` will be a useful command to help us track our progress.

Next, add the `mongoose` npm package to the project with the `npm install` command:

`npm install mongoose`

This command will create a `node_modules` directory in your project directory, using the dependencies listed in the project's `package.json` file, and will add `mongoose` to that directory. It will also add `mongoose` to the dependencies listed in your `package.json` file. For a more detailed discussion of `package.json`, please see [Step 1](#) in [How To Build a Node.js Application with Docker](#).

Before creating any Mongoose schemas or models, we will add our database connection information so that our application will be able to connect to our database.

In order to separate your application's concerns as much as possible, create a separate file for your database connection information called `db.js`. You can open this file with `nano` or your favorite editor:

```
nano db.js
```

First, import the `mongoose` [module](#) using the `require` function:

```
const mongoose = require('mongoose');
```

This will give you access to Mongoose's built-in methods, which you will use to create the connection to your database.

Next, add the following [constants](#) to define information for Mongo's connection URI. Though the username and password are optional, we will include them so that we can require authentication for our database. Be sure to replace the username and password listed below with your own information, and feel free to call the database something other than `'sharkinfo'` if you would prefer:

```
const mongoose = require('mongoose');

const MONGO_USERNAME = 'sammy';

const MONGO_PASSWORD = 'your_password';

const MONGO_HOSTNAME = '127.0.0.1';

const MONGO_PORT = '27017';

const MONGO_DB = 'sharkinfo';
```

Because we are running our database locally, we have used `127.0.0.1` as the hostname. This would change in other development contexts: for example, if you are using a separate database server or working with multiple nodes in a containerized workflow.

Finally, define a constant for the URI and create the connection using the `mongoose.connect()` method:

~/node_project/db.js

```
...
const url =
`mongodb://${MONGO_USERNAME}:${MONGO_PASSWORD}@${MONGO_HOSTNAME}:${
MONGO_PORT}/${MONGO_DB}?authSource=admin`;


mongoose.connect(url, {useNewUrlParser: true});
```

Note that in the URI we've specified the `authSource` for our user as the `admin` database. This is necessary since we have specified a username in our connection string. Using the `useNewUrlParser` flag with `mongoose.connect()` specifies that we want to use Mongo's new URL parser.

Save and close the file when you are finished editing.

As a final step, add the database connection information to the `app.js` file so that the application can use it. Open `app.js`:

`nano app.js`

The first lines of the file will look like this:

```
const express = require('express');

const app = express();

const router = express.Router();



const path = __dirname + '/views/';

...
```

Below the `router` constant definition, located near the top of the file, add the following line:

```
...
const router = express.Router();

const db = require('./db');



const path = __dirname + '/views/';

...
```

This tells the application to use the database connection information specified in `db.js`.

Save and close the file when you are finished editing.

With your database information in place and Mongoose added to your project, you are ready to create the schemas and models that will shape the data in your **sharks** collection.

Step 3 — Creating Mongoose Schemas and Models

Our next step will be to think about the structure of the `sharks` collection that users will be creating in the `sharkinfo` database with their input. What structure do we want these created documents to have? The shark information page of our current application includes some details about different sharks and their behaviors:
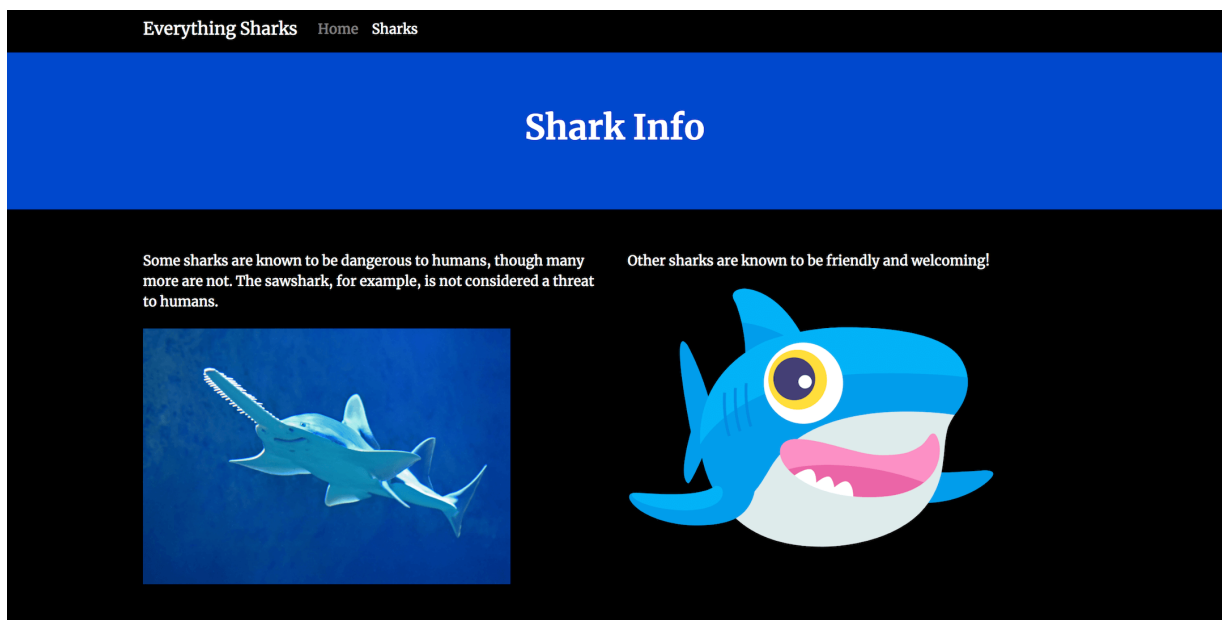
Shark Info Page

In keeping with this theme, we can have users add new sharks with details about their overall character. This goal will shape how we create our schema.

To keep your schemas and models distinct from the other parts of your application, create a `models` directory in the current project directory:

`mkdir models`

Next, open a file called `sharks.js` to create your schema and model:

```
nano models/sharks.js
```

Import the `mongoose` module at the top of the file:

```
const mongoose = require('mongoose');
```

Below this, define a `Schema` object to use as the basis for your shark schema:

```
const mongoose = require('mongoose');
const Schema = mongoose.Schema;
```

You can now define the fields you would like to include in your schema. Because we want to create a collection with individual sharks and information about their behaviors, let's include a `name` key and a `character` key. Add the following `Shark` schema below your constant definitions:

```
...
const Shark = new Schema ({
        name: { type: String, required: true },
        character: { type: String, required: true },
});
```

This definition includes information about the type of input we expect from users — in this case, a string — and whether or not that input is required.

Finally, create the `Shark` model using Mongoose's [model() function](model()%20function). This model will allow you to query documents from your collection and validate new documents. Add the following line at the bottom of the file:

~/node_project/models/sharks.js

```
...
module.exports = mongoose.model('Shark', Shark)
```

This last line makes our `Shark` model available as a module using the [module.exports property](module.exports%20property). This property defines the values that the module will export, making them available for use elsewhere in the application.

The finished `models/sharks.js` file looks like this:

```
const mongoose = require('mongoose');

const Schema = mongoose.Schema;


const Shark = new Schema ({

        name: { type: String, required: true },

        character: { type: String, required: true },

});


module.exports = mongoose.model('Shark', Shark)
```

Save and close the file when you are finished editing.

With the `Shark` schema and model in place, you can start working on the logic that will determine how your application will handle user input.

Step 4 — Creating Controllers

Our next step will be to create the controller component that will determine how user input gets saved to our database and returned to the user.

First, create a directory for the controller:

`mkdir controllers`

Next, open a file in that folder called `sharks.js`:

`nano controllers/sharks.js`

At the top of the file, we'll import the module with our `Shark` model so that we can use it in our controller's logic. We'll also import the path

[module](#) to access utilities that will allow us to set the path to the form where users will input their sharks.

Add the following `require` functions to the beginning of the file:

~/node_project/controllers/sharks.js

```
const path = require('path');
const Shark = require('../models/sharks');
```

Next, we'll write a sequence of functions that we will export with the controller module using Node's [exports shortcut](#). These functions will include the three tasks related to our user's shark data: - Sending users the shark input form. - Creating a new shark entry. - Displaying the sharks back to users.

To begin, create an `index` function to display the sharks page with the input form. Add this function below your imports:

~/node_project/controllers/sharks.js

```
...
exports.index = function (req, res) {
    res.sendFile(path.resolve('views/sharks.html'));
};
```

Next, below the `index` function, add a function called `create` to make a new shark entry in your `sharks` collection:

~/node_project/controllers/sharks.js

```javascript
...

exports.create = function (req, res) {

    var newShark = new Shark(req.body);

    console.log(req.body);

    newShark.save(function (err) {

            if(err) {

            res.status(400).send('Unable to save shark to database')

        } else {

            res.redirect('/sharks/getshark');

        }

    });

                };
```

This function will be called when a user posts shark data to the form on the `sharks.html` page. We will create the route with this POST endpoint later in the tutorial when we create our application's routes. With the `body` of the POST request, our `create` function will make a new shark document object, here called `newShark`, using the `Shark` model that we've imported. We've added a console.log method to output the shark entry to the console in order to check that our POST method is working as intended, but you should feel free to omit this if you would prefer.

Using the `newShark` object, the `create` function will then call Mongoose's model.save() method to make a new shark document using the keys you defined in the `Shark` model. This callback function

follows the [standard Node callback pattern](): `callback(error, results)`. In the case of an error, we will send a message reporting the error to our users, and in the case of success, we will use the [`res.redirect()` method]() to send users to the endpoint that will render their shark information back to them in the browser.

Finally, the `list` function will display the collection's contents back to the user. Add the following code below the `create` function:

~/node_project/controllers/sharks.js

```
...
exports.list = function (req, res) {
        Shark.find({}).exec(function (err, sharks) {
                if (err) {
                        return res.send(500, err);
                }
                res.render('getshark', {
                        sharks: sharks
                });
        });
};
```

This function uses the `Shark` model with Mongoose's [`model.find()` method]() to return the sharks that have been entered into the `sharks` collection. It does this by returning the query object — in this case, all of the entries in the `sharks` collection — as a promise, using

Mongoose's `exec() function`. In the case of an error, the callback function will send a 500 error.

The returned query object with the `sharks` collection will be rendered in a `getshark` page that we will create in the next step using the EJS templating language.
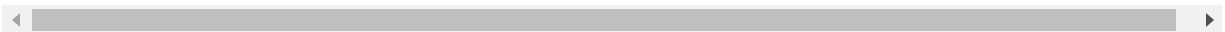
The finished file will look like this:

```javascript
const path = require('path');

const Shark = require('../models/sharks');


exports.index = function (req, res) {

    res.sendFile(path.resolve('views/sharks.html'));

};


exports.create = function (req, res) {

    var newShark = new Shark(req.body);

    console.log(req.body);

    newShark.save(function (err) {

            if(err) {

            res.status(400).send('Unable to save shark to database')

        } else {

            res.redirect('/sharks/getshark');

        }

    });

                };


exports.list = function (req, res) {

        Shark.find({}).exec(function (err, sharks) {

                if (err) {

                        return res.send(500, err);

                }

                res.render('getshark', {
```

```
                    sharks: sharks

        });

    });

};
```

Keep in mind that though we are not using <u>arrow functions</u> here, you may wish to include them as you iterate on this code in your own development process.

Save and close the file when you are finished editing.

Before moving on to the next step, you can run `tree` again from your **node_project** directory to view the project's structure at this point. This time, for the sake of brevity, we'll tell `tree` to omit the node_modules directory using the `-I` option:

`tree -I node_modules`

With the additions you've made, your project's structure will look like this:

Output

```
├── Dockerfile
├── README.md
├── app.js
├── controllers
│   └── sharks.js
├── db.js
├── models
│   └── sharks.js
├── package-lock.json
├── package.json
└── views
    ├── css
    │   └── styles.css
    ├── index.html
    └── sharks.html
```

Now that you have a controller component to direct how user input gets saved and returned to the user, you can move on to creating the views that will implement your controller's logic.

Step 5 — Using EJS and Express Middleware to Collect and Render Data

To enable our application to work with user data, we will do two things: first, we will include a built-in Express middleware function, <u>urlencoded()</u>, that will enable our application to parse our user's

entered data. Second, we will add template tags to our views to enable dynamic interaction with user data in our code.

To work with Express's `urlencoded()` function, first open your `app.js` file:

```
nano app.js
```

Above your `express.static()` function, add the following line:

~/node_project/app.js

```
...

app.use(express.urlencoded({ extended: true }));

app.use(express.static(path));

...
```

Adding this function will enable access to the parsed POST data from our shark information form. We are specifying `true` with the `extended` option to enable greater flexibility in the type of data our application will parse (including things like nested objects). Please see the [function documentation](#) for more information about options.

Save and close the file when you are finished editing.

Next, we will add template functionality to our views. First, install the [ejs package](#) with `npm install`:

```
npm install ejs
```

Next, open the `sharks.html` file in the `views` folder:

```
nano views/sharks.html
```

In Step 3, we looked at this page to determine how we should write our Mongoose schema and model:
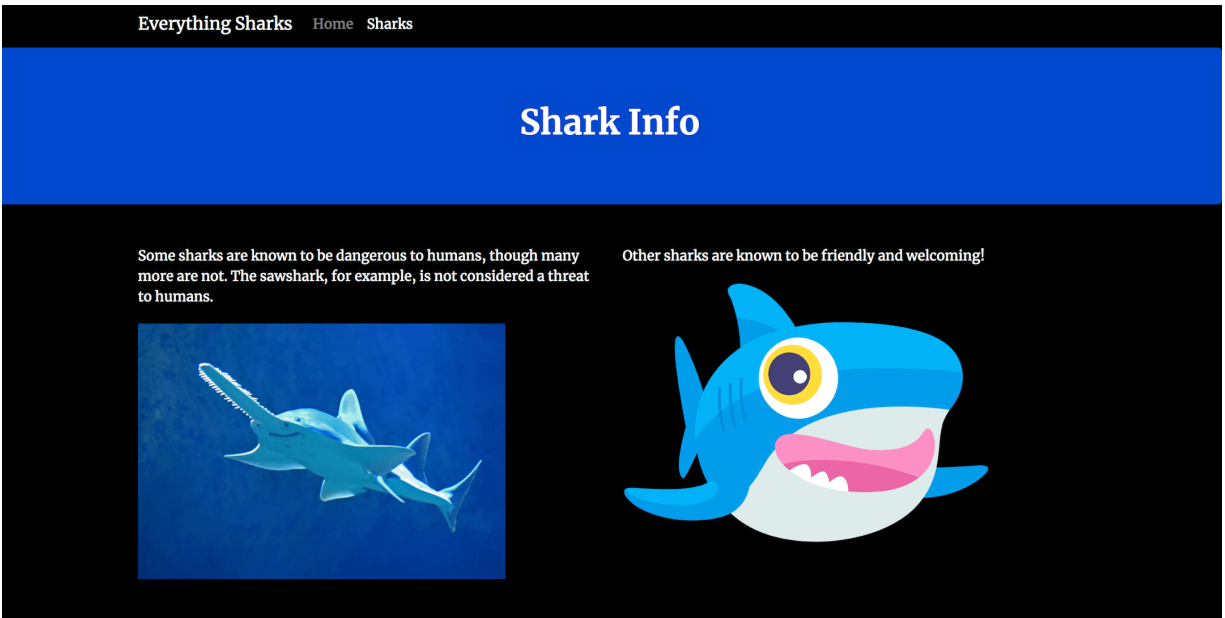
Shark Info Page

Now, rather than having a two column [layout](), we will introduce a third column with a form where users can input information about sharks.

As a first step, change the dimensions of the existing columns to `4` to create three equal-sized columns. Note that you will need to make this change on the two lines that currently read `<div class="col-lg-6">`. These will both become `<div class="col-lg-`**`4`**`">`:

```
...

<div class="container">

    <div class="row">

        <div class="col-lg-4">

            <p>

                <div class="caption">Some sharks are known to be

dangerous to humans, though many more are not. The sawshark, for

example, is not considered a threat to humans.

                </div>

                <img

src="https://assets.digitalocean.com/articles/docker_node_image/saw

shark.jpg" alt="Sawshark">

            </p>

        </div>

        <div class="col-lg-4">

            <p>

                <div class="caption">Other sharks are known to be

friendly and welcoming!</div>

                <img

src="https://assets.digitalocean.com/articles/docker_node_image/sam

my.png" alt="Sammy the Shark">

            </p>

        </div>

    </div>

  </div>
```

```
</html>
```

For an introduction to Bootstrap's grid system, including its row and column layouts, please see this [introduction to Bootstrap](#).

Next, add another column that includes the named endpoint for the POST request with the user's shark data and the EJS template tags that will capture that data. This column will go below the closing `</p>` and `</div>` tags from the preceding column and above the closing tags for the row, container, and HTML document. These closing tags are already in place in your code; they are also marked below with comments. Leave them in place as you add the following code to create the new column:

```
...

        </p> <!-- closing p from previous column -->

    </div> <!-- closing div from previous column -->

<div class="col-lg-4">

            <p>

                <form action="/sharks/addshark" method="post">

                    <div class="caption">Enter Your Shark</div>

                    <input type="text" placeholder="Shark Name"

name="name" <%=sharks[i].name; %>

                    <input type="text" placeholder="Shark

Character" name="character" <%=sharks[i].character; %>

                    <button type="submit">Submit</button>

                </form>

            </p>

        </div>

    </div> <!-- closing div for row -->

</div> <!-- closing div for container -->


</html> <!-- closing html tag -->
```

In the `form` tag, you are adding a `"/sharks/addshark"` endpoint for the user's shark data and specifying the POST method to submit it. In the input fields, you are specifying fields for `"Shark Name"` and `"Shark Character"`, aligning with the `Shark` model you defined earlier.

To add the user input to your `sharks` collection, you are using EJS template tags (`<%=, %>`) along with JavaScript syntax to map the user's entries to the appropriate fields in the newly created document. For more about JavaScript objects, please see our article on [Understanding JavaScript Objects](). For more on EJS template tags, please see the [EJS documentation]().

The entire container with all three columns, including the column with your shark input form, will look like this when finished:

```
...

<div class="container">

    <div class="row">

        <div class="col-lg-4">

            <p>

                <div class="caption">Some sharks are known to be
dangerous to humans, though many more are not. The sawshark, for
example, is not considered a threat to humans.

                </div>

                <img
src="https://assets.digitalocean.com/articles/docker_node_image/saw
shark.jpg" alt="Sawshark">

            </p>

        </div>

        <div class="col-lg-4">

            <p>

                <div class="caption">Other sharks are known to be
friendly and welcoming!</div>

                <img
src="https://assets.digitalocean.com/articles/docker_node_image/sam
my.png" alt="Sammy the Shark">

            </p>

        </div>

    <div class="col-lg-4">

            <p>

                <form action="/sharks/addshark" method="post">
```

```
                    <div class="caption">Enter Your Shark</div>

                    <input type="text" placeholder="Shark Name"
name="name" <%=sharks[i].name; %>

                    <input type="text" placeholder="Shark
Character" name="character" <%=sharks[i].character; %>

                    <button type="submit">Submit</button>

              </form>

          </p>

        </div>

      </div>


</html>
```

Save and close the file when you are finished editing.

Now that you have a way to collect your user's input, you can create an endpoint to display the returned sharks and their associated character information.

Copy the newly modified `sharks.html` file to a file called `getshark.html`:

`cp views/sharks.html views/getshark.html`

Open `getshark.html`:

`nano views/getshark.html`

Inside the file, we will modify the column that we used to create our sharks input form by replacing it with a column that will display the sharks in our `sharks` collection. Again, your code will go between the existing `</p>` and `</div>` tags from the preceding column and the

closing tags for the row, container, and HTML document. Remember to leave these tags in place as you add the following code to create the column:

~/node_project/views/getshark.html

```
...
        </p> <!-- closing p from previous column -->
    </div> <!-- closing div from previous column -->
<div class="col-lg-4">
            <p>
                <div class="caption">Your Sharks</div>
                    <ul>
                        <% sharks.forEach(function(shark) { %>
                            <p>Name: <%= shark.name %></p>
                            <p>Character: <%= shark.character %></p>
                        <% }); %>
                    </ul>
            </p>
        </div>
    </div> <!-- closing div for row -->
</div> <!-- closing div for container -->


</html> <!-- closing html tag -->
```

Here you are using EJS template tags and the <u>forEach() method</u> to output each value in your `sharks` collection, including information about

the most recently added shark.

The entire container with all three columns, including the column with your `sharks` collection, will look like this when finished:

```
...

<div class="container">

    <div class="row">

        <div class="col-lg-4">

            <p>

                <div class="caption">Some sharks are known to be

dangerous to humans, though many more are not. The sawshark, for

example, is not considered a threat to humans.

                </div>

                <img

src="https://assets.digitalocean.com/articles/docker_node_image/saw

shark.jpg" alt="Sawshark">

            </p>

        </div>

        <div class="col-lg-4">

            <p>

                <div class="caption">Other sharks are known to be

friendly and welcoming!</div>

                <img

src="https://assets.digitalocean.com/articles/docker_node_image/sam

my.png" alt="Sammy the Shark">

            </p>

        </div>

    <div class="col-lg-4">

            <p>

                <div class="caption">Your Sharks</div>
```

```
            <ul>
                <% sharks.forEach(function(shark) { %>
                    <p>Name: <%= shark.name %></p>
                    <p>Character: <%= shark.character %></p>
                <% }); %>
            </ul>
        </p>
    </div>
  </div>
</div>


</html>
```

Save and close the file when you are finished editing.

In order for the application to use the templates you've created, you will need to add a few lines to your `app.js` file. Open it again:

```
nano app.js
```

Above where you added the `express.urlencoded()` function, add the following lines:

```
...

app.engine('html', require('ejs').renderFile);

app.set('view engine', 'html');

app.use(express.urlencoded({ extended: true }));

app.use(express.static(path));


...
```

The app.engine method tells the application to map the EJS template engine to HTML files, while app.set defines the default view engine.

Your app.js file should now look like this:

```javascript
const express = require('express');

const app = express();

const router = express.Router();

const db = require('./db');


const path = __dirname + '/views/';

const port = 8080;


router.use(function (req,res,next) {

  console.log('/' + req.method);

  next();

});


router.get('/',function(req,res){

  res.sendFile(path + 'index.html');

});


router.get('/sharks',function(req,res){

  res.sendFile(path + 'sharks.html');

});


app.engine('html', require('ejs').renderFile);

app.set('view engine', 'html');

app.use(express.urlencoded({ extended: true }));

app.use(express.static(path));
```

```
app.use('/', router);


app.listen(port, function () {
  console.log('Example app listening on port 8080!')
})
```

Now that you have created views that can work dynamically with user data, it's time to create your project's routes to bring together your views and controller logic.

Step 6 — Creating Routes

The final step in bringing the application's components together will be creating routes. We will separate our routes by function, including a route to our application's landing page and another route to our sharks page. Our `sharks` route will be where we integrate our controller's logic with the views we created in the previous step.

First, create a `routes` directory:

```
mkdir routes
```

Next, open a file called `index.js` in this directory:

```
nano routes/index.js
```

This file will first import the `express`, `router`, and `path` objects, allowing us to define the routes we want to export with the `router` object, and making it possible to work dynamically with file paths. Add the following code at the top of the file:

```
const express = require('express');

const router = express.Router();

const path = require('path');
```

Next, add the following `router.use` function, which loads a middleware function that will log the router's requests and pass them on to the application's route:

```
...

router.use (function (req,res,next) {

  console.log('/' + req.method);

  next();
});
```

Requests to our application's root will be directed here first, and from here users will be directed to our application's landing page, the route we will define next. Add the following code below the `router.use` function to define the route to the landing page:

```
...

router.get('/',function(req,res){
  res.sendFile(path.resolve('views/index.html'));
});
```

When users visit our application, the first place we want to send them is to the `index.html` landing page that we have in our `views` directory.

Finally, to make these routes accessible as importable modules elsewhere in the application, add a closing expression to the end of the file to export the `router` object:

```
...

module.exports = router;
```

The finished file will look like this:

```
const express = require('express');

const router = express.Router();

const path = require('path');


router.use (function (req,res,next) {

  console.log('/' + req.method);

  next();

});


router.get('/',function(req,res){

  res.sendFile(path.resolve('views/index.html'));

});


module.exports = router;
```

Save and close this file when you are finished editing.

Next, open a file called `sharks.js` to define how the application should use the different endpoints and views we've created to work with our user's shark input:

`nano routes/sharks.js`

At the top of the file, import the `express` and `router` objects:

```
const express = require('express');

const router = express.Router();
```

Next, import a module called `shark` that will allow you to work with the exported functions you defined with your controller:

```javascript
const express = require('express');

const router = express.Router();

const shark = require('../controllers/sharks');
```

Now you can create routes using the `index`, `create`, and `list` functions you defined in your `sharks` controller file. Each route will be associated with the appropriate HTTP method: GET in the case of rendering the main sharks information landing page and returning the list of sharks to the user, and POST in the case of creating a new shark entry:

```
...

router.get('/', function(req, res){

    shark.index(req,res);

});

router.post('/addshark', function(req, res) {

    shark.create(req,res);

});

router.get('/getshark', function(req, res) {

    shark.list(req,res);

});
```

Each route makes use of the related function in `controllers/sharks.js`, since we have made that module accessible by importing it at the top of this file.

Finally, close the file by attaching these routes to the `router` object and exporting them:

```
...

module.exports = router;
```

The finished file will look like this:

~/node_project/routes/sharks.js

```javascript
const express = require('express');

const router = express.Router();

const shark = require('../controllers/sharks');


router.get('/', function(req, res){

    shark.index(req,res);

});


router.post('/addshark', function(req, res) {

    shark.create(req,res);

});


router.get('/getshark', function(req, res) {

    shark.list(req,res);

});


module.exports = router;
```

Save and close the file when you are finished editing.

The last step in making these routes accessible to your application will be to add them to `app.js`. Open that file again:

`nano app.js`

Below your `db` constant, add the following import for your routes:

```
...

const db = require('./db');

const sharks = require('./routes/sharks');
```

Next, replace the `app.use` function that currently mounts your
`router` object with the following line, which will mount the `sharks`
router module:

```
...
app.use(express.static(path));

app.use('/sharks', sharks);


app.listen(port, function () {

        console.log("Example app listening on port 8080!")

})
```

You can now delete the routes that were previously defined in this file,
since you are importing your application's routes using the `sharks` router
module.

The final version of your `app.js` file will look like this:

```js
const express = require('express');

const app = express();

const router = express.Router();

const db = require('./db');

const sharks = require('./routes/sharks');


const path = __dirname + '/views/';

const port = 8080;


app.engine('html', require('ejs').renderFile);

app.set('view engine', 'html');

app.use(express.urlencoded({ extended: true }));

app.use(express.static(path));

app.use('/sharks', sharks);


app.listen(port, function () {

  console.log('Example app listening on port 8080!')

})
```

Save and close the file when you are finished editing.

You can now run `tree` again to see the final structure of your project:

```
tree -I node_modules
```

Your project structure will now look like this:

Output

```
├── Dockerfile
├── README.md
├── app.js
├── controllers
│   └── sharks.js
├── db.js
├── models
│   └── sharks.js
├── package-lock.json
├── package.json
├── routes
│   ├── index.js
│   └── sharks.js
└── views
    ├── css
    │   └── styles.css
    ├── getshark.html
    ├── index.html
    └── sharks.html
```

With all of your application components created and in place, you are now ready to add a test shark to your database!

If you followed the initial server setup tutorial in the prerequisites, you will need to modify your firewall, since it currently only allows SSH traffic. To permit traffic to port 8080 run:

```
sudo ufw allow 8080
```

Start the application:

```
node app.js
```

Next, navigate your browser to `http://`**`your_server_ip`**`:8080.` You will see the following landing page:
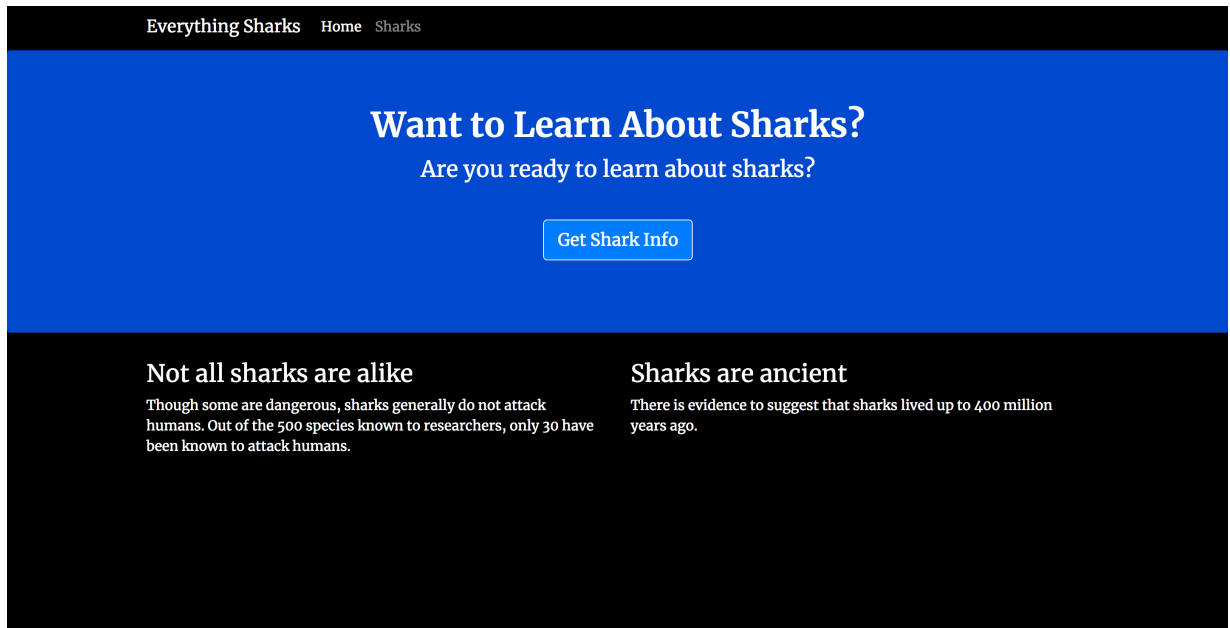
Application Landing Page

Click on the Get Shark Info button. You will see the following information page, with the shark input form added:

Shark Info Form

In the form, add a shark of your choosing. For the purpose of this demonstration, we will add **Megalodon Shark** to the Shark Name field, and **Ancient** to the Shark Character field:

Filled Shark Form

Click on the Submit button. You will see a page with this shark information displayed back to you:

Shark Output

You will also see output in your console indicating that the shark has been added to your collection:

Output

```
Example app listening on port 8080!
{ name: 'Megalodon Shark', character: 'Ancient' }
```

If you would like to create a new shark entry, head back to the Sharks page and repeat the process of adding a shark.

You now have a working shark information application that allows users to add information about their favorite sharks.

Conclusion

In this tutorial, you built out a Node application by integrating a MongoDB database and rewriting the application's logic using the MVC architectural pattern. This application can act as a good starting point for a fully-fledged CRUD application.

For more resources on the MVC pattern in other contexts, please see our Django Development series or How To Build a Modern Web Application to Manage Customer Information with Django and React on Ubuntu 18.04.

For more information on working with MongoDB, please see our library of tutorials on MongoDB.

[Containerizing a Node.js Application for Development With Docker Compose](#)

Written by Kathleen Juell

In the previous chapters, you created a Docker image that you used to run your application as a container. You also integrated an external database layer for persistent data. In this chapter you will create two images, one for the application and another for the MongoDB database. Once you have images of both components, you will learn how to run them together using Docker Compose.

If you are actively developing an application, using [Docker](#) can simplify your workflow and the process of deploying your application to production. Working with containers in development offers the following benefits: - Environments are consistent, meaning that you can choose the languages and dependencies you want for your project without worrying about system conflicts. - Environments are isolated, making it easier to troubleshoot issues and onboard new team members. - Environments are portable, allowing you to package and share your code with others.

This tutorial will show you how to set up a development environment for a [Node.js](#) application using Docker. You will create two containers — one for the Node application and another for the [MongoDB](#) database — with [Docker Compose](#). Because this application works with Node and MongoDB, our setup will do the following: - Synchronize the application code on the host with the code in the container to facilitate changes during development. - Ensure that changes to the application code work without a

restart. - Create a user and password-protected database for the application's data. - Persist this data.

At the end of this tutorial, you will have a working shark information application running on Docker containers:
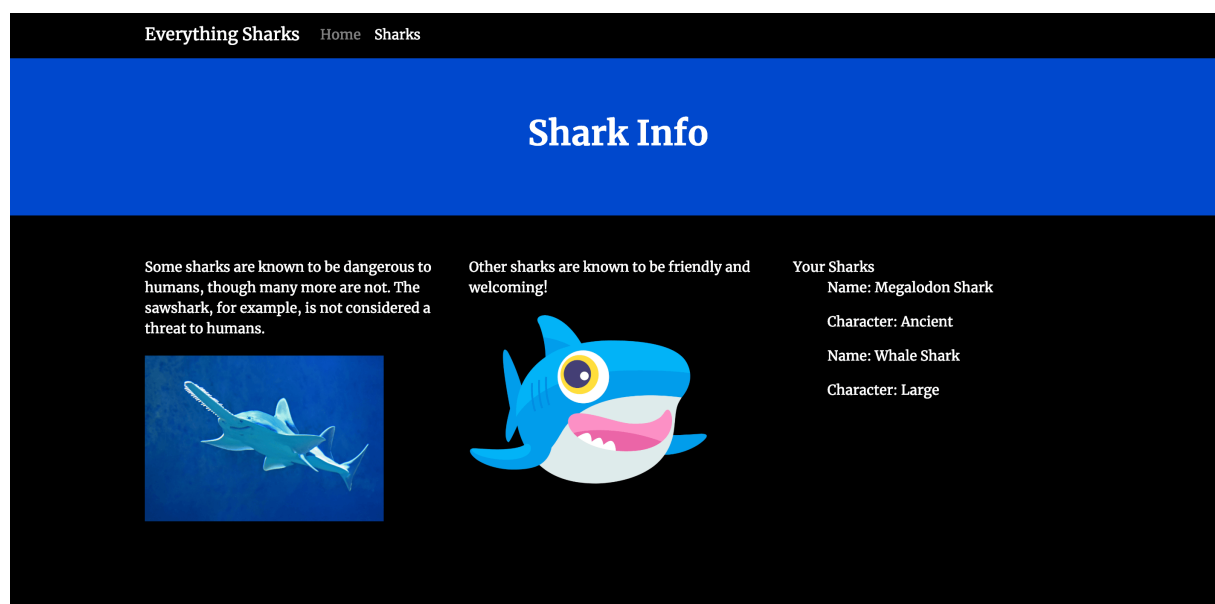
Complete Shark Collection

Prerequisites

To follow this tutorial, you will need: - A development server running Ubuntu 18.04, along with a non-root user with `sudo` privileges and an active firewall. For guidance on how to set these up, please see this [Initial Server Setup guide](). - Docker installed on your server, following Steps 1 and 2 of [How To Install and Use Docker on Ubuntu 18.04](). - Docker Compose installed on your server, following Step 1 of [How To Install Docker Compose on Ubuntu 18.04]().

Step 1 — Cloning the Project and Modifying Dependencies

The first step in building this setup will be cloning the project code and modifying its `package.json` file, which includes the project's dependencies. We will add `nodemon` to the project's `devDependencies`, specifying that we will be using it during development. Running the application with `nodemon` ensures that it will be automatically restarted whenever you make changes to your code.

First, clone the `nodejs-mongo-mongoose repository` from the DigitalOcean Community GitHub account. This repository includes the code from the setup described in How To Integrate MongoDB with Your Node Application, which explains how to integrate a MongoDB database with an existing Node application using Mongoose.

Clone the repository into a directory called **node_project**:

```
git clone https://github.com/do-community/nodejs-
mongo-mongoose.git node_project
```

Navigate to the **node_project** directory:

```
cd node_project
```

Open the project's `package.json` file using `nano` or your favorite editor:

```
nano package.json
```

Beneath the project dependencies and above the closing curly brace, create a new `devDependencies` object that includes `nodemon`:

```
...
"dependencies": {

    "ejs": "^2.6.1",

    "express": "^4.16.4",

    "mongoose": "^5.4.10"

  },

  "devDependencies": {

    "nodemon": "^1.18.10"

  }

}
```

Save and close the file when you are finished editing.

With the project code in place and its dependencies modified, you can move on to refactoring the code for a containerized workflow.

Step 2 — Configuring Your Application to Work with Containers

Modifying our application for a containerized workflow means making our code more modular. Containers offer portability between environments, and our code should reflect that by remaining as decoupled from the underlying operating system as possible. To achieve this, we will refactor our code to make greater use of Node's process.env property, which returns an object with information about your user environment at runtime. We can use this object in our code to dynamically assign configuration information at runtime with environment variables.

Let's begin with `app.js`, our main application entrypoint. Open the file:

```
nano app.js
```

Inside, you will see a definition for a `port` [constant](#), as well a [listen function](#) that uses this constant to specify the port the application will listen on:

~/home/node_project/app.js

```
...
const port = 8080;
...
app.listen(port, function () {
  console.log('Example app listening on port 8080!');
});
```

Let's redefine the `port` constant to allow for dynamic assignment at runtime using the `process.env` object. Make the following changes to the constant definition and `listen` function:

~/home/node_project/app.js

```
...
const port = process.env.PORT || 8080;
...
app.listen(port, function () {
  console.log(`Example app listening on ${port}!`);
});
```

Our new constant definition assigns `port` dynamically using the value passed in at runtime or `8080`. Similarly, we've rewritten the `listen` function to use a [template literal](), which will interpolate the port value when listening for connections. Because we will be mapping our ports elsewhere, these revisions will prevent our having to continuously revise this file as our environment changes.

When you are finished editing, save and close the file.

Next, we will modify our database connection information to remove any configuration credentials. Open the `db.js` file, which contains this information:

```
nano db.js
```

Currently, the file does the following things: - Imports Mongoose, the Object Document Mapper (ODM) that we're using to create schemas and models for our application data. - Sets the database credentials as constants, including the username and password. - Connects to the database using the [mongoose.connect method]().

For more information about the file, please see [Step 3]() of [How To Integrate MongoDB with Your Node Application]().

Our first step in modifying the file will be redefining the constants that include sensitive information. Currently, these constants look like this:

```
...
const MONGO_USERNAME = 'sammy';

const MONGO_PASSWORD = 'your_password';

const MONGO_HOSTNAME = '127.0.0.1';

const MONGO_PORT = '27017';

const MONGO_DB = 'sharkinfo';
...
```

Instead of hardcoding this information, you can use the `process.env` object to capture the runtime values for these constants. Modify the block to look like this:

```
...
const {

  MONGO_USERNAME,

  MONGO_PASSWORD,

  MONGO_HOSTNAME,

  MONGO_PORT,

  MONGO_DB
} = process.env;
...
```

Save and close the file when you are finished editing.

At this point, you have modified `db.js` to work with your application's environment variables, but you still need a way to pass these variables to your application. Let's create an `.env` file with values that you can pass to your application at runtime.

Open the file:

```
nano .env
```

This file will include the information that you removed from `db.js`: the username and password for your application's database, as well as the port setting and database name. Remember to update the username, password, and database name listed here with your own information:

~/node_project/.env

```
MONGO_USERNAME=sammy

MONGO_PASSWORD=your_password

MONGO_PORT=27017

MONGO_DB=sharkinfo
```

Note that we have removed the host setting that originally appeared in `db.js`. We will now define our host at the level of the Docker Compose file, along with other information about our services and containers.

Save and close this file when you are finished editing.

Because your `.env` file contains sensitive information, you will want to ensure that it is included in your project's `.dockerignore` and `.gitignore` files so that it does not copy to your version control or containers.

Open your `.dockerignore` file:

```
nano .dockerignore
```

Add the following line to the bottom of the file:

```
...
.gitignore
.env
```

Save and close the file when you are finished editing.

The `.gitignore` file in this repository already includes `.env`, but feel free to check that it is there:

```
nano .gitignore
```

```
...
.env
...
```

At this point, you have successfully extracted sensitive information from your project code and taken measures to control how and where this information gets copied. Now you can add more robustness to your database connection code to optimize it for a containerized workflow.

Step 3 — Modifying Database Connection Settings

Our next step will be to make our database connection method more robust by adding code that handles cases where our application fails to connect to

our database. Introducing this level of resilience to your application code is a [recommended practice](#) when working with containers using Compose.

Open `db.js` for editing:

`nano db.js`

You will see the code that we added earlier, along with the `url` constant for Mongo's connection URI and the [Mongoose `connect`](#) method:

~/node_project/db.js

```
...
const {
  MONGO_USERNAME,
  MONGO_PASSWORD,
  MONGO_HOSTNAME,
  MONGO_PORT,
  MONGO_DB
} = process.env;


const url =
`mongodb://${MONGO_USERNAME}:${MONGO_PASSWORD}@${MONGO_HOSTNAME}:${
MONGO_PORT}/${MONGO_DB}?authSource=admin`;


mongoose.connect(url, {useNewUrlParser: true});
```

Currently, our `connect` method accepts an option that tells Mongoose to use Mongo's [new URL parser](#). Let's add a few more options to this method to define parameters for reconnection attempts. We can do this by creating an `options` constant that includes the relevant information, in

addition to the new URL parser option. Below your Mongo constants, add the following definition for an `options` constant:

~/node_project/db.js

```
...
const {
  MONGO_USERNAME,
  MONGO_PASSWORD,
  MONGO_HOSTNAME,
  MONGO_PORT,
  MONGO_DB
} = process.env;

const options = {
  useNewUrlParser: true,
  reconnectTries: Number.MAX_VALUE,
  reconnectInterval: 500,
  connectTimeoutMS: 10000,
};
...
```

The `reconnectTries` option tells Mongoose to continue trying to connect indefinitely, while `reconnectInterval` defines the period between connection attempts in milliseconds. `connectTimeoutMS` defines 10 seconds as the period that the Mongo driver will wait before failing the connection attempt.

We can now use the new `options` constant in the Mongoose `connect` method to fine tune our Mongoose connection settings. We will also add a [promise](#) to handle potential connection errors.

Currently, the Mongoose `connect` method looks like this:

~/node_project/db.js

```
...
mongoose.connect(url, {useNewUrlParser: true});
```

Delete the existing `connect` method and replace it with the following code, which includes the `options` constant and a promise:

~/node_project/db.js

```
...
mongoose.connect(url, options).then( function() {
  console.log('MongoDB is connected');
})
  .catch( function(err) {
  console.log(err);
});
```

In the case of a successful connection, our function logs an appropriate message; otherwise it will [catch](#) and log the error, allowing us to troubleshoot.

The finished file will look like this:

~/node_project/db.js

```javascript
const mongoose = require('mongoose');

const {
  MONGO_USERNAME,
  MONGO_PASSWORD,
  MONGO_HOSTNAME,
  MONGO_PORT,
  MONGO_DB
} = process.env;

const options = {
  useNewUrlParser: true,
  reconnectTries: Number.MAX_VALUE,
  reconnectInterval: 500,
  connectTimeoutMS: 10000,
};

const url =
`mongodb://${MONGO_USERNAME}:${MONGO_PASSWORD}@${MONGO_HOSTNAME}:${MONGO_PORT}/${MONGO_DB}?authSource=admin`;

mongoose.connect(url, options).then( function() {
  console.log('MongoDB is connected');
})
  .catch( function(err) {
```

```
    console.log(err);
});
```

Save and close the file when you have finished editing.

You have now added resiliency to your application code to handle cases where your application might fail to connect to your database. With this code in place, you can move on to defining your services with Compose.

Step 4 — Defining Services with Docker Compose

With your code refactored, you are ready to write the `docker-compose.yml` file with your service definitions. A service in Compose is a running container, and service definitions — which you will include in your `docker-compose.yml` file — contain information about how each container image will run. The Compose tool allows you to define multiple services to build multi-container applications.

Before defining our services, however, we will add a tool to our project called [wait-for](#) to ensure that our application only attempts to connect to our database once the database startup tasks are complete. This wrapper script uses [netcat](#) to poll whether or not a specific host and port are accepting TCP connections. Using it allows you to control your application's attempts to connect to your database by testing whether or not the database is ready to accept connections.

Though Compose allows you to specify dependencies between services using the [depends_on option](#), this order is based on whether or not the container is running rather than its readiness. Using `depends_on` won't be optimal for our setup, since we want our application to connect only

when the database startup tasks, including adding a user and password to the `admin` authentication database, are complete. For more information on using `wait-for` and other tools to control startup order, please see the relevant [recommendations in the Compose documentation](#).

Open a file called `wait-for.sh`:

```
nano wait-for.sh
```

Paste the following code into the file to create the polling function:

```sh
#!/bin/sh

# original script: https://github.com/eficode/wait-
for/blob/master/wait-for

TIMEOUT=15
QUIET=0

echoerr() {
  if [ "$QUIET" -ne 1 ]; then printf "%s\n" "$*" 1>&2; fi
}

usage() {
  exitcode="$1"
  cat << USAGE >&2
Usage:
  $cmdname host:port [-t timeout] [-- command args]
  -q | --quiet                        Do not output any status
messages
  -t TIMEOUT | --timeout=timeout      Timeout in seconds, zero for
no timeout
  -- COMMAND ARGS                     Execute command with args
after the test finishes
USAGE
  exit "$exitcode"
}
```

```
wait_for() {

  for i in `seq $TIMEOUT` ; do

    nc -z "$HOST" "$PORT" > /dev/null 2>&1


    result=$?

    if [ $result -eq 0 ] ; then

      if [ $# -gt 0 ] ; then

        exec "$@"

      fi

      exit 0

    fi

    sleep 1

  done

  echo "Operation timed out" >&2

  exit 1

}


while [ $# -gt 0 ]

do

  case "$1" in

    *:* )

    HOST=$(printf "%s\n" "$1"| cut -d : -f 1)

    PORT=$(printf "%s\n" "$1"| cut -d : -f 2)

    shift 1

    ;;

    -q | --quiet)
```

```
        QUIET=1

        shift 1

        ;;

        -t)

        TIMEOUT="$2"

        if [ "$TIMEOUT" = "" ]; then break; fi

        shift 2

        ;;

        --timeout=*)

        TIMEOUT="${1#*=}"

        shift 1

        ;;

        --)

        shift

        break

        ;;

        --help)

        usage 0

        ;;

        *)

        echoerr "Unknown argument: $1"

        usage 1

        ;;

    esac

done


if [ "$HOST" = "" -o "$PORT" = "" ]; then
```

```
  echoerr "Error: you need to provide a host and port to test."
  usage 2
fi


wait_for "$@"
```

Save and close the file when you are finished adding the code.

Make the script executable:

```
chmod +x wait-for.sh
```

Next, open the `docker-compose.yml` file:

```
nano docker-compose.yml
```

First, define the `nodejs` application service by adding the following code to the file:

```
version: '3'

services:
  nodejs:
    build:
      context: .
      dockerfile: Dockerfile
    image: nodejs
    container_name: nodejs
    restart: unless-stopped
    env_file: .env
    environment:
      - MONGO_USERNAME=$MONGO_USERNAME
      - MONGO_PASSWORD=$MONGO_PASSWORD
      - MONGO_HOSTNAME=db
      - MONGO_PORT=$MONGO_PORT
      - MONGO_DB=$MONGO_DB
    ports:
      - "80:8080"
    volumes:
      - .:/home/node/app
      - node_modules:/home/node/app/node_modules
    networks:
      - app-network
    command: ./wait-for.sh db:27017 --
/home/node/app/node_modules/.bin/nodemon app.js
```

The `nodejs` service definition includes the following options: - `build`: This defines the configuration options, including the `context` and `dockerfile`, that will be applied when Compose builds the application image. If you wanted to use an existing image from a registry like [Docker Hub](#), you could use the [image instruction](#) instead, with information about your username, repository, and image tag. - `context`: This defines the build context for the image build — in this case, the current project directory. - `dockerfile`: This specifies the `Dockerfile` in your current project directory as the file Compose will use to build the application image. For more information about this file, please see [How To Build a Node.js Application with Docker](#). - `image`, `container_name`: These apply names to the image and container. - `restart`: This defines the restart policy. The default is `no`, but we have set the container to restart unless it is stopped. - `env_file`: This tells Compose that we would like to add environment variables from a file called `.env`, located in our build context. - `environment`: Using this option allows you to add the Mongo connection settings you defined in the `.env` file. Note that we are not setting `NODE_ENV` to `development`, since this is [Express's](#) [default](#) behavior if `NODE_ENV` is not set. When moving to production, you can set this to `production` to [enable view caching and less verbose error messages](#). Also note that we have specified the `db` database container as the host, as discussed in [Step 2](#). - `ports`: This maps port `80` on the host to port `8080` on the container. - `volumes`: We are including two types of mounts here: - The first is a [bind mount](#) that mounts our application code on the host to the `/home/node/app` directory on the container. This will facilitate rapid development, since any changes you make to your host code will be populated immediately in

the container. - The second is a named volume, `node_modules`. When Docker runs the `npm install` instruction listed in the application `Dockerfile`, npm will create a new node_modules directory on the container that includes the packages required to run the application. The bind mount we just created will hide this newly created `node_modules` directory, however. Since `node_modules` on the host is empty, the bind will map an empty directory to the container, overriding the new `node_modules` directory and preventing our application from starting. The named `node_modules` volume solves this problem by persisting the contents of the `/home/node/app/node_modules` directory and mounting it to the container, hiding the bind.

```
**Keep the following points in mind when using
this approach**:
- Your bind will mount the contents of the
`node_modules` directory on the container to the
host and this directory will be owned by `root`,
since the named volume was created by Docker.
- If you have a pre-existing `node_modules`
directory on the host, it will override the
`node_modules` directory created on the container.
The setup that we're building in this tutorial
assumes that you do **not** have a pre-existing
`node_modules` directory and that you won't be
working with `npm` on your host. This is in
keeping with a [twelve-factor approach to
application development](https://12factor.net/),
```

which minimizes dependencies between execution
environments.

- `networks`: This specifies that our application service will join the `app-network` network, which we will define at the bottom on the file.
- `command`: This option lets you set the command that should be executed when Compose runs the image. Note that this will override the `CMD` instruction that we set in our application `Dockerfile`. Here, we are running the application using the `wait-for` script, which will poll the `db` service on port `27017` to test whether or not the database service is ready. Once the readiness test succeeds, the script will execute the command we have set, `/home/node/app/node_modules/.bin/nodemon app.js`, to start the application with `nodemon`. This will ensure that any future changes we make to our code are reloaded without our having to restart the application.

Next, create the `db` service by adding the following code below the application service definition:

```
...

  db:

    image: mongo:4.1.8-xenial

    container_name: db

    restart: unless-stopped

    env_file: .env

    environment:

      - MONGO_INITDB_ROOT_USERNAME=$MONGO_USERNAME

      - MONGO_INITDB_ROOT_PASSWORD=$MONGO_PASSWORD

    volumes:

      - dbdata:/data/db

    networks:

      - app-network
```

Some of the settings we defined for the `nodejs` service remain the same, but we've also made the following changes to the `image`, `environment`, and `volumes` definitions: - `image`: To create this service, Compose will pull the `4.1.8-xenial` [Mongo image](#) from Docker Hub. We are pinning a particular version to avoid possible future conflicts as the Mongo image changes. For more information about version pinning, please see the Docker documentation on [Dockerfile best practices](#). - `MONGO_INITDB_ROOT_USERNAME`, `MONGO_INITDB_ROOT_PASSWORD`: The `mongo` image makes these [environment variables](#) available so that you can modify the initialization of your database instance. `MONGO_INITDB_ROOT_USERNAME` and `MONGO_INITDB_ROOT_PASSWORD` together create a `root` user in the

`admin` authentication database and ensure that authentication is enabled when the container starts. We have set `MONGO_INITDB_ROOT_USERNAME` and `MONGO_INITDB_ROOT_PASSWORD` using the values from our `.env` file, which we pass to the `db` service using the `env_file` option. Doing this means that our **sammy** application user will be a [root user](#) on the database instance, with access to all of the administrative and operational privileges of that role. When working in production, you will want to create a dedicated application user with appropriately scoped privileges.

Note: Keep in mind that these variables will not take effect if you start the container with an existing data directory in place.

- `dbdata:/data/db`: The named volume `dbdata` will persist the data stored in Mongo's [default data directory](#), `/data/db`. This will ensure that you don't lose data in cases where you stop or remove containers.

We've also added the `db` service to the `app-network` network with the `networks` option.

As a final step, add the volume and network definitions to the bottom of the file:

```
...
networks:
  app-network:
    driver: bridge

volumes:
  dbdata:
  node_modules:
```

The user-defined bridge network `app-network` enables communication between our containers since they are on the same Docker daemon host. This streamlines traffic and communication within the application, as it opens all ports between containers on the same bridge network, while exposing no ports to the outside world. Thus, our `db` and `nodejs` containers can communicate with each other, and we only need to expose port `80` for front-end access to the application.

Our top-level `volumes` key defines the volumes `dbdata` and `node_modules`. When Docker creates volumes, the contents of the volume are stored in a part of the host filesystem, `/var/lib/docker/volumes/`, that's managed by Docker. The contents of each volume are stored in a directory under `/var/lib/docker/volumes/` and get mounted to any container that uses the volume. In this way, the shark information data that our users will create will persist in the `dbdata` volume even if we remove and recreate the `db` container.

The finished `docker-compose.yml` file will look like this:

~/node_project/docker-compose.yml

```yaml
version: '3'

services:
  nodejs:
    build:
      context: .
      dockerfile: Dockerfile
    image: nodejs
    container_name: nodejs
    restart: unless-stopped
    env_file: .env
    environment:
      - MONGO_USERNAME=$MONGO_USERNAME
      - MONGO_PASSWORD=$MONGO_PASSWORD
      - MONGO_HOSTNAME=db
      - MONGO_PORT=$MONGO_PORT
      - MONGO_DB=$MONGO_DB
    ports:
      - "80:8080"
    volumes:
      - .:/home/node/app
      - node_modules:/home/node/app/node_modules
    networks:
      - app-network
    command: ./wait-for.sh db:27017 --
/home/node/app/node_modules/.bin/nodemon app.js
```

```
  db:
    image: mongo:4.1.8-xenial
    container_name: db
    restart: unless-stopped
    env_file: .env
    environment:
      - MONGO_INITDB_ROOT_USERNAME=$MONGO_USERNAME
      - MONGO_INITDB_ROOT_PASSWORD=$MONGO_PASSWORD
    volumes:
      - dbdata:/data/db
    networks:
      - app-network

networks:
  app-network:
    driver: bridge

volumes:
  dbdata:
  node_modules:
```

Save and close the file when you are finished editing.

With your service definitions in place, you are ready to start the application.

Step 5 — Testing the Application

With your `docker-compose.yml` file in place, you can create your services with the [docker-compose up](#) command. You can also test that your data will persist by stopping and removing your containers with [docker-compose down](#).

First, build the container images and create the services by running `docker-compose up` with the `-d` flag, which will then run the `nodejs` and `db` containers in the background:

```
docker-compose up -d
```

You will see output confirming that your services have been created:

Output

```
...
Creating db ... done
Creating nodejs ... done
```

You can also get more detailed information about the startup processes by displaying the log output from the services:

```
docker-compose logs
```

You will see something like this if everything has started correctly:

```
...

nodejs    | [nodemon] starting `node app.js`

nodejs    | Example app listening on 8080!

nodejs    | MongoDB is connected

...

db        | 2019-02-22T17:26:27.329+0000 I ACCESS   [conn2]

Successfully authenticated as principal **sammy** on admin
```

You can also check the status of your containers with <u>docker-compose ps</u>:

```
docker-compose ps
```

You will see output indicating that your containers are running:
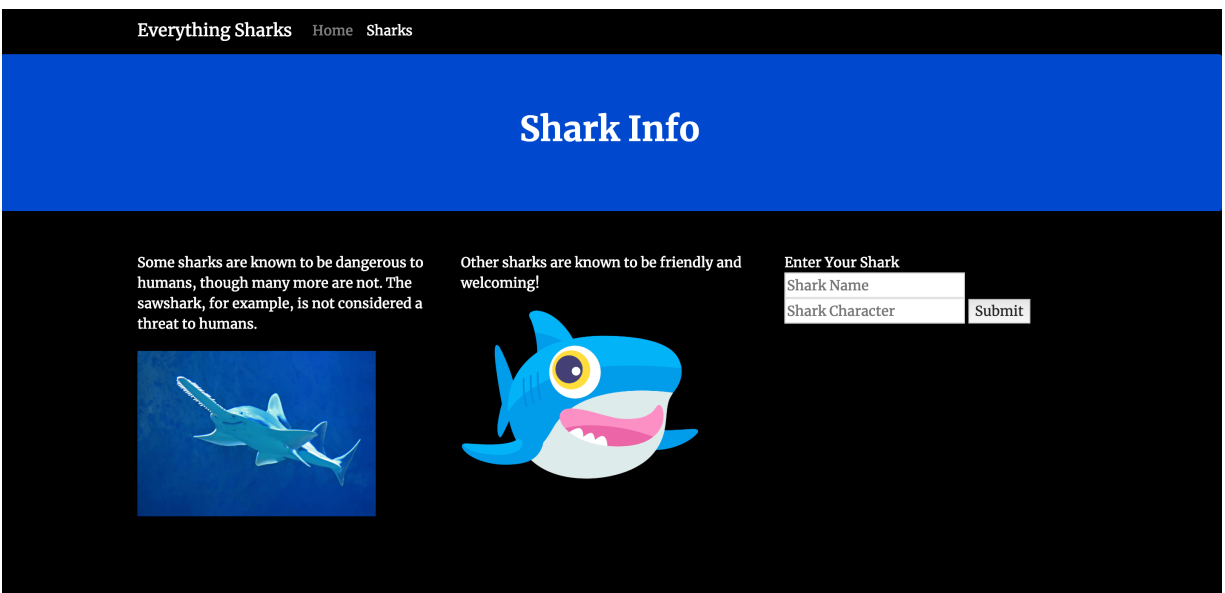
```
 Name              Command              State         Ports
-----------------------------------------------------------
---
db        docker-entrypoint.sh mongod    Up      27017/tcp

nodejs    ./wait-for.sh db:27017 --  ...  Up      0.0.0.0:80-
>8080/tcp
```

With your services running, you can visit `http://`**`your_server_ip`** in the browser. You will see a landing page that looks like this:

Application Landing Page

Click on the Get Shark Info button. You will see a page with an entry form where you can enter a shark name and a description of that shark's general character:

Shark Info Form

In the form, add a shark of your choosing. For the purpose of this demonstration, we will add **Megalodon Shark** to the Shark Name field, and **Ancient** to the Shark Character field:
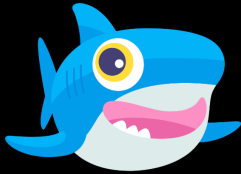

Filled Shark Form

Click on the Submit button. You will see a page with this shark information displayed back to you:

Shark Output

As a final step, we can test that the data you've just entered will persist if you remove your database container.

Back at your terminal, type the following command to stop and remove your containers and network:

```
docker-compose down
```

Note that we are not including the `--volumes` option; hence, our `dbdata` volume is not removed.

The following output confirms that your containers and network have been removed:

Output

```
Stopping nodejs ... done

Stopping db     ... done

Removing nodejs ... done

Removing db     ... done

Removing network node_project_app-network
```

Recreate the containers:

```
docker-compose up -d
```

Now head back to the shark information form:

Shark Info Form

Enter a new shark of your choosing. We'll go with **Whale Shark** and **Large**:

Enter New Shark

Once you click Submit, you will see that the new shark has been added to the shark collection in your database without the loss of the data you've already entered:
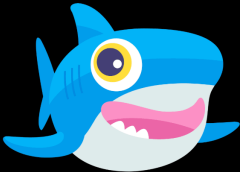
Complete Shark Collection

Your application is now running on Docker containers with data persistence and code synchronization enabled.

Conclusion

By following this tutorial, you have created a development setup for your Node application using Docker containers. You've made your project more modular and portable by extracting sensitive information and decoupling your application's state from your application code. You have also configured a boilerplate `docker-compose.yml` file that you can revise as your development needs and requirements change.

As you develop, you may be interested in learning more about designing applications for containerized and [Cloud Native](#) workflows. Please see [Architecting Applications for Kubernetes](#) and [Modernizing Applications for Kubernetes](#) for more information on these topics.

To learn more about the code used in this tutorial, please see [How To Build a Node.js Application with Docker](#) and [How To Integrate MongoDB with Your Node Application](#). For information about deploying a Node application with an [Nginx](#) reverse proxy using containers, please see [How To Secure a Containerized Node.js Application with Nginx, Let's Encrypt, and Docker Compose](#).

How To Migrate a Docker Compose Workflow to Kubernetes

Written by Kathleen Juell

So far you have built a containerized application and database, and learned how to manage and run your containers using Docker Compose. This chapter will explain how to migrate from running your application with Docker Compose to Kubernetes. Kubernetes will help you scale your application and make it resilient so that deployments and bugs don't cause downtime.

To migrate from Docker Compose to Kubernetes, you'll learn how to create Kubernetes objects that duplicate the functionality in your `docker-compose.yml` file. Once your application is running in Kubernetes, you will be able to scale and manage it using tools like Helm, which you will learn about in the next chapter.

When building modern, stateless applications, containerizing your application's components is the first step in deploying and scaling on distributed platforms. If you have used Docker Compose in development, you will have modernized and containerized your application by: - Extracting necessary configuration information from your code. - Offloading your application's state. - Packaging your application for repeated use.

You will also have written service definitions that specify how your container images should run.

To run your services on a distributed platform like [Kubernetes](), you will need to translate your Compose service definitions to Kubernetes objects. This will allow you to [scale your application with resiliency](). One tool that can speed up the translation process to Kubernetes is [kompose](), a conversion tool that helps developers move Compose workflows to container orchestrators like Kubernetes or [OpenShift]().

In this tutorial, you will translate Compose services to Kubernetes [objects]() using kompose. You will use the object definitions that kompose provides as a starting point and make adjustments to ensure that your setup will use [Secrets](), [Services](), and [PersistentVolumeClaims]() in the way that Kubernetes expects. By the end of the tutorial, you will have a single-instance [Node.js]() application with a [MongoDB]() database running on a Kubernetes cluster. This setup will mirror the functionality of the code described in [Containerizing a Node.js Application with Docker Compose]() and will be a good starting point to build out a production-ready solution that will scale with your needs.

Prerequisites

- A Kubernetes 1.10+ cluster with role-based access control (RBAC) enabled. This setup will use a [DigitalOcean Kubernetes cluster](), but you are free to [create a cluster using another method]().
- The `kubectl` command-line tool installed on your local machine or development server and configured to connect to your cluster. You can read more about installing `kubectl` in the [official documentation]().

- [Docker](#) installed on your local machine or development server. If you are working with Ubuntu 18.04, follow Steps 1 and 2 of [How To Install and Use Docker on Ubuntu 18.04](#); otherwise, follow the [official documentation](#) for information about installing on other operating systems. Be sure to add your non-root user to the `docker` group, as described in Step 2 of the linked tutorial.
- A [Docker Hub](#) account. For an overview of how to set this up, refer to [this introduction](#) to Docker Hub.

Step 1 — Installing kompose

To begin using kompose, navigate to the [project's GitHub Releases page](#), and copy the link to the current release (version **1.18.0** as of this writing). Paste this link into the following `curl` command to download the latest version of kompose:

```
curl -L
https://github.com/kubernetes/kompose/releases/dow
nload/v1.18.0/kompose-linux-amd64 -o kompose
```

For details about installing on non-Linux systems, please refer to the [installation instructions](#).

Make the binary executable:

```
chmod +x kompose
```

Move it to your `PATH`:

```
sudo mv ./kompose /usr/local/bin/kompose
```

To verify that it has been installed properly, you can do a version check:

```
kompose version
```

If the installation was successful, you will see output like the following:

```
1.18.0 (06a2e56)
```

With `kompose` installed and ready to use, you can now clone the Node.js project code that you will be translating to Kubernetes.

Step 2 — Cloning and Packaging the Application

To use our application with Kubernetes, we will need to clone the project code and package the application so that the `kubelet` service can pull the image.

Our first step will be to clone the node-mongo-docker-dev repository from the DigitalOcean Community GitHub account. This repository includes the code from the setup described in Containerizing a Node.js Application for Development With Docker Compose, which uses a demo Node.js application to demonstrate how to set up a development environment using Docker Compose. You can find more information about the application itself in the series From Containers to Kubernetes with Node.js.

Clone the repository into a directory called **node_project**:

```
git clone https://github.com/do-community/node-
mongo-docker-dev.git node_project
```

Navigate to the **node_project** directory:

```
cd node_project
```

The **node_project** directory contains files and directories for a shark information application that works with user input. It has been modernized to work with containers: sensitive and specific configuration

information has been removed from the application code and refactored to be injected at runtime, and the application's state has been offloaded to a MongoDB database.

For more information about designing modern, stateless applications, please see [Architecting Applications for Kubernetes](#) and [Modernizing Applications for Kubernetes](#).

The project directory includes a `Dockerfile` with instructions for building the application image. Let's build the image now so that you can push it to your Docker Hub account and use it in your Kubernetes setup.

Using the [`docker build`](#) command, build the image with the `-t` flag, which allows you to tag it with a memorable name. In this case, tag the image with your Docker Hub username and name it **node-kubernetes** or a name of your own choosing:

```
docker build -t your_dockerhub_username/node-kubernetes .
```

The `.` in the command specifies that the build context is the current directory.

It will take a minute or two to build the image. Once it is complete, check your images:

```
docker images
```

You will see the following output:

Output

```
REPOSITORY                              TAG                 IMAGE
ID              CREATED             SIZE
your_dockerhub_username/node-kubernetes    latest
9c6f897e1fbc            3 seconds ago       90MB
node                                        10-alpine
94f3c8956482            12 days ago         71MB
```

Next, log in to the Docker Hub account you created in the prerequisites:

```
docker login -u your_dockerhub_username
```

When prompted, enter your Docker Hub account password. Logging in this way will create a `~/.docker/config.json` file in your user's home directory with your Docker Hub credentials.

Push the application image to Docker Hub with the [docker push command](). Remember to replace **your_dockerhub_username** with your own Docker Hub username:

```
docker push your_dockerhub_username/node-kubernetes
```

You now have an application image that you can pull to run your application with Kubernetes. The next step will be to translate your application service definitions to Kubernetes objects.

Step 3 — Translating Compose Services to Kubernetes Objects with kompose

Our Docker Compose file, here called `docker-compose.yaml`, lays out the definitions that will run our services with Compose. A service in

Compose is a running container, and service definitions contain information about how each container image will run. In this step, we will translate these definitions to Kubernetes objects by using kompose to create `yaml` files. These files will contain specs for the Kubernetes objects that describe their desired state.

We will use these files to create different types of objects: [Services](), which will ensure that the [Pods]() running our containers remain accessible; [Deployments](), which will contain information about the desired state of our Pods; a [PersistentVolumeClaim]() to provision storage for our database data; a [ConfigMap]() for environment variables injected at runtime; and a [Secret]() for our application's database user and password. Some of these definitions will be in the files kompose will create for us, and others we will need to create ourselves.

First, we will need to modify some of the definitions in our `docker-compose.yaml` file to work with Kubernetes. We will include a reference to our newly-built application image in our `nodejs` service definition and remove the [bind mounts](), [volumes](), and additional [commands]() that we used to run the application container in development with Compose. Additionally, we'll redefine both containers' restart policies to be in line with [the behavior Kubernetes expects]().

Open the file with `nano` or your favorite editor:

`nano docker-compose.yaml`

The current definition for the `nodejs` application service looks like this:

~/node_project/docker-compose.yaml

```yaml
...
services:

  nodejs:

    build:

      context: .

      dockerfile: Dockerfile

    image: nodejs

    container_name: nodejs

    restart: unless-stopped

    env_file: .env

    environment:

      - MONGO_USERNAME=$MONGO_USERNAME

      - MONGO_PASSWORD=$MONGO_PASSWORD

      - MONGO_HOSTNAME=db

      - MONGO_PORT=$MONGO_PORT

      - MONGO_DB=$MONGO_DB

    ports:

      - "80:8080"

    volumes:

      - .:/home/node/app

      - node_modules:/home/node/app/node_modules

    networks:

      - app-network

    command: ./wait-for.sh db:27017 --
/home/node/app/node_modules/.bin/nodemon app.js
...
```

Make the following edits to your service definition: - Use your **node-kubernetes** image instead of the local `Dockerfile`. - Change the container `restart` policy from `unless-stopped` to `always`. - Remove the `volumes` list and the `command` instruction.

The finished service definition will now look like this:

~/node_project/docker-compose.yaml

```
...
services:
  nodejs:
    image: your_dockerhub_username/node-kubernetes
    container_name: nodejs
    restart: always
    env_file: .env
    environment:
      - MONGO_USERNAME=$MONGO_USERNAME
      - MONGO_PASSWORD=$MONGO_PASSWORD
      - MONGO_HOSTNAME=db
      - MONGO_PORT=$MONGO_PORT
      - MONGO_DB=$MONGO_DB
    ports:
      - "80:8080"
    networks:
      - app-network
...
```

Next, scroll down to the `db` service definition. Here, make the following edits: - Change the `restart` policy for the service to `always`. - Remove the `.env` file. Instead of using values from the `.env` file, we will pass the values for our `MONGO_INITDB_ROOT_USERNAME` and `MONGO_INITDB_ROOT_PASSWORD` to the database container using the Secret we will create in .

The `db` service definition will now look like this:

~/node_project/docker-compose.yaml

```
...
  db:
    image: mongo:4.1.8-xenial
    container_name: db
    restart: always
    environment:
      - MONGO_INITDB_ROOT_USERNAME=$MONGO_USERNAME
      - MONGO_INITDB_ROOT_PASSWORD=$MONGO_PASSWORD
    volumes:
      - dbdata:/data/db
    networks:
      - app-network
...
```

Finally, at the bottom of the file, remove the `node_modules` volumes from the top-level `volumes` key. The key will now look like this:

```
...
volumes:

  dbdata:
```

Save and close the file when you are finished editing.

Before translating our service definitions, we will need to write the `.env` file that kompose will use to create the ConfigMap with our non-sensitive information. Please see [Step 2](#) of [Containerizing a Node.js Application for Development With Docker Compose](#) for a longer explanation of this file.

In that tutorial, we added `.env` to our `.gitignore` file to ensure that it would not copy to version control. This means that it did not copy over when we cloned the [node-mongo-docker-dev repository](#) in [Step 2 of this tutorial](#). We will therefore need to recreate it now.

Create the file:

```
nano .env
```

kompose will use this file to create a ConfigMap for our application. However, instead of assigning all of the variables from the `nodejs` service definition in our Compose file, we will add only the `MONGO_DB` database name and the `MONGO_PORT`. We will assign the database username and password separately when we manually create a Secret object in [Step 4](#).

Add the following port and database name information to the `.env` file. Feel free to rename your database if you would like:

```
MONGO_PORT=27017

MONGO_DB=sharkinfo
```

Save and close the file when you are finished editing.

You are now ready to create the files with your object specs. kompose offers [multiple options](#) for translating your resources. You can: - Create `yaml` files based on the service definitions in your `docker-compose.yaml` file with `kompose convert`. - Create Kubernetes objects directly with `kompose up`. - Create a [Helm](#) chart with `kompose convert -c`.

For now, we will convert our service definitions to `yaml` files and then add to and revise the files kompose creates.

Convert your service definitions to `yaml` files with the following command:

`kompose convert`

You can also name specific or multiple Compose files using the `-f` flag.

After you run this command, kompose will output information about the files it has created:

Output

```
INFO Kubernetes file "nodejs-service.yaml" created

INFO Kubernetes file "db-deployment.yaml" created

INFO Kubernetes file "dbdata-persistentvolumeclaim.yaml" created

INFO Kubernetes file "nodejs-deployment.yaml" created

INFO Kubernetes file "nodejs-env-configmap.yaml" created
```

These include `yaml` files with specs for the Node application Service, Deployment, and ConfigMap, as well as for the `dbdata` PersistentVolumeClaim and MongoDB database Deployment.

These files are a good starting point, but in order for our application's functionality to match the setup described in [Containerizing a Node.js Application for Development With Docker Compose](#) we will need to make a few additions and changes to the files kompose has generated.

Step 4 — Creating Kubernetes Secrets

In order for our application to function in the way we expect, we will need to make a few modifications to the files that kompose has created. The first of these changes will be generating a Secret for our database user and password and adding it to our application and database Deployments. Kubernetes offers two ways of working with environment variables: ConfigMaps and Secrets. kompose has already created a ConfigMap with the non-confidential information we included in our `.env` file, so we will now create a Secret with our confidential information: our database username and password.

The first step in manually creating a Secret will be to convert your username and password to [base64](#), an encoding scheme that allows you to uniformly transmit data, including binary data.

Convert your database username:

```
echo -n 'your_database_username' | base64
```

Note down the value you see in the output.

Next, convert your password:

```
echo -n 'your_database_password' | base64
```

Take note of the value in the output here as well.

Open a file for the Secret:

```
nano secret.yaml
```

Note: Kubernetes objects are [typically defined](#) using [YAML](#), which strictly forbids tabs and requires two spaces for indentation. If you would like to check the formatting of any of your `yaml` files, you can use a [linter](#) or test the validity of your syntax using `kubectl create` with the `--dry-run` and `--validate` flags:

```
kubectl create -f your_yaml_file.yaml --dry-run --validate=true
```

In general, it is a good idea to validate your syntax before creating resources with `kubectl`.

Add the following code to the file to create a Secret that will define your `MONGO_USERNAME` and `MONGO_PASSWORD` using the encoded values you just created. Be sure to replace the dummy values here with your encoded username and password:

~/node_project/secret.yaml

```
apiVersion: v1
kind: Secret
metadata:
  name: mongo-secret
data:
  MONGO_USERNAME: your_encoded_username
  MONGO_PASSWORD: your_encoded_password
```

We have named the Secret object **mongo-secret**, but you are free to name it anything you would like.

Save and close this file when you are finished editing. As you did with your `.env` file, be sure to add `secret.yaml` to your `.gitignore` file to keep it out of version control.

With `secret.yaml` written, our next step will be to ensure that our application and database Pods both use the values we added to the file. Let's start by adding references to the Secret to our application Deployment.

Open the file called `nodejs-deployment.yaml`:

`nano nodejs-deployment.yaml`

The file's container specifications include the following environment variables defined under the `env` key:

```yaml
apiVersion: extensions/v1beta1

kind: Deployment

...

    spec:

      containers:

      - env:

        - name: MONGO_DB

          valueFrom:

            configMapKeyRef:

              key: MONGO_DB

              name: nodejs-env

        - name: MONGO_HOSTNAME

          value: db

        - name: MONGO_PASSWORD

        - name: MONGO_PORT

          valueFrom:

            configMapKeyRef:

              key: MONGO_PORT

              name: nodejs-env

        - name: MONGO_USERNAME
```

We will need to add references to our Secret to the `MONGO_USERNAME` and `MONGO_PASSWORD` variables listed here, so that our application will have access to those values. Instead of including a `configMapKeyRef` key to point to our `nodejs-env` ConfigMap, as is the case with the values for `MONGO_DB` and `MONGO_PORT`, we'll include a

`secretKeyRef` key to point to the values in our **mongo-secret** secret.

Add the following Secret references to the `MONGO_USERNAME` and `MONGO_PASSWORD` variables:

~/node_project/nodejs-deployment.yaml

```yaml
apiVersion: extensions/v1beta1

kind: Deployment

...

    spec:

      containers:

      - env:

        - name: MONGO_DB

          valueFrom:

            configMapKeyRef:

              key: MONGO_DB

              name: nodejs-env

        - name: MONGO_HOSTNAME

          value: db

        - name: MONGO_PASSWORD

          valueFrom:

            secretKeyRef:

              name: mongo-secret

              key: MONGO_PASSWORD

        - name: MONGO_PORT

          valueFrom:

            configMapKeyRef:

              key: MONGO_PORT

              name: nodejs-env

        - name: MONGO_USERNAME

          valueFrom:
```

```
        secretKeyRef:

          name: mongo-secret

          key: MONGO_USERNAME
```

Save and close the file when you are finished editing.

Next, we'll add the same values to the `db-deployment.yaml` file.

Open the file for editing:

```
nano db-deployment.yaml
```

In this file, we will add references to our Secret for following variable keys: `MONGO_INITDB_ROOT_USERNAME` and `MONGO_INITDB_ROOT_PASSWORD`. The `mongo` image makes these variables available so that you can modify the initialization of your database instance. `MONGO_INITDB_ROOT_USERNAME` and `MONGO_INITDB_ROOT_PASSWORD` together create a `root` user in the `admin` authentication database and ensure that authentication is enabled when the database container starts.

Using the values we set in our Secret ensures that we will have an application user with [root privileges](#) on the database instance, with access to all of the administrative and operational privileges of that role. When working in production, you will want to create a dedicated application user with appropriately scoped privileges.

Under the `MONGO_INITDB_ROOT_USERNAME` and `MONGO_INITDB_ROOT_PASSWORD` variables, add references to the Secret values:

```
apiVersion: extensions/v1beta1

kind: Deployment

...

    spec:

      containers:

      - env:

        - name: MONGO_INITDB_ROOT_PASSWORD

          valueFrom:

            secretKeyRef:

              name: mongo-secret

              key: MONGO_PASSWORD

        - name: MONGO_INITDB_ROOT_USERNAME

          valueFrom:

            secretKeyRef:

              name: mongo-secret

              key: MONGO_USERNAME

        image: mongo:4.1.8-xenial

...
```

Save and close the file when you are finished editing.

With your Secret in place, you can move on to creating your database Service and ensuring that your application container only attempts to connect to the database once it is fully set up and initialized.

Step 5 — Creating the Database Service and an Application Init Container

Now that we have our Secret, we can move on to creating our database Service and an [Init Container](#) that will poll this Service to ensure that our application only attempts to connect to the database once the database startup tasks, including creating the `MONGO_INITDB` user and password, are complete.

For a discussion of how to implement this functionality in Compose, please see [Step 4](#) of [Containerizing a Node.js Application for Development with Docker Compose](#).

Open a file to define the specs for the database Service:

```
nano db-service.yaml
```

Add the following code to the file to define the Service:

```
apiVersion: v1

kind: Service

metadata:

  annotations:

    kompose.cmd: kompose convert

    kompose.version: 1.18.0 (06a2e56)

  creationTimestamp: null

  labels:

    io.kompose.service: db

  name: db

spec:

  ports:

  - port: 27017

    targetPort: 27017

  selector:

    io.kompose.service: db

status:

  loadBalancer: {}
```

The `selector` that we have included here will match this Service object with our database Pods, which have been defined with the label `io.kompose.service: db` by kompose in the `db-deployment.yaml` file. We've also named this service `db`.

Save and close the file when you are finished editing.

Next, let's add an Init Container field to the `containers` array in `nodejs-deployment.yaml`. This will create an Init Container that we

can use to delay our application container from starting until the `db` Service has been created with a Pod that is reachable. This is one of the possible uses for Init Containers; to learn more about other use cases, please see the [official documentation](#).

Open the `nodejs-deployment.yaml` file:

```
nano nodejs-deployment.yaml
```

Within the Pod spec and alongside the `containers` array, we are going to add an `initContainers` field with a container that will poll the `db` Service.

Add the following code below the `ports` and `resources` fields and above the `restartPolicy` in the `nodejs containers` array:

~/node_project/nodejs-deployment.yaml

```
apiVersion: extensions/v1beta1

kind: Deployment

...

    spec:

      containers:

      ...

        name: nodejs

        ports:

        - containerPort: 8080

        resources: {}

      initContainers:

      - name: init-db

        image: busybox

        command: ['sh', '-c', 'until nc -z db:27017; do echo
waiting for db; sleep 2; done;']

        restartPolicy: Always

...
```

This Init Container uses the [BusyBox image](#), a lightweight image that includes many UNIX utilities. In this case, we'll use the [netcat](#) utility to poll whether or not the Pod associated with the db Service is accepting TCP connections on port 27017.

This container command replicates the functionality of the [wait-for](#) script that we removed from our docker-compose.yaml file in [Step 3](#). For a longer discussion of how and why our application used the wait-

`for` script when working with Compose, please see [Step 4](#) of [Containerizing a Node.js Application for Development with Docker Compose](#).

Init Containers run to completion; in our case, this means that our Node application container will not start until the database container is running and accepting connections on port `27017`. The `db` Service definition allows us to guarantee this functionality regardless of the exact location of the database container, which is mutable.

Save and close the file when you are finished editing.

With your database Service created and your Init Container in place to control the startup order of your containers, you can move on to checking the storage requirements in your PersistentVolumeClaim and exposing your application service using a [LoadBalancer](#).

Step 6 — Modifying the PersistentVolumeClaim and Exposing the Application Frontend

Before running our application, we will make two final changes to ensure that our database storage will be provisioned properly and that we can expose our application frontend using a LoadBalancer.

First, let's modify the `storage` [resource](#) defined in the PersistentVolumeClaim that kompose created for us. This Claim allows us to [dynamically provision](#) storage to manage our application's state.

To work with PersistentVolumeClaims, you must have a [StorageClass](#) created and configured to provision storage resources. In our case, because we are working with [DigitalOcean Kubernetes](#), our default StorageClass

`provisioner` is set to `dobs.csi.digitalocean.com` — [DigitalOcean Block Storage](#).

We can check this by typing:

```
kubectl get storageclass
```

If you are working with a DigitalOcean cluster, you will see the following output:

Output

```
NAME                       PROVISIONER                 AGE
do-block-storage (default) dobs.csi.digitalocean.com   76m
```

If you are not working with a DigitalOcean cluster, you will need to create a StorageClass and configure a `provisioner` of your choice. For details about how to do this, please see the [official documentation](#).

When kompose created `dbdata-persistentvolumeclaim.yaml`, it set the `storage resource` to a size that does not meet the minimum size requirements of our `provisioner`. We will therefore need to modify our PersistentVolumeClaim to use the [minimum viable DigitalOcean Block Storage unit](#): 1GB. Please feel free to modify this to meet your storage requirements.

Open `dbdata-persistentvolumeclaim.yaml`:

```
nano dbdata-persistentvolumeclaim.yaml
```

Replace the `storage` value with **1Gi**:

~/node_project/dbdata-persistentvolumeclaim.yaml

```yaml
apiVersion: v1

kind: PersistentVolumeClaim

metadata:

  creationTimestamp: null

  labels:

    io.kompose.service: dbdata

  name: dbdata

spec:

  accessModes:

  - ReadWriteOnce

  resources:

    requests:

      storage: 1Gi

status: {}
```

Also note the `accessMode: ReadWriteOnce` means that the volume provisioned as a result of this Claim will be read-write only by a single node. Please see the [documentation](#) for more information about different access modes.

Save and close the file when you are finished.

Next, open `nodejs-service.yaml`:

```
nano nodejs-service.yaml
```

We are going to expose this Service externally using a [DigitalOcean Load Balancer](#). If you are not using a DigitalOcean cluster, please consult the relevant documentation from your cloud provider for information

about their load balancers. Alternatively, you can follow the official [Kubernetes documentation](#) on setting up a highly available cluster with [kubeadm](#), but in this case you will not be able to use PersistentVolumeClaims to provision storage.

Within the Service spec, specify `LoadBalancer` as the Service `type`:

~/node_project/nodejs-service.yaml

```
apiVersion: v1

kind: Service

...

spec:

  type: LoadBalancer

  ports:

...
```

When we create the `nodejs` Service, a load balancer will be automatically created, providing us with an external IP where we can access our application.

Save and close the file when you are finished editing.

With all of our files in place, we are ready to start and test the application.

Step 7 — Starting and Accessing the Application

It's time to create our Kubernetes objects and test that our application is working as expected.

To create the objects we've defined, we'll use <u>kubectl create</u> with the `-f` flag, which will allow us to specify the files that kompose created for us, along with the files we wrote. Run the following command to create the Node application and MongoDB database Services and Deployments, along with your Secret, ConfigMap, and PersistentVolumeClaim:

```
kubectl create -f nodejs-service.yaml,nodejs-
deployment.yaml,nodejs-env-configmap.yaml,db-
service.yaml,db-deployment.yaml,dbdata-
persistentvolumeclaim.yaml,secret.yaml
```

You will see the following output indicating that the objects have been created:

Output

```
service/nodejs created

deployment.extensions/nodejs created

configmap/nodejs-env created

service/db created

deployment.extensions/db created

persistentvolumeclaim/dbdata created

secret/mongo-secret created
```

To check that your Pods are running, type:

```
kubectl get pods
```

You don't need to specify a <u>Namespace</u> here, since we have created our objects in the `default` Namespace. If you are working with multiple Namespaces, be sure to include the `-n` flag when running this command, along with the name of your Namespace.

You will see the following output while your `db` container is starting and your application Init Container is running:

Output

```
NAME                      READY   STATUS            RESTARTS
AGE
db-679d658576-kfpsl       0/1     ContainerCreating 0
10s
nodejs-6b9585dc8b-pnsws   0/1     Init:0/1          0
10s
```

Once that container has run and your application and database containers have started, you will see this output:

Output

```
NAME                      READY   STATUS    RESTARTS   AGE
db-679d658576-kfpsl       1/1     Running   0          54s
nodejs-6b9585dc8b-pnsws   1/1     Running   0          54s
```

The `Running STATUS` indicates that your Pods are bound to nodes and that the containers associated with those Pods are running. `READY` indicates how many containers in a Pod are running. For more information, please consult the [documentation on Pod lifecycles](#).

Note: If you see unexpected phases in the `STATUS` column, remember that you can troubleshoot your Pods with the following commands:

```
kubectl describe pods your_pod
kubectl logs your_pod
```

With your containers running, you can now access the application. To get the IP for the LoadBalancer, type:
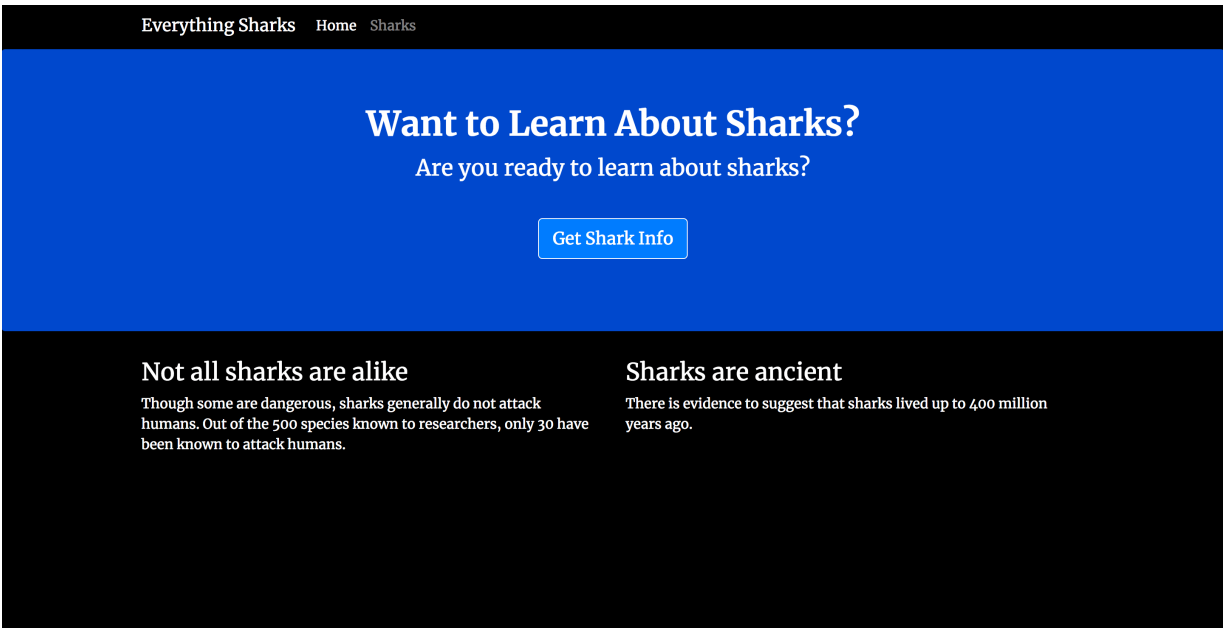
```
kubectl get svc
```

You will see the following output:

Output

```
NAME          TYPE           CLUSTER-IP      EXTERNAL-IP
PORT(S)          AGE
db            ClusterIP      10.245.189.250  <none>
27017/TCP        93s
kubernetes    ClusterIP      10.245.0.1      <none>
443/TCP          25m12s
nodejs        LoadBalancer   10.245.15.56    your_lb_ip
80:30729/TCP     93s
```

The `EXTERNAL_IP` associated with the `nodejs` service is the IP address where you can access the application. If you see a `<pending>` status in the `EXTERNAL_IP` column, this means that your load balancer is still being created.
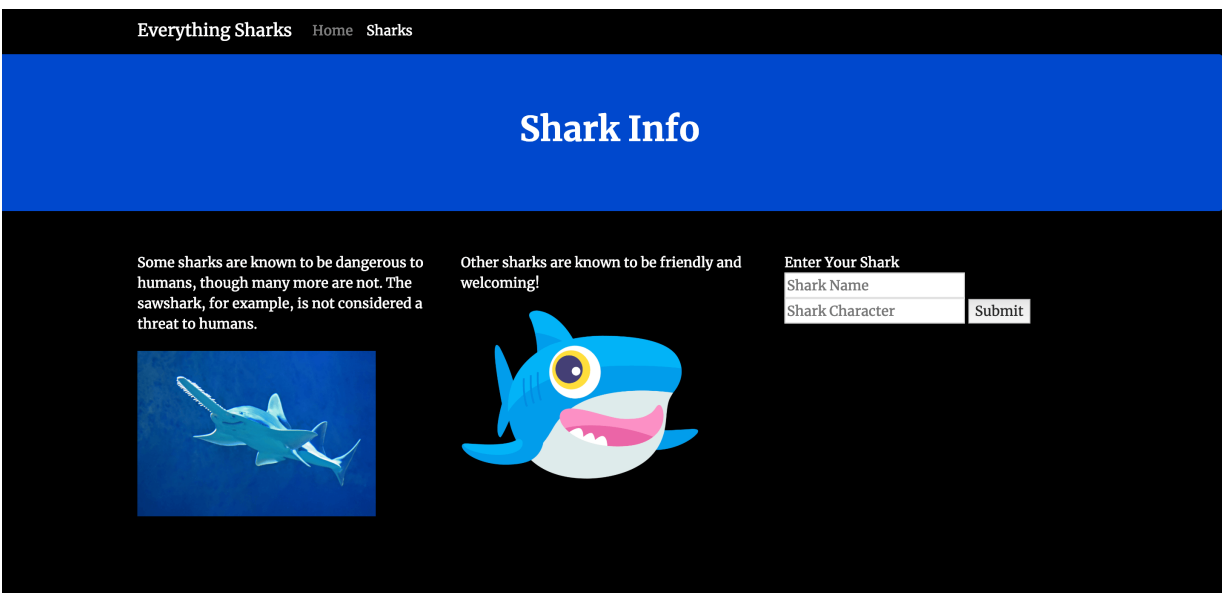
Once you see an IP in that column, navigate to it in your browser: `http://your_lb_ip`.

You should see the following landing page:

Application Landing Page

Click on the Get Shark Info button. You will see a page with an entry form where you can enter a shark name and a description of that shark's general character:

Shark Info Form

In the form, add a shark of your choosing. To demonstrate, we will add **Megalodon Shark** to the Shark Name field, and **Ancient** to the Shark Character field:
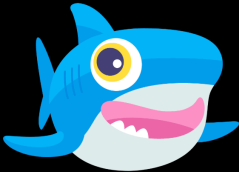

Filled Shark Form

Click on the Submit button. You will see a page with this shark information displayed back to you:

Shark Output

You now have a single instance setup of a Node.js application with a MongoDB database running on a Kubernetes cluster.

Conclusion

The files you have created in this tutorial are a good starting point to build from as you move toward production. As you develop your application, you can work on implementing the following: - Centralized logging and monitoring. Please see the [relevant discussion](#) in [Modernizing Applications for Kubernetes](#) for a general overview. You can also look at [How To Set Up an Elasticsearch, Fluentd and Kibana (EFK) Logging Stack on Kubernetes](#) to learn how to set up a logging stack with [Elasticsearch](#), [Fluentd](#), and [Kibana](#). Also check out [An Introduction to Service Meshes](#) for information about how service meshes like [Istio](#) implement this functionality. - Ingress Resources to route traffic to your cluster. This is a good alternative to a LoadBalancer in cases where you are running

multiple Services, which each require their own LoadBalancer, or where you would like to implement application-level routing strategies (A/B & canary tests, for example). For more information, check out [How to Set Up an Nginx Ingress with Cert-Manager on DigitalOcean Kubernetes](#) and the [related discussion](#) of routing in the service mesh context in [An Introduction to Service Meshes](#). - Backup strategies for your Kubernetes objects. For guidance on implementing backups with [Velero](#) (formerly Heptio Ark) with DigitalOcean's Kubernetes product, please see [How To Back Up and Restore a Kubernetes Cluster on DigitalOcean Using Heptio Ark](#).

[How To Scale a Node.js Application with MongoDB on Kubernetes Using Helm](#)

Written by Kathleen Juell

At this point in the book you have learned how to build a Node.js application using Docker images, and run it as a container. You have also learned how to add a database to store persistent data, and coordinate running the application and database using Docker Compose, followed by Kubernetes.

In this chapter you will learn how to scale your application on Kubernetes using Helm. By the end of this chapter, you will be able to run multiple copies of your application with MongoDB on Kubernetes, using Helm to scale the application up or down as you see fit.

[Kubernetes](#) is a system for running modern, containerized applications at scale. With it, developers can deploy and manage applications across clusters of machines. And though it can be used to improve efficiency and reliability in single-instance application setups, Kubernetes is designed to run multiple instances of an application across groups of machines.

When creating multi-service deployments with Kubernetes, many developers opt to use the [Helm](#) package manager. Helm streamlines the process of creating multiple Kubernetes resources by offering charts and templates that coordinate how these objects interact. It also offers pre-packaged charts for popular open-source projects.

In this tutorial, you will deploy a [Node.js](#) application with a MongoDB database onto a Kubernetes cluster using Helm charts. You will use the

[official Helm MongoDB replica set chart](#) to create a [StatefulSet object](#) consisting of three [Pods](#), a [Headless Service](#), and three [PersistentVolumeClaims](#). You will also create a chart to deploy a multi-replica Node.js application using a custom application image. The setup you will build in this tutorial will mirror the functionality of the code described in [Containerizing a Node.js Application with Docker Compose](#) and will be a good starting point to build a resilient Node.js application with a MongoDB data store that can scale with your needs.

Prerequisites

To complete this tutorial, you will need: - A Kubernetes 1.10+ cluster with role-based access control (RBAC) enabled. This setup will use a [DigitalOcean Kubernetes cluster](#), but you are free to [create a cluster using another method](#). - The `kubectl` command-line tool installed on your local machine or development server and configured to connect to your cluster. You can read more about installing `kubectl` in the [official documentation](#). - Helm installed on your local machine or development server and Tiller installed on your cluster, following the directions outlined in Steps 1 and 2 of [How To Install Software on Kubernetes Clusters with the Helm Package Manager](#). - [Docker](#) installed on your local machine or development server. If you are working with Ubuntu 18.04, follow Steps 1 and 2 of [How To Install and Use Docker on Ubuntu 18.04](#); otherwise, follow the [official documentation](#) for information about installing on other operating systems. Be sure to add your non-root user to the `docker` group, as described in Step 2 of the linked tutorial. - A

[Docker Hub](#) account. For an overview of how to set this up, refer to [this introduction](#) to Docker Hub.

Step 1 — Cloning and Packaging the Application

To use our application with Kubernetes, we will need to package it so that the [`kubelet agent`](#) can pull the image. Before packaging the application, however, we will need to modify the MongoDB [connection URI](#) in the application code to ensure that our application can connect to the members of the replica set that we will create with the Helm `mongodb-replicaset` chart.

Our first step will be to clone the [node-mongo-docker-dev repository](#) from the [DigitalOcean Community GitHub account](#). This repository includes the code from the setup described in [Containerizing a Node.js Application for Development With Docker Compose](#), which uses a demo Node.js application with a MongoDB database to demonstrate how to set up a development environment with Docker Compose. You can find more information about the application itself in the series [From Containers to Kubernetes with Node.js](#).

Clone the repository into a directory called **`node_project`**:

```
git clone https://github.com/do-community/node-mongo-docker-dev.git node_project
```

Navigate to the **`node_project`** directory:

```
cd node_project
```

The **`node_project`** directory contains files and directories for a shark information application that works with user input. It has been modernized to work with containers: sensitive and specific configuration

information has been removed from the application code and refactored to be injected at runtime, and the application's state has been offloaded to a MongoDB database.

For more information about designing modern, containerized applications, please see [Architecting Applications for Kubernetes](#) and [Modernizing Applications for Kubernetes](#).

When we deploy the Helm `mongodb-replicaset` chart, it will create: - A StatefulSet object with three Pods — the members of the MongoDB [replica set](#). Each Pod will have an associated PersistentVolumeClaim and will maintain a fixed identity in the event of rescheduling. - A MongoDB replica set made up of the Pods in the StatefulSet. The set will include one primary and two secondaries. Data will be replicated from the primary to the secondaries, ensuring that our application data remains highly available.

For our application to interact with the database replicas, the MongoDB connection URI in our code will need to include both the hostnames of the replica set members as well as the name of the replica set itself. We therefore need to include these values in the URI.

The file in our cloned repository that specifies database connection information is called `db.js`. Open that file now using `nano` or your favorite editor:

`nano db.js`

Currently, the file includes [constants](#) that are referenced in the database connection URI at runtime. The values for these constants are injected using Node's [`process.env`](#) property, which returns an object with information about your user environment at runtime. Setting values dynamically in our application code allows us to decouple the code from

the underlying infrastructure, which is necessary in a dynamic, stateless environment. For more information about refactoring application code in this way, see [Step 2](#) of [Containerizing a Node.js Application for Development With Docker Compose](#) and the relevant discussion in [The 12-Factor App](#).

The constants for the connection URI and the URI string itself currently look like this:

~/node_project/db.js

```
...
const {
  MONGO_USERNAME,
  MONGO_PASSWORD,
  MONGO_HOSTNAME,
  MONGO_PORT,
  MONGO_DB
} = process.env;

...

const url =
`mongodb://${MONGO_USERNAME}:${MONGO_PASSWORD}@${MONGO_HOSTNAME}:${MONGO_PORT}/${MONGO_DB}?authSource=admin`;
...
```

In keeping with a 12FA approach, we do not want to hard code the hostnames of our replica instances or our replica set name into this URI

string. The existing `MONGO_HOSTNAME` constant can be expanded to include multiple hostnames — the members of our replica set — so we will leave that in place. We will need to add a replica set constant to the [options section](#) of the URI string, however.

Add `MONGO_REPLICASET` to both the URI constant object and the connection string:

~/node_project/db.js

```
...
const {
  MONGO_USERNAME,
  MONGO_PASSWORD,
  MONGO_HOSTNAME,
  MONGO_PORT,
  MONGO_DB,
  MONGO_REPLICASET
} = process.env;


...
const url =
`mongodb://${MONGO_USERNAME}:${MONGO_PASSWORD}@${MONGO_HOSTNAME}:${MONGO_PORT}/${MONGO_DB}?
replicaSet=${MONGO_REPLICASET}&authSource=admin`;

...
```

Using the [replicaSet option](#) in the options section of the URI allows us to pass in the name of the replica set, which, along with the hostnames defined in the `MONGO_HOSTNAME` constant, will allow us to connect to the set members.

Save and close the file when you are finished editing.

With your database connection information modified to work with replica sets, you can now package your application, build the image with the [`docker build`](#) command, and push it to Docker Hub.

Build the image with `docker build` and the `-t` flag, which allows you to tag the image with a memorable name. In this case, tag the image with your Docker Hub username and name it **node-replicas** or a name of your own choosing:

```
docker build -t your_dockerhub_username/node-replicas .
```

The `.` in the command specifies that the build context is the current directory.

It will take a minute or two to build the image. Once it is complete, check your images:

```
docker images
```

You will see the following output:

Output

```
REPOSITORY                                 TAG              IMAGE
ID              CREATED           SIZE
your_dockerhub_username/node-replicas     latest
56a69b4bc882          7 seconds ago       90.1MB
node                                       10-alpine
aa57b0242b33          6 days ago          71MB
```

Next, log in to the Docker Hub account you created in the prerequisites:

```
docker login -u your_dockerhub_username
```

When prompted, enter your Docker Hub account password. Logging in this way will create a `~/.docker/config.json` file in your non-root user's home directory with your Docker Hub credentials.

Push the application image to Docker Hub with the [docker push command](). Remember to replace **your_dockerhub_username** with your own Docker Hub username:

```
docker push your_dockerhub_username/node-replicas
```

You now have an application image that you can pull to run your replicated application with Kubernetes. The next step will be to configure specific parameters to use with the MongoDB Helm chart.

Step 2 — Creating Secrets for the MongoDB Replica Set

The `stable/mongodb-replicaset` chart provides different options when it comes to using Secrets, and we will create two to use with our chart deployment: - A Secret for our [replica set keyfile]() that will function as a shared password between replica set members, allowing them to

authenticate other members. - A Secret for our MongoDB admin user, who will be created as a root user on the `admin` database. This role will allow you to create subsequent users with limited permissions when deploying your application to production.

With these Secrets in place, we will be able to set our preferred parameter values in a dedicated values file and create the StatefulSet object and MongoDB replica set with the Helm chart.

First, let's create the keyfile. We will use the openssl command with the `rand` option to generate a 756 byte random string for the keyfile:

```
openssl rand -base64 756 > key.txt
```

The output generated by the command will be base64 encoded, ensuring uniform data transmission, and redirected to a file called `key.txt`, following the guidelines stated in the mongodb-replicaset chart authentication documentation. The key itself must be between 6 and 1024 characters long, consisting only of characters in the base64 set.

You can now create a Secret called **keyfilesecret** using this file with kubectl create:

```
kubectl create secret generic keyfilesecret --from-file=key.txt
```

This will create a Secret object in the `default` namespace, since we have not created a specific namespace for our setup.

You will see the following output indicating that your Secret has been created:

Output

```
secret/keyfilesecret created
```

Remove `key.txt`:

```
rm key.txt
```

Alternatively, if you would like to save the file, be sure [restrict its permissions](#) and add it to your [`.gitignore` file](#) to keep it out of version control.

Next, create the Secret for your MongoDB admin user. The first step will be to convert your desired username and password to base64.

Convert your database username:

```
echo -n 'your_database_username' | base64
```

Note down the value you see in the output.

Next, convert your password:

```
echo -n 'your_database_password' | base64
```

Take note of the value in the output here as well.

Open a file for the Secret:

```
nano secret.yaml
```

Note: Kubernetes objects are [typically defined](#) using [YAML](#), which strictly forbids tabs and requires two spaces for indentation. If you would like to check the formatting of any of your YAML files, you can use a [linter](#) or test the validity of your syntax using `kubectl create` with the `--dry-run` and `--validate` flags:

```
kubectl create -f your_yaml_file.yaml --dry-run --validate=true
```

In general, it is a good idea to validate your syntax before creating resources with `kubectl`.

Add the following code to the file to create a Secret that will define a `user` and `password` with the encoded values you just created. Be sure to

replace the dummy values here with your own encoded username and password:

```
apiVersion: v1

kind: Secret

metadata:

  name: mongo-secret

data:

  user: your_encoded_username

  password: your_encoded_password
```

Here, we're using the key names that the `mongodb-replicaset` chart expects: `user` and `password`. We have named the Secret object **mongo-secret**, but you are free to name it anything you would like.

Save and close the file when you are finished editing.

Create the Secret object with the following command:

```
kubectl create -f secret.yaml
```

You will see the following output:

Output

```
secret/mongo-secret created
```

Again, you can either remove `secret.yaml` or restrict its permissions and add it to your `.gitignore` file.

With your Secret objects created, you can move on to specifying the parameter values you will use with the `mongodb-replicaset` chart and creating the MongoDB deployment.

Step 3 — Configuring the MongoDB Helm Chart and Creating a Deployment

Helm comes with an actively maintained repository called stable that contains the chart we will be using: `mongodb-replicaset`. To use this chart with the Secrets we've just created, we will create a file with configuration parameter values called `mongodb-values.yaml` and then install the chart using this file.

Our `mongodb-values.yaml` file will largely mirror the default [values.yaml file](#) in the `mongodb-replicaset` chart repository. We will, however, make the following changes to our file: - We will set the `auth` parameter to `true` to ensure that our database instances start with [authorization enabled](#). This means that all clients will be required to authenticate for access to database resources and operations. - We will add information about the Secrets we created in the previous Step so that the chart can use these values to create the replica set keyfile and admin user. - We will decrease the size of the PersistentVolumes associated with each Pod in the StatefulSet to use the [minimum viable DigitalOcean Block Storage unit](#), 1GB, though you are free to modify this to meet your storage requirements.

Before writing the `mongodb-values.yaml` file, however, you should first check that you have a [StorageClass](#) created and configured to provision storage resources. Each of the Pods in your database StatefulSet

will have a sticky identity and an associated [PersistentVolumeClaim](#), which will dynamically provision a PersistentVolume for the Pod. If a Pod is rescheduled, the PersistentVolume will be mounted to whichever node the Pod is scheduled on (though each Volume must be manually deleted if its associated Pod or StatefulSet is permanently deleted).

Because we are working with [DigitalOcean Kubernetes](#), our default StorageClass `provisioner` is set to `dobs.csi.digitalocean.com` — [DigitalOcean Block Storage](#) — which we can check by typing:

```
kubectl get storageclass
```

If you are working with a DigitalOcean cluster, you will see the following output:

Output

```
NAME                      PROVISIONER                 AGE
do-block-storage (default)  dobs.csi.digitalocean.com  21m
```

If you are not working with a DigitalOcean cluster, you will need to create a StorageClass and configure a `provisioner` of your choice. For details about how to do this, please see the [official documentation](#).

Now that you have ensured that you have a StorageClass configured, open `mongodb-values.yaml` for editing:

```
nano mongodb-values.yaml
```

You will set values in this file that will do the following: - Enable authorization. - Reference your **keyfilesecret** and **mongo-secret** objects. - Specify **1Gi** for your PersistentVolumes. - Set your replica set

name to **db**. - Specify 3 replicas for the set. - Pin the `mongo` image to the latest version at the time of writing: **4.1.9**.

Paste the following code into the file:

```yaml
replicas: 3
port: 27017
replicaSetName: db
podDisruptionBudget: {}
auth:
  enabled: true
  existingKeySecret: keyfilesecret
  existingAdminSecret: mongo-secret
imagePullSecrets: []
installImage:
  repository: unguiculus/mongodb-install
  tag: 0.7
  pullPolicy: Always
copyConfigImage:
  repository: busybox
  tag: 1.29.3
  pullPolicy: Always
image:
  repository: mongo
  tag: 4.1.9
  pullPolicy: Always
extraVars: {}
metrics:
  enabled: false
  image:
```

```yaml
      repository: ssalaues/mongodb-exporter

      tag: 0.6.1

      pullPolicy: IfNotPresent

    port: 9216

    path: /metrics

    socketTimeout: 3s

    syncTimeout: 1m

    prometheusServiceDiscovery: true

    resources: {}
podAnnotations: {}
securityContext:

  enabled: true

  runAsUser: 999

  fsGroup: 999

  runAsNonRoot: true
init:

  resources: {}

  timeout: 900
resources: {}
nodeSelector: {}
affinity: {}
tolerations: []
extraLabels: {}
persistentVolume:

  enabled: true

  #storageClass: "-"

  accessModes:
```

```
    - ReadWriteOnce

  size: 1Gi

  annotations: {}
serviceAnnotations: {}
terminationGracePeriodSeconds: 30
tls:
  enabled: false
configmap: {}
readinessProbe:
  initialDelaySeconds: 5
  timeoutSeconds: 1
  failureThreshold: 3
  periodSeconds: 10
  successThreshold: 1
livenessProbe:
  initialDelaySeconds: 30
  timeoutSeconds: 5
  failureThreshold: 3
  periodSeconds: 10
  successThreshold: 1
```

The `persistentVolume.storageClass` parameter is commented out here: removing the comment and setting its value to `"-"` would disable dynamic provisioning. In our case, because we are leaving this value undefined, the chart will choose the default `provisioner` — in our case, `dobs.csi.digitalocean.com`.

Also note the `accessMode` associated with the `persistentVolume` key: `ReadWriteOnce` means that the provisioned volume will be read-write only by a single node. Please see the [documentation](#) for more information about different access modes.

To learn more about the other parameters included in the file, see the [configuration table](#) included with the repo.

Save and close the file when you are finished editing.

Before deploying the `mongodb-replicaset` chart, you will want to update the stable repo with the [helm repo update command](#):

```
helm repo update
```

This will get the latest chart information from the stable repository.

Finally, install the chart with the following command:

```
helm install --name mongo -f mongodb-values.yaml
stable/mongodb-replicaset
```

Note: Before installing a chart, you can run `helm install` with the `--dry-run` and `--debug` options to check the generated manifests for your release:

```
helm install --name your_release_name -f
your_values_file.yaml --dry-run --debug your_chart
```

Note that we are naming the Helm release **mongo**. This name will refer to this particular deployment of the chart with the configuration options we've specified. We've pointed to these options by including the `-f` flag and our `mongodb-values.yaml` file.

Also note that because we did not include the `--namespace` flag with `helm install`, our chart objects will be created in the `default` namespace.

Once you have created the release, you will see output about its status, along with information about the created objects and instructions for interacting with them:

Output

```
NAME:   mongo

LAST DEPLOYED: Tue Apr 16 21:51:05 2019

NAMESPACE: default

STATUS: DEPLOYED


RESOURCES:

==> v1/ConfigMap

NAME                            DATA   AGE

mongo-mongodb-replicaset-init      1      1s

mongo-mongodb-replicaset-mongodb   1      1s

mongo-mongodb-replicaset-tests     1      0s

...
```

You can now check on the creation of your Pods with the following command:

```
kubectl get pods
```

You will see output like the following as the Pods are being created:

Output

```
NAME                          READY   STATUS     RESTARTS   AGE

mongo-mongodb-replicaset-0    1/1     Running    0          67s

mongo-mongodb-replicaset-1    0/1     Init:0/3   0          8s
```

The `READY` and `STATUS` outputs here indicate that the Pods in our StatefulSet are not fully ready: the [Init Containers](#) associated with the Pod's containers are still running. Because StatefulSet members are [created in sequential order](#), each Pod in the StatefulSet must be `Running` and `Ready` before the next Pod will be created.

Once the Pods have been created and all of their associated containers are running, you will see this output:

Output

```
NAME                          READY   STATUS     RESTARTS   AGE
mongo-mongodb-replicaset-0    1/1     Running    0          2m33s
mongo-mongodb-replicaset-1    1/1     Running    0          94s
mongo-mongodb-replicaset-2    1/1     Running    0          36s
```

The `Running STATUS` indicates that your Pods are bound to nodes and that the containers associated with those Pods are running. `READY` indicates how many containers in a Pod are running. For more information, please consult the [documentation on Pod lifecycles](#).

Note: If you see unexpected phases in the `STATUS` column, remember that you can troubleshoot your Pods with the following commands:

```
kubectl describe pods your_pod
kubectl logs your_pod
```

Each of the Pods in your StatefulSet has a name that combines the name of the StatefulSet with the [ordinal index](#) of the Pod. Because we created three replicas, our StatefulSet members are numbered 0-2, and each has a [stable DNS entry](#) comprised of the following elements:

```
$(statefulset-name)-$(ordinal).$(service
name).$(namespace).svc.cluster.local.
```

In our case, the StatefulSet and the [Headless Service](#) created by the mongodb-replicaset chart have the same names:

```
kubectl get statefulset
```

Output

```
NAME                         READY    AGE
mongo-mongodb-replicaset     3/3      4m2s
```

```
kubectl get svc
```

Output

```
NAME                              TYPE        CLUSTER-IP
EXTERNAL-IP    PORT(S)      AGE
kubernetes                        ClusterIP   10.245.0.1   <none>
443/TCP       42m
mongo-mongodb-replicaset          ClusterIP   None         <none>
27017/TCP     4m35s
mongo-mongodb-replicaset-client   ClusterIP   None         <none>
27017/TCP     4m35s
```

This means that the first member of our StatefulSet will have the following DNS entry:

```
mongo-mongodb-replicaset-0.mongo-mongodb-
replicaset.default.svc.cluster.local
```

Because we need our application to connect to each MongoDB instance, it's essential that we have this information so that we can communicate directly with the Pods, rather than with the Service. When we create our custom application Helm chart, we will pass the DNS entries for each Pod to our application using environment variables.

With your database instances up and running, you are ready to create the chart for your Node application.

Step 4 — Creating a Custom Application Chart and Configuring Parameters

We will create a custom Helm chart for our Node application and modify the default files in the standard chart directory so that our application can work with the replica set we have just created. We will also create files to define ConfigMap and Secret objects for our application.

First, create a new chart directory called **nodeapp** with the following command:

```
helm create nodeapp
```

This will create a directory called **nodeapp** in your `~/`**node_project** folder with the following resources: - A `Chart.yaml` file with basic information about your chart. - A `values.yaml` file that allows you to set specific parameter values, as you did with your MongoDB deployment. - A `.helmignore` file with file and directory patterns that will be ignored when packaging charts. - A `templates/` directory with the template files that will generate Kubernetes manifests. - A `templates/tests/` directory for test files. - A `charts/` directory for any charts that this chart depends on.

The first file we will modify out of these default files is `values.yaml`. Open that file now:

`nano `**`nodeapp`**`/values.yaml`

The values that we will set here include: - The number of replicas. - The application image we want to use. In our case, this will be the `node-replicas` image we created in [Step 1](). - The [ServiceType](). In this case, we will specify [LoadBalancer]() to create a point of access to our application for testing purposes. Because we are working with a DigitalOcean Kubernetes cluster, this will create a [DigitalOcean Load Balancer]() when we deploy our chart. In production, you can configure your chart to use [Ingress Resources]() and [Ingress Controllers]() to route traffic to your Services. - The [targetPort]() to specify the port on the Pod where our application will be exposed.

We will not enter environment variables into this file. Instead, we will create templates for ConfigMap and Secret objects and add these values to our application Deployment manifest, located at `~/node_project/`**`nodeapp`**`/templates/deployment.yaml`.

Configure the following values in the `values.yaml` file:

```
# Default values for nodeapp.

# This is a YAML-formatted file.

# Declare variables to be passed into your templates.


replicaCount: 3


image:

  repository: your_dockerhub_username/node-replicas

  tag: latest

  pullPolicy: IfNotPresent


nameOverride: ""
fullnameOverride: ""


service:

  type: LoadBalancer

  port: 80

  targetPort: 8080
...
```

Save and close the file when you are finished editing.

Next, open a `secret.yaml` file in the **nodeapp**/templates directory:

```
nano nodeapp/templates/secret.yaml
```

In this file, add values for your `MONGO_USERNAME` and `MONGO_PASSWORD` application constants. These are the constants that your application will expect to have access to at runtime, as specified in `db.js`, your database connection file. As you add the values for these constants, remember to the use the base64-encoded values that you used earlier in Step 2 when creating your **mongo-secret** object. If you need to recreate those values, you can return to Step 2 and run the relevant commands again.

Add the following code to the file:

~/node_project/nodeapp/templates/secret.yaml

```
apiVersion: v1

kind: Secret

metadata:

  name: {{ .Release.Name }}-auth

data:

  MONGO_USERNAME: your_encoded_username

  MONGO_PASSWORD: your_encoded_password
```

The name of this Secret object will depend on the name of your Helm release, which you will specify when you deploy the application chart.

Save and close the file when you are finished.

Next, open a file to create a ConfigMap for your application:

```
nano nodeapp/templates/configmap.yaml
```

In this file, we will define the remaining variables that our application expects: `MONGO_HOSTNAME`, `MONGO_PORT`, `MONGO_DB`, and

`MONGO_REPLICASET`. Our `MONGO_HOSTNAME` variable will include the DNS entry for each instance in our replica set, since this is what the [MongoDB connection URI requires](#).

According to the [Kubernetes documentation](#), when an application implements liveness and readiness checks, [SRV records](#) should be used when connecting to the Pods. As discussed in [Step 3](#), our Pod SRV records follow this pattern: `$(`**`statefulset-name`**`)-$(`**`ordinal`**`).$(`**`service name`**`).$(`**`namespace`**`).svc.cluster.local`. Since our MongoDB StatefulSet implements liveness and readiness checks, we should use these stable identifiers when defining the values of the `MONGO_HOSTNAME` variable.

Add the following code to the file to define the `MONGO_HOSTNAME`, `MONGO_PORT`, `MONGO_DB`, and `MONGO_REPLICASET` variables. You are free to use another name for your `MONGO_DB` database, but your `MONGO_HOSTNAME` and `MONGO_REPLICASET` values must be written as they appear here:

```
apiVersion: v1

kind: ConfigMap

metadata:

  name: {{ .Release.Name }}-config

data:

  MONGO_HOSTNAME: "mongo-mongodb-replicaset-0.mongo-mongodb-

replicaset.default.svc.cluster.local,mongo-mongodb-replicaset-

1.mongo-mongodb-replicaset.default.svc.cluster.local,mongo-mongodb-

replicaset-2.mongo-mongodb-replicaset.default.svc.cluster.local"

  MONGO_PORT: "27017"

  MONGO_DB: "sharkinfo"

  MONGO_REPLICASET: "db"
```

Because we have already created the StatefulSet object and replica set, the hostnames that are listed here must be listed in your file exactly as they appear in this example. If you destroy these objects and rename your MongoDB Helm release, then you will need to revise the values included in this ConfigMap. The same applies for MONGO_REPLICASET, since we specified the replica set name with our MongoDB release.

Also note that the values listed here are quoted, which is [the expectation for environment variables in Helm](#).

Save and close the file when you are finished editing.

With your chart parameter values defined and your Secret and ConfigMap manifests created, you can edit the application Deployment template to use your environment variables.

Step 5 — Integrating Environment Variables into Your Helm Deployment

With the files for our application Secret and ConfigMap in place, we will need to make sure that our application Deployment can use these values. We will also customize the [liveness and readiness probes](#) that are already defined in the Deployment manifest.

Open the application Deployment template for editing:

```
nano nodeapp/templates/deployment.yaml
```

Though this is a YAML file, Helm templates use a different syntax from standard Kubernetes YAML files in order to generate manifests. For more information about templates, see the [Helm documentation](#).

In the file, first add an `env` key to your application container specifications, below the `imagePullPolicy` key and above `ports`:

~/node_project/nodeapp/templates/deployment.yaml

```
apiVersion: apps/v1

kind: Deployment

metadata:

...

  spec:

    containers:

      - name: {{ .Chart.Name }}

        image: "{{ .Values.image.repository }}:{{ .Values.image.tag
}}"

        imagePullPolicy: {{ .Values.image.pullPolicy }}

        env:

        ports:
```

Next, add the following keys to the list of env variables:

~/node_project/nodeapp/templates/deployment.yaml

```yaml
apiVersion: apps/v1

kind: Deployment

metadata:

...

  spec:

    containers:

      - name: {{ .Chart.Name }}

        image: "{{ .Values.image.repository }}:{{ .Values.image.tag }}"

        imagePullPolicy: {{ .Values.image.pullPolicy }}

        env:

        - name: MONGO_USERNAME

          valueFrom:

            secretKeyRef:

              key: MONGO_USERNAME

              name: {{ .Release.Name }}-auth

        - name: MONGO_PASSWORD

          valueFrom:

            secretKeyRef:

              key: MONGO_PASSWORD

              name: {{ .Release.Name }}-auth

        - name: MONGO_HOSTNAME

          valueFrom:

            configMapKeyRef:

              key: MONGO_HOSTNAME
```

```
        name: {{ .Release.Name }}-config
    - name: MONGO_PORT
      valueFrom:
        configMapKeyRef:
          key: MONGO_PORT
          name: {{ .Release.Name }}-config
    - name: MONGO_DB
      valueFrom:
        configMapKeyRef:
          key: MONGO_DB
          name: {{ .Release.Name }}-config
    - name: MONGO_REPLICASET
      valueFrom:
        configMapKeyRef:
          key: MONGO_REPLICASET
          name: {{ .Release.Name }}-config
```

Each variable includes a reference to its value, defined either by a secretKeyRef key, in the case of Secret values, or configMapKeyRef for ConfigMap values. These keys point to the Secret and ConfigMap files we created in the previous Step.

Next, under the `ports` key, modify the `containerPort` definition to specify the port on the container where our application will be exposed:

~/node_project/nodeapp/templates/deployment.yaml

```
apiVersion: apps/v1

kind: Deployment

metadata:

...

  spec:

    containers:

    ...

      env:

    ...

      ports:

        - name: http

          containerPort: 8080

          protocol: TCP

    ...
```

Next, let's modify the liveness and readiness checks that are included in this Deployment manifest by default. These checks ensure that our application Pods are running and ready to serve traffic: - Readiness probes assess whether or not a Pod is ready to serve traffic, stopping all requests to the Pod until the checks succeed. - Liveness probes check basic application behavior to determine whether or not the application in the container is running and behaving as expected. If a liveness probe fails, Kubernetes will restart the container.

For more about both, see the relevant discussion in Architecting Applications for Kubernetes.

In our case, we will build on the [httpGet request](#) that Helm has provided by default and test whether or not our application is accepting requests on the `/sharks` endpoint. The [kubelet service](#) will perform the probe by sending a GET request to the Node server running in the application Pod's container and listening on port `8080`. If the status code for the response is between 200 and 400, then the `kubelet` will conclude that the container is healthy. Otherwise, in the case of a 400 or 500 status, `kubelet` will either stop traffic to the container, in the case of the readiness probe, or restart the container, in the case of the liveness probe.

Add the following modification to the stated `path` for the liveness and readiness probes:

~/node_project/nodeapp/templates/deployment.yaml

```yaml
apiVersion: apps/v1

kind: Deployment

metadata:

...

  spec:

    containers:

    ...

      env:

    ...

      ports:

        - name: http

          containerPort: 8080

          protocol: TCP

      livenessProbe:

        httpGet:

          path: /sharks

          port: http

      readinessProbe:

        httpGet:

          path: /sharks

          port: http
```

Save and close the file when you are finished editing.

You are now ready to create your application release with Helm. Run the following helm install command, which includes the name of the

release and the location of the chart directory:

```
helm install --name nodejs ./nodeapp
```

Remember that you can run `helm install` with the `--dry-run` and `--debug` options first, as discussed in [Step 3](), to check the generated manifests for your release.

Again, because we are not including the `--namespace` flag with `helm install`, our chart objects will be created in the `default` namespace.

You will see the following output indicating that your release has been created:

Output

```
NAME:    nodejs

LAST DEPLOYED: Wed Apr 17 18:10:29 2019

NAMESPACE: default

STATUS: DEPLOYED


RESOURCES:

==> v1/ConfigMap

NAME            DATA   AGE

nodejs-config   4      1s


==> v1/Deployment

NAME              READY   UP-TO-DATE   AVAILABLE   AGE

nodejs-nodeapp    0/3     3            0           1s


...
```

Again, the output will indicate the status of the release, along with information about the created objects and how you can interact with them.

Check the status of your Pods:

```
kubectl get pods
```

```
NAME                         READY   STATUS    RESTARTS   AGE
mongo-mongodb-replicaset-0   1/1     Running   0          57m
mongo-mongodb-replicaset-1   1/1     Running   0          56m
mongo-mongodb-replicaset-2   1/1     Running   0          55m
nodejs-nodeapp-577df49dcc-b5fq5   1/1   Running   0      117s
nodejs-nodeapp-577df49dcc-bkk66   1/1   Running   0      117s
nodejs-nodeapp-577df49dcc-lpmt2   1/1   Running   0      117s
```

Once your Pods are up and running, check your Services:

```
kubectl get svc
```

```
NAME                         TYPE           CLUSTER-IP
EXTERNAL-IP        PORT(S)         AGE
kubernetes                   ClusterIP      10.245.0.1
<none>             443/TCP         96m
mongo-mongodb-replicaset     ClusterIP      None
<none>             27017/TCP       58m
mongo-mongodb-replicaset-client   ClusterIP   None
<none>             27017/TCP       58m
nodejs-nodeapp               LoadBalancer   10.245.33.46
your_lb_ip         80:31518/TCP    3m22s
```

The EXTERNAL_IP associated with the nodejs-nodeapp Service is the IP address where you can access the application from outside of the

cluster. If you see a `<pending>` status in the `EXTERNAL_IP` column, this means that your load balancer is still being created.

Once you see an IP in that column, navigate to it in your browser: `http://`**`your_lb_ip`**.

You should see the following landing page:
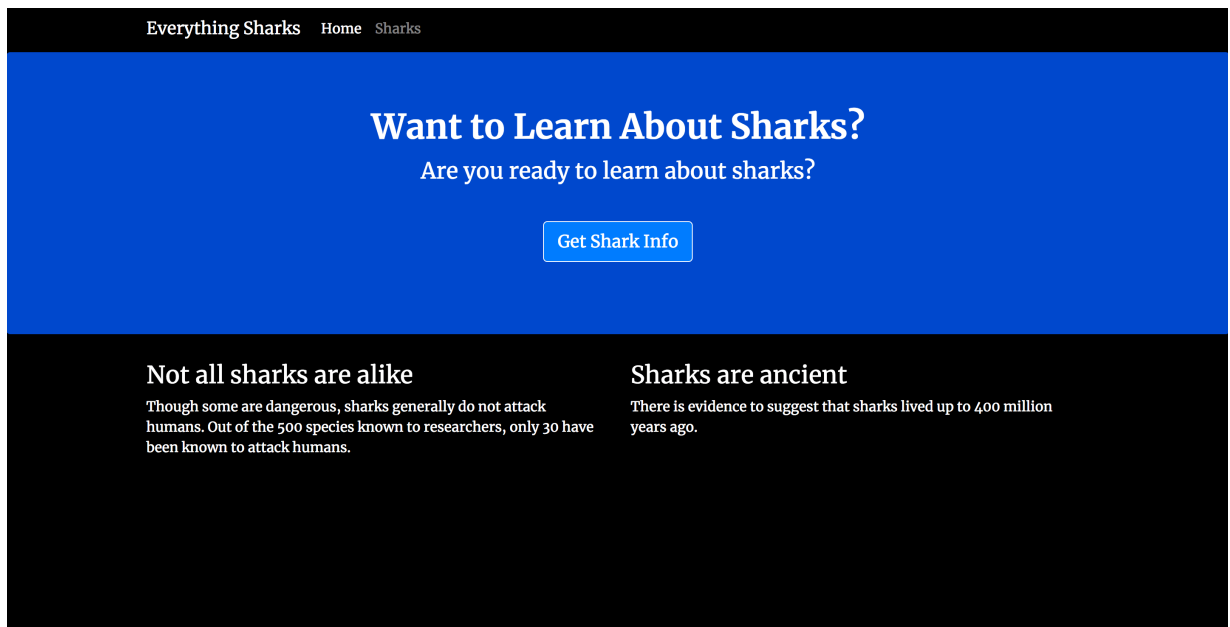
Application Landing Page

Now that your replicated application is working, let's add some test data to ensure that replication is working between members of the replica set.

Step 6 — Testing MongoDB Replication

With our application running and accessible through an external IP address, we can add some test data and ensure that it is being replicated between the members of our MongoDB replica set.

First, make sure you have navigated your browser to the application landing page:
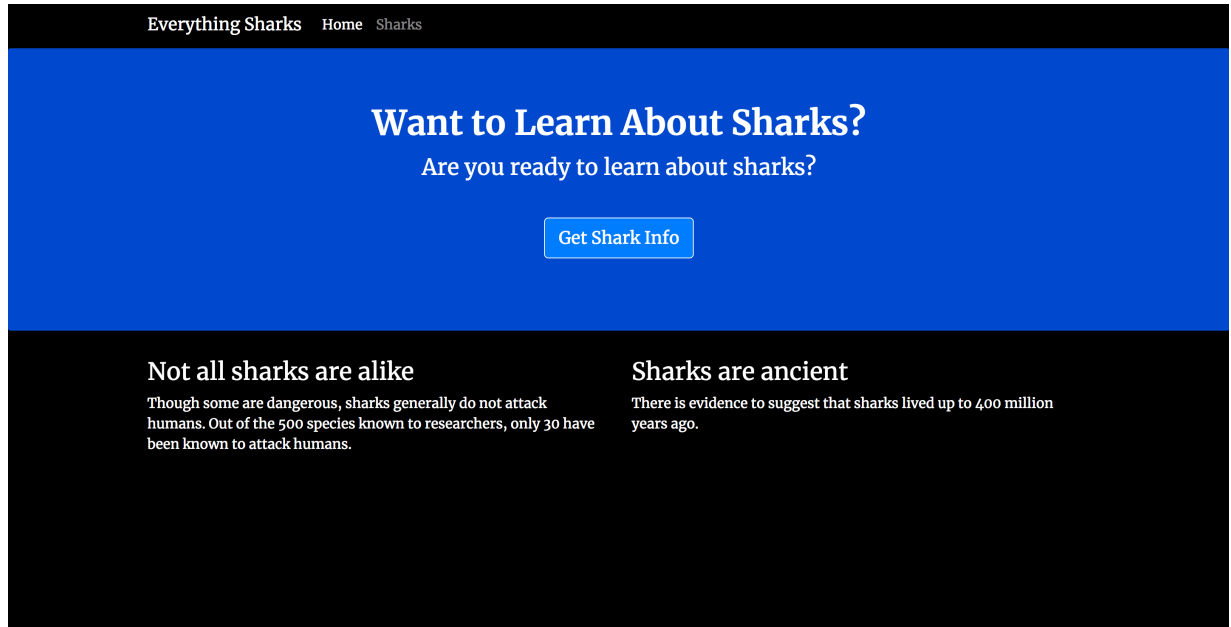
Application Landing Page

Click on the Get Shark Info button. You will see a page with an entry form where you can enter a shark name and a description of that shark's general character:
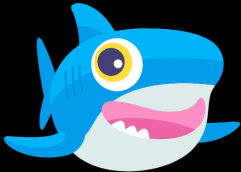
Shark Info Form

In the form, add an initial shark of your choosing. To demonstrate, we will add **Megalodon Shark** to the Shark Name field, and **Ancient** to the Shark Character field:
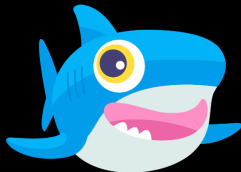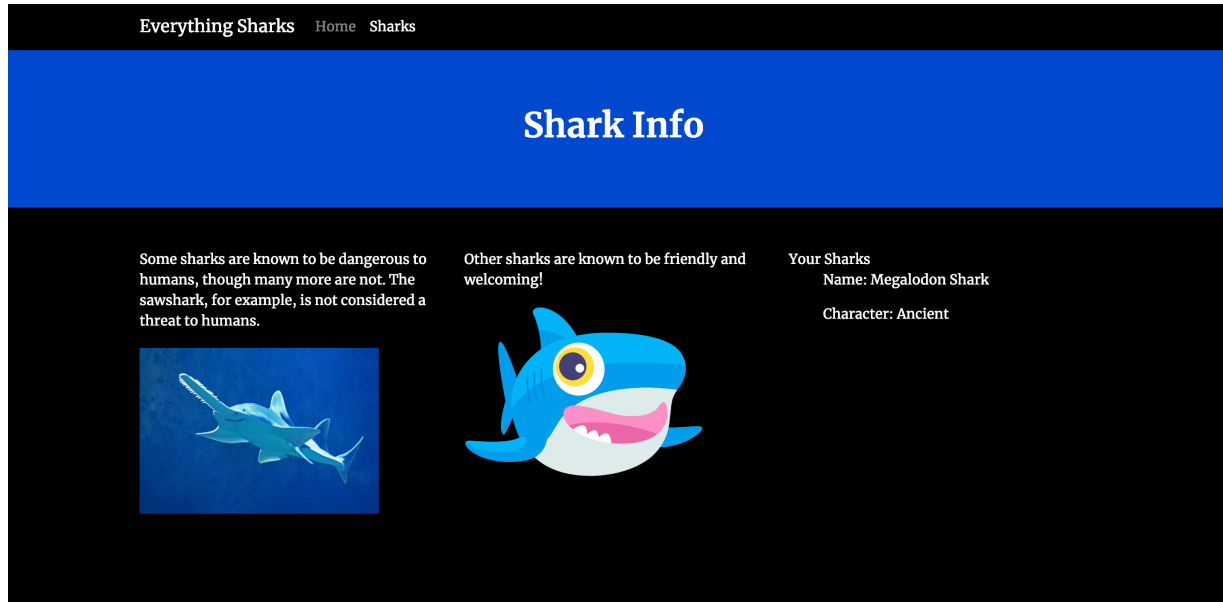

Filled Shark Form

Click on the Submit button. You will see a page with this shark information displayed back to you:

Shark Output

Now head back to the shark information form by clicking on Sharks in the top navigation bar:

Shark Info Form

Enter a new shark of your choosing. We'll go with **Whale Shark** and **Large**:

Enter New Shark

Once you click Submit, you will see that the new shark has been added to the shark collection in your database:

Complete Shark Collection

Let's check that the data we've entered has been replicated between the primary and secondary members of our replica set.

Get a list of your Pods:

```
kubectl get pods
```

```
NAME                             READY   STATUS    RESTARTS   AGE

mongo-mongodb-replicaset-0       1/1     Running   0          74m

mongo-mongodb-replicaset-1       1/1     Running   0          73m

mongo-mongodb-replicaset-2       1/1     Running   0          72m

nodejs-nodeapp-577df49dcc-b5fq5  1/1     Running   0          5m4s

nodejs-nodeapp-577df49dcc-bkk66  1/1     Running   0          5m4s

nodejs-nodeapp-577df49dcc-lpmt2  1/1     Running   0          5m4s
```

To access the <u>mongo shell</u> on your Pods, you can use the <u>kubectl</u> <u>exec command</u> and the username you used to create your **mongo-secret** in <u>Step 2</u>. Access the `mongo` shell on the first Pod in the StatefulSet with the following command:

```
kubectl exec -it mongo-mongodb-replicaset-0 --
mongo -u your_database_username -p --
authenticationDatabase admin
```

When prompted, enter the password associated with this username:

Output

```
MongoDB shell version v4.1.9

Enter password:
```

You will be dropped into an administrative shell:

Output

```
MongoDB server version: 4.1.9

Welcome to the MongoDB shell.

...


db:PRIMARY>
```

Though the prompt itself includes this information, you can manually check to see which replica set member is the primary with the [rs.isMaster() method]():

```
rs.isMaster()
```

You will see output like the following, indicating the hostname of the primary:

```
db:PRIMARY> rs.isMaster()
{
        "hosts" : [
                "mongo-mongodb-replicaset-0.mongo-mongodb-
replicaset.default.svc.cluster.local:27017",
                "mongo-mongodb-replicaset-1.mongo-mongodb-
replicaset.default.svc.cluster.local:27017",
                "mongo-mongodb-replicaset-2.mongo-mongodb-
replicaset.default.svc.cluster.local:27017"
        ],
        ...
        "primary" : "mongo-mongodb-replicaset-0.mongo-mongodb-
replicaset.default.svc.cluster.local:27017",
        ...
```

Next, switch to your **sharkinfo** database:

```
use sharkinfo
```

```
switched to db sharkinfo
```

List the collections in the database:

```
show collections
```

```
sharks
```

Output the documents in the collection:

```
db.sharks.find()
```

You will see the following output:

Output

```
{ "_id" : ObjectId("5cb7702c9111a5451c6dc8bb"), "name" : "Megalodon

Shark", "character" : "Ancient", "__v" : 0 }

{ "_id" : ObjectId("5cb77054fcdbf563f3b47365"), "name" : "Whale

Shark", "character" : "Large", "__v" : 0 }
```

Exit the MongoDB Shell:

```
exit
```

Now that we have checked the data on our primary, let's check that it's being replicated to a secondary. `kubectl exec` into `mongo-mongodb-replicaset-1` with the following command:

```
kubectl exec -it mongo-mongodb-replicaset-1 --

mongo -u your_database_username -p --

authenticationDatabase admin
```

Once in the administrative shell, we will need to use the `db.setSlaveOk()` method to permit read operations from the secondary instance:

```
db.setSlaveOk(1)
```

Switch to the **sharkinfo** database:

```
use sharkinfo
```

```
switched to db sharkinfo
```

Permit the read operation of the documents in the `sharks` collection:

```
db.setSlaveOk(1)
```

Output the documents in the collection:

```
db.sharks.find()
```

You should now see the same information that you saw when running this method on your primary instance:

Output

```
db:SECONDARY> db.sharks.find()
{ "_id" : ObjectId("5cb7702c9111a5451c6dc8bb"), "name" : "Megalodon
Shark", "character" : "Ancient", "__v" : 0 }
{ "_id" : ObjectId("5cb77054fcdbf563f3b47365"), "name" : "Whale
Shark", "character" : "Large", "__v" : 0 }
```

This output confirms that your application data is being replicated between the members of your replica set.

Conclusion

You have now deployed a replicated, highly-available shark information application on a Kubernetes cluster using Helm charts. This demo application and the workflow outlined in this tutorial can act as a starting

point as you build custom charts for your application and take advantage of Helm's stable repository and [other chart repositories](#).

As you move toward production, consider implementing the following: - Centralized logging and monitoring. Please see the [relevant discussion](#) in [Modernizing Applications for Kubernetes](#) for a general overview. You can also look at [How To Set Up an Elasticsearch, Fluentd and Kibana (EFK) Logging Stack on Kubernetes](#) to learn how to set up a logging stack with [Elasticsearch](#), [Fluentd](#), and [Kibana](#). Also check out [An Introduction to Service Meshes](#) for information about how service meshes like [Istio](#) implement this functionality. - Ingress Resources to route traffic to your cluster. This is a good alternative to a LoadBalancer in cases where you are running multiple Services, which each require their own LoadBalancer, or where you would like to implement application-level routing strategies (A/B & canary tests, for example). For more information, check out [How to Set Up an Nginx Ingress with Cert-Manager on DigitalOcean Kubernetes](#) and the [related discussion](#) of routing in the service mesh context in [An Introduction to Service Meshes](#). - Backup strategies for your Kubernetes objects. For guidance on implementing backups with [Velero](#) (formerly Heptio Ark) with DigitalOcean's Kubernetes product, please see [How To Back Up and Restore a Kubernetes Cluster on DigitalOcean Using Heptio Ark](#).

To learn more about Helm, see [An Introduction to Helm, the Package Manager for Kubernetes](#), [How To Install Software on Kubernetes Clusters with the Helm Package Manager](#), and the [Helm documentation](#).

[How To Secure a Containerized Node.js Application with Nginx, Let's Encrypt, and Docker Compose](#)

Written by Kathleen Juell

In this final chapter, you will learn how to secure your application using Nginx as a reverse proxy, and Let's Encrypt, a free Transport Layer Security (TLS) certificate provider. Using a TLS certificate means that web traffic to your application will be secured using HTTPS to encrypt requests.

You will use containers to build, run, and manage your application and database like in Chapter 3 of this book. You will add the Nginx reverse proxy and learn how to configure it with TLS. By the end of this chapter, you will have a secure application that uses an automatically acquired and renewed TLS certificate, and you will coordinate running everything using Docker Compose.

There are multiple ways to enhance the flexibility and security of your [Node.js](#) application. Using a [reverse proxy](#) like [Nginx](#) offers you the ability to load balance requests, cache static content, and implement Transport Layer Security (TLS). Enabling encrypted HTTPS on your server ensures that communication to and from your application remains secure.

Implementing a reverse proxy with TLS/SSL on containers involves a different set of procedures from working directly on a host operating system. For example, if you were obtaining certificates from [Let's Encrypt](#)

for an application running on a server, you would install the required software directly on your host. Containers allow you to take a different approach. Using [Docker Compose](), you can create containers for your application, your web server, and the [Certbot client]() that will enable you to obtain your certificates. By following these steps, you can take advantage of the modularity and portability of a containerized workflow.

In this tutorial, you will deploy a Node.js application with an Nginx reverse proxy using Docker Compose. You will obtain TLS/SSL certificates for the domain associated with your application and ensure that it receives a high security rating from [SSL Labs](). Finally, you will set up a `cron` job to renew your certificates so that your domain remains secure.

Prerequisites

To follow this tutorial, you will need: - An Ubuntu 18.04 server, a non-root user with `sudo` privileges, and an active firewall. For guidance on how to set these up, please see this [Initial Server Setup guide](). - Docker and Docker Compose installed on your server. For guidance on installing Docker, follow Steps 1 and 2 of [How To Install and Use Docker on Ubuntu 18.04](). For guidance on installing Compose, follow Step 1 of [How To Install Docker Compose on Ubuntu 18.04](). - A registered domain name. This tutorial will use example.com throughout. You can get one for free at [Freenom](), or use the domain registrar of your choice. - Both of the following DNS records set up for your server. You can follow [this introduction to DigitalOcean DNS]() for details on how to add them to a DigitalOcean account, if that's what you're using:

- An A record with **example.com** pointing to your server's public IP address.

- An A record with www.**example.com** pointing to your server's public IP address.

Step 1 — Cloning and Testing the Node Application

As a first step, we will clone the repository with the Node application code, which includes the Dockerfile that we will use to build our application image with Compose. We can first test the application by building and running it with the <u>docker run command</u>, without a reverse proxy or SSL.

In your non-root user's home directory, clone the <u>nodejs-image-demo repository</u> from the <u>DigitalOcean Community GitHub account</u>. This repository includes the code from the setup described in <u>How To Build a Node.js Application with Docker</u>.

Clone the repository into a directory called **node_project**:

```
git clone https://github.com/do-community/nodejs-image-demo.git node_project
```

Change to the **node_project** directory:

```
cd  node_project
```

In this directory, there is a Dockerfile that contains instructions for building a Node application using the <u>Docker node:10 image</u> and the contents of your current project directory. You can look at the contents of the Dockerfile by typing:

```
cat Dockerfile
```

Output

```
FROM node:10-alpine

RUN mkdir -p /home/node/app/node_modules && chown -R node:node
/home/node/app

WORKDIR /home/node/app

COPY package*.json ./

USER node

RUN npm install

COPY --chown=node:node . .

EXPOSE 8080

CMD [ "node", "app.js" ]
```

These instructions build a Node image by copying the project code from the current directory to the container and installing dependencies with `npm install`. They also take advantage of Docker's [caching and image layering](#) by separating the copy of `package.json` and `package-lock.json`, containing the project's listed dependencies, from the copy of the rest of the application code. Finally, the instructions specify that the

container will be run as the non-root node user with the appropriate permissions set on the application code and `node_modules` directories.

For more information about this Dockerfile and Node image best practices, please see the complete discussion in [Step 3 of How To Build a Node.js Application with Docker](#).

To test the application without SSL, you can build and tag the image using [`docker build`](#) and the `-t` flag. We will call the image **node-demo**, but you are free to name it something else:

```
docker build -t node-demo .
```

Once the build process is complete, you can list your images with [`docker images`](#):

```
docker images
```

You will see the following output, confirming the application image build:

Output

```
REPOSITORY          TAG             IMAGE ID            CREATED
SIZE
node-demo           latest          23961524051d        7
seconds ago      73MB
node                10-alpine       8a752d5af4ce        3 weeks
ago         70.7MB
```

Next, create the container with `docker run`. We will include three flags with this command: - `-p`: This publishes the port on the container and maps it to a port on our host. We will use port `80` on the host, but you

should feel free to modify this as necessary if you have another process running on that port. For more information about how this works, see this discussion in the Docker docs on [port binding](#). - `-d`: This runs the container in the background. - `--name`: This allows us to give the container a memorable name.

Run the following command to build the container:

```
docker run --name node-demo -p 80:8080 -d node-demo
```

Inspect your running containers with [`docker ps`](#):

```
docker ps
```

You will see output confirming that your application container is running:

Output

```
CONTAINER ID        IMAGE               COMMAND             CREATED
STATUS              PORTS                   NAMES
4133b72391da        node-demo               "node app.js"       17
seconds ago     Up 16 seconds       0.0.0.0:80->8080/tcp    node-demo
```

You can now visit your domain to test your setup: `http://example.com`. Remember to replace **example.com** with your own domain name. Your application will display the following landing page:
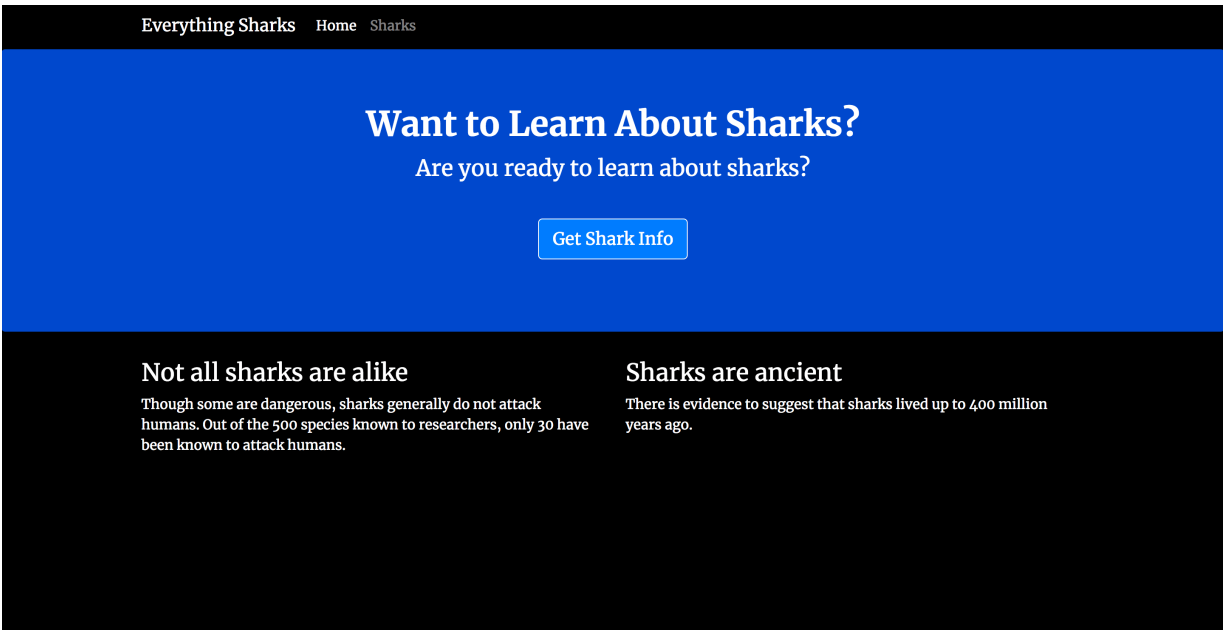
Application Landing Page

Now that you have tested the application, you can stop the container and remove the images. Use `docker ps` again to get your `CONTAINER ID`:

```
docker ps
```

Output

```
CONTAINER ID        IMAGE               COMMAND             CREATED
STATUS              PORTS                   NAMES
4133b72391da        node-demo               "node app.js"       17
seconds ago     Up 16 seconds       0.0.0.0:80->8080/tcp    node-
demo
```

Stop the container with [docker stop](). Be sure to replace the `CONTAINER ID` listed here with your own application `CONTAINER ID`:

```
docker stop 4133b72391da
```

You can now remove the stopped container and all of the images, including unused and dangling images, with `docker system prune` and the `-a` flag:

```
docker system prune -a
```

Type `y` when prompted in the output to confirm that you would like to remove the stopped container and images. Be advised that this will also remove your build cache.

With your application image tested, you can move on to building the rest of your setup with Docker Compose.

Step 2 — Defining the Web Server Configuration

With our application Dockerfile in place, we can create a configuration file to run our Nginx container. We will start with a minimal configuration that will include our domain name, [document root](#), proxy information, and a location block to direct Certbot's requests to the `.well-known` directory, where it will place a temporary file to validate that the DNS for our domain resolves to our server.

First, create a directory in the current project directory for the configuration file:

```
mkdir nginx-conf
```

Open the file with `nano` or your favorite editor:

```
nano nginx-conf/nginx.conf
```

Add the following server block to proxy user requests to your Node application container and to direct Certbot's requests to the `.well-known` directory. Be sure to replace **example.com** with your own domain name:

```
server {

        listen 80;

        listen [::]:80;


        root /var/www/html;

        index index.html index.htm index.nginx-debian.html;


        server_name example.com www.example.com;


        location / {

                proxy_pass http://nodejs:8080;

        }


        location ~ /.well-known/acme-challenge {

                allow all;

                root /var/www/html;

        }

}
```

This server block will allow us to start the Nginx container as a reverse proxy, which will pass requests to our Node application container. It will also allow us to use Certbot's [webroot plugin](#) to obtain certificates for our domain. This plugin depends on the [HTTP-01 validation method](#), which uses an HTTP request to prove that Certbot can access resources from a server that responds to a given domain name.

Once you have finished editing, save and close the file. To learn more about Nginx server and location block algorithms, please refer to this article on [Understanding Nginx Server and Location Block Selection Algorithms](#).

With the web server configuration details in place, we can move on to creating our `docker-compose.yml` file, which will allow us to create our application services and the Certbot container we will use to obtain our certificates.

Step 3 — Creating the Docker Compose File

The `docker-compose.yml` file will define our services, including the Node application and web server. It will specify details like named volumes, which will be critical to sharing SSL credentials between containers, as well as network and port information. It will also allow us to specify specific commands to run when our containers are created. This file is the central resource that will define how our services will work together.

Open the file in your current directory:

```
nano docker-compose.yml
```

First, define the application service:

```yaml
version: '3'


services:

  nodejs:

    build:

      context: .

      dockerfile: Dockerfile

    image: nodejs

    container_name: nodejs

    restart: unless-stopped
```

The `nodejs` service definition includes the following: - `build`: This defines the configuration options, including the `context` and `dockerfile`, that will be applied when Compose builds the application image. If you wanted to use an existing image from a registry like [Docker Hub](), you could use the [image instruction]() instead, with information about your username, repository, and image tag. - `context`: This defines the build context for the application image build. In this case, it's the current project directory. - `dockerfile`: This specifies the Dockerfile that Compose will use for the build — the Dockerfile you looked at in [Step 1](). - `image`, `container_name`: These apply names to the image and container. - `restart`: This defines the restart policy. The default is `no`, but we have set the container to restart unless it is stopped.

Note that we are not including bind mounts with this service, since our setup is focused on deployment rather than development. For more

information, please see the Docker documentation on [bind mounts](#) and [volumes](#).

To enable communication between the application and web server containers, we will also add a bridge network called `app-network` below the restart definition:

~/node_project/docker-compose.yml

```
services:
  nodejs:
...
    networks:
      - app-network

```

A user-defined bridge network like this enables communication between containers on the same Docker daemon host. This streamlines traffic and communication within your application, since it opens all ports between containers on the same bridge network, while exposing no ports to the outside world. Thus, you can be selective about opening only the ports you need to expose your frontend services.

Next, define the `webserver` service:

```yaml
...
 webserver:
    image: nginx:mainline-alpine

    container_name: webserver

    restart: unless-stopped

    ports:

      - "80:80"

    volumes:

      - web-root:/var/www/html

      - ./nginx-conf:/etc/nginx/conf.d

      - certbot-etc:/etc/letsencrypt

      - certbot-var:/var/lib/letsencrypt

    depends_on:

      - nodejs

    networks:

      - app-network
```

Some of the settings we defined for the `nodejs` service remain the same, but we've also made the following changes: - `image`: This tells Compose to pull the latest [Alpine-based](#) [Nginx image](#) from Docker Hub. For more information about `alpine` images, please see Step 3 of [How To Build a Node.js Application with Docker](#). - `ports`: This exposes port `80` to enable the configuration options we've defined in our Nginx configuration.

We have also specified the following named volumes and bind mounts:
- `web-root:/var/www/html`: This will add our site's static assets, copied to a volume called `web-root`, to the the `/var/www/html` directory on the container. - `./nginx-conf:/etc/nginx/conf.d`: This will bind mount the Nginx configuration directory on the host to the relevant directory on the container, ensuring that any changes we make to files on the host will be reflected in the container. - `certbot-etc:/etc/letsencrypt`: This will mount the relevant Let's Encrypt certificates and keys for our domain to the appropriate directory on the container. - `certbot-var:/var/lib/letsencrypt`: This mounts Let's Encrypt's default working directory to the appropriate directory on the container.

Next, add the configuration options for the `certbot` container. Be sure to replace the domain and email information with your own domain name and contact email:

```
...

  certbot:

    image: certbot/certbot

    container_name: certbot

    volumes:

      - certbot-etc:/etc/letsencrypt

      - certbot-var:/var/lib/letsencrypt

      - web-root:/var/www/html

    depends_on:

      - webserver

    command: certonly --webroot --webroot-path=/var/www/html --email
```

This definition tells Compose to pull the [certbot/certbot image](#) from Docker Hub. It also uses named volumes to share resources with the Nginx container, including the domain certificates and key in `certbot-etc`, the Let's Encrypt working directory in `certbot-var`, and the application code in `web-root`.

Again, we've used `depends_on` to specify that the `certbot` container should be started once the `webserver` service is running.

We've also included a `command` option that specifies the command to run when the container is started. It includes the `certonly` subcommand with the following options: - `--webroot`: This tells Certbot to use the webroot plugin to place files in the webroot folder for authentication. - `--webroot-path`: This specifies the path of the webroot directory. - `--email`: Your preferred email for registration and recovery. - `--agree-`

`tos`: This specifies that you agree to [ACME's Subscriber Agreement](). - `--no-eff-email`: This tells Certbot that you do not wish to share your email with the [Electronic Frontier Foundation]() (EFF). Feel free to omit this if you would prefer. - `--staging`: This tells Certbot that you would like to use Let's Encrypt's staging environment to obtain test certificates. Using this option allows you to test your configuration options and avoid possible domain request limits. For more information about these limits, please see Let's Encrypt's [rate limits documentation](). - `-d`: This allows you to specify domain names you would like to apply to your request. In this case, we've included **example.com** and `www.`**example.com**. Be sure to replace these with your own domain preferences.

As a final step, add the volume and network definitions. Be sure to replace the username here with your own non-root user:

~/node_project/docker-compose.yml

```yaml
...
volumes:
  certbot-etc:
  certbot-var:
  web-root:
    driver: local
    driver_opts:
      type: none
      device: /home/sammy/node_project/views/
      o: bind

networks:
  app-network:
    driver: bridge
```

Our named volumes include our Certbot certificate and working directory volumes, and the volume for our site's static assets, `web-root`. In most cases, the default driver for Docker volumes is the `local` driver, which on Linux accepts options similar to the [mount command](). Thanks to this, we are able to specify a list of driver options with `driver_opts` that mount the `views` directory on the host, which contains our application's static assets, to the volume at runtime. The directory contents can then be shared between containers. For more information about the contents of the `views` directory, please see [Step 2 of How To Build a Node.js Application with Docker]().

The `docker-compose.yml` file will look like this when finished:

```yaml
version: '3'

services:
  nodejs:
    build:
      context: .
      dockerfile: Dockerfile
    image: nodejs
    container_name: nodejs
    restart: unless-stopped
    networks:
      - app-network

  webserver:
```

```yaml
    image: nginx:mainline-alpine<^>
    container_name: webserver
    restart: unless-stopped
    ports:
      - "80:80"
    volumes:
      - web-root:/var/www/html
      - ./nginx-conf:/etc/nginx/conf.d
      - certbot-etc:/etc/letsencrypt
      - certbot-var:/var/lib/letsencrypt
    depends_on:
      - nodejs
    networks:
      - app-network

  certbot:
    image: certbot/certbot
    container_name: certbot
    volumes:
      - certbot-etc:/etc/letsencrypt
      - certbot-var:/var/lib/letsencrypt
      - web-root:/var/www/html
    depends_on:
      - webserver
    command: certonly --webroot --webroot-path=/var/www/html --email


volumes:

  certbot-etc:

  certbot-var:

  web-root:

    driver: local

    driver_opts:

      type: none

      device: /home/sammy/node_project/views/

      o: bind


networks:
```

```
  app-network:

    driver: bridge
```

With the service definitions in place, you are ready to start the containers and test your certificate requests.

Step 4 — Obtaining SSL Certificates and Credentials

We can start our containers with `docker-compose up`, which will create and run our containers and services in the order we have specified. If our domain requests are successful, we will see the correct exit status in our output and the right certificates mounted in the `/etc/letsencrypt/live` folder on the `webserver` container.

Create the services with `docker-compose up` and the `-d` flag, which will run the `nodejs` and `webserver` containers in the background:

```
docker-compose up -d
```

You will see output confirming that your services have been created:

Output

```
Creating nodejs ... done

Creating webserver ... done

Creating certbot   ... done
```

Using `docker-compose ps`, check the status of your services:

```
docker-compose ps
```

If everything was successful, your `nodejs` and `webserver` services should be `Up` and the `certbot` container will have exited with a `0` status message:

Output

```
 Name              Command                  State           Ports

-------------------------------------------------------------------
-----

certbot     certbot certonly --webroot ...   Exit 0

nodejs      node app.js                      Up        8080/tcp

webserver   nginx -g daemon off;             Up        0.0.0.0:80-
>80/tcp
```

If you see anything other than `Up` in the `State` column for the `nodejs` and `webserver` services, or an exit status other than `0` for the `certbot` container, be sure to check the service logs with the [docker-compose logs](#) command:

```
docker-compose logs service_name
```

You can now check that your credentials have been mounted to the `webserver` container with [docker-compose exec](#):

```
docker-compose exec webserver ls -la
/etc/letsencrypt/live
```

If your request was successful, you will see output like this:

Output

```
total 16

drwx------ 3 root root 4096 Dec 23 16:48 .

drwxr-xr-x 9 root root 4096 Dec 23 16:48 ..

-rw-r--r-- 1 root root  740 Dec 23 16:48 README

drwxr-xr-x 2 root root 4096 Dec 23 16:48 example.com
```

Now that you know your request will be successful, you can edit the `certbot` service definition to remove the `--staging` flag.

Open `docker-compose.yml`:

```
nano docker-compose.yml
```

Find the section of the file with the `certbot` service definition, and replace the `--staging` flag in the `command` option with the `--force-renewal` flag, which will tell Certbot that you want to request a new certificate with the same domains as an existing certificate. The `certbot` service definition should now look like this:

```
...
  certbot:
    image: certbot/certbot
    container_name: certbot
    volumes:
      - certbot-etc:/etc/letsencrypt
      - certbot-var:/var/lib/letsencrypt
      - web-root:/var/www/html
    depends_on:
      - webserver
    command: certonly --webroot --webroot-path=/var/www/html --
email sammy@example.com --agree-tos --no-eff-email --force-renewal
-d example.com -d www.example.com
...
```

You can now run `docker-compose up` to recreate the `certbot` container and its relevant volumes. We will also include the `--no-deps` option to tell Compose that it can skip starting the `webserver` service, since it is already running:

```
docker-compose up --force-recreate --no-deps
certbot
```

You will see output indicating that your certificate request was successful:

Output

```
certbot      | IMPORTANT NOTES:

certbot      | - Congratulations! Your certificate and chain have
been saved at:

certbot      |    /etc/letsencrypt/live/example.com/fullchain.pem

certbot      |    Your key file has been saved at:

certbot      |    /etc/letsencrypt/live/example.com/privkey.pem

certbot      |    Your cert will expire on 2019-03-26. To obtain a
new or tweaked

certbot      |    version of this certificate in the future, simply
run certbot

certbot      |    again. To non-interactively renew *all* of your
certificates, run

certbot      |    "certbot renew"

certbot      | - Your account credentials have been saved in your
Certbot

certbot      |    configuration directory at /etc/letsencrypt. You
should make a

certbot      |    secure backup of this folder now. This
configuration directory will

certbot      |    also contain certificates and private keys
obtained by Certbot so

certbot      |    making regular backups of this folder is ideal.

certbot      | - If you like Certbot, please consider supporting
our work by:

certbot      |
```

```
certbot        |        Donating to ISRG / Let's Encrypt:
https://letsencrypt.org/donate
certbot        |        Donating to EFF:
https://eff.org/donate-le
certbot        |
certbot exited with code 0
```

With your certificates in place, you can move on to modifying your Nginx configuration to include SSL.

Step 5 — Modifying the Web Server Configuration and Service Definition

Enabling SSL in our Nginx configuration will involve adding an HTTP redirect to HTTPS and specifying our SSL certificate and key locations. It will also involve specifying our Diffie-Hellman group, which we will use for [Perfect Forward Secrecy](#).

Since you are going to recreate the `webserver` service to include these additions, you can stop it now:

```
docker-compose stop webserver
```

Next, create a directory in your current project directory for your Diffie-Hellman key:

```
mkdir dhparam
```

Generate your key with the [openssl command](#):

```
sudo openssl dhparam -out
/home/sammy/node_project/dhparam/dhparam-2048.pem
2048
```

It will take a few moments to generate the key.

To add the relevant Diffie-Hellman and SSL information to your Nginx configuration, first remove the Nginx configuration file you created earlier:

```
rm nginx-conf/nginx.conf
```

Open another version of the file:

```
nano nginx-conf/nginx.conf
```

Add the following code to the file to redirect HTTP to HTTPS and to add SSL credentials, protocols, and security headers. Remember to replace **example.com** with your own domain:

```
server {

        listen 80;

        listen [::]:80;

        server_name example.com www.example.com;


        location ~ /.well-known/acme-challenge {

          allow all;

          root /var/www/html;

        }


        location / {

                rewrite ^ https://$host$request_uri? permanent;

        }

}


server {

        listen 443 ssl http2;

        listen [::]:443 ssl http2;

        server_name example.com www.example.com;


        server_tokens off;


        ssl_certificate
/etc/letsencrypt/live/example.com/fullchain.pem;
```

```
        ssl_certificate_key
/etc/letsencrypt/live/example.com/privkey.pem;


        ssl_buffer_size 8k;


        ssl_dhparam /etc/ssl/certs/dhparam-2048.pem;


        ssl_protocols TLSv1.2 TLSv1.1 TLSv1;

        ssl_prefer_server_ciphers on;


        ssl_ciphers
ECDH+AESGCM:ECDH+AES256:ECDH+AES128:DH+3DES:!ADH:!AECDH:!MD5;


        ssl_ecdh_curve secp384r1;

        ssl_session_tickets off;


        ssl_stapling on;

        ssl_stapling_verify on;

        resolver 8.8.8.8;


        location / {

                try_files $uri @nodejs;

        }


        location @nodejs {

                proxy_pass http://nodejs:8080;
```

```
            add_header X-Frame-Options "SAMEORIGIN" always;

            add_header X-XSS-Protection "1; mode=block" always;

            add_header X-Content-Type-Options "nosniff" always;

            add_header Referrer-Policy "no-referrer-when-
downgrade" always;

            add_header Content-Security-Policy "default-src *
data: 'unsafe-eval' 'unsafe-inline'" always;

            # add_header Strict-Transport-Security "max-
age=31536000; includeSubDomains; preload" always;

            # enable strict transport security only if you
understand the implications
      }


      root /var/www/html;

      index index.html index.htm index.nginx-debian.html;
}
```

The HTTP server block specifies the webroot for Certbot renewal requests to the `.well-known/acme-challenge` directory. It also includes a [rewrite directive](#) that directs HTTP requests to the root directory to HTTPS.

The HTTPS server block enables `ssl` and `http2`. To read more about how HTTP/2 iterates on HTTP protocols and the benefits it can have for website performance, please see the introduction to [How To Set Up Nginx with HTTP/2 Support on Ubuntu 18.04](#). This block also includes a series of options to ensure that you are using the most up-to-date SSL protocols and ciphers and that OSCP stapling is turned on. OSCP stapling allows you to

offer a time-stamped response from your [certificate authority](#) during the initial [TLS handshake](#), which can speed up the authentication process.

The block also specifies your SSL and Diffie-Hellman credentials and key locations.

Finally, we've moved the proxy pass information to this block, including a location block with a [`try_files`](#) directive, pointing requests to our aliased Node.js application container, and a location block for that alias, which includes security headers that will enable us to get A ratings on things like the [SSL Labs](#) and [Security Headers](#) server test sites. These headers include [`X-Frame-Options`](#), [`X-Content-Type-Options`](#), [`Referrer Policy`](#), [`Content-Security-Policy`](#), and [`X-XSS-Protection`](#). The [`HTTP Strict Transport Security`](#) (HSTS) header is commented out — enable this only if you understand the implications and have assessed its ["preload" functionality](#).

Once you have finished editing, save and close the file.

Before recreating the `webserver` service, you will need to add a few things to the service definition in your `docker-compose.yml` file, including relevant port information for HTTPS and a Diffie-Hellman volume definition.

Open the file:

```
nano docker-compose.yml
```

In the `webserver` service definition, add the following port mapping and the `dhparam` named volume:

```
...

  webserver:

    image: nginx:latest

    container_name: webserver

    restart: unless-stopped

    ports:

      - "80:80"

      - "443:443"

    volumes:

      - web-root:/var/www/html

      - ./nginx-conf:/etc/nginx/conf.d

      - certbot-etc:/etc/letsencrypt

      - certbot-var:/var/lib/letsencrypt

      - dhparam:/etc/ssl/certs

    depends_on:

      - nodejs

    networks:

      - app-network
```

Next, add the dhparam volume to your volumes definitions:

```
...

volumes:

  ...

  dhparam:

    driver: local

    driver_opts:

      type: none

      device: /home/sammy/node_project/dhparam/

      o: bind
```

Similarly to the `web-root` volume, the `dhparam` volume will mount the Diffie-Hellman key stored on the host to the `webserver` container.

Save and close the file when you are finished editing.

Recreate the `webserver` service:

```
docker-compose up -d --force-recreate --no-deps webserver
```

Check your services with `docker-compose ps`:

```
docker-compose ps
```

You should see output indicating that your `nodejs` and `webserver` services are running:

Output

```
 Name              Command                  State
Ports
------------------------------------------------------------------
-------------------------
certbot     certbot certonly --webroot ...   Exit 0
nodejs      node app.js                      Up        8080/tcp
webserver   nginx -g daemon off;             Up        0.0.0.0:443-
>443/tcp, 0.0.0.0:80->80/tcp
```

Finally, you can visit your domain to ensure that everything is working as expected. Navigate your browser to https://**example.com**, making sure to substitute **example.com** with your own domain name. You will see the following landing page:
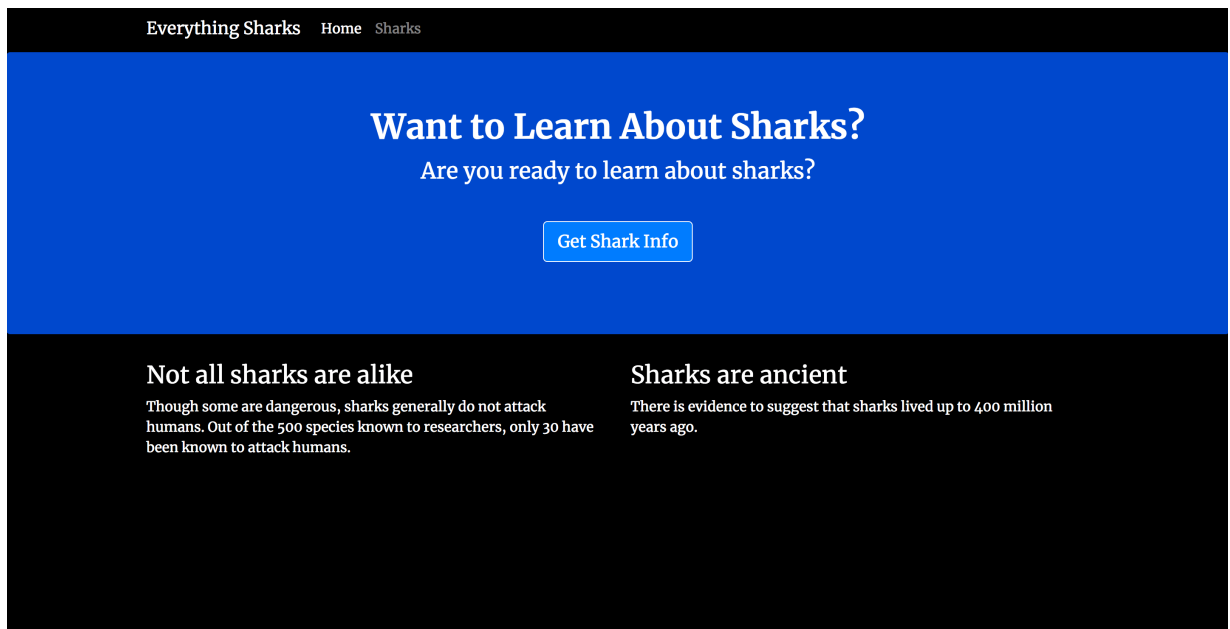
Application Landing Page

You should also see the lock icon in your browser's security indicator. If you would like, you can navigate to the [SSL Labs Server Test landing page](#) or the [Security Headers server test landing page](#). The configuration options we've included should earn your site an A rating on both.

Step 6 — Renewing Certificates

Let's Encrypt certificates are valid for 90 days, so you will want to set up an automated renewal process to ensure that they do not lapse. One way to do this is to create a job with the `cron` scheduling utility. In this case, we will schedule a `cron` job using a script that will renew our certificates and reload our Nginx configuration.

Open a script called `ssl_renew.sh` in your project directory:

`nano ssl_renew.sh`

Add the following code to the script to renew your certificates and reload your web server configuration:

~/node_project/ssl_renew.sh

```
#!/bin/bash


COMPOSE="/usr/local/bin/docker-compose --no-ansi"

DOCKER="/usr/bin/docker"


cd /home/<^>sammy<^>/<^>node_project<^>/

$COMPOSE run certbot renew --dry-run && $COMPOSE kill -s SIGHUP webs

$DOCKER system prune -af
```

This script first assigns the `docker-compose` binary to a variable called `COMPOSE`, and specifies the `--no-ansi` option, which will run `docker-compose` commands without [ANSI control characters](). It then does the same with the `docker` binary. Finally, it changes to the `~/node_project` directory and runs the following `docker-compose` commands: - `docker-compose run`: This will start a `certbot` container and override the `command` provided in our `certbot` service definition. Instead of using the `certonly` subcommand, we're using the `renew` subcommand here, which will renew certificates that are close to expiring. We've included the `--dry-run` option here to test our script. - [`docker-compose kill`](): This will send a [SIGHUP signal]() to the `webserver` container to reload the Nginx configuration. For more information on using this process to reload your Nginx configuration, please see [this Docker blog post on deploying the official Nginx image with Docker]().

It then runs [`docker system prune`]() to remove all unused containers and images.

Close the file when you are finished editing. Make it executable:

`chmod +x ssl_renew.sh`

Next, open your root `crontab` file to run the renewal script at a specified interval:

`sudo crontab -e`

If this is your first time editing this file, you will be asked to choose an editor:

crontab

```
no crontab for root - using an empty one

Select an editor.  To change later, run 'select-editor'.
  1. /bin/ed
  2. /bin/nano         <---- easiest
  3. /usr/bin/vim.basic
  4. /usr/bin/vim.tiny
Choose 1-4 [2]:
...
```

At the bottom of the file, add the following line:

crontab

```
...
*/5 * * * * /home/sammy/node_project/ssl_renew.sh >>
/var/log/cron.log 2>&1
```

This will set the job interval to every five minutes, so you can test whether or not your renewal request has worked as intended. We have also created a log file, `cron.log`, to record relevant output from the job.

After five minutes, check `cron.log` to see whether or not the renewal request has succeeded:

```
tail -f /var/log/cron.log
```

You should see output confirming a successful renewal:

Output

```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - -
** DRY RUN: simulating 'certbot renew' close to cert expiry
**          (The test certificates below have not been saved.)


Congratulations, all renewals succeeded. The following certs have
been renewed:
  /etc/letsencrypt/live/example.com/fullchain.pem (success)
** DRY RUN: simulating 'certbot renew' close to cert expiry
**          (The test certificates above have not been saved.)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - -
Killing webserver ... done
```

You can now modify the `crontab` file to set a daily interval. To run the script every day at noon, for example, you would modify the last line of the file to look like this:

crontab

```
...
0 12 * * * /home/sammy/node_project/ssl_renew.sh >>
/var/log/cron.log 2>&1
```

You will also want to remove the `--dry-run` option from your `ssl_renew.sh` script:

~/node_project/ssl_renew.sh

```bash
#!/bin/bash


COMPOSE="/usr/local/bin/docker-compose --no-ansi"
DOCKER="/usr/bin/docker"


cd /home/<^>sammy<^>/<^>node_project<^>/
$COMPOSE run certbot renew && $COMPOSE kill -s SIGHUP webserver
$DOCKER system prune -af
```

Your `cron` job will ensure that your Let's Encrypt certificates don't lapse by renewing them when they are eligible. You can also [set up log rotation with the Logrotate utility](#) to rotate and compress your log files.

Conclusion

You have used containers to set up and run a Node application with an Nginx reverse proxy. You have also secured SSL certificates for your application's domain and set up a `cron` job to renew these certificates when necessary.

If you are interested in learning more about Let's Encrypt plugins, please see our articles on using the [Nginx plugin](#) or the [standalone plugin](#).

You can also learn more about Docker Compose by looking at the following resources: - [How To Install Docker Compose on Ubuntu 18.04](#). - [How To Configure a Continuous Integration Testing Environment with Docker and Docker Compose on Ubuntu 16.04](#). - [How To Set Up Laravel, Nginx, and MySQL with Docker Compose](#).

The [Compose documentation](#) is also a great resource for learning more about multi-container applications.