International Institute of Information Technology, Bangalore
(IIIT Bangalore)

Software Production Engineering
Project Report

FinTrack - Shareable Investment Watchlists!

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1. Abstract

“Share your Investment Watchlists now!”

The youth of our country are getting more and more interested in the securities market. For a newbie, it would be more helpful if they can get an overview of the correct investments by looking at the watchlists of experienced players in the ring.

There is a need for a platform where users can share their investments easily with their friends or relatives.

Typically any investment or investment tracker platform only lets you create watchlists for your own account and not let them be shareable.

Fintrack is the exact solution for this.

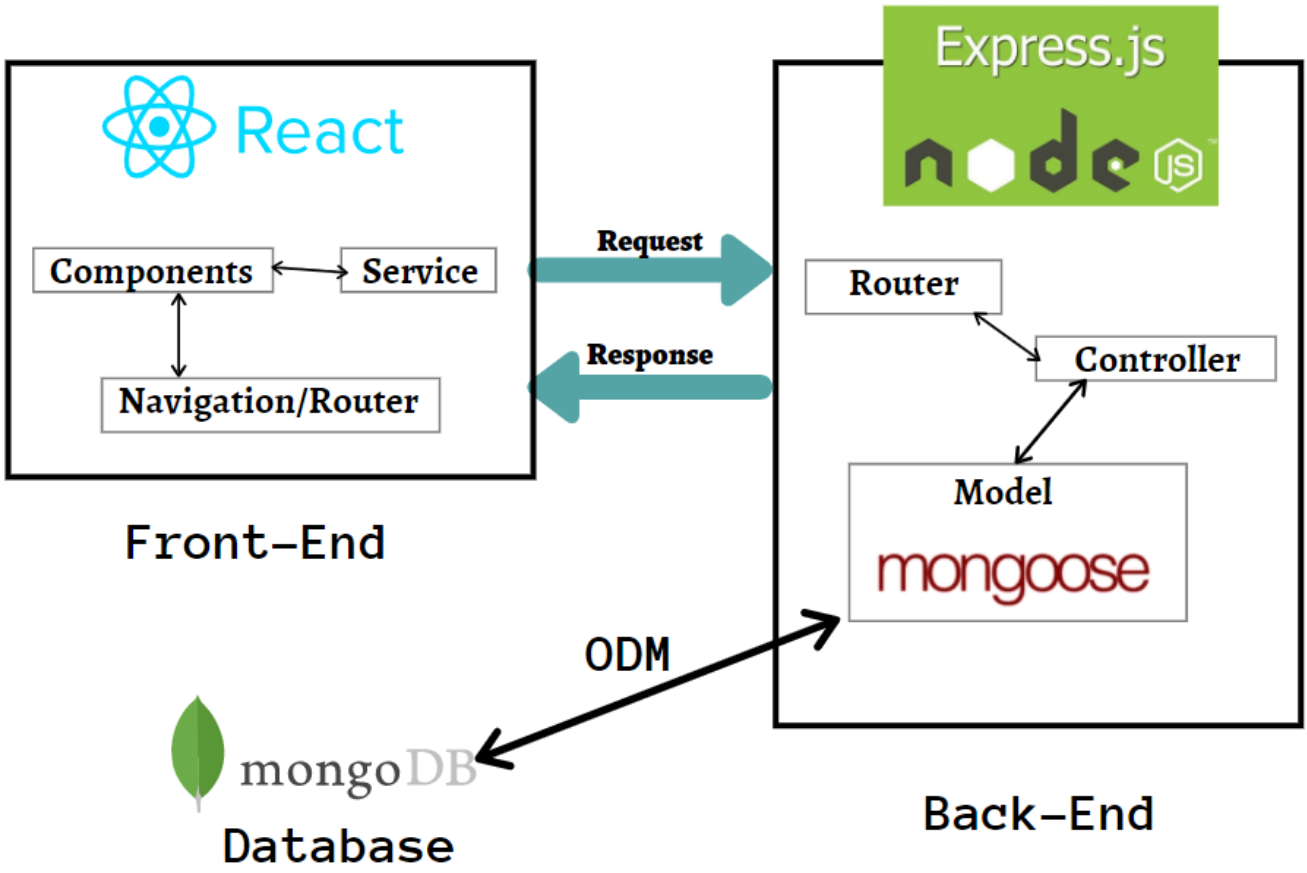
Here users can create their watchlists for stocks and mutual funds (MFs) as per their investments and share it with anyone they would want to - with ease!

2. Introduction

2.1. Overview

FinTrack is a website that allows users to create their watchlists for stocks and mutual funds (MFs) and share it anytime, anywhere and with anyone they would want to.

TechStack used → MERN (MongoDB, ExpressJS, ReactJS, NodeJS)



2.2. Features

a. Login/Signup
Account creation and login for users.

b. Home Page
Shows all the watchlists of the user.

c. Search Instruments
Search for stocks and mutual funds (MFs) on a search bar and add them to watchlists. A user can create multiple watchlists so there will be an option displayed to the user to determine which watchlist to add the current security to.

d. Create Watchlist
Users can create any number of watchlists they want with no duplicate entries. A watchlist can be a stock or MF watchlist but not both.

e. Share Watchlist
Each watchlist will have a share button that will send a publicly shareable link to anyone that visits that URL.

f. View Watchlist (Single Watchlist View)
This will show the specified watchlist's instruments. The view displayed when a user opens the shareable watchlist URL.

g. Delete Watchlist
Users can delete their watchlists anytime they want.

h. Delete Instrument
Delete a stock/MF from a Watchlist.

i. View live stock/mutual fund price → Each stock/MF has a URL to the TickerTape page for the corresponding stock/MF which will show the dynamic rate of change of stock/MF prices.

3. System Configuration

3.1. Host System Configuration

Operating System: 20.04.4 LTS (Focal Fossa)
CPU and RAM: 8 core processor with 16 GB RAM
Kernel Version: Linux version 5.13.0-40-generic

3.2. Project Technology Stack

Frontend: React (HTML, JSX, JavaScript, Bootstrap)
Backend: Express (NodeJS, JavaScript)
Database: MongoDB (No-SQL)
Cloud: MongoDB Atlas, Netlify, Heroku
Build Tool: npm

3.3. DevOps Tools

Source Control Management: Git/Github
Continuous Integration: Jenkins/Github Actions
Containerization: Docker/Docker Hub
Container Orchestration: Docker Compose
Testing: Supertest (Backend) + React Testing Library (Frontend)
Continuous Deployment: Ansible and/or Heroku & Netlify
Logger: Morgan
Monitoring: ELK Stack (Elastic Search, Logstash, Kibana)
Secrets Management: Ansible Vault

4. Software Development Life Cycle

4.1. Installations

React

React is a free and open-source front-end JavaScript library for building user interfaces based on UI components. It is maintained by Meta and a community of individual developers and companies.

Update local before installing:

Keep the local packages and softwares updated.

```
sudo apt-get update
```

Install NodeJS and NPM:

Inorder to run React, Node environment shall be installed before starting,

```
sudo apt-get install nodejs
sudo apt-get install npm
```

```
jasvin@jasvin-Bravo-15:~$ node -v
v16.13.2
jasvin@jasvin-Bravo-15:~$ npm -v
8.1.2
```

React App

```
npx create-react-app fintrack
```

```
jasvin@jasvin-Bravo-15:~/Work/MTech/SPE/FinTrack/frontend$ npm start

> fintrack@0.1.0 start
> react-scripts start
```

Express

Express.js, or simply Express, is a back end web application framework for Node.js, released as free and open-source software under the MIT License. It is designed for building web applications and APIs. It has been called the de facto standard server framework for Node.js.

Express App

Initializing node project with the default config:

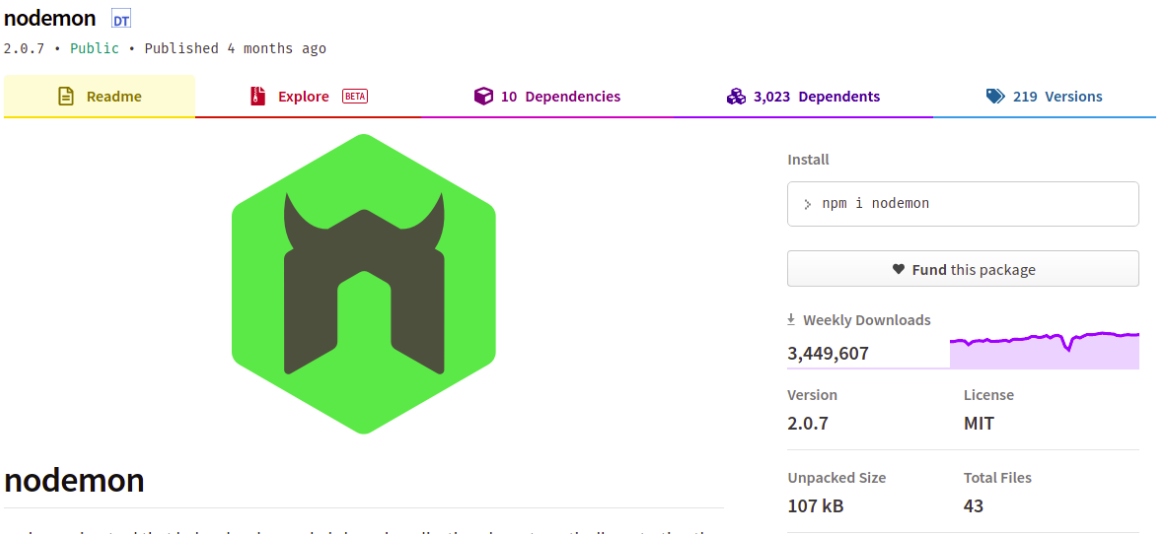
```
npm init -y
```

-y automates the config with node default values i.e without going through the interactive process.

Running the Node Application locally:

```
node server.js
```

Running the Node Application locally with nodemon:



Nodemon automatically restarts the node application whenever a file change in the directory is detected.

```
npm install nodemon
nodemon server.js
```

The server is setup to run on localhost:3001

```
jasvin@jasvin-Bravo-15:~/Work/MTech/SPE/FinTrack/backend$ npm run dev

> fintrack@1.0.0 dev
> NODE_ENV=development nodemon index.js

[nodemon] 2.0.15
[nodemon] to restart at any time, enter `rs`
[nodemon] watching path(s): *.*
[nodemon] watching extensions: js,mjs,json
[nodemon] starting `node index.js`
Server running on port 3001
Successfully connected to MongoDB
```

4.2. Testing

4.2.1. Backend Testing (Supertest)

Supertest provides a high-level abstraction for testing HTTP, while still allowing you to drop down to the lower-level API provided by superagent.

Here is a snippet of how to write tests with Supertest, in this case, we are testing the */users/* API. Similarly we have tested the */watchlists* and */watchlistInstruments* APIs.

```
const mongoose = require('mongoose')
const supertest = require('supertest')
const app = require('../app')
const User = require('../models/user')
const api = supertest(app)
const helper = require('./tests_helper')

beforeEach(async () => {
  // Increasing timeout otherwise sometimes a timeout error can wreck the whole testing phase
  jest.setTimeout(30000)

  await User.deleteMany({})
  await User.insertMany(helper.initialUsers)
})

describe('adding a new user', () => {
  test('valid user is added succesfully', async () => {
    const user = {
      'username': 'murray',
      'name': 'James Murray',
      'password': '123456'
    }

    await api
      .post('/api/users')
      .send(user)
      .expect(201)
      .expect('Content-Type', /application\/json/)

    const users = await helper.usersInDb()
    expect(users).toHaveLength(helper.initialUsers.length + 1)

    const usernames = users.map(user => user.username)
    expect(usernames).toContain('murray')
  })
```

Note that these files must have the extension *.test.js* in order for Jest to pick up these files as testing files. After this you can run the tests by running the command *npm run test*

```
jasvin@jasvin-Bravo-15:~/Work/MTech/SPE/FinTrack/backend$ npm run test

> fintrack@1.0.0 test
> NODE_ENV=local-test jest --verbose --runInBand

 PASS  tests/watchlist_instruments_api.test.js (14.453 s)
  viewing a watchlist's instruments
    ✓ watchlistInstrument object has id property instead of _id (2986 ms)
    ✓ total instruments contained are 1 (836 ms)
    ✓ cannot view watchlists without bearer token (807 ms)
  adding a watchlist instrument
    ✓ new watchlist instrument is created successfully (1050 ms)
    ✓ watchlist instrument with missing instrumentId gets 400 response (796 ms)
    ✓ stock instrument cannot be added to mf watchlist (810 ms)
    ✓ mf instrument cannot be added to stock watchlist (804 ms)
    ✓ cannot add same instrument twice in the same watchlist (787 ms)
  deleting a watchlist instrument
    ✓ existing watchlist instrument is deleted successfully (880 ms)
    ✓ non-existing watchlist returns 404 (928 ms)
  deleting all instruments of a watchlist
    ✓ deletion happens successfully (867 ms)
    ✓ non-existing watchlist returns 404 (837 ms)

 PASS  tests/watchlists_api.test.js (9.024 s)
  viewing a user's watchlists
    ✓ watchlist object has id property instead of _id (1707 ms)
    ✓ total watchlists contained are 4 (623 ms)
    ✓ cannot view watchlists without bearer token (593 ms)
  viewing a single watchlist
    ✓ existing watchlist can be viewed successfully (645 ms)
    ✓ existing watchlist cannot be viewed without bearer token (592 ms)
    ✓ non-existing watchlist returns 404 (686 ms)
  adding a watchlist
    ✓ new watchlist is created successfully (682 ms)
    ✓ watchlist object with missing name gets 400 response (646 ms)
    ✓ watchlist object with missing isMF parameter gets 400 response (630 ms)
  deleting a watchlist
    ✓ existing watchlist is deleted successfully (734 ms)
    ✓ non-existing watchlist returns 404 (677 ms)
```

For backend testing we have created a testing database on MongoDB Atlas which has its own URI separate from the production database. This ensures that testing doesn't interfere with the production database at any point in time and we can do operations like deleting entire entries from collections in the testing database in order to maintain consistency between tests.

4.2.2. Frontend Testing (React Testing Library)

The React Testing Library is a very light-weight solution for testing React components. It provides light utility functions on top of react-dom and react-dom/test-utils, in a way that encourages better testing practices. Its primary guiding principle is:

> “The more your tests resemble the way your software is used, the more confidence they can give you.”

So rather than dealing with instances of rendered React components, your tests will work with actual DOM nodes. The utilities this library provides facilitate querying the DOM in the same way the user would. Finding form elements by their label text (just like a user would), finding links and buttons from their text (like a user would). It also exposes a recommended way to find elements by a data-testid as an "escape hatch" for elements where the text content and label do not make sense or are not practical.

Here is how we have tested the WatchlistForm component with just the frontend, no backend involved.

```
import React from 'react'
import '@testing-library/jest-dom/extend-expect'
import userEvent from "@testing-library/user-event";
import { render, fireEvent, screen } from '@testing-library/react'
import WatchlistForm from './WatchlistForm'

describe('<WatchlistForm/>', () => {
  const createWatchlist = jest.fn()

  test('watchlist form submission simulated successfully', () => {
    render(<WatchlistForm createWatchlist={createWatchlist} />)

    const watchlistNameInput = screen.getByLabelText('Watchlist Name:')
    const isMFInput = screen.getByTestId('mf-radio-button')

    const form = screen.getByTestId('watchlist-form')

    fireEvent.change(watchlistNameInput, {
      target: {
        value: 'Joe Mama'
      }
    })

    userEvent.click(isMFInput)

    fireEvent.submit(form)

    expect(createWatchlist.mock.calls).toHaveLength(1)

    expect(createWatchlist.mock.calls[0][0].name).toBe('Joe Mama')
    expect(createWatchlist.mock.calls[0][0].isMF).toBe(true)
  })
})
```

We run these tests using the *npm run test* command as well,

```
PASS src/components/Watchlist.test.js
PASS src/components/WatchlistForm.test.js

Test Suites: 2 passed, 2 total
Tests:       3 passed, 3 total
Snapshots:   0 total
Time:        2.457 s, estimated 3 s
Ran all test suites.

Watch Usage: Press w to show more.
```

4.3. Source Control Management (SCM)

Source Control Management is used for tracking the file change history, source code, etc. It helps us in many ways in keeping the running project in a structured and organized way.

Repository Link: https://github.com/james-jasvin/FinTrack
The frontend is created in the *frontend/* directory and the backend is created in the *backend/* directory.

Initializing the project with git:

```
git init
git remote add origin https://github.com/james-jasvin/FinTrack.git
```

Workflow:

```
git add <files>
git commit -m "commit message"
git pull origin master
git push origin master
```

The code is first pulled before making a push to make sure that our project is in the latest stage and to avoid merge conflicts. For the above, the pull and push is done on the “master” branch.

Working on a feature/issue:

```
git checkout master
git checkout -b "<your_branch_name>"
```

After creating a branch, required changes are done and a pull request to the main is created.

```
git add <files>
git commit -m "commit message"
git pull origin master
git push origin master
```

Then merge the pull request from Github.

4.4. Containerization with Docker

Docker is an open platform for developing, shipping, and running applications. Docker enables you to separate your applications from your infrastructure so you can deliver software quickly.

With Docker, you can manage your infrastructure in the same ways you manage your applications. By taking advantage of Docker's methodologies for shipping, testing, and deploying code quickly, you can significantly reduce the delay between writing code and running it in production.

Docker builds images automatically by reading the instructions from a Dockerfile -- a text file that contains all commands, in order, needed to build a given image. A Dockerfile adheres to a specific format and set of instructions which you can find at Dockerfile reference.

Frontend Dockerfile

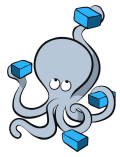
```
# Dockerfile for React client

# Use node's alpine variant to save on space and version number is 17 (latest)
FROM node:17-alpine

# Create the folder "app" under the /usr/src path and set it to be the working directory
# for the further COPY, RUN and CMD instructions
WORKDIR /usr/src/app

# Copy the package.json and package-lock.json files to the "app" folder
COPY package*.json ./

# Install the dependencies mentioned in package.json
RUN npm install

# Copy the local files to the "app" folder
COPY . .

# Expose port 3000 on the host machine to the container for listening to external connections
EXPOSE 3000

# Start the React applications
CMD ["npm", "start"]
```

Backend Dockerfile

```
# Dockerfile for Express Backend

# Use node's alpine variant to save on space and version number is 17 (latest)
FROM node:17-alpine

# Create the folder "app" under the /usr/src path and set it to be the working directory
# for the further COPY, RUN and CMD instructions
WORKDIR /usr/src/app

# Copy the package.json and package-lock.json files to the "app" folder
COPY ./package*.json ./

# Install the dependencies mentioned in package.json
RUN npm install

# Copy the local files to the "app" folder
COPY . .

# Expose port 3001 on the host machine to the container for listening to external connections
EXPOSE 3001

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

Running *docker build* using this Dockerfile as the source creates the required Docker image that is ready to run our application.

We need to build the Docker image and push it to Docker Hub which requires logging in to the DockerHub account as well.
This will be covered in the Continuous Integration section.



4.5. Docker Compose

Docker Compose is a tool that was developed to help define and share multi-container applications. With Compose, we can create a YAML file to define the services and with a single command, can spin everything up or tear it all down.

The big advantage of using Compose is you can define your application stack in a file, keep it at the root of your project repo (it's now version controlled), and easily enable someone else to contribute to your project. Someone would only need to clone your repo and start the Compose app.

On the host machine, follow the instruction of this link
https://docs.docker.com/compose/install/

After installation, you should be able to run the following and see version information.

```
docker-compose version
```

Compose File

At the root of the app project, create a file named *docker-compose.yml*

You can look at the Compose file reference for Compose file syntax and features.
https://docs.docker.com/compose/compose-file/
Note: *"version"* parameter is not required in Docker Compose YAML files since version 1.27.

Next, we'll define the list of services (or containers) we want to run as part of our application.

Create two containers for running the app, one for the frontend and one for the backend.

Map port 3000 on the host machine to port 3000 on the frontend container because that's where React runs and do the same with the backend but with port 3001 because we've configured the Express app to listen on port 3001.

Attach both containers to the same network which is named *fintrack*, this enables the frontend container to communicate with the backend container and vice-versa. We fix

the subnet of the *fintrack* network and then apply static IP addresses to both the frontend and backend containers. Because of the static IP addresses, the frontend can fire queries to the backend using a fixed backend URL.

The reason for using a Docker volume is already specified in the code itself.

```yaml
services:
  fintrack-frontend:
    image: jasvinjames/fintrack-frontend:latest
    container_name: fintrack-frontend
    # Keep stdin_open because we don't want this container to exit immediately which it
    # otherwise would have because there's no foreground processes
    stdin_open: true
    ports:
      - "3000:3000"
    networks:
      fintrack:
        ipv4_address: 172.28.1.6

  fintrack-backend:
    image: jasvinjames/fintrack-backend:latest
    container_name: fintrack-backend
    ports:
      - "3001:3001"
    networks:
      fintrack:
        ipv4_address: 172.28.1.7
    # Using Docker volume for persisting logs
    # ./backend/logs refers to the path /home/backend/logs on the host machine
    # and we're linking it to logs folder on the container machine where Morgan logger logs its output
    volumes:
      - ./backend/logs:/usr/src/app/logs/

networks:
  fintrack:
    ipam:
      driver: default
      config:
      - subnet: 172.28.1.0/24
```

4.6. Ansible

Ansible is an open-source automation tool, or platform, used for IT tasks such as configuration management, application deployment, intraservice orchestration and provisioning.

Ansible is mainly used to perform a lot of tasks that otherwise are time-consuming, complex, repetitive, and can make a lot of errors or issues.

Note: We are going to be pulling the Docker Hub image to the host system for Ansible deployment.

Creating Inventory file

The inventory file is used to specify the list of managed hosts/server machines.

The inventory file looks as,

```
<host-machine-IP-address> ansible_user=jasvin
```

jasvin is the host machine's user on which Ansible shall execute the specified commands.

Create this file in the root directory of your project repository with the name *inventory*.

Configuring OpenSSH Server

Install openssh-server on the host machine and because it is the Jenkins user that is going to be doing the pulling of Docker image, we need to SSH from the Jenkins user to the user that is specified in the inventory file, i.e. *jasvin*.

```
apt-get install openssh-server
service ssh restart
su jenkins
ssh-keygen -t rsa
ssh-copy-id <host-username>@<host-ip-address>
sudo chmod 666 /var/run/docker.sock
```

The *chmod* command is required so that the Jenkins user has access to the Docker socket for performing the docker build and push operations.

Because we use MongoDB Atlas for storing our database, we require the MongoDB URI in order to access the database and this URI should be kept secret. However we have to send this URI in a *.env* type of file to the backend container, how to do this and not leak the URI in any way? This is where Ansible Vault comes in the picture.

Ansible Vault

Ansible Vault is a feature of ansible that allows you to keep sensitive data such as passwords or keys in encrypted files, rather than as plaintext in playbooks or roles. These vault files can then be distributed or placed in source control.

First we have to encrypt the environment file using *ansible-vault*

```
jasvin@jasvin-Bravo-15:~/Work/MTech/SPE/FinTrack/backend$ ansible-vault encrypt env-local.yaml
New Vault password:
Confirm New Vault password:
Encryption successful
```

Command for decrypting the environment file using *ansible-vault*

```
jasvin@jasvin-Bravo-15:~/Work/MTech/SPE/FinTrack/backend$ ansible-vault decrypt env-local.yaml
Vault password:
Decryption successful
```

Encrypted YAML file

```
$ANSIBLE_VAULT;1.1;AES256
396430613335303138383962376536383633303430393732336362316663643666334338323661
363263323466383531303263336333263373961376536616 40a6630326434326265323331383661 34
366562653038353635383334343933316432366636637306630373961316630646236306332353261
313364316662313365 0a3634353761656437633836386665326638376231343931393436363536 61
393137343530663661346464613861626136353535303364356632646436313733326339333337 30
663662343933653634613733366135376362383031313533363530393064343737633573264386 6
356665323161353439656161653834326134376465343736316263336533323439303263373865 64
623065633834656661363537323937653134316438326430303031633533633066656231663936 37
303537326435333433626163343433393765613234633562376262393463316166356432343366 31
653939353865313537326433655383933336363643431373235656131643331353536376265633 0
386561656531306433383334313037653039386138383239363937343666386639666338333461 65
303365373864643730313534373135333535633939383431366363633630666162333966333430 35
333635376536373664316135386461373634353337633131383134343656666343631313662646 137
316466646365383766376531366630353439336531333832643639633439653138343435643635 30
616637336435396433393138303835623865346162346139666235636433346437306363336236 38
333432316233616535316262363737346535663166643664346133353166616539353433646230 32
613731316432653331666139343034643331643265343636333337373238663832653534303730 37
306336623364306566396637383237303134313731346430376261316362633436633913533636 5
373231623162343964343134633439356637386432653965643062653563355313765363332666 335
643062356136613835366361646263653737316130646263653162333531393938656262353830 30
323830653734363636376534656132643438383133376537313962663837656337613335633962 61
303132333936616537616332333963303530632303562623962666539343663643837326337766 35
323731643535353563663656365636263346330623937626363646565613236643038616133373 5
306562343061366462343133363566396565313336646537346364333431393230303133646531 30
363031343234346638336662653032326564333436303336356130646533316138613262393038 32
663838616266333436333563333633616537356531396334353432636530656439333163313430 66
396366323563336530636635323637393463363166653535356665383037616165326661366236 36
626233373566343839396539333839623962656333466313862643765313737643165373439663 066
656234363364666434343535353930633663326632362306232623666633532623532616533386 1
376661663738366132653237313239633161303765306663731663865303563303732393932643 2
646333313761353838613734393766393238633036373837363964353163346235326130623363 33
613232643866636430626439613834366262363532656537313031633139306338353134333934 31
383231646631393238333362316434366333636231306331663165663335666534613563353534 31
636666626663643733616433366238343763631663731323037
```

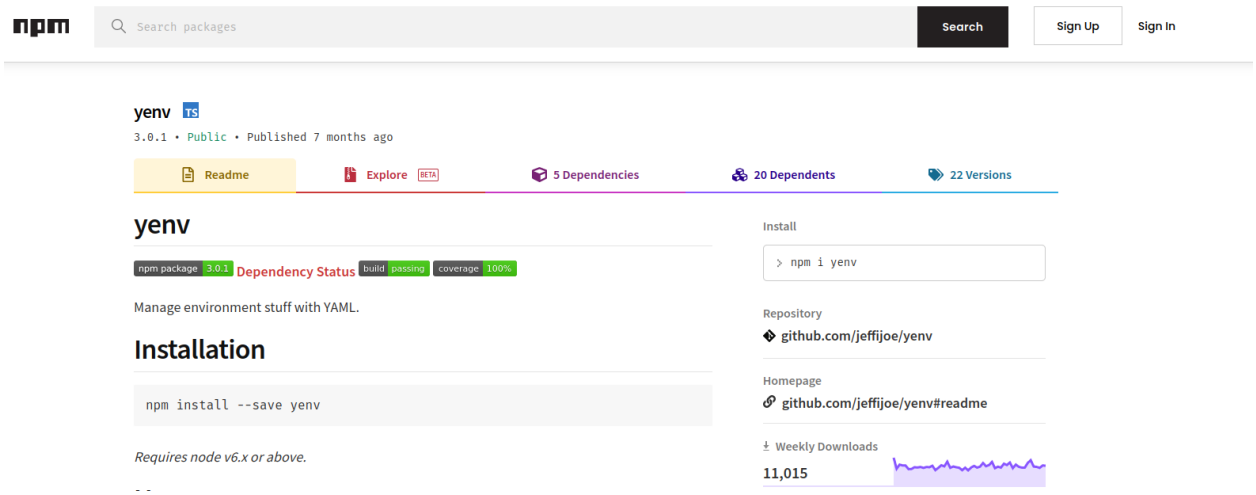
We are using yaml files for storing environment configuration instead of a *.env* file because Ansible Vault requires a yaml or JSON type file for encrypting and decrypting. This will become more clear when the playbook is explained.

Environment YAML decrypted

```yaml
production:
  PORT: '3001'
  MONGODB_URI: '<URI here>'
  SECRET: '<Secret here>'

local-test:
  PORT: '3001'
  MONGODB_URI: '<URI here>'
  SECRET: '<Secret here>'

development:
  PORT: '3001'
  MONGODB_URI: '<URI here>'
  SECRET: '<Secret here>'
```

The environment tags like production, local-test and development are what will be used to separate the environment variables from each other, because some values like URI will be different for production and testing environments and so on.

yenv library for reading environment variables,



Using the *yenv* library in the *config.js* file for setting up environment variables

```
const yenv = require('yenv')

let env = null

/*
* If production environment then use the env.yaml file (generated via Ansible Vault + Playbook)
* for the environment variables.
* If testing environment then use the env-enc.yaml file (which will be decrypted in the Jenkins pipeline).
* And if in development environment, use the env-local.yaml file.
*/
if (process.env.NODE_ENV == 'production')
  env = yenv()
else if (process.env.NODE_ENV == 'test')
  env = yenv('env-enc.yaml')
else if (process.env.NODE_ENV == 'production-heroku')
  env = process.env
else
  env = yenv('env-local.yaml')

const PORT = env.PORT
const MONGODB_URI = env.MONGODB_URI
const SECRET = env.SECRET

module.exports = { PORT, MONGODB_URI, SECRET }
```

Jinja2 Template that will be required for decrypting environment variables via Ansible Vault,

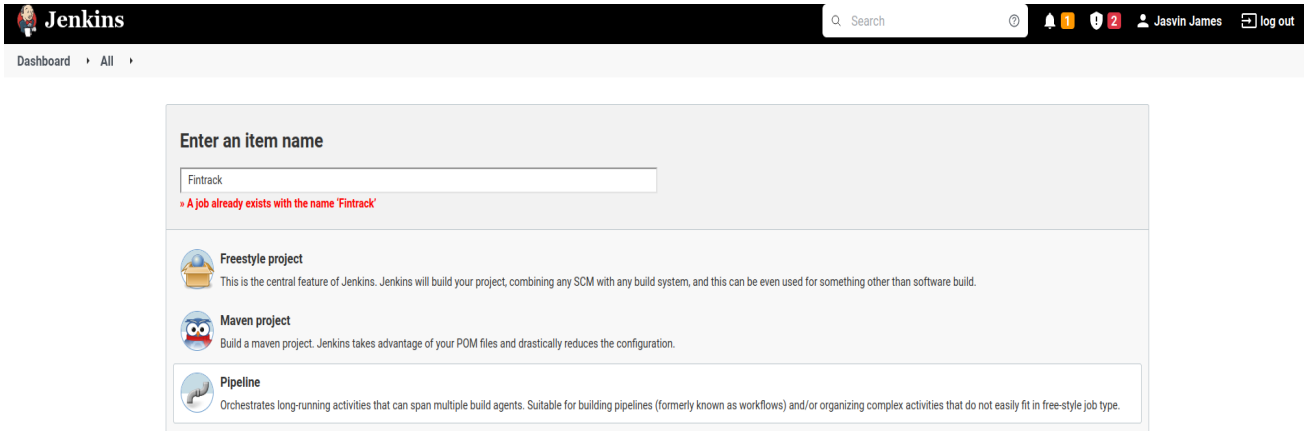
```
production:
  PORT: {{ production.PORT }}
  MONGODB_URI: {{ production.MONGODB_URI }}
  SECRET: {{ production.SECRET }}
```

The Ansible playbook will be explained after the next section.

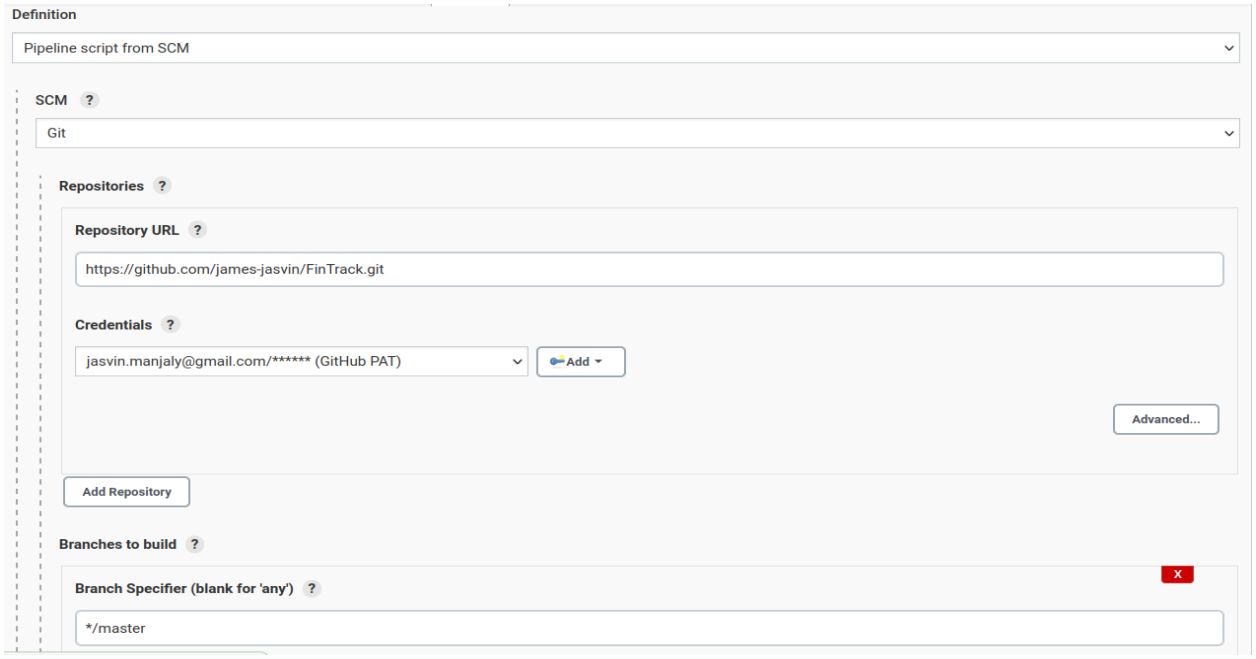
4.7. Continuous Integration: Jenkins

Jenkins is an open source automation server. It helps automate the parts of software development related to building, testing, and deploying, facilitating continuous integration and continuous delivery. It is a server-based system that runs in servlet containers such as Apache Tomcat.

Create a Jenkins Pipeline project,



Reading Jenkins pipeline script, *Jenkinsfile* from the SCM repository

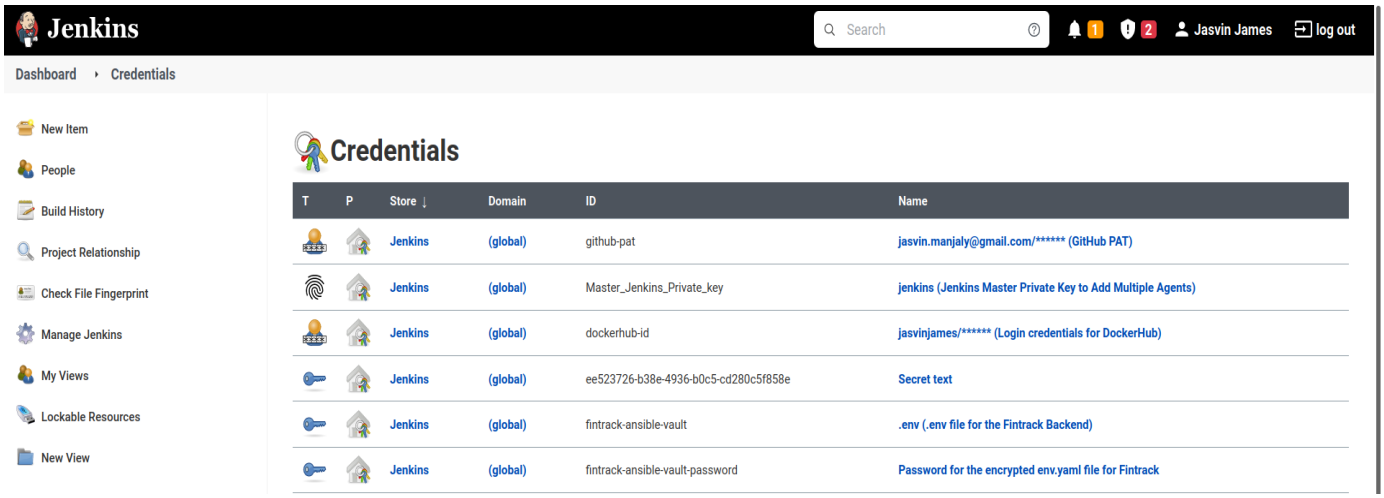


Credentials & Jenkins

Github PAT: For accessing private Github repositories.

Docker Hub Credentials: For logging into Docker Hub account and pushing Docker images (it is preferred to use Access Token instead of your actual Docker Hub password).

Ansible Vault Password: Save the password that was used to encrypt the *env-enc.yaml* file as a *Secret Text* credential on Jenkins.



Pipeline Script

First we set up the environment variables which includes importing the Docker Hub and Ansible Vault passwords as credentials.

```
pipeline {
    // Declare variables that will be used by the later stages
    environment {
      DOCKERHUB_REGISTRY = "jasvinjames/fintrack"
      DOCKERHUB_CREDENTIALS = credentials('dockerhub-id')
      ANSIBLE_VAULT_CREDENTIALS = credentials('fintrack-ansible-vault-password')
    }

    agent any
```

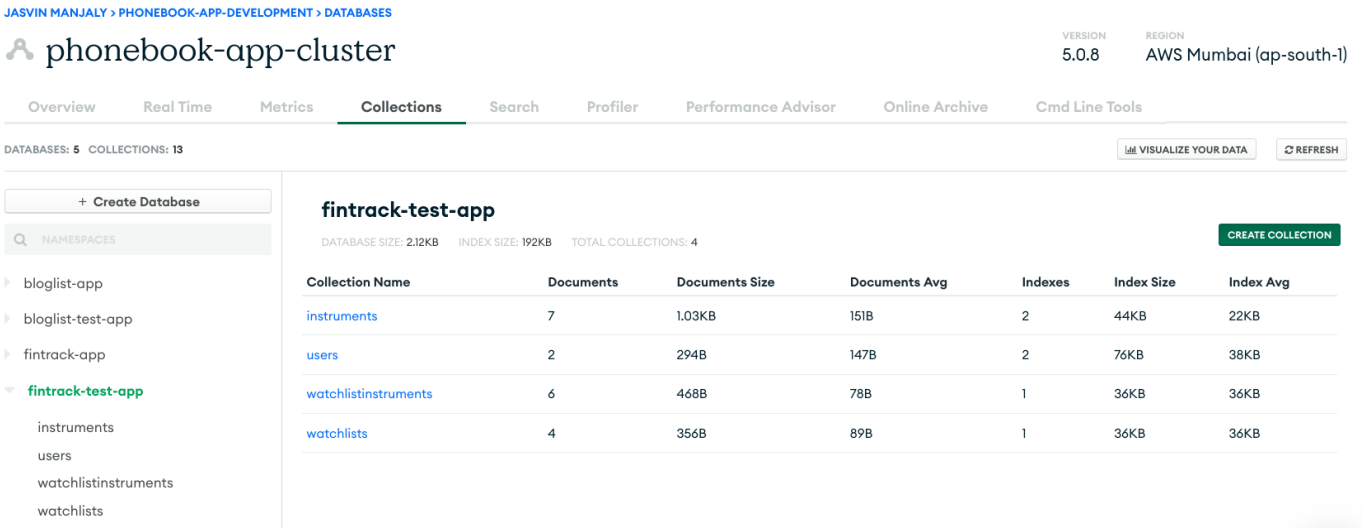
Then we perform a Git pull on the repository's master branch with the Github PAT as the *credentialsId*.

```
stages {

  stage('Git Pull') {
    steps {
      // credentials are required because its a private repository
      git url: 'https://github.com/james-jasvin/FinTrack.git',
      branch: 'master',
      credentialsId: 'github-pat'
    }
  }
```

After this we run the frontend testing which is done via the React Testing Library and for this we use a multi-line shell script (triple quoted string) in which we *cd* to the *frontend* directory, install all the dependencies and run the tests.

```
stage ('Running React Tests (Jest)') {
  steps {
    sh '''
      cd frontend
      npm ci
      npm run test
    '''
  }
}
```

Now we run backend testing via the Supertest library. An important point to note here is that we need to connect to the MongoDB Atlas cluster in order to access the database while testing. So we have set up a separate database in the same collection for testing.



But a big problem now is that we have encrypted the yaml file which contains this testing database's URI, so what to do?

We decrypt the *env-enc.yaml* file using the Ansible Vault password which we have saved as a credential in Jenkins, store it in a file called *secret.txt*, run the backend tests, encrypt the file once again using the *secret.txt* file and now delete the *secret.txt* file if it exists.

```
stage ('Running API Tests (Supertest)') {
  steps {
    sh '''
        cd backend
        echo $ANSIBLE_VAULT_CREDENTIALS > secret.txt
        ansible-vault decrypt env-enc.yaml --vault-password-file secret.txt
        npm ci
        npm run test
        ansible-vault encrypt env-enc.yaml --vault-password-file secret.txt
        if [ -f secret.txt ] ; then
          rm secret.txt
        fi
    '''
  }
}
```

After this we build the Docker images, push them to Docker Hub and remove the local Docker images.

```
stage('Build Fintrack Backend Docker Image') {
  steps {
    sh "docker build -t $DOCKERHUB_REGISTRY-backend:latest backend/"
  }
}

stage('Build Fintrack Frontend Docker Image') {
  steps {
    sh "docker build -t $DOCKERHUB_REGISTRY-frontend:latest frontend/"
  }
}

stage('Login to Docker Hub') {
  steps {
    sh "echo $DOCKERHUB_CREDENTIALS_PSW | docker login -u $DOCKERHUB_CREDENTIALS_USR --password-stdin"
  }
}

stage('Push Backend Docker Image to Docker Hub') {
  steps {
    sh "docker push $DOCKERHUB_REGISTRY-backend:latest"
  }
}

stage('Push Frontend Docker Image to Docker Hub') {
  steps {
    sh "docker push $DOCKERHUB_REGISTRY-frontend:latest"
  }
}

stage('Removing Docker Images from Local') {
  steps {
    sh "docker rmi $DOCKERHUB_REGISTRY-frontend:latest"
    sh "docker rmi $DOCKERHUB_REGISTRY-backend:latest"
  }
}
```

Now we finally call the Ansible playbook, note that we also supply the Ansible Vault password to it.

```
// Ansible Deploy to remote server (managed host)
stage('Ansible Deploy') {
  steps {
    ansiblePlaybook becomeUser: 'null',
    colorized: true,
    installation: 'Ansible',
    inventory: 'inventory',
    playbook: 'ansible-playbook.yml',
    sudoUser: 'null',
    vaultCredentialsId: 'fintrack-ansible-vault-password'
  }
}
```

4.8. Ansible Playbook

The main purpose of creating playbooks is that it encapsulates all the tasks under one playbook file.

In this playbook, the toughest task is to use the encrypted *env-enc.yaml* file and decrypt it somehow to send to the managed nodes and somehow place it inside the running container.

That is why we use the *vars_files* module with the Ansible playbook. We specify the *env-enc.yaml* as the file to look for and because Jenkins invoked the Ansible playbook with the Vault credentials, the file will now be decrypted for direct use but we cannot copy this file into the Docker container, which is why we use templating and this is where that *env.j2* template comes into the picture.

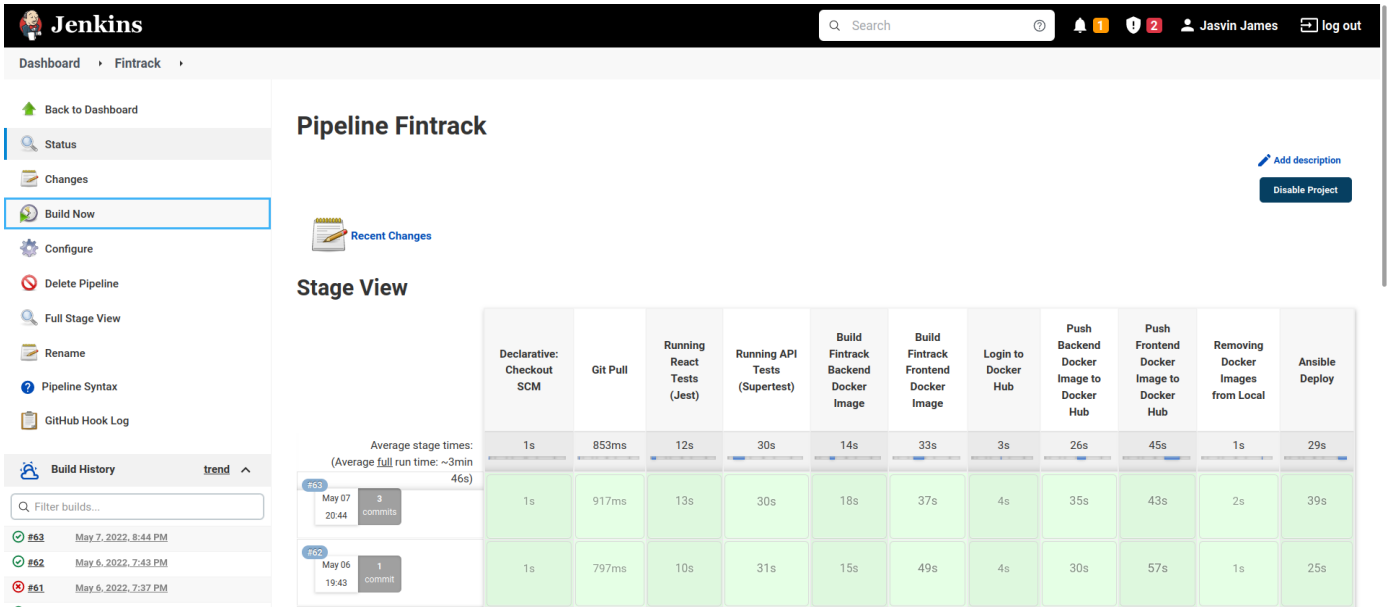
The *backend/env.j2* file which contains Jinja2 template variables will now be replaced by the decrypted environment variables in *env-enc.yaml* and we use the template module to store the created file under the name, *env.yaml* under the root directory of the managed nodes.

Now all we have to do is copy this *env.yaml* file into the backend container.

Everything else is explained in the comments of the playbook whose image is attached below.

```yaml
---
- name: Deploy Docker Images
  hosts: all
  vars_files:
  - ./backend/env-enc.yaml
  tasks:
    - name: Copy Docker Compose file from host machine to remote host
      copy:
        src: ./docker-compose.yml
        dest: ./

    - name: Replace Jinja2 template with decrypted environment variables into env.yaml file
      template:
        src: backend/env.j2
        dest: env.yaml

    # Pull the Docker images from Docker Hub
    - name: Pull the Docker images specifed in docker-compose
      command: docker-compose pull

    # We don't start the containers because we need to copy the env.yaml file into the backend container
    # before we can start anything.
    # So we first create the containers so that the next command "docker cp" can run properly
    - name: Create containers for the pulled Docker images
      command: docker-compose up --no-start

    - name: Copy the env.yaml file to backend Docker container
      command: docker cp env.yaml fintrack-backend:/usr/src/app/env.yaml

    # Now we actually run the Docker containers because the env.yaml has been copied and the app will no longer crash
    # Detached mode is required, otherwise Jenkins build never exits
    # even though the docker-compose up command has successfully executed
    - name: Run the pulled Docker images in detached mode
      command: docker-compose up -d

    # This is added so that the Docker images of the previous builds
    # which will now become dangling images are removed
    - name: Prune the dangling Docker images
      command: docker image prune --force
```

Running Jenkins build,



Running Docker containers after build,

```
jasvin@jasvin-Bravo-15:~$ docker container ls
CONTAINER ID   IMAGE                                COMMAND                  CREATED         STATUS         PORTS                                            NAMES
3edcdc2b22b9   jasvinjames/fintrack-backend:latest   "docker-entrypoint.s…"   8 minutes ago   Up 8 minutes   0.0.0.0:3001->3001/tcp, :::3001->3001/tcp        fintrack-backend
0fb2de566d3f   jasvinjames/fintrack-frontend:latest  "docker-entrypoint.s…"   8 minutes ago   Up 8 minutes   0.0.0.0:3000->3000/tcp, :::3000->3000/tcp        fintrack-frontend
jasvin@jasvin-Bravo-15:~$
```

4.9. PaaS Deployment with Netlify & Heroku & Github Actions

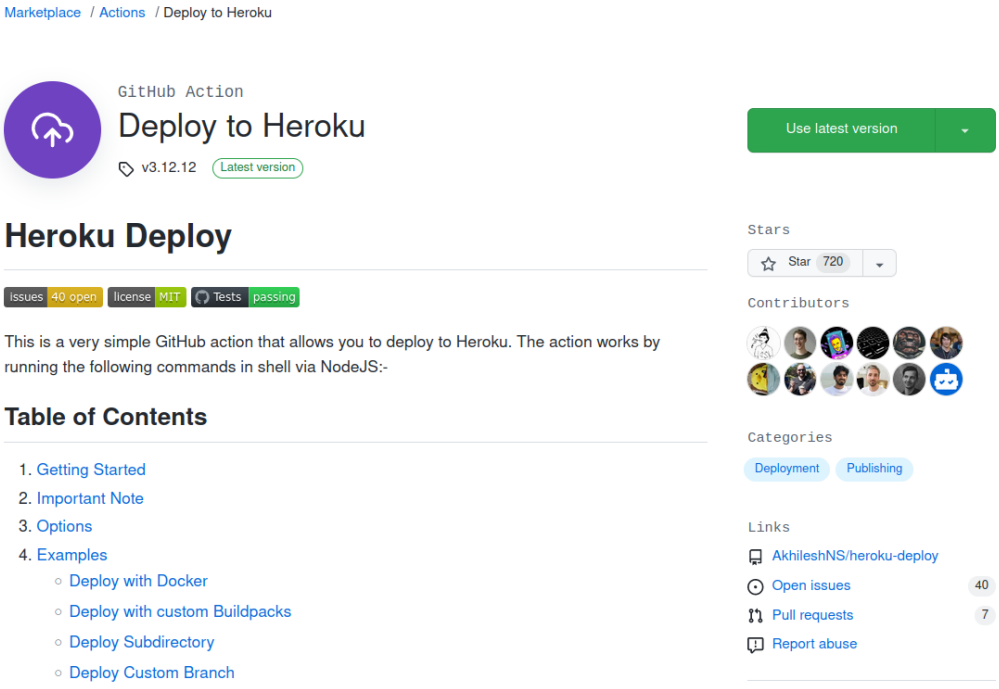
We can deploy a MERN stack based application directly to Heroku and serve the React frontend as a static production build, however this is only applicable when the React app is a SPA (Single Page Application), whereas we have used React Router in order to create a Multi Page Application. So that is where Netlify helps with its ease of use for deployment as well as handling React Router based applications.

Following describes the steps that have to be followed for deploying the Express backend to Heroku and the React frontend to Netlify.

Heroku Configuration

Create a Heroku account and create a new app.
We can deploy to Heroku using several methods but we have used the Github Actions route. Before we could directly connect a Github repository to a Heroku app but a recent vulnerability with Heroku has forced them to disable this option.

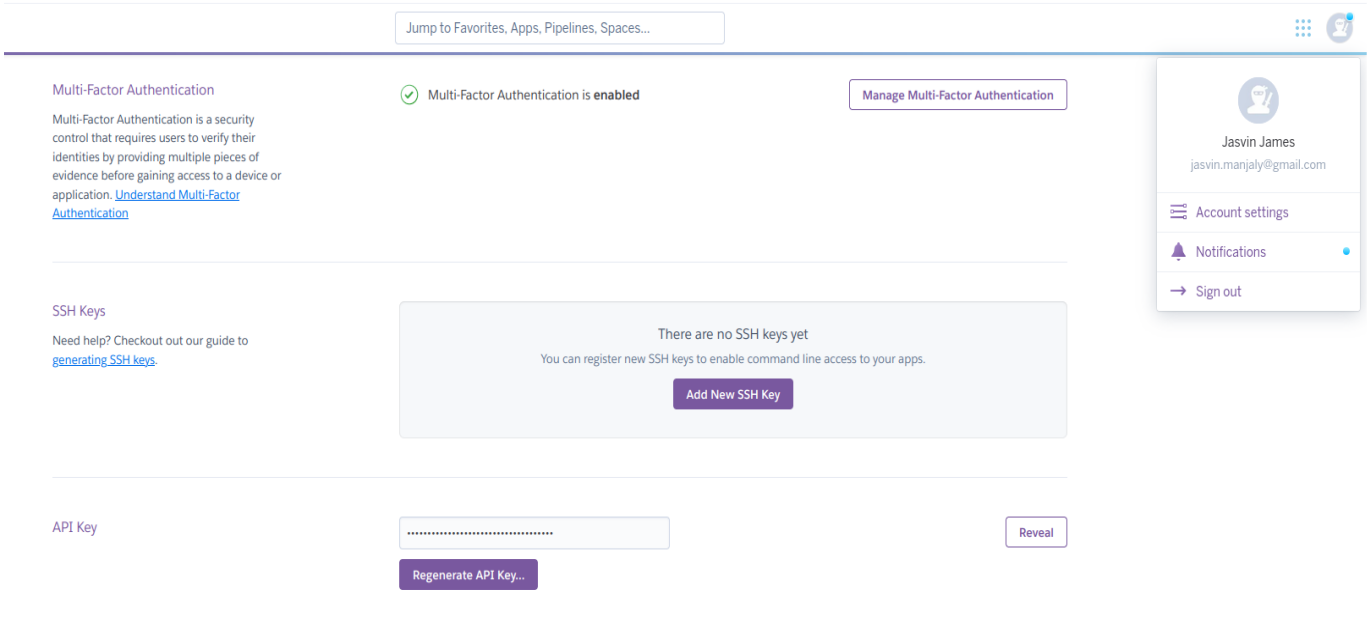
So we use a third-party Github Action for deploying to Heroku

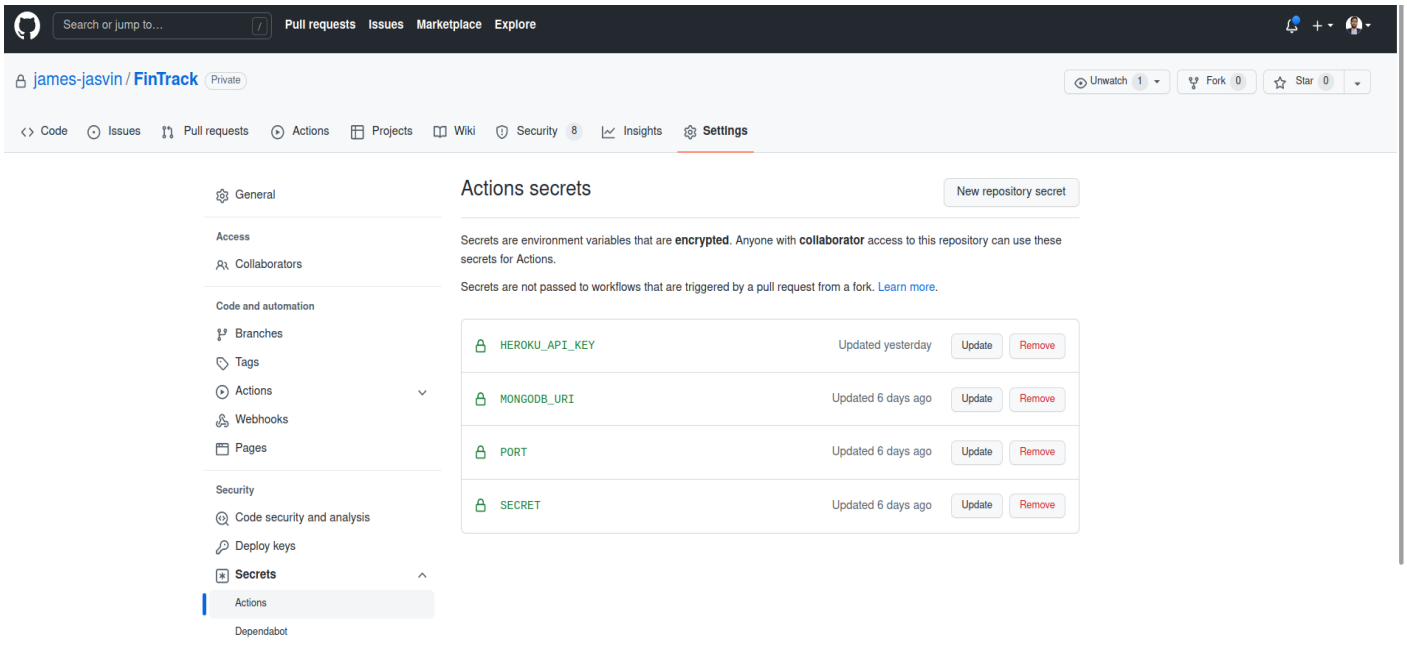


For the Action to work, it should be able to login to your Heroku account and we also need a new way to manage secret environment variables because Ansible will not be

involved with this deployment. We configure these secret environment variables in the repository's secrets which can be set by going to the *Settings* menu of your repository.

Also to login to Heroku we save the Heroku API key (available in the *Account Settings* section of your Heroku account) in the Github secrets as well.

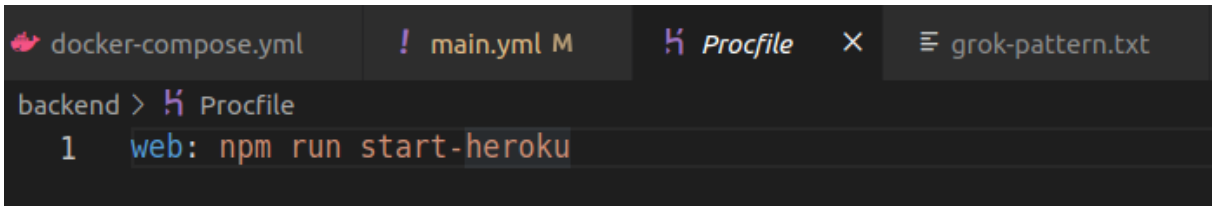




And this is what the yml file looks like for the Workflow,

```yaml
name: Deploy

on:
  push:
    branches:
      - master

jobs:
  build:
    runs-on: ubuntu-latest
    steps:
      - uses: actions/checkout@v2
      - uses: akhileshns/heroku-deploy@v3.12.12
        with:
          heroku_api_key: ${{secrets.HEROKU_API_KEY}}
          heroku_app_name: "fintrack-420"
          heroku_email: "jamesjasvin5@gmail.com"
          # Specifies the directory in the repository that will be treated as the root by Heroku
          # because we are only deploying the backend, that is our appdir
          appdir: "backend"
        env:
          # All environment variables for this Action must be specified with the HD_ prefix
          HD_MONGODB_URI: ${{secrets.MONGODB_URI}}
          HD_PORT: ${{secrets.PORT}}
          HD_SECRET: ${{secrets.SECRET}}
```

Finally in order to get a Heroku app running we need to add a *Procfile* which in this case will be in the *backend* directory.

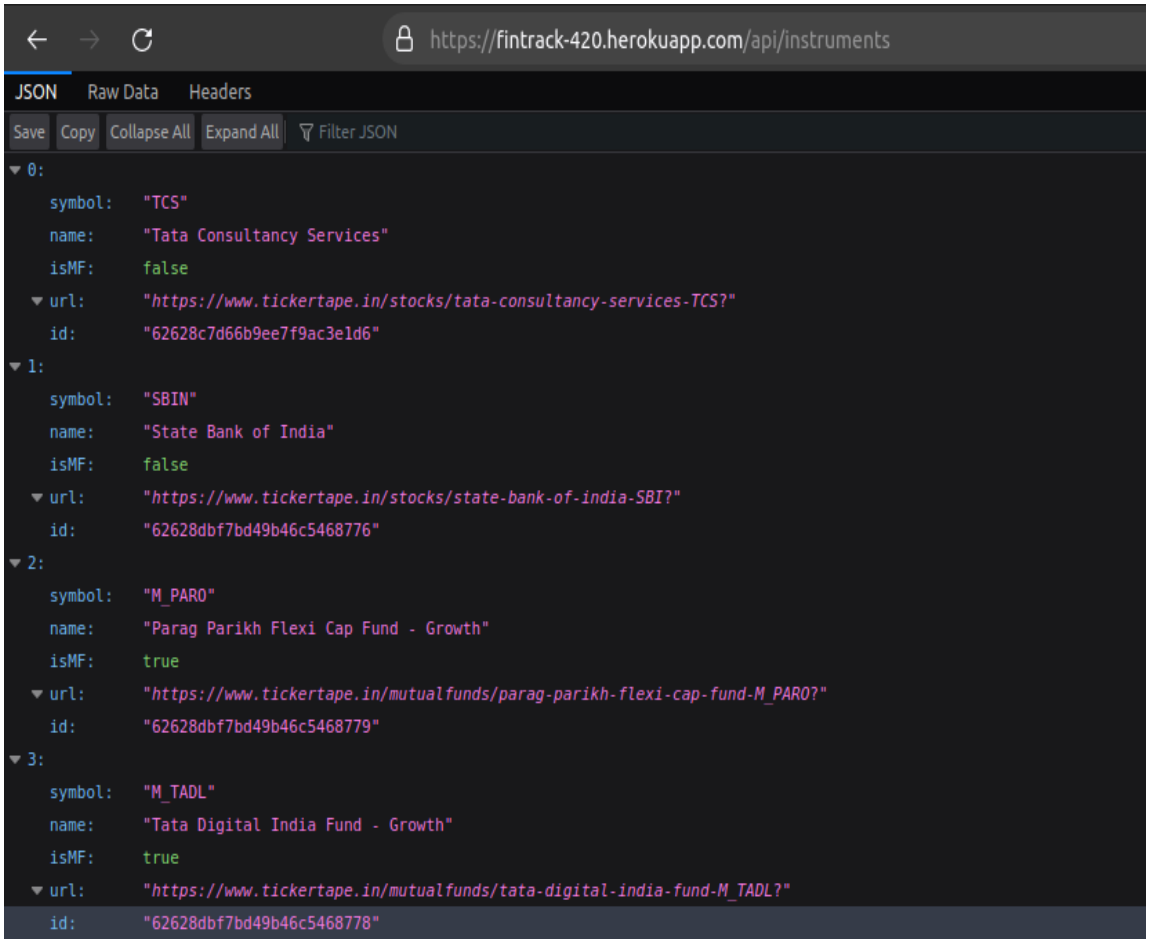


start-heroku is a *NODE_ENV* value that is set in *package.json* and it was also used in the *config.js* file to specify the fact that we'll be reading the environment variables from the *process.env* JSON.

```json
"scripts": {
  "start": "NODE_ENV=production node index.js",
  "start-heroku": "NODE_ENV=production-heroku node index.js",
  "test": "NODE_ENV=test jest --verbose --runInBand",
  "local-test": "NODE_ENV=local-test jest --verbose --runInBand",
  "dev": "NODE_ENV=development nodemon index.js",
  "lint": "eslint ."
},
```

Now pushing these changes to your Github repo will automatically trigger the Action and build the Heroku app.

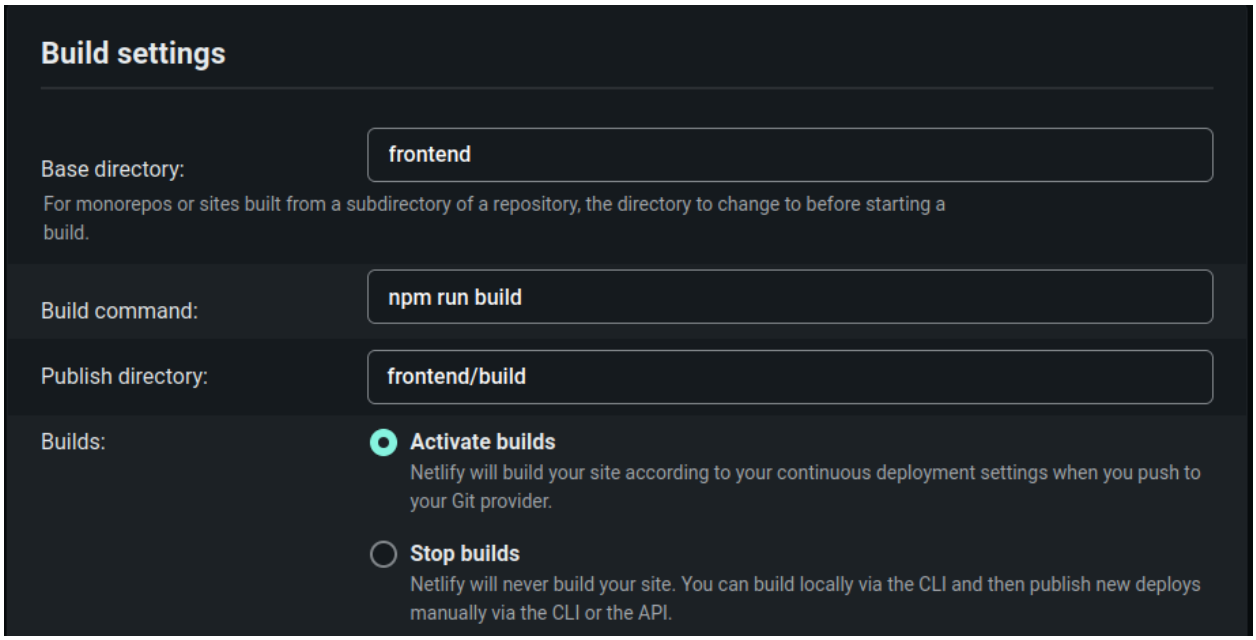
Verifying that the Heroku app is indeed serving the backend.



Netlify Configuration

Create a Netlify account and link your Github repository in order to deploy the frontend app.

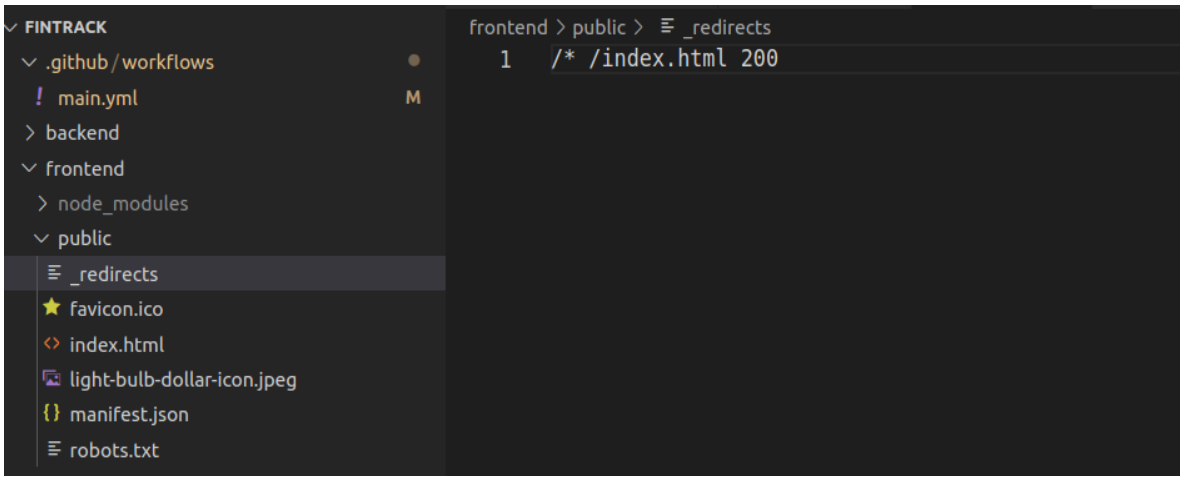
Update the Deploy build settings as follows,



The *Publish directory* is *frontend/build* otherwise Netlify will try to read the *build* directory in the root directory itself which is not where *npm run build* will save the *build* directory and crash the app.

Now the frontend will also automatically deploy but there will be a problem with React Router. You cannot directly access any routed paths such as https://fintrack-420.netlify.app/search without going through the home page first.

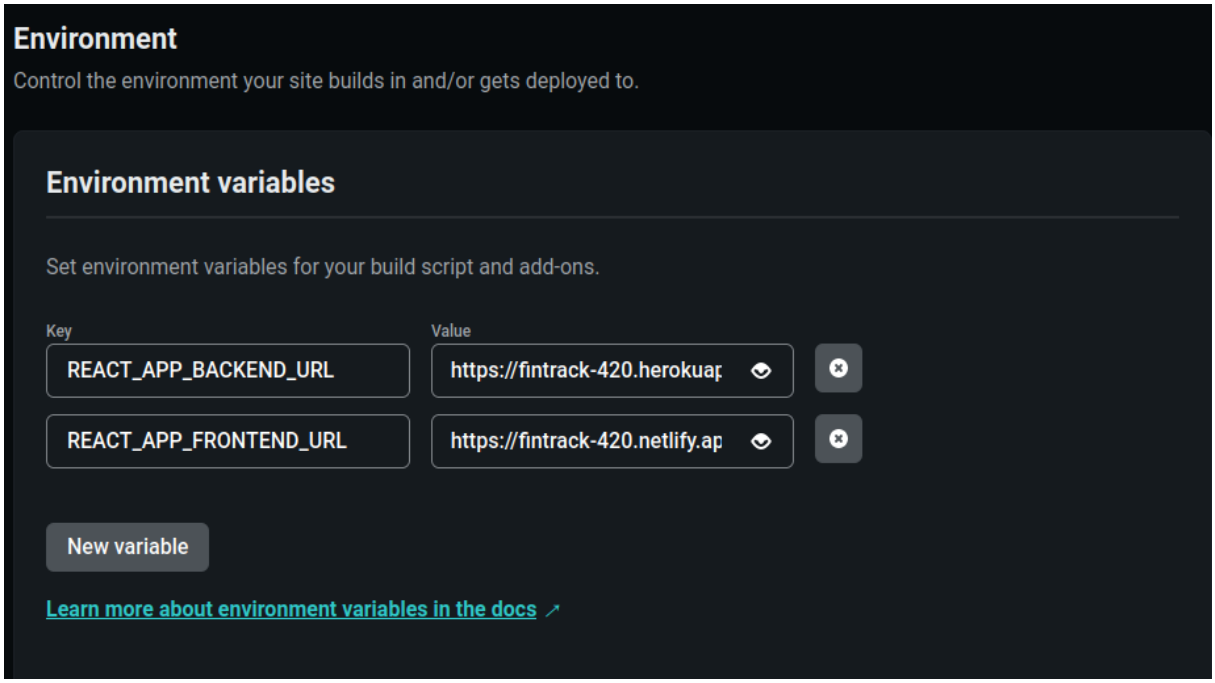
For this you have to add a file called *_redirects* under the *public* folder of your React app which also contains the *index.html* file.



This basically tells Netlify that if the URL to serve has anything after the '/' then redirect to rendering *index.html* with a 200 status code.

And now React Router will be able to pick up the specified URL and appropriately route the user to the correct page without having to go through the home page, nor result in an error.

We will also have to add the same environment variables that we have used in the *.env.development* file in the frontend in order for this deployment to work.



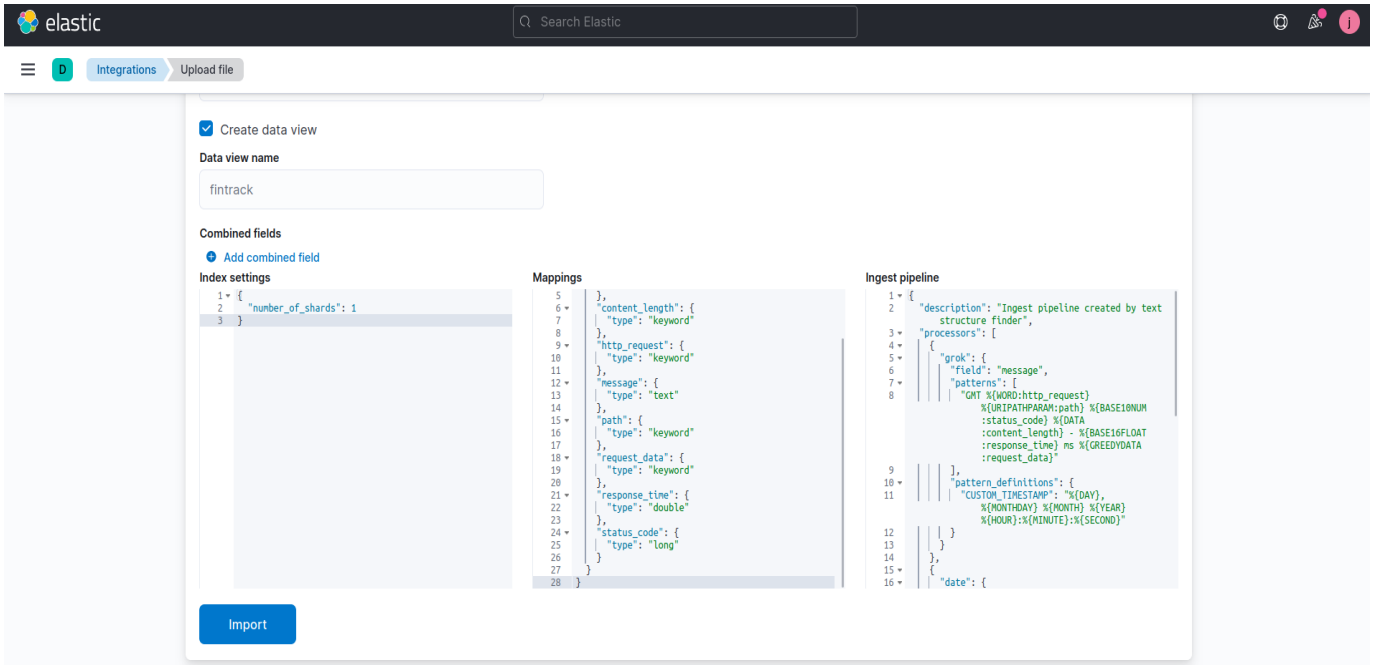
And that does it for the entire Heroku + Netlify configuration!

4.10. Monitoring - ELK Stack

"ELK" is the acronym for three open source projects: Elasticsearch, Logstash, and Kibana. ELK stack gives us the ability to aggregate logs from all the systems and applications, analyze these logs, and create visualizations for application and infrastructure monitoring, faster troubleshooting, security analytics, and more.

To use the ELK stack we first require the logs that are generated from the application. Because we have used Docker volumes for persisting the logs as specified in the Docker Compose file, we can get the logs at the path */home/backend/logs/access.log.*

Now we can upload this log file into our Elastic Cloud cluster.

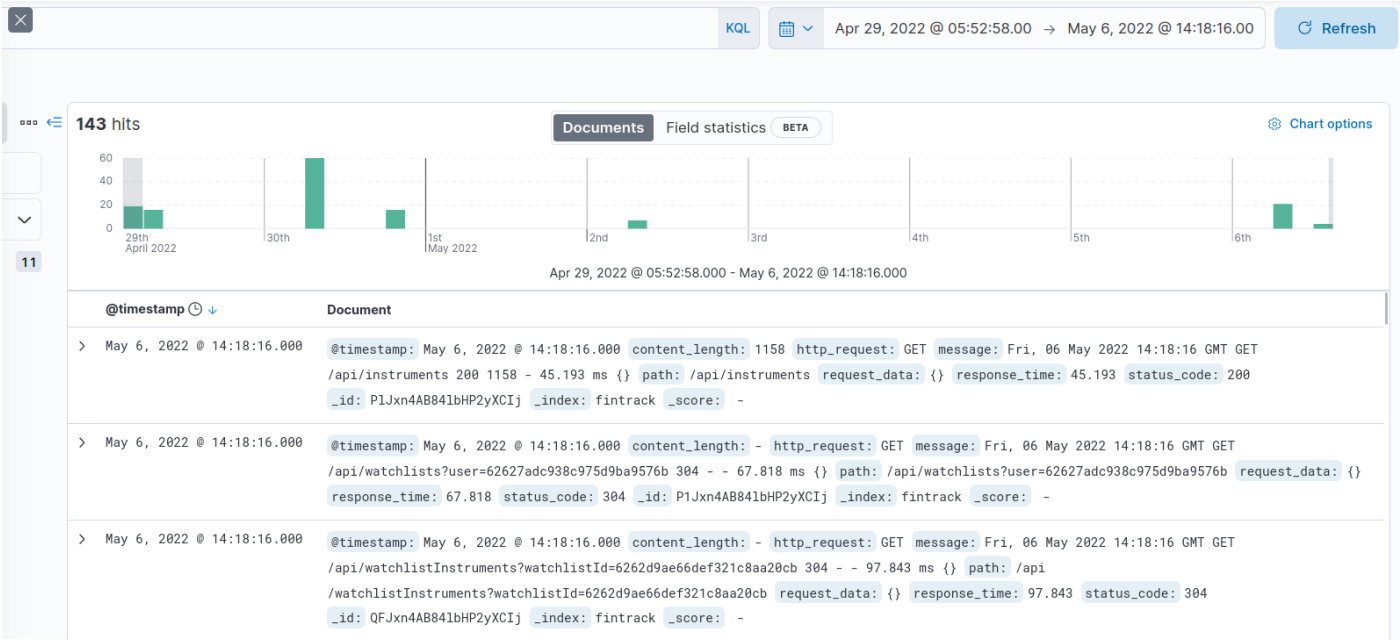


To infer the proper fields from the log file we have to use the following Grok pattern

```
"CUSTOM_TIMESTAMP": "%{DAY}, %{MONTHDAY} %{MONTH} %{YEAR} %{TIME}"

"%{CUSTOM_TIMESTAMP:timestamp} GMT %{WORD:http_request}
%{URIPATHPARAM:path} %{BASE10NUM:status_code} %{DATA:content_length}
- %{BASE16FLOAT:response_time} ms %{GREEDYDATA:request_data}"
```

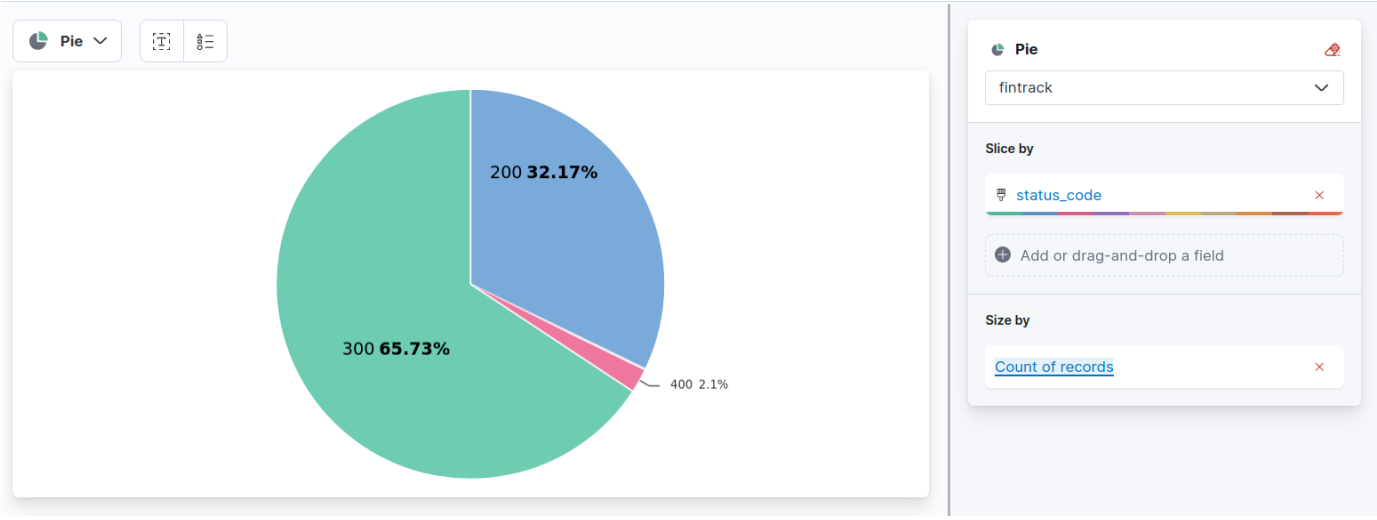
Visualizations

1. Time Series View

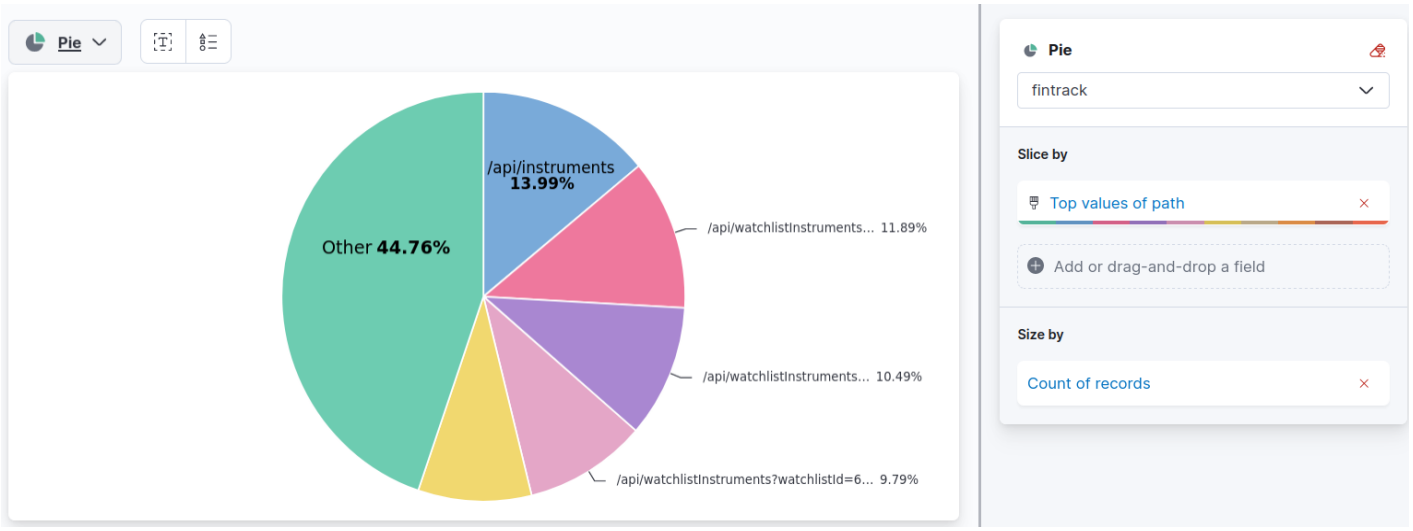


2. Visualizing http_request field

3. Visualizing status_code field



4. Visualizing path field



We also created a Kibana Dashboard containing these three visualizations.

5. Experimental Setup

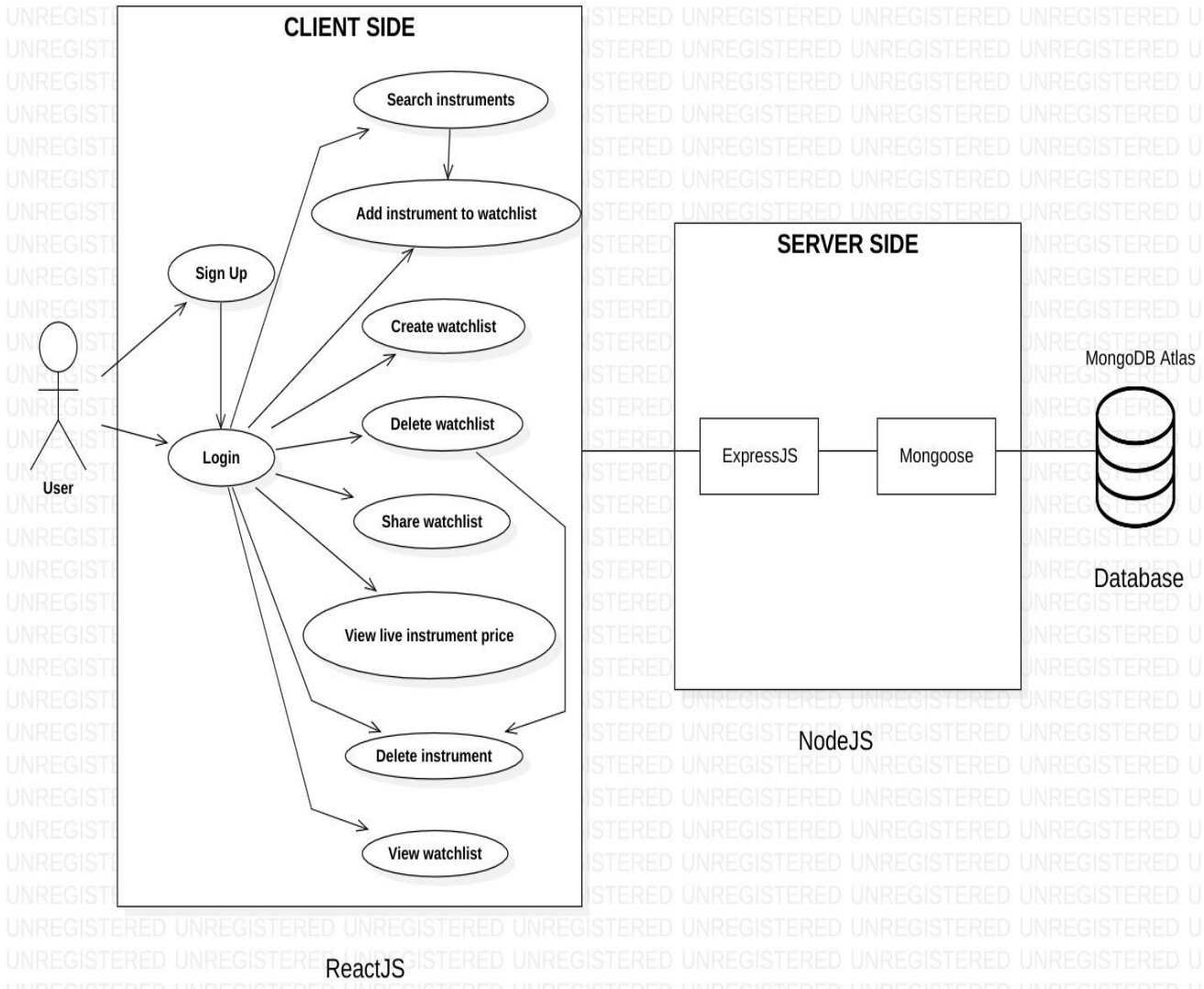
5.1. Functional Requirements:

1. Users can register and create their account.
2. Users can create watchlists without creating duplicate entries.
3. Users can view their watchlists and its contained instruments.
4. Users can edit the desired watchlist (delete the instruments or add the instruments) as per their wish.
5. Users can search for the instruments for adding them to their watchlist.
6. Each watchlist will have a share button that will send a publicly shareable link to anyone that visits that URL.
7. To view a shared watchlist, a user must be logged in to a Fintrack account, which can be any account but a login is required.
8. Watchlists cannot be amalgamated. ‘Mutual Funds’ watchlists must only contain Mutual Funds, whereas ‘Stocks’ watchlists must contain only Stocks.

5.2. Non-Functional Requirements:

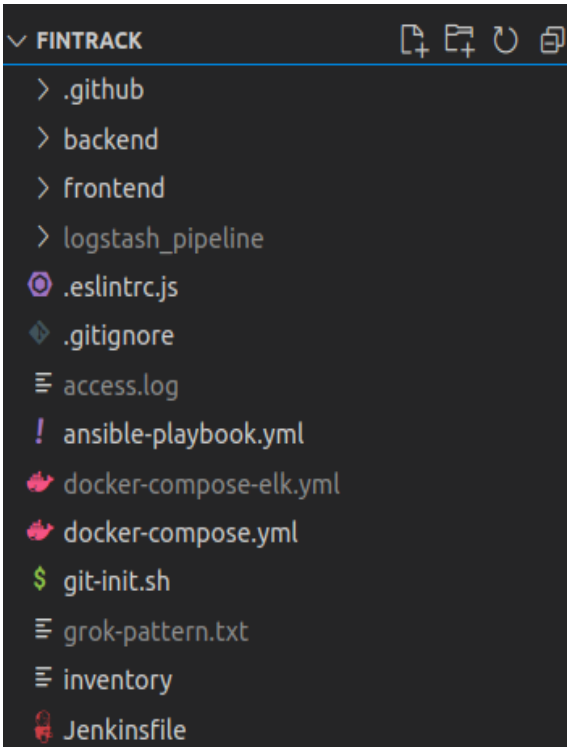
1. **Portability**: To ensure portability, Docker images have been built for the frontend and backend.
2. **Scalability**: The database is created on MongoDB Atlas and in case of high traffic, Atlas will automatically handle this via scaling and thus scalability is achieved.
3. **Security**: To improve security, JWT tokens are being used for setting up a session and checking the authorization.
4. **User Friendly**: The website has to be user friendly and error messages should pop up when relevant.
5. **Performance**: The performance of the website should not degrade in case of multiple users.

5.3. Architectural Diagram:



5.4. Code Walkthrough

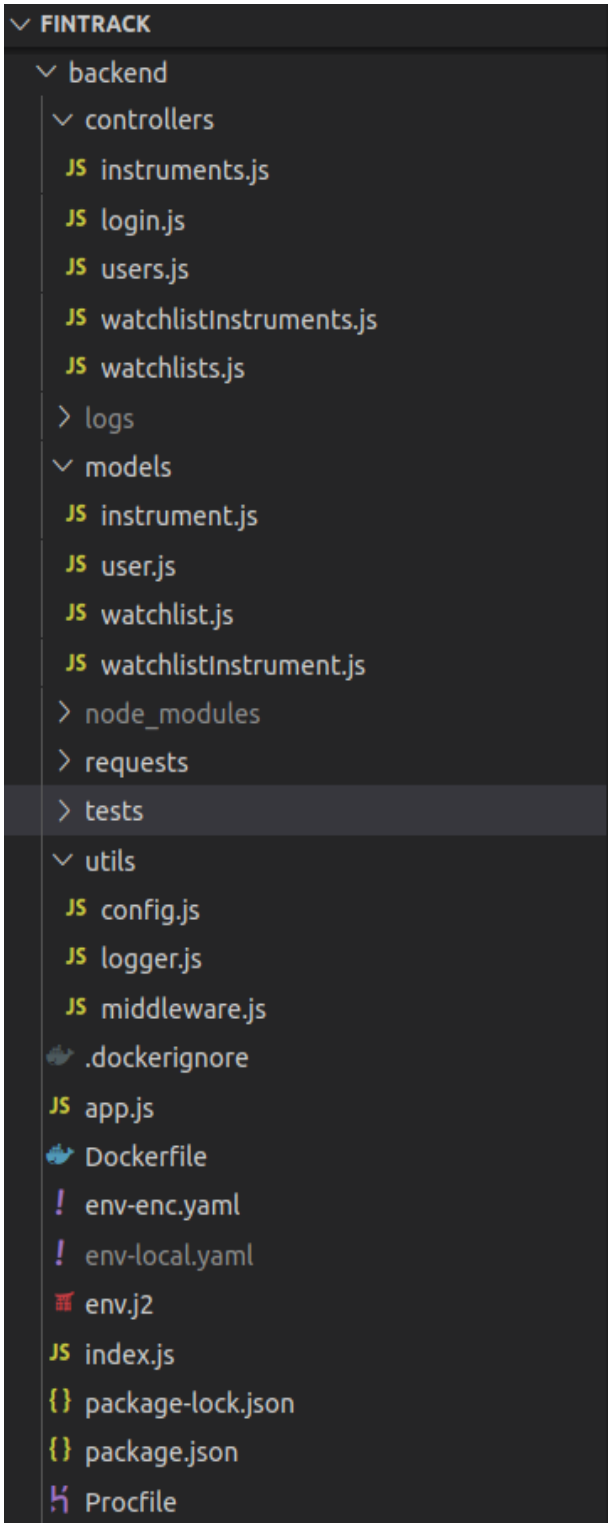
The folder structure that we have followed includes the client-side *frontend/* and the server-side *backend/* with subfolders within them to ensure proper flow of data in the website.



Directory structure for the project

5.4.1. Backend

Directory structure for the Backend



We have incorporated MVC architecture (Model View Controller) in the project.

Model:

- It is known as the lowest level which means it is responsible for maintaining data.
- The Model is actually connected to the database so anything you do with data - adding or retrieving data is done in the Model component.
- It responds to the controller requests because the controller never talks to the database by itself. The Model talks to the database back and forth and then it gives the needed data to the controller.

Here are the Models that we have used in our project.

1. User Model

```
const mongoose = require('mongoose')
const uniqueValidator = require('mongoose-unique-validator')

const userSchema = new mongoose.Schema({
   username: { type: String, required: true, minLength: 3, unique: true },
   name: { type: String, required: true },
   passwordHash: { type: String, required: true },
})
```

2. Instrument Model

```
const instrumentSchema = new mongoose.Schema({
   symbol: { type: String, required: true, unique: true },
   name: String,
   isMF: { type: Boolean, required: true },
   url: { type: String, required: true }
})
```

3. Watchlist Model

```
const watchlistSchema = new mongoose.Schema({
   name: { type: String, required: true },
   user: {
       type: mongoose.Schema.Types.ObjectId,
       ref: 'User'
   },
   isMF: { type: Boolean, required: true }
})
```

4. WatchlistInstrument Model

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

const watchlistInstrumentSchema = new mongoose.Schema({
   watchlist: {
       type: mongoose.Schema.Types.ObjectId,
       ref: 'Watchlist',
       required: true
   },
   instrument: {
       type: mongoose.Schema.Types.ObjectId,
       ref: 'Instrument',
       required: true
   }
})
```

View:

- Data representation is done by the View component.
- It actually generates UI or user interface for the user.
- So in web applications when you think of the View component just think of it as the HTML/CSS part.
- Views are created by the data which is collected by the model component but this data isn't taken directly from the Model and instead obtained through the Controller.
- View only speaks to the Controller.

Controller:

- It's known as the main man because the controller is the component that enables the interconnection between the View and the Model, so it acts as an intermediary.
- The Controller doesn't have to worry about handling data logic, it just tells the Model what to do.
- After receiving data from the Model, the Controller processes it and sends the information to the View.
- **Note**: Views and Models cannot talk directly.

Express & NodeJS do all the functional programming and will be used to write the Business Tier.

This tier represents the Application Server that acts as the bridge of communication between the Client and Database. This tier will serve the React components to the

user's device and accept HTTP requests from the user and follow with the appropriate response.

Here is an overview of the Controllers in our project.

1. Instruments Controller

```
const instrumentRouter = require('express').Router()
const Instrument = require('../models/instrument')

/*
* Return all instruments stored in the Database
*/
instrumentRouter.get('/', async (request, response) => {
    const instruments = await Instrument.find({})
    response.status(200).json(instruments)
})

module.exports = instrumentRouter
```

2. Users Controller

Handles the signup of users into our web-app.

```
/*
* Create a new user in the database using the data provided in the request
* Do validation checks in the password specified so that it satisfies the criteria for a good password
* Encrypt the password using bcrypt to obtain the hash value and store this data in the DB
* Return the saved user (which will also include user id added by MongoDB) back
* as a response with 201 Status (Content Created)
*/
userRouter.post('/', async (request, response) => {
  const body = request.body

  if (body.password.length < 3)
    return response.status(400).json({ error: 'password should have length atleast 3' })

  const saltRounds = 10
  const passwordHash = await bcrypt.hash(body.password, saltRounds)

  const userObject = new User({
    username: body.username,
    passwordHash,
    name: body.name
  })

  const savedUser = await userObject.save()

  const userForToken = {
    username: savedUser.username,
    id: savedUser.id
  }

  const token = jwt.sign(userForToken, config.SECRET)

  response.status(201).send({ token, username: savedUser.username, name: savedUser.name, id: savedUser.id })
})

module.exports = userRouter
```

3. Login Controller

```
const jwt = require('jsonwebtoken')
const bcrypt = require('bcrypt')
const User = require('../models/user')
const loginRouter = require('express').Router()
const config = require('../utils/config')

/*
* For the provided username, check whether such a user exists in the DB
* If there is a user, then check whether the hash of the password sent and stored passwordHash match
* If they do, then login is valid and generate a token using the username, user id & SECRET env variable
* as input to the jwt.sign() method
* Return the token, username, name and user id upon successful login with 200 status code
* Otherwise return 401 status code with error message in response
*/
loginRouter.post('/', async (request, response) => {
  const body = request.body

  const user = await User.findOne({ username: body.username })
  const passwordCorrect = user === null? false: await bcrypt.compare(body.password, user.passwordHash)

  if (!passwordCorrect)
    return response.status(401).json({ error: 'Invalid username or password' })

  const userForToken = {
    username: user.username,
    id: user.id
  }

  const token = jwt.sign(userForToken, config.SECRET)

  response.status(200).send({ token, username: user.username, name: user.name, id: user.id })
})

module.exports = loginRouter
```

4. Watchlists Controller

```
/*
* Create a new watchlist in the database with data provided in request body.
* Check whether user has sent jwt token in packet header
* Otherwise, return 401 status code with error "invalid token"
* Return watchlist name, type, user-id upon successful creation with 201 status code
*/
watchlistRouter.post('/', async (request, response) => {
    const body = request.body
    const user = request.user

    if(!user)
        return response.status(401).json({ error: 'token missing or invalid' })

    const watchlistObject = new Watchlist({
        name: body.name,
        isMF: body.isMF,
        user: user._id
    })

    const savedWatchlist = await watchlistObject.save()
    response.status(201).json(savedWatchlist)
})
```

5. WatchlistInstruments Controller

```
/*
* Return all watchlist-instruments which belong to given watchlist-id
* Check if watchlist-id exists. If it does, populate instrument database in a new object using mongoose' populate() method.
* Otherwise, return 401 status code with error "Invalid Watchlist-id"
*/
watchlistInstrumentRouter.get('/', async (request, response) => {
  const watchlistId = request.query.watchlistId

  const user = request.user
  if(!user)
    return response.status(401).json({ error: 'token missing or invalid' })

  const watchlistInstrumentsList = await WatchlistInstrument.find({watchlist: watchlistId}).populate('instrument')

  if(!watchlistInstrumentsList)
    return response.status(404).json({ error: 'Invalid watchlist' })

  const modifiedWatchlistInstrumentsList = watchlistInstrumentsList.map((watchlistInstrument) =>{
    return {
      symbol: watchlistInstrument.instrument.symbol,
      name: watchlistInstrument.instrument.name,
      isMF: watchlistInstrument.instrument.isMF,
      url: watchlistInstrument.instrument.url,
      instrumentId: watchlistInstrument.instrument.id,
      watchlistId: watchlistInstrument.watchlist,
      id: watchlistInstrument.id
    }
  })

  response.status(200).json(modifiedWatchlistInstrumentsList)
})
```

***utils* directory**

Contains middleware, config and logger files to support controller's functionalities.

***tests* directory**

Contains the supertest test files as described in the SDLC section.

Here is a snippet of the *watchlists_api.test.js* file which shows how we use the beforeEach() method to login as an existing user and perform authorized operations in the tests with the JWT token.

```
let user = null

beforeEach(async () => {
  // Increasing timeout otherwise sometimes a timeout error can wreck the whole testing phase
  jest.setTimeout(30000)

  await User.deleteMany({})
  await User.insertMany(helper.initialUsers)
  await Watchlist.deleteMany({})

  user = await api
    .post('/api/login')
    .send(helper.loginUser)

  for (let watchlist of helper.initialWatchlists) {
    await api
      .post('/api/watchlists')
      .send(watchlist)
      .set('Authorization', `Bearer ${user.body.token}`)
  }
})

describe('viewing a user\'s watchlists', () => {
  test('watchlist object has id property instead of _id', async () => {
    const response = await api
      .get(`/api/watchlists?user=${user.body.id}`)
      .set('Authorization', `Bearer ${user.body.token}`)

    expect(response.body[0].id).toBeDefined()
    expect(response.body[0]._id).toBeUndefined()
    expect(response.body[0].__v).toBeUndefined()
  })

  test('total watchlists contained are 4', async () => {
    const response = await api
      .get(`/api/watchlists?user=${user.body.id}`)
      .set('Authorization', `Bearer ${user.body.token}`)
```

package.json

This file is the heart of our Node project. It records important metadata about our project which is required before publishing to npm and also defines functional attributes of our project that npm uses to install dependencies, run scripts, and identify the entry point to our package.

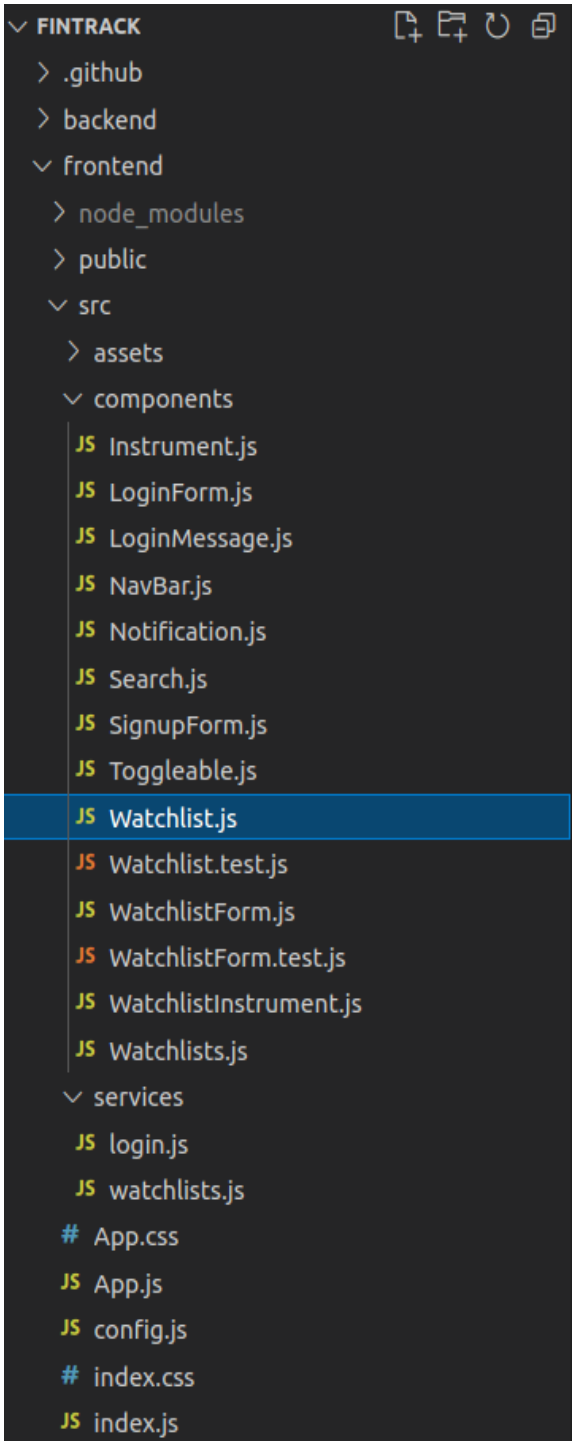
```
{
  "name": "fintrack",
  "version": "1.0.0",
  "description": "Create shareable investment watchlists!",
  "main": "index.js",
  ▷ Debug
  "scripts": {
    "start": "NODE_ENV=production node index.js",
    "start-heroku": "NODE_ENV=production-heroku node index.js",
    "test": "NODE_ENV=test jest --verbose --runInBand",
    "local-test": "NODE_ENV=local-test jest --verbose --runInBand",
    "dev": "NODE_ENV=development nodemon index.js",
    "lint": "eslint ."
  },
  "engines": {
    "node": "16.x"
  },
  "author": "Jasvin James",
  "license": "ISC",
  "dependencies": {
    "bcrypt": "^5.0.1",
    "cors": "^2.8.5",
    "dotenv": "^14.3.0",
    "express": "^4.17.2",
    "express-async-errors": "^3.1.1",
    "jsonwebtoken": "^8.5.1",
    "mongoose": "^6.1.7",
    "mongoose-unique-validator": "^3.0.0",
    "morgan": "^1.10.0",
    "run": "^1.4.0",
    "yenv": "^3.0.1"
  },
  "devDependencies": {
    "eslint": "^8.7.0",
    "jest": "^27.4.7",
    "nodemon": "^2.0.15",
    "supertest": "^6.2.3"
  },
  "jest": {
    "testEnvironment": "node"
  }
}
```

API Documentation

Endpoint	HTTP method	Input	Description
/api/users	GET	–	Get all the users from the database
/api/users	POST	username, name, password	User signup → Store user details in database →Do validation checks in the password specified → Store the encrypted password in the database → Return token (JWT specification), name, username, id
/api/login	POST	username, password	User login → Check username → do password validation →Return token, name, username, id
/api/watchlists/:watchlistid	GET	watchlist-id	Return watchlist data with given watchlist ID
/api/watchlists?user=user.id	GET	user-id	Return all the watchlists of the given user
/api/watchlists	POST	watchlist-name, type, user-id	Check JWT token → Create watchlist → Return watchlist name, type, user-id
/api/watchlists/:watchlistid	DELETE	watchlist-id	Delete watchlist with given watchlist-id
/api/watchlistInstruments	POST	Watchlist-id, instrument-id	Check if watchlist-instrument already exists in the given watchlist → Check if added instrument is of same type as as watchlist → Return symbol, name, type, url, id , watchlist-id, instrument-id
/api/watchlistInstruments?watchlistId=watchlist.id	GET	watchlist-id	Return all watchlist-instruments (symbol, name, type, url, id , watchlist-id, instrument-id, watchlistInstrument-id) which belong to given watchlist-id
/api/watchlistInstruments/:watchlistInstrument.id	DELETE	watchlistInstrument-id	Delete the watchlist-instrument with given watchlistInstrument-id
/api/watchlistInstruments?watchlistId=watchlist.id	DELETE	watchlist-id	Delete all instruments which belong to given watchlist-id
/api/instruments	GET	–	Return all the instruments stored in database

5.4.2. Frontend

Directory structure for frontend



We use functional components, React state and React hooks in order to build the frontend. In order to enable routing we have used React Router (BrowserRouter).

Components

Start of the App *component (App.js)*

```
const App = () => {
  // user state will store the logged in user object, if no login has been done yet then it will be null
  const [ user, setUser ] = useState(null)
```

How React Router is used to match routes appropriately

```
// A useRouteMatch that will check whether the current page's route matches the pattern /watchlists/:id
// match = Object that contains various information about route matched including the "id" in path,
// if route matched successfully
// Else, match = null
const match = useRouteMatch('/watchlists/:id')
```

Effect Hook usage

```
// Effect hook that fetches all the instrument data from the backend and sets the appropriate state
useEffect(() => {
  watchlistService
    .getInstrumentData()
    .then(data => {
      setInstruments(data)
    })
}, [])
```

Effect Hook + React Router to fetch correct watchlist data

```
// Fetch specific watchlist data only if we are single watchlist view mode, i.e. /watchlists/:id route, so match !== null
// Providing "match" as a parameter in the dependency array of the useEffect hook
// results in an infinite loop of getWatchlistData() being called
// and crashing the system, so that's why dependency array is kept as empty
useEffect(() => {
  if (match && user !== null) {
    watchlistService
    .getWatchlistData(match.params.id)
    .then(data => setWatchlist(data))
  }
}, [user])
```

JSX that the *App* component returns

```
return (
  <div>
    <div className='text-center page-header p-2 regular-text-shadow regular-shadow'>
      <div className='display-4 font-weight-bold'>
        F<small>IN</small>T<small>RACK</small> {' '}
        <i className='fa fa-cog fa-spin' aria-hidden='true'></i> {' '}
      </div>
      <h5>Share investment watchlists easily!</h5>
    </div>

    <Notification notification={notification} type={notificationType} />

    {
      user === null && showLoginForm &&
      <LoginForm startLogin={handleLogin} showLoginForm={showLoginForm} setShowLoginForm={setShowLoginForm}/>
    }
    {
      user === null && showLoginForm === false &&
      <SignupForm startSignup={handleLogin} showLoginForm={showLoginForm} setShowLoginForm={setShowLoginForm}/>
    }

    {
      user !== null &&
      <NavBar user={user} setUser={setUser}/>
    }

    {
      user !== null &&
      <Switch>
        <Route path='/watchlists/:id'>
          <Watchlist watchlist={watchlist} removeWatchlist={null} removeWatchlistInstrument={null} />
        </Route>
```

```
        <Route path='/search'>
          {
            // If watchlists or instruments haven't loaded or if even one watchlist doesn't have instruments
            // property loaded then redirect to home page instead of remaining on search page
            // It's a stopgap solution but it is what it is :(
            watchlists && instruments && checkWhetherWatchlistInstrumentsLoaded(watchlists)?
            <Search instruments={instruments} watchlists={watchlists} addToWatchlist={addToWatchlist}/>:
            <Redirect to='/' />
          }
        </Route>

        <Route path='/'>
          {/* <Toggleable buttonLabel={'Click Here!'} ref={watchlistFormRef}> */}
            <WatchlistForm createWatchlist={createWatchlist} />
          {/* </Toggleable> */}

          <Watchlists
            watchlists={watchlists}
            removeWatchlist={removeWatchlist}
            removeWatchlistInstrument={removeWatchlistInstrument}
          />
        </Route>

      </Switch>
    }
```

Services

Login & Signup Service

```
import axios from 'axios'
const config = require('../config')

const loginBaseUrl = `${config.BACKEND_URL}/api/login`
const signupBaseUrl = `${config.BACKEND_URL}/api/users/`

const login = async (credentials, isLogin) => {
  let response = ""

  if (isLogin)
    response = await axios.post(loginBaseUrl, credentials)
  else
    response = await axios.post(signupBaseUrl, credentials)

  return response.data
}
```

Create & Delete Watchlist Services with Token Authentication

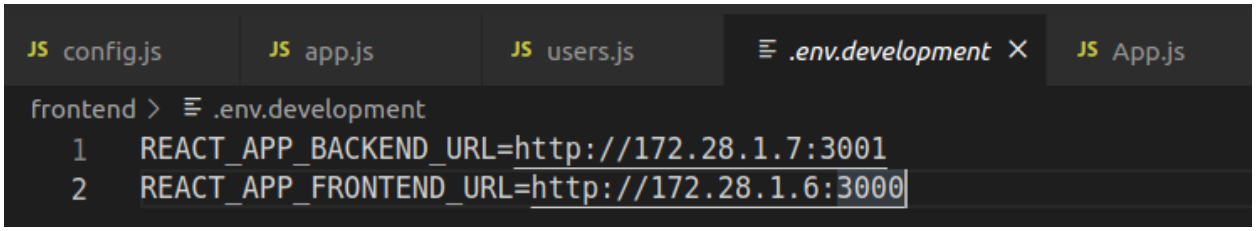
```
const createWatchlist = async (watchlist) => {
  setToken()
  const config = {
    headers: {
      Authorization: `Bearer ${token}`
    }
  }

  const response = await axios.post(watchlistUrl, watchlist, config)
  return response.data
}

const deleteWatchlist = async (watchlist) => {
  setToken()
  const config = {
    headers: {
      Authorization: `Bearer ${token}`
    }
  }

  const response = await axios.delete(`${watchlistUrl}/${watchlist.id}`, config)
  return response.data
}
```

Similar structure is then followed for all other required services.

URL Management with Environment variables: config.js

```
/*
  React Apps created with Create-React-App can use environment variables without the dotenv package
  But such variable names must begin with REACT_APP and that's why
  the environment variable is named such here
*/

const BACKEND_URL = process.env.REACT_APP_STAGE === 'local'? 'http://localhost:3001': process.env.REACT_APP_BACKEND_URL
const FRONTEND_URL = process.env.REACT_APP_STAGE === 'local'? 'http://localhost:3000': process.env.REACT_APP_FRONTEND_URL

export {  BACKEND_URL, FRONTEND_URL }
```

.env.development file



How the REACT_APP_STAGE variable is used in the *package.json* scripts,

```
{
  "name": "fintrack",
  "version": "0.1.0",
  "private": true,
  "dependencies": {
    "@testing-library/jest-dom": "^5.16.1",
    "@testing-library/react": "^12.1.2",
    "@testing-library/user-event": "^13.5.0",
    "axios": "^0.25.0",
    "react": "^17.0.2",
    "react-bootstrap": "^2.2.1",
    "react-dom": "^17.0.2",
    "react-router-dom": "^5.2.0",
    "react-scripts": "5.0.0",
    "web-vitals": "^2.1.4"
  },
  ▷ Debug
  "scripts": {
    "start": "react-scripts start",
    "local-start": "REACT_APP_STAGE=local npm start",
    "build": "react-scripts build",
    "test": "react-scripts test",
    "eject": "react-scripts eject",
    "server": "json-server -p3001 --watch db.json"
  },
```

We know the IP addresses of the backend and frontend because these are made static in the Docker-Compose of the backend and frontend containers respectively.

Testing

Snippet of the *Watchlist.test.js* file which tests the *Watchlist* component along with mock data.

```
describe('<Watchlist />', () => {
  const removeWatchlistInstrument = jest.fn()
  const removeWatchlist = jest.fn()

  const watchlist = {
    name: 'Test Watchlist 1',
    isMF: false,
    user: {
      username: 'Joe',
      name: 'Joe Mama'
    },
    instruments: [
      {
        "id": "1",
        "symbol": "TCS",
        "name": "Tata Consultancy Services",
        "isMF": false,
        "url": "https://www.tickertape.in/stocks/tata-consultancy-services-TCS?"
      },
      {
        "id": "2",
        "symbol": "INFY",
        "name": "Infosys",
        "isMF": false,
        "url": "https://www.tickertape.in/stocks/infosys-INFY?"
      }
    ]
  }

  test('watchlist rendered with name and watchlist instruments are not visible', () => {
    const { container } = render(
      <Watchlist watchlist={watchlist} removeWatchlist={removeWatchlist} removeWatchlistInstrument={removeWatchlistInstrument} />
    )
    expect(container).toHaveTextContent('Test Watchlist 1')
    expect(screen.queryByText('TCS')).toBeNull()
  })
```

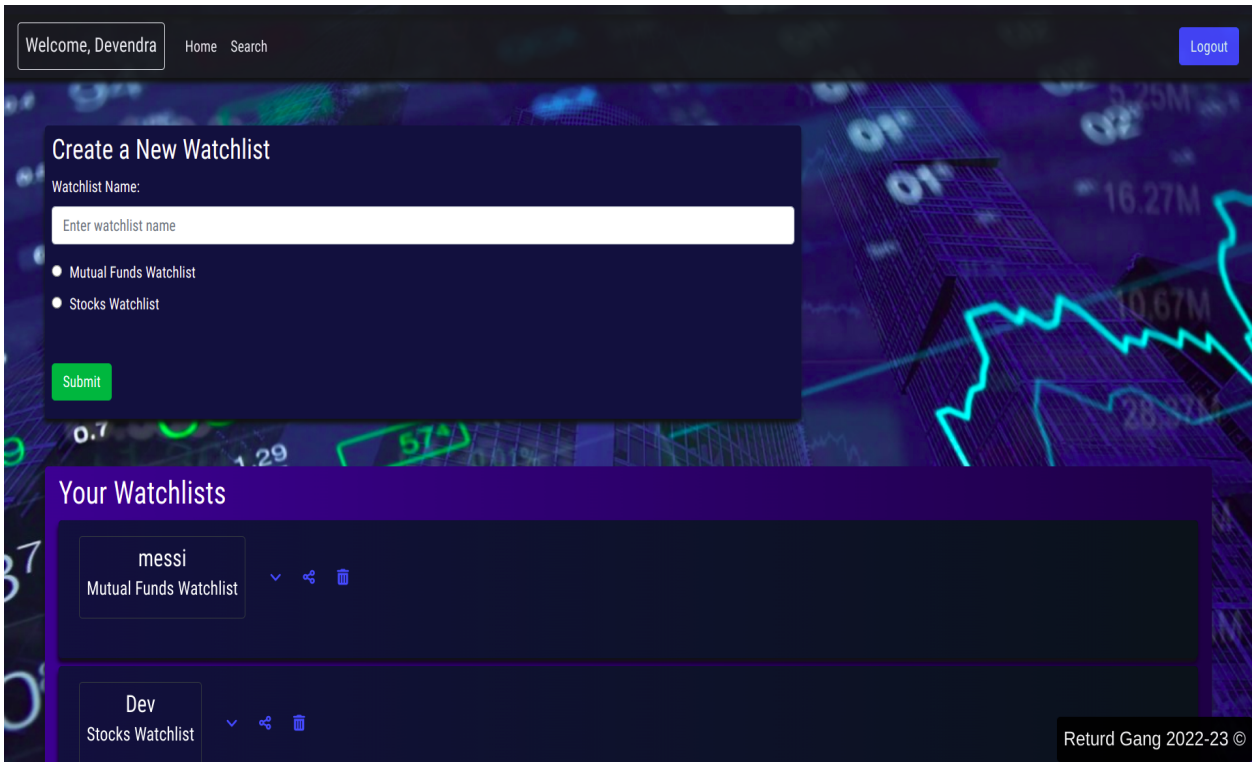
Similar testing format is used for other component tests with *react-testing-library.*

6. Result and Discussion

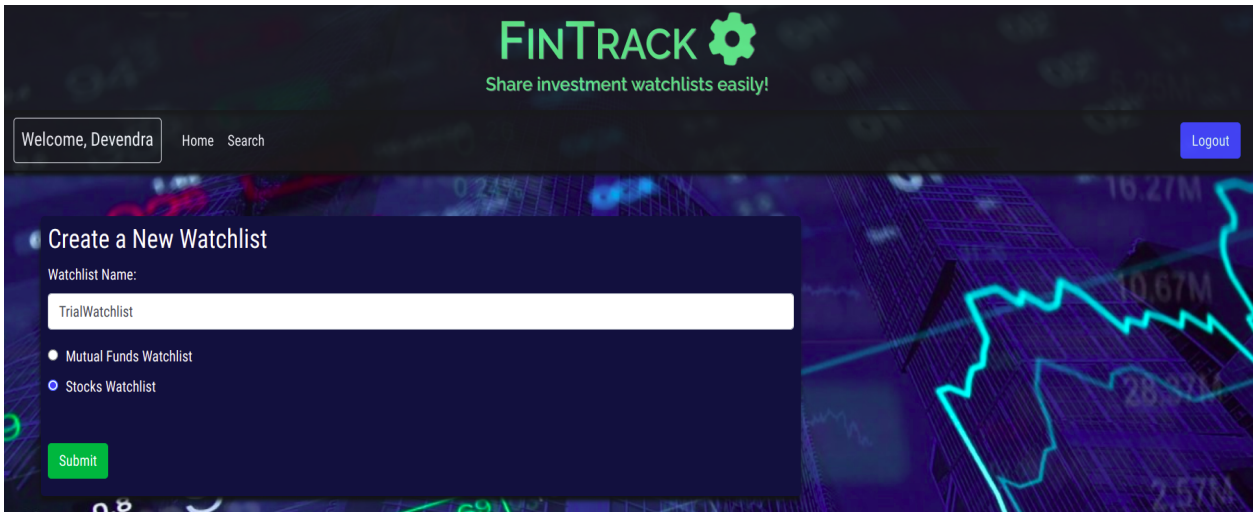
6.1. Login Page

6.2. Signup Page

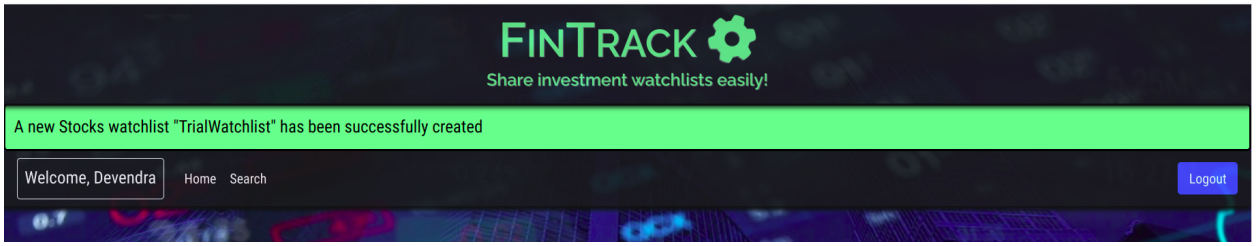
6.3. Home Page



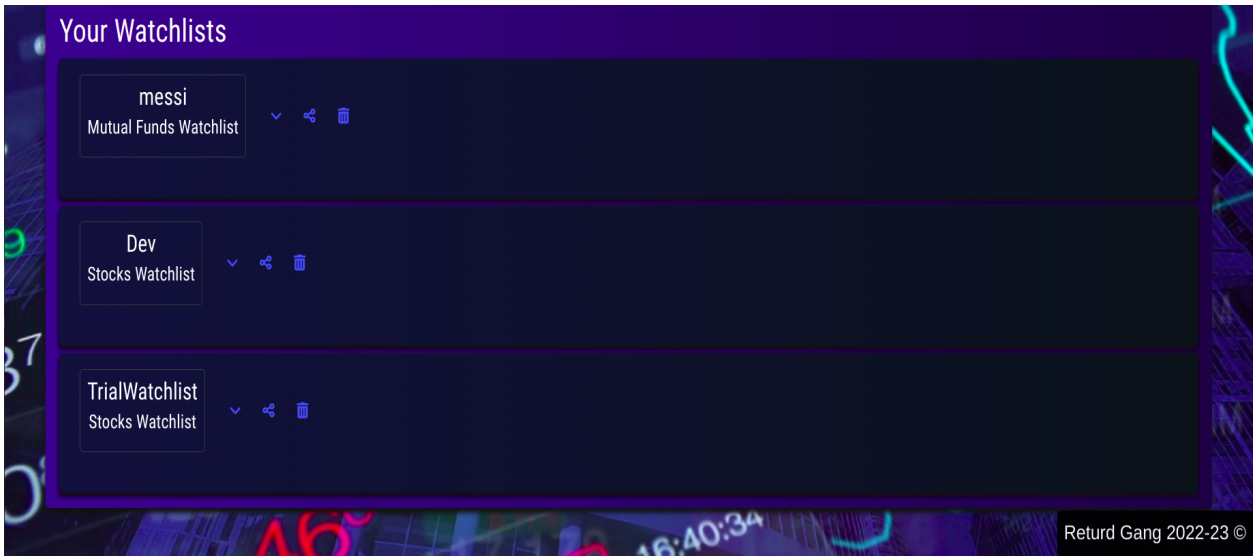
6.4. Watchlist Form

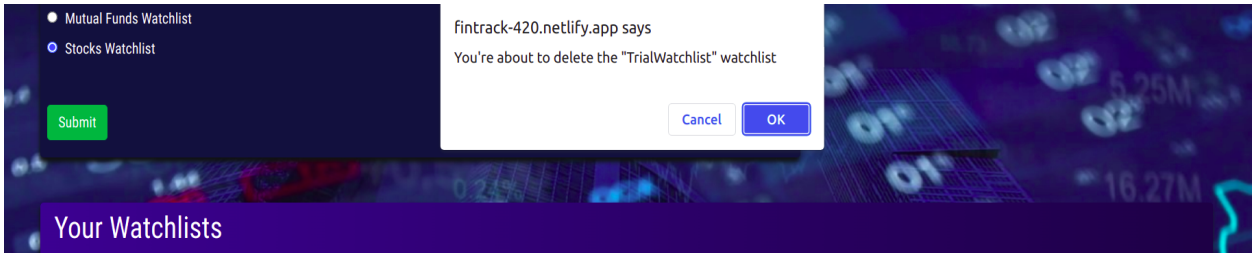


Watchlist created successfully

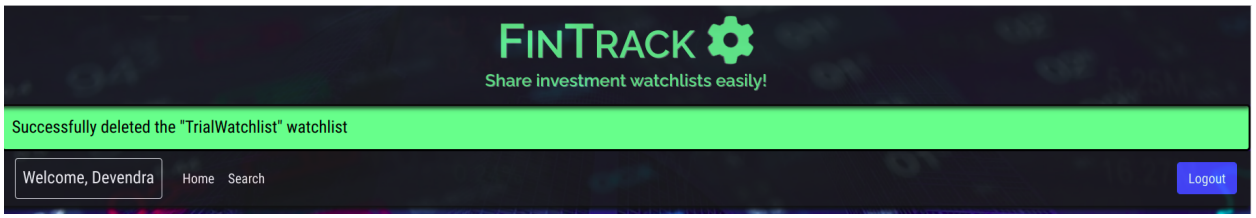


6.5. Delete a Watchlist

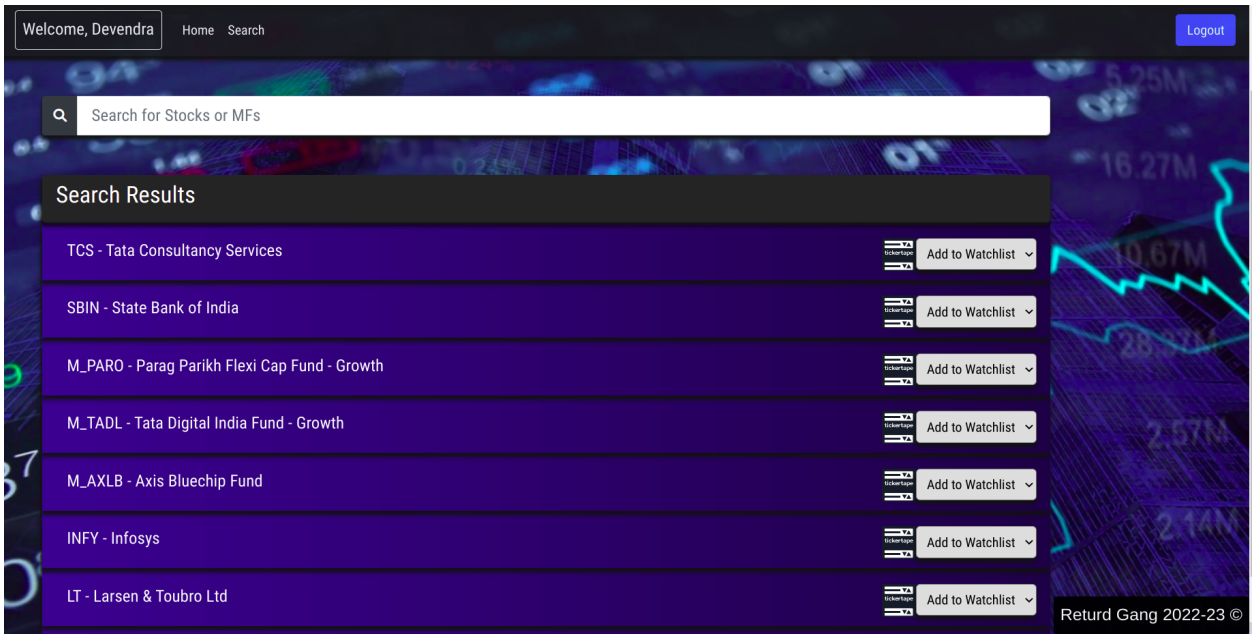




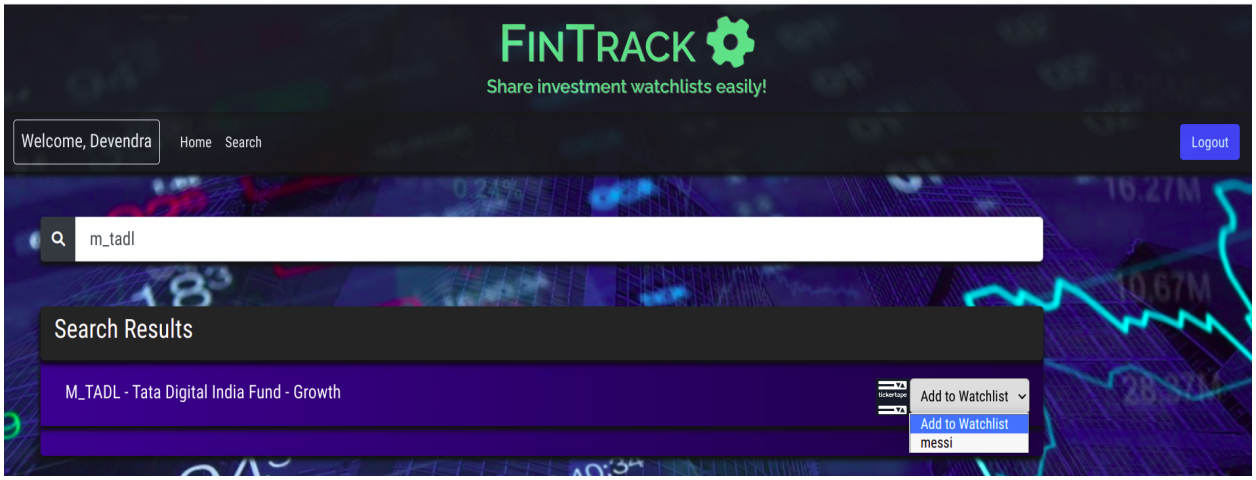
Watchlist deleted successfully



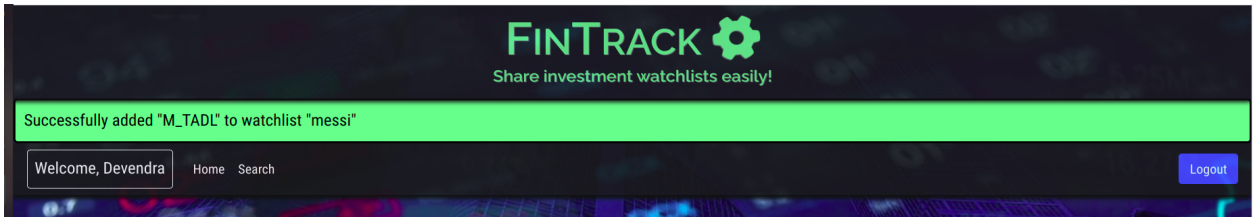
6.6. Search Instruments



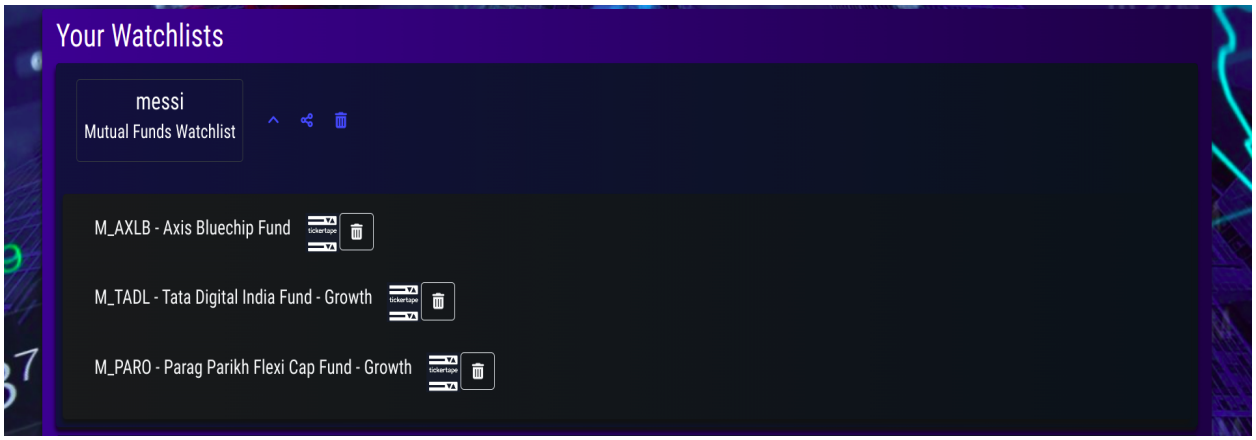
6.7. Adding an Instrument in a Watchlist



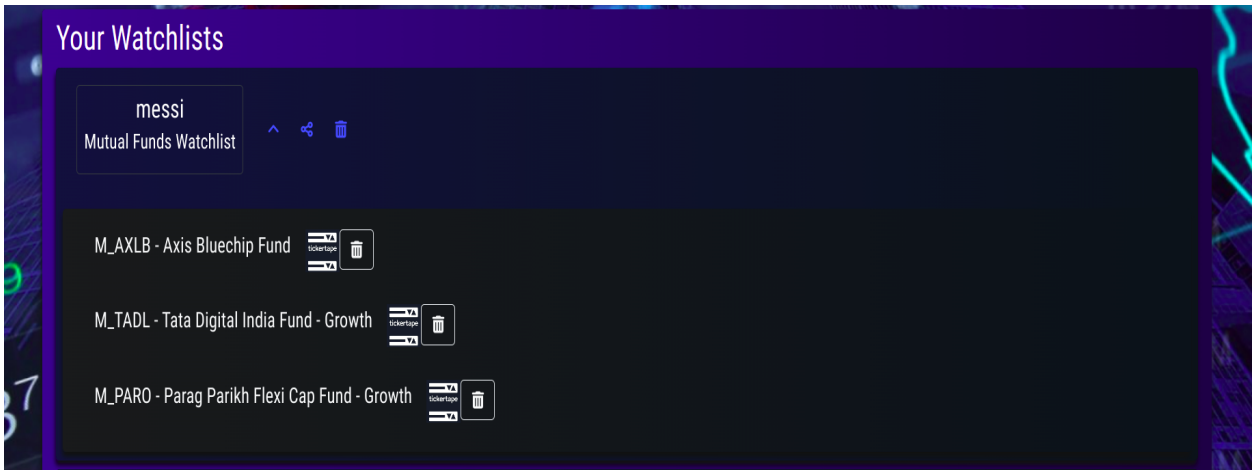
Successfully added instrument to watchlist



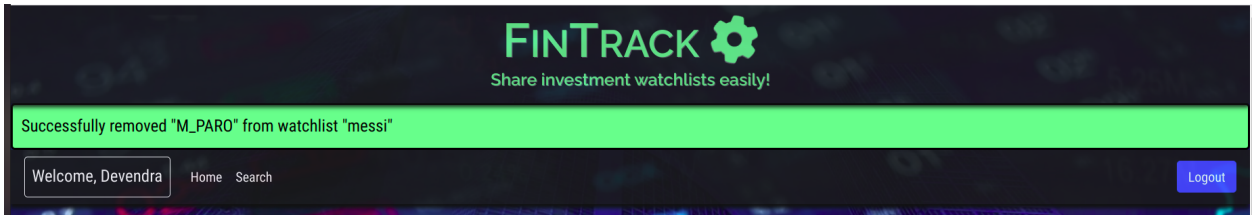
6.8. View a Watchlist



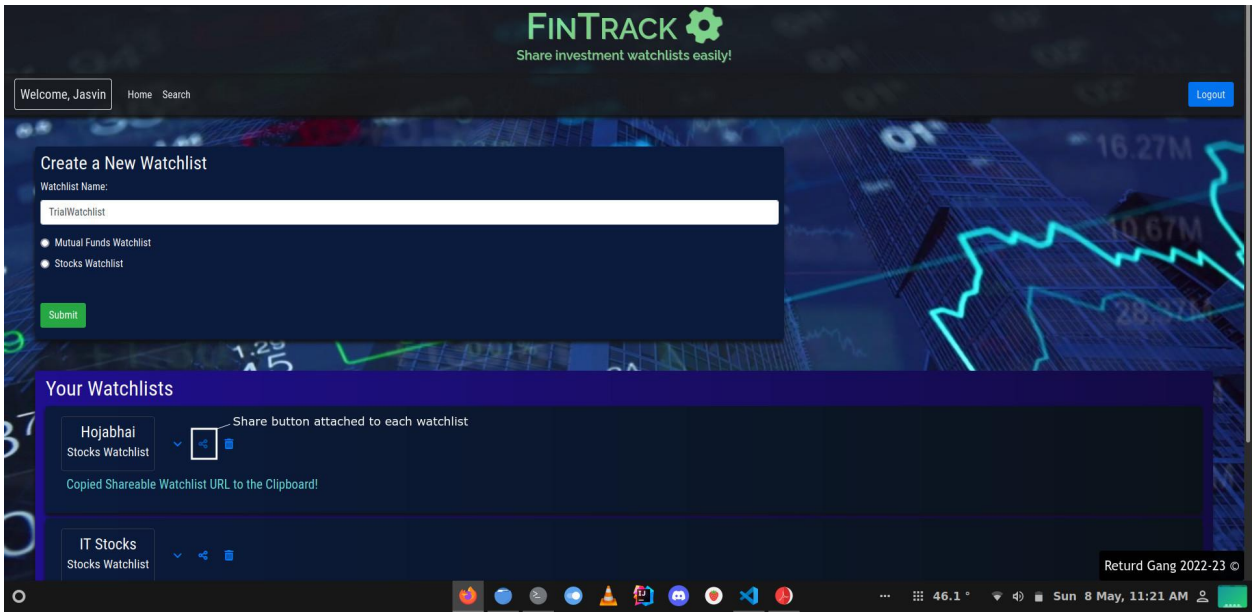
6.9. Delete an Instrument from a Watchlist



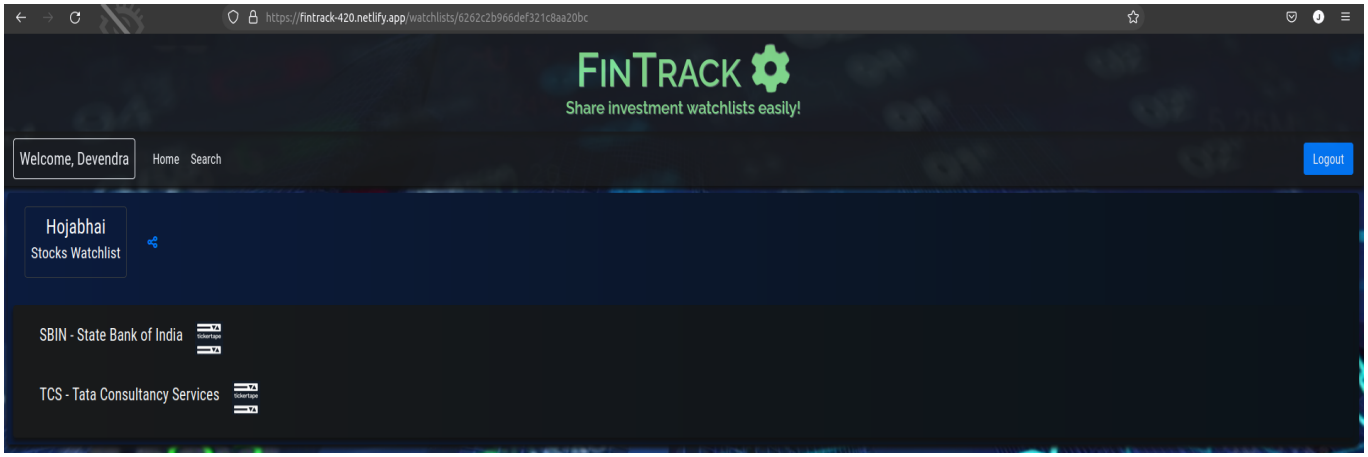
Successfully deleted the instrument from watchlist



6.10. Share Watchlist



Viewing shared watchlist from another account



7. Scope for Future Work

Rename a watchlist
Users can rename their already existing watchlists.

Rearrangement of instruments in watchlist
Users can rearrange the instruments in any of their watchlists as per their priority.

Dynamic presentation of actual price of instrument
Users can view the dynamic rate of change of prices of stock/MFs.

Add end-to-end testing
Test the entire application from frontend to backend via automation tools like Selenium, Cypress, etc.

Deployment on EC2 instance
Deploy the project on Amazon EC2 instance or a proper IaaS deployment basically.

8. Conclusion

We have successfully created the web-app *Fintrack* that will be helpful for users to share their watchlists with anyone they would want to.

We have integrated the entire DevOps CI/CD pipeline with the help of Jenkins.

Used Docker containers for increasing portability and adopting a microservice architecture development.

Used Docker Compose to orchestrate container deployment and manage them.

Used supertest for backend API testing and the React Testing Library for frontend testing.

Used Ansible for deployment and Ansible Vault with Jenkins for secrets management with templating via Jinja2.

We also visualized the logs on the ELK stack in an Elastic Cloud cluster.

And finally we also provided a PaaS deployment with the Heroku + Netlify + Github Actions alternative.

9. References

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