Crio.Do

Visualising and forecasting stocks using Dash

Overview

Objective

You will be creating a single-page web application using Dash (a python framework) and some machine learning models which will show company information (logo, registered name and description) and stock plots based on the stock code given by the user. Also the ML model will enable the user to get predicted stock prices for the date inputted by the user.

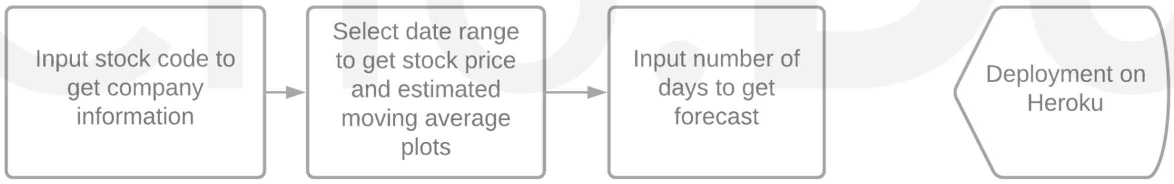
Project Context

Stock investments provide one of the highest returns in the market. Even though they are volatile in nature, one can visualize share prices and other statistical factors which helps the keen investors carefully decide on which company they want to spend their earnings on.

Developing this simple project idea using the Dash library (of Python), we can make dynamic plots of the financial data of a specific company by using the tabular data provided by yfinance python library. On top of it, we can use a machine learning algorithm to predict the upcoming stock prices.

This project is a good start for beginners in python/data science and a good refresher for professionals who have dabbled in python / ML before. This web application can be applied to any company (whose stock code is available) of one's choosing, so feel free to explore!

Project Stages


Input stock code to get company information
Select date range to get stock price and estimated moving average plots
Input number of days to get forecast
Deployment on Heroku

High-Level Approach

- Make the main website's structure using mainly Dash HTML Components and Dash Core Components.
- Enhance the site's UI by styling using CSS

- Generate plots of data using the `plotly` library of Python. The data is fetched using yfinance python library
- Implement a machine learning model to predict the stock price for the dates requested by the user.
- Deploy the project on Heroku to host the application live.

The end result of this project would look something like this:

https://www.youtube.com/embed/-r93RexMntM

Task 1

Getting started with required files and dependencies

First validate the idea by doing a low level implementation (Proof of Concept) of the components involved in this project.

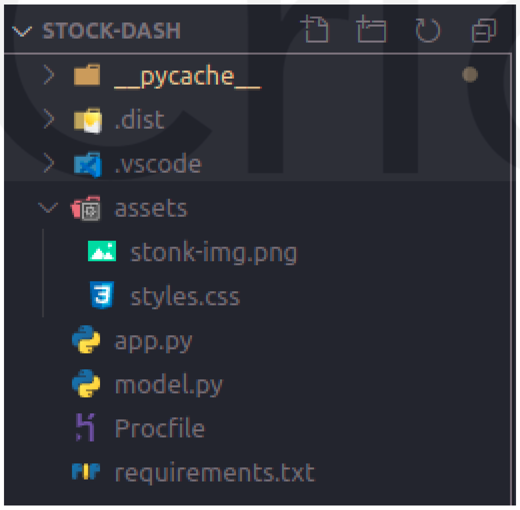
This helps you to:

1. Get more clarity around the unknowns.
2. Get a better understanding of the stages involved in the project.

We are going to set up the project's environment by setting up the application's starter files/folders. Also the dependencies to be installed will be covered here.

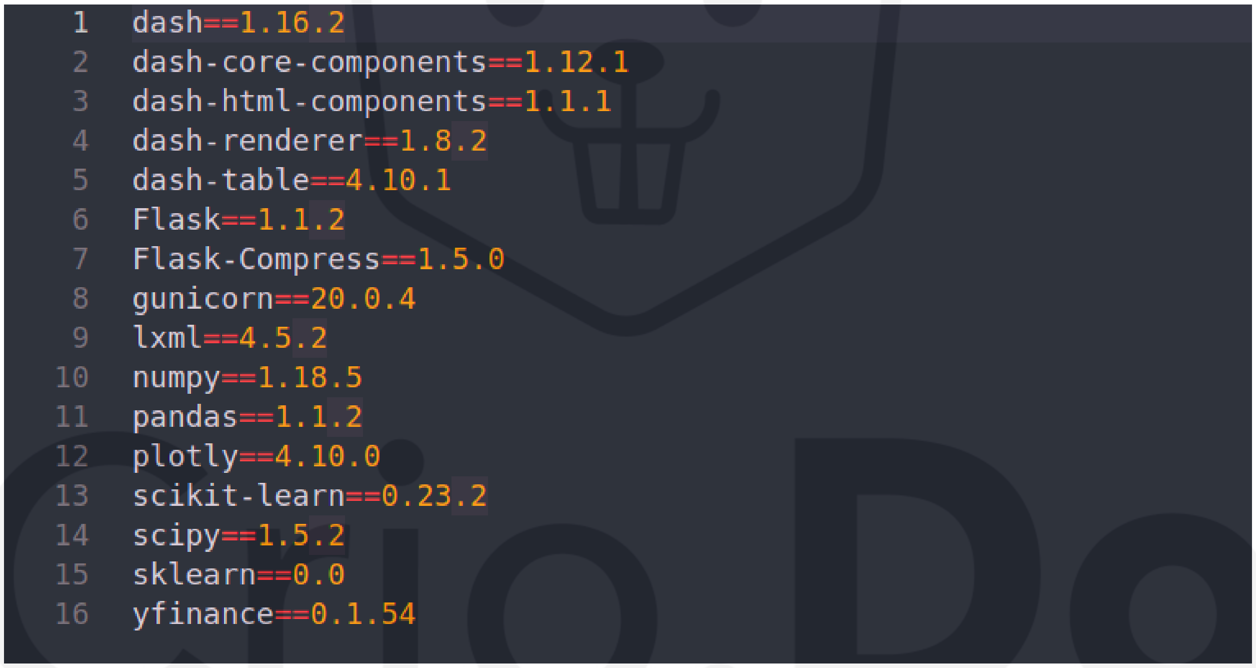
Requirements

- In your working directory, you can create the following file structure.



```
STOCK-DASH
> __pycache__
> .dist
> .vscode
v assets
    stonk-img.png
    styles.css
  app.py
  model.py
  Procfile
  requirements.txt
```

- You may follow the convention mentioned below -
  - `app.py` contains web layout and server function. We will be referring to it as our main file.
  - `model.py` is where we will implement a machine learning model for forecasting the stock price.
  - The `assets` folder is where we keep our CSS files for styling and any other miscellaneous files like images (if u wish to include it in your site)
  - `requirements.txt` is created so that other developers can install the correct versions of the required Python packages to run your Python code.
  - The `Procfile` is created for deployment using Heroku. It is not needed to run the app locally.
- Install necessary libraries using pip package installer. It is recommended to use the following packages/libraries for this project.



```
dash==1.16.2
dash-core-components==1.12.1
dash-html-components==1.1.1
dash-renderer==1.8.2
dash-table==4.10.1
Flask==1.1.2
Flask-Compress==1.5.0
gunicorn==20.0.4
lxml==4.5.2
numpy==1.18.5
pandas==1.1.2
plotly==4.10.0
scikit-learn==0.23.2
scipy==1.5.2
sklearn==0.0
yfinance==0.1.54
```

Tip

- While installing the packages (preferably while using the terminal) you can install multiple packages/libraries in a single line of command (by separating them by spaces) like this: `$ pip install lib1 lib2 lib3`

Note

- `numpy` library is used for multi-dimensional array operations.
- `pandas` is used for creating DataFrames to efficiently manage the data.

- `yfinance` is a library that allows us to fetch financial data of a company (since its listing in the stock market) from its stock code directly.
- `gunicorn` and `lxml` libraries will be used for the application's deployment i.e. to host the app on a target server.
- `sklearn` and `scikit-learn` are tools used in the development of Machine Learning (ML) models.

Task 2

Create basic website layout

The basic layout of the application will be built using Dash in this task.

Requirements

- Import relevant libraries as shown below:

```
import dash

import dash_core_components as dcc

import dash_html_components as html

from datetime import datetime as dt
```

- Create a Dash instance and store it in an app variable. Also, store the application's server property in a `server` variable as it will be frequently used.

```
app = dash.Dash(__name__)

server = app.server
```

- Make the web layout using Dash HTML Components and Dash Core Components, then store it in the app's layout component i.e. the `app.layout`. Your code should look something like this :

```
app.layout = html.Div([item1, item2])
```

- We mainly need two divisions (.Div) for the entire layout.

- The first one is for our inputs like stock code, date range selector, number of days of forecast and buttons. These components are the ones which the user will be interacting with. They should be given appropriate IDs and class names for the upcoming tasks. You can follow the code given below:

```
html.Div(
     [
      html.P("Welcome to the Stock Dash App!", className="start"),
      html.Div([
        # stock code input
      ]),
      html.Div([
        # Date range picker input
      ]),
      html.Div([
        # Stock price button
        # Indicators button
        # Number of days of forecast input
        # Forecast button
      ]),
     ],
    className="nav")
```

- The second division will be for the data plots and company's basic information (name, logo, brief intro) only. Leave the divisions inside them as blank and give unique IDs because these will get updated as you will see in the next task. You can refer to the code below :

```
html.Div(
     [
      html.Div(
          [  # Logo
            # Company Name
          ],
        className="header"),
      html.Div( #Description
        id="description", className="decription_ticker"),
      html.Div([
         # Stock price plot
      ], id="graphs-content"),
      html.Div([
          # Indicator plot
      ], id="main-content"),
      html.Div([
          # Forecast plot
      ], id="forecast-content")
     ],
   className="content")
```

- Write the following at the end of the main file for running the app in development mode (mandate this step for now)

```
if __name__ == '__main__':
    app.run_server(debug=True)
```

References

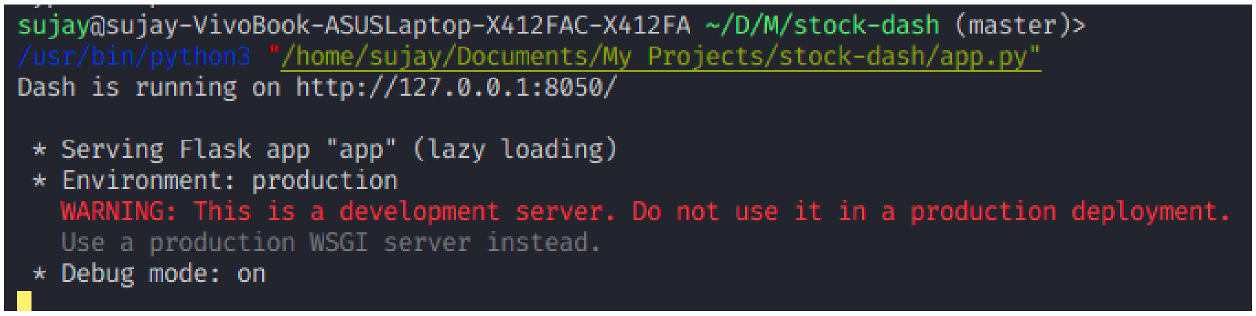
- Dash Layout
- Dash HTML Components
- Dash Core Components

Note

- Dash HTML Components are similar to HTML syntaxes, so try relating the two syntaxes together.
- Dash Core Components are useful for buildings certain things like input methods (text, number, range, slider etc).
- The equivalent of HTML's `class` is `className` in Dash layout.
- DatePickerRange component allows the user to pick a start and end date. It will be used to update the stock plots accordingly.
- Use the following command in the terminal of the working directory to run your Dash app's server locally - `$python3 app.py`

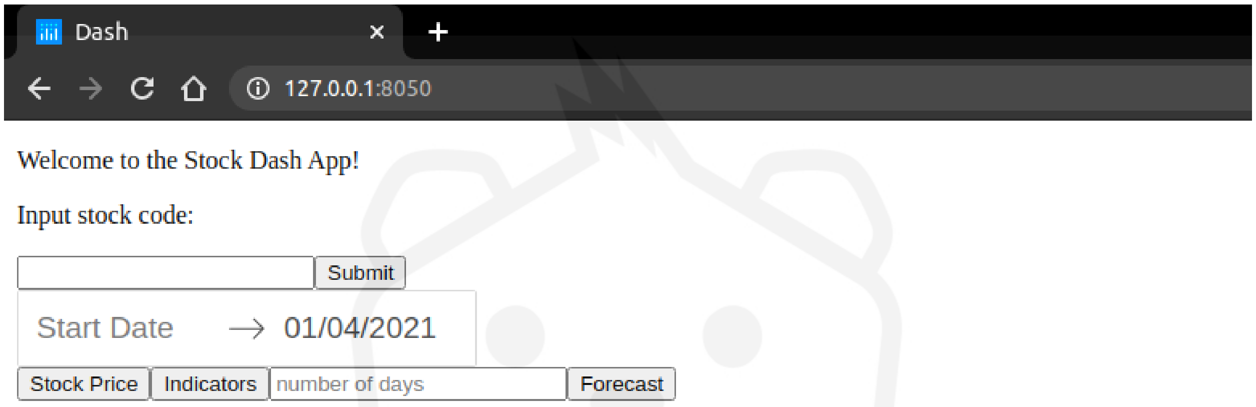
Expected Outcome

By now you should have the basic web page setup (as shown below in the second image) which can be seen by starting the server locally (as shown below in the first image).



```
sujay@sujay-VivoBook-ASUSLaptop-X412FAC-X412FA ~/D/M/stock-dash (master)>
/usr/bin/python3 "/home/sujay/Documents/My Projects/stock-dash/app.py"
Dash is running on http://127.0.0.1:8050/

 * Serving Flask app "app" (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production deployment.
   Use a production WSGI server instead.
 * Debug mode: on
```



Welcome to the Stock Dash App!

Input stock code:

Task 3

Styling the application's web page

Using CSS we will style our webpage to make it look more neat and user friendly.

Requirements

- Give a class name to the parent division (the one which contains both our main divisions) you created in Task 1. Name it something appropriate like `container`.
- Style the `container` division by giving the `display` property `flex` value. This will ensure that both the divisions are laid out in the same horizon.

```
.container {
  display: flex;
}
```

- Similarly, style the first division (the one containing our inputs). Again, give the `display` property `flex` value and the `flex-direction` property `column` value. Give it a suitable width too, ideally less than 40%. You can keep the items aligned at the center.

```
.inputs {
  width: 25vw;
  align-items: center;
  display: flex;
  flex-direction: column;
  justify-content: flex-start;
  background-color: rgb(5, 107, 107);
}
```

- Give class names to any of the components you want to further style.

References

- CSS Tutorial
- A Complete Guide to Flexbox

Tip

- You can apply some styles to the entire web page simply by using the * selector.

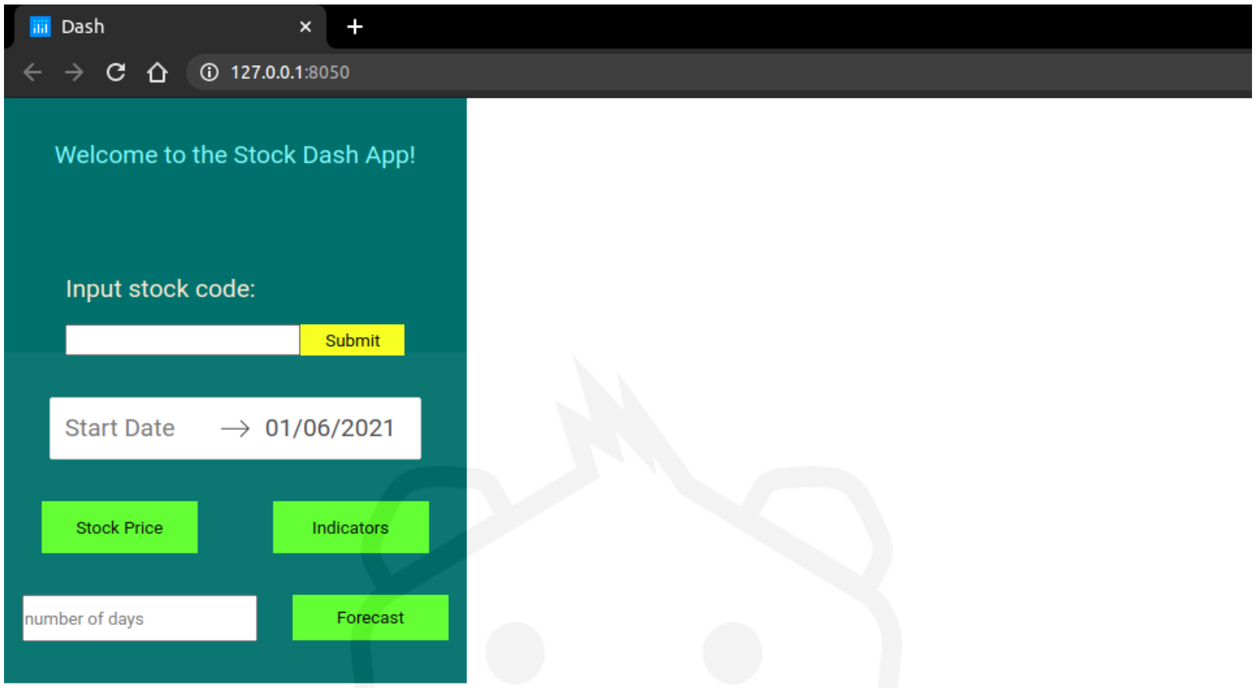
```
  * {
  margin: 0;
  padding: 0;
  box-sizing: 0;
  font-family: "Roboto", sans-serif;
}
```

Bring it On!

- Enhance your webpage by exploring and improving the styling

Expected Outcome

At this stage, your webpage should have a much better look than before. You may use the below web page as your starter template -



Task 4

Generating a company's information and graphs

We are going to use the `yfinance` python library to get company information (name, logo and description) and stock price history. Dash's callback functions will be used to trigger updates based on change in inputs.

Requirements

- In the main file, import relevant libraries as shown below

```
import yfinance as yf

import pandas as pd

import plotly.graph_objs as go

import plotly.express as px
```

- Make callback functions to update the empty divisions (.Div) we created in the basic web layout previously(for company information, stock graph and indicator graph). Dash's callback functions are called whenever an input component's property changes. List out theOutputalong with their respective IDs and property of the components you want to change. After that list theInputalong with their IDs and property of the components which will be used as a trigger for the change in Output components. You may also enlistState` to just use the component values without using them as a trigger. You may refer to the code example below.

```
@app.callback([
   Output("component-id-1", "property"),
   Output(# Output of component-id-2),
   ],
  [Input(# Input of component-id-2)],
  [State("component-id-4", "property")])
def update_data(arg1, arg2):  # input parameter(s)
   # your function here
   return output1, output2
```

- In the first callback function, use the input field (for stock code) and submit buttons as `State` and `Input` components respectively. For the `Output` component use the first empty `Div` you had created in Task 2. Use the yfinance library's `Ticker` function to fetch the company info and return it from the first callback function (you may refer to the code snippet below)

```
ticker = yf.Ticker(val)
inf = ticker.info
df = pd.DataFrame().from_dict(inf, orient="index").T
return # df's first element of 'longBusinessSummary', df's first element
value of 'logo_url', df's first element value of 'shortName'
```

- For making the second callback function, use the date range picker's start date, end date and also the stock price button as `Input` components. For the `Output` component use the second empty `Div` we had created in Task 2. You can download the stock price history with the `download` function of the `yfinance` library. We get a DataFrame in return. You can pass that DataFrame to a user defined function (which we will make) that returns the required plot (using `plotly` library). Finally, that plot can be returned from our callback function as a Dash Core Component Graph. You may refer to the code examples below.

```
df = yf.download(# input parameter, start_date str, end_date str )
df.reset_index(inplace=True)
fig = get_stock_price_fig(df)
return # plot the graph of fig using DCC function
```

User defined function for stock price graph generation from a given DataFrame

```
def get_stock_price_fig(df):
    fig = px.line(df,
              x= # Date str,
              y= # list of 'Open' and 'Close',
              title="Closing and Opening Price vs Date")
    return fig
```

- The third callback will be for generating our indicator graph. You may use estimated moving average (EMA) for it. The callback function for it will be similar to the second one. However, we need to make a new user defined function which will return an EMA plot over time. You can refer to the code given below

```
def get_more(df):
    df['EWA_20'] = df['Close'].ewm(span=20, adjust=False).mean()
    fig = px.scatter(df,
               x= # Date str,
               y= # EWA_20 str,
               title="Exponential Moving Average vs Date")

    fig.update_traces(mode= # appropriate mode)

    return fig
```

- Till here we have completed the `app.py` file, i.e. the web layout and server functions are in place and hence the app is partially functional (prediction feature is yet to be implemented).

References

- Basic Callbacks
- Plotly Express
- Hands-On Guide To Using YFinance library In Python

Note

- You will most likely encounter many callbacks errors in Dash. This is because Dash had stopped supporting 'events' after a particular version. You may try using properties like `n_clicks` instead.
- Specifically, the callbacks are supposed to trigger some action when a given input parameter changes. To overcome unnecessary updates, use the raise PreventUpdate statement.
- We will have to make another callback function for the ML model later.

Expected Outcome

By now, your webpage should get updated by the respective inputs. You should be able to display company info and the dynamic plotly graphs

https://www.youtube.com/embed/8x3oUb5hdSw

Task 5

Creating the machine learning model

We are now going to build a machine learning model - Support Vector Regression (SVR) for predicting the stock prices.

Requirements

- Make the model in the `model.py` file.
- Use the support vector regression (SVR) module from the `sklearn` library. Fetch the stock prices for the last 60 days. Split the dataset into 9:1 ratio for training and testing respectively.
- Use the rbf kernel in `GridSearchCV` for tuning your hyperparameters.
- Then, train the SVR model with the training dataset.
- Test your model's performance by using metrics such as Mean Squared Error (MSE) and Mean Absolute Error (MAE) on the testing dataset.
- After the model is built, make sure another callback function (as seen in Task 2) for the same is made in the main file i.e. `app.py` (where the model is to be imported).

References

- Build A Stock Prediction Program
- Stock Market Predictions with LSTM in Python
- An introduction to Grid Search

Tip

- If the testing results are poor you can try changing the train-test split ratio or even modify the gridsearch values. You can visit here for more enhancements.
- LSTM is a deep learning model and gives us far more accurate results when compared to Support Vector Regression.

Note

- Try to tune the C, epsilon and gamma parameters in the grid search. Then use them to train the SVR model.
- Keep in mind that stock prices are volatile and using a deep learning model might yield better results for larger training sets.

Expected Outcome

After finishing all this, we should have a complete project where user input - stock, code can give us the company information and relevant plots. Also, user input number of days can give us a forecast plot.

https://www.youtube.com/embed/D3WjXpVipCk

Task 6

Deploying the project on Heroku

Now that your project is complete, feel free to deploy it on Heroku for free!

Requirements

- Create a Heroku account.
- Run `$ pip install gunicorn` in the terminal.
- Run `$ pip freeze > requirements.txt` in the terminal. This creates a text file containing all our dependencies.
- Create a `Procfile` in the working directory. In that paste `web: gunicorn app:server`
- Run `$ sudo snap install --classic heroku` on terminal to install the Heroku CLI.
- In the terminal, run the commands below:

```
$ heroku create unique-name-here

$ git add .

$ git commit -m 'Initial app template'

$ git push heroku master
```

- Finally, run the app on one dyno by doing `$ heroku ps:scale web=1`

References

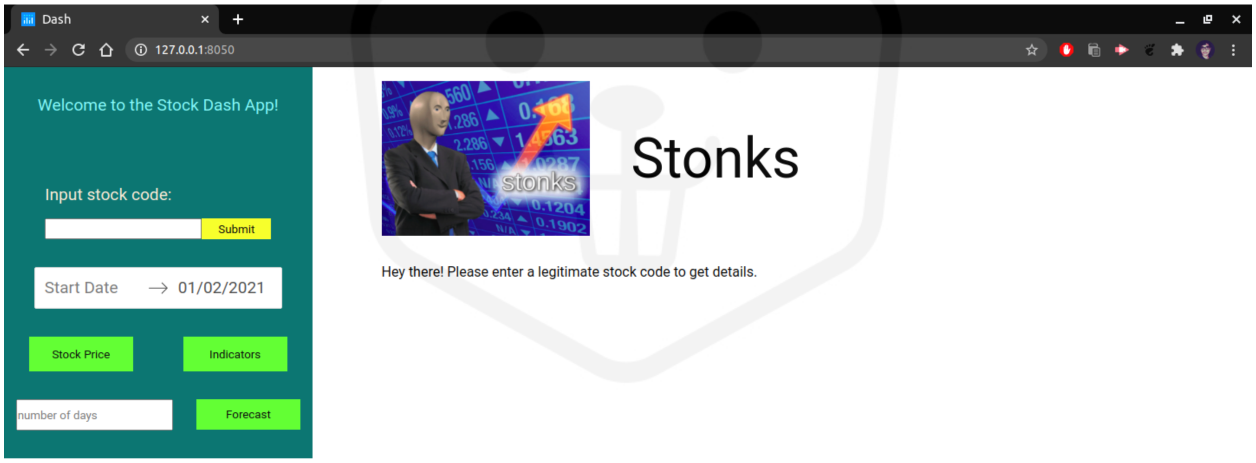
- Deploying Dash Apps
- Heroku CLI

Note

- The URL should be generated after following the aforementioned steps. It should look like https://unique-name-here.herokuapp.com
- Heroku has some limitations on free plans. However, you can upgrade by paying a fee.
- In case of deployment errors, Heroku maintains a log of it for you to check out.
- You may use any other hosting services too if you are uncomfortable with using Heroku.

Expected Outcome

Finally, our web app is deployed and can be accessed by anyone in the world.



Hey there! Please enter a legitimate stock code to get details.