Predicting Compressive Strength of Concrete

Category: Machine Learning

Project Description:

Concrete is a material used in construction that has great versatility and which is used across the globe. Concrete has several advantages, including good compressive strength, durability, workability, construction availability, and low cost. Determining accurate concrete strength is a major civil engineering problem. Test results of 28- day concrete cylinder represent the characteristic strength of the concrete that has been prepared and cast to form the concrete work. It is important to wait 28 days to ensure the quality control of the process, although it is very time consuming. Machine learning techniques are progressively used to simulate the characteristic of concrete materials and have developed into an important research area.

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1) Introduction

1.1 Overview:

Concrete is a complex composite material. Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate.

The predictability of concrete strength is extremely low. Therefore, it is challenging to create a model with the dependent variables of the concrete. One of the biggest challenge is to consider too many independent variables precisely and get a relation between them.

In this project, we are considering 8 independent variables for predicting the concrete strength. This is dataset can be trained and tested using Multivariant Linear Regression Model which comes under Supervised Machine Learning. We are building and evaluating multiple Machine Learning Models, and finding the lowest RMSE to understand which model has higher accuracy.

strength is just one application of the regression function of ML. Compared with other traditional regression method, ML adopts certain

1.2 Purpose:

In recent years, the ML methods have become popular as they allow researchers to improve the prediction accuracy of concrete properties and are used for various engineering applications. The ML methods have been used to increase the prediction accuracy of concrete properties, and the data derived from the literature sources were used

Regression models tend to be used for the prediction of the compressive strength of high-strength concrete. These models also demonstrate how the concrete compressive strength depends on the mixing ratios.

Previous studies evaluated the amount of the concrete component materials and compared their results to the published data. In this study, the ML regression methods were compared to predict the compressive strength and slump values of the cube samples. The samples were prepared by accounting for seven simultaneously controllable effect variables in the laboratory.

2) Literature Survey

2.1 Existing Problem

This is generally determined by a standard crushing test on a concrete cylinder. This requires engineers to build small concrete cylinders with different combinations of raw materials and test these cylinders for strength variations with a change in each raw material. The recommended wait time for testing the cylinder will take some days to ensure correct results. This consumes a lot of time and requires a lot of labour to prepare different prototypes and test them. Also, this method is prone to human error and one small mistake can cause the wait time to drastically increase**.**

2.2 Proposed Solution

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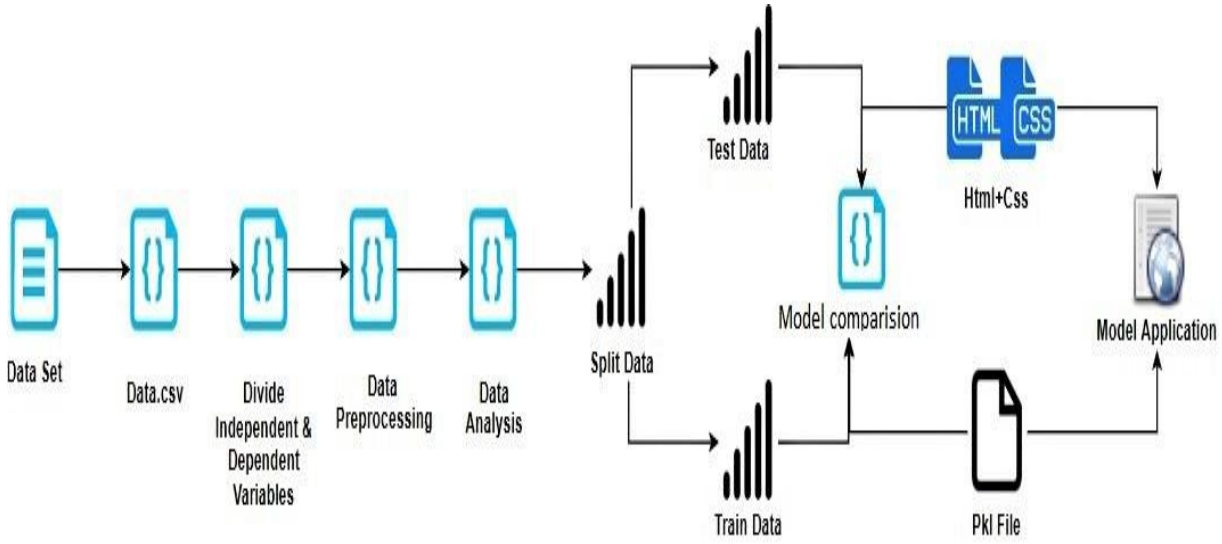
for testing the cylinder is period of days to ensure correct results. This consumes a lot of time and requires a lot of labour to prepare different prototypes and test them. Also, this method is used to human error and one small mistake can cause the wait time to increase time

3) Theoretical Analysis

3.1 Block Diagram



3.2 Hardware / Software designing

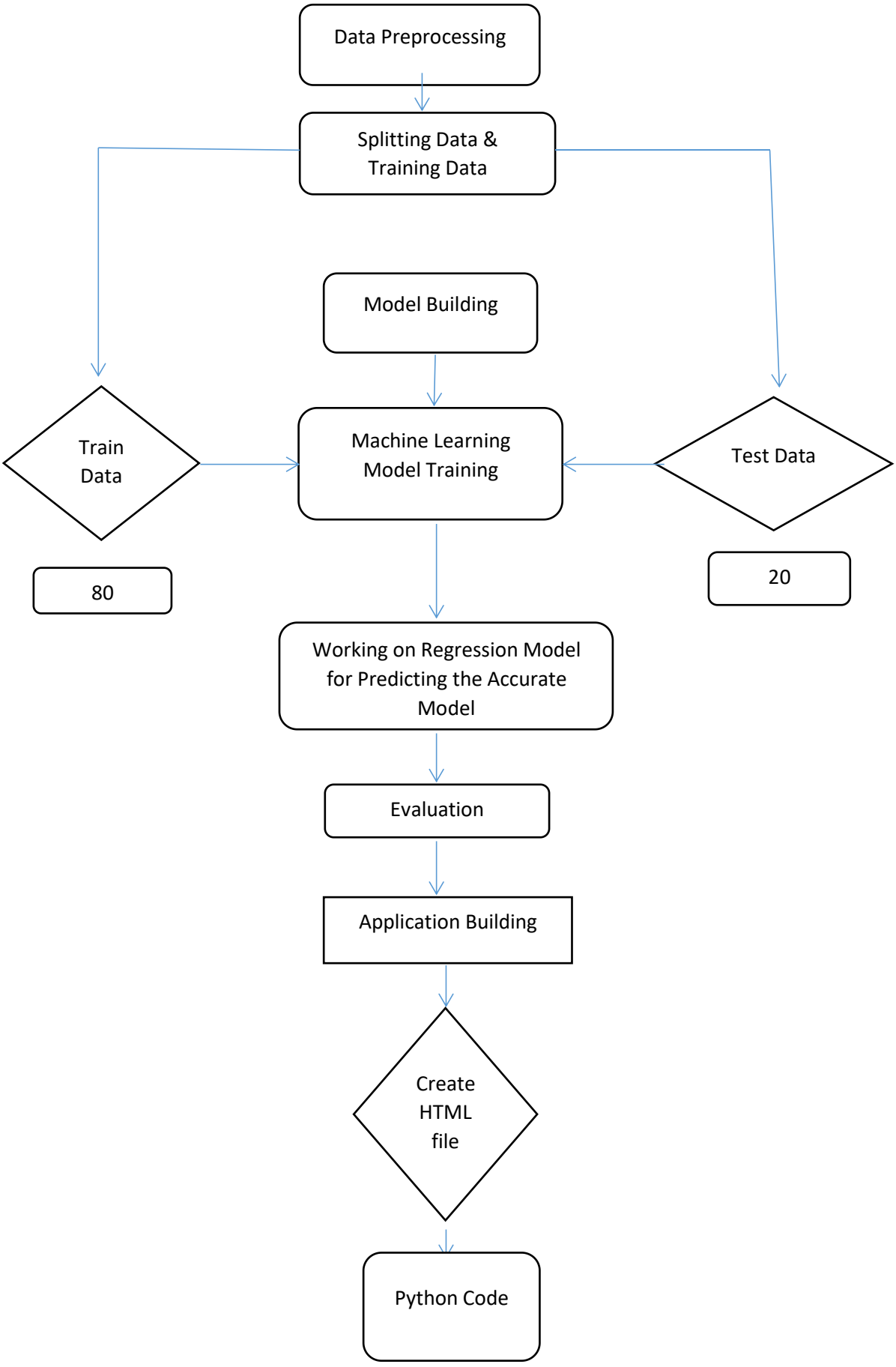
- Python, Python Web Frame Works
- Python for Data Analysis
- Python For Data Visualization
- Data Pre-processing Techniques
- Machine Learning
- Regression Algorithms

4) Experimental Investigation

Range of various parameters

1. Cement (component 1)(kg in a m^3 mixture) = 102-540
2. Blast Furnace Slag (component 2)(kg in a m^3 mixture) = 0-359.4
3. Fly Ash (component 3)(kg in a m^3 mixture) =0-200.1
4. Water (component 4)(kg in a m^3 mixture) = 121.75-247
5. Superplasticizer (component 5)(kg in a m^3 mixture) = 0-32.2
6. Coarse Aggregate (component 6)(kg in a m^3 mixture) = 801-1145
7. Fine Aggregate (component 7)(kg in a m^3 mixture) = 594-992.6
8. Age (day) =1-365

5) Flowchart


Data Preprocessing
Splitting Data & Training Data
Model Building
Train Data
Machine Learning Model Training
Test Data
80
20
Working on Regression Model for Predicting the Accurate Model
Evaluation
Application Building
Create HTML file
Python Code

6) RESULT

Based on the 8 inputs entered by the user, the model predicts the strength of the concrete prepared and displays the predicted strength

7) Advantages and Disadvantages

Advantages:

Using Machine learning to predict the strength of the concrete will be time and more accuracy in predicting the approximately close value can be done easily. Its more trust worthy and cost effective .It also reduces the man power for doing the experiments to find the strength of the concrete in different unknown situations.

Disadvantages:

There is a 8% chances that the outcome will not predict the approximate value in that situation it can be troublesome.

8) Applications:

- Can predict the strength of the concrete using the inputs provided.
- Implementable on the website

9) Conclusion

Maximum accuracy received is 92 %.

A total of 1030 sample data collected from the experimental test were used to develop the Random Forest Regression model for predicting compressive strength.

10) Future Scope

This model can predict the outcome with many different inputs within seconds. The model will save a lot of time of the construction companies and the civil engineers. Experiment cost is also reduced with creates a bigger opportunity for construction companies in cost effectiveness work.

11) Bibliography

Model Building:

- Dataset
- Notebook

Application Building:

- HTML 5 and CSS 3 files
- Flask
- Joblib

12) Appendix

A.Source code:

Notebook:

https://colab.research.google.com/drive/166z4aPr3tcktNemjGrBtlfv2A5Sq9iv1?usp=sharing

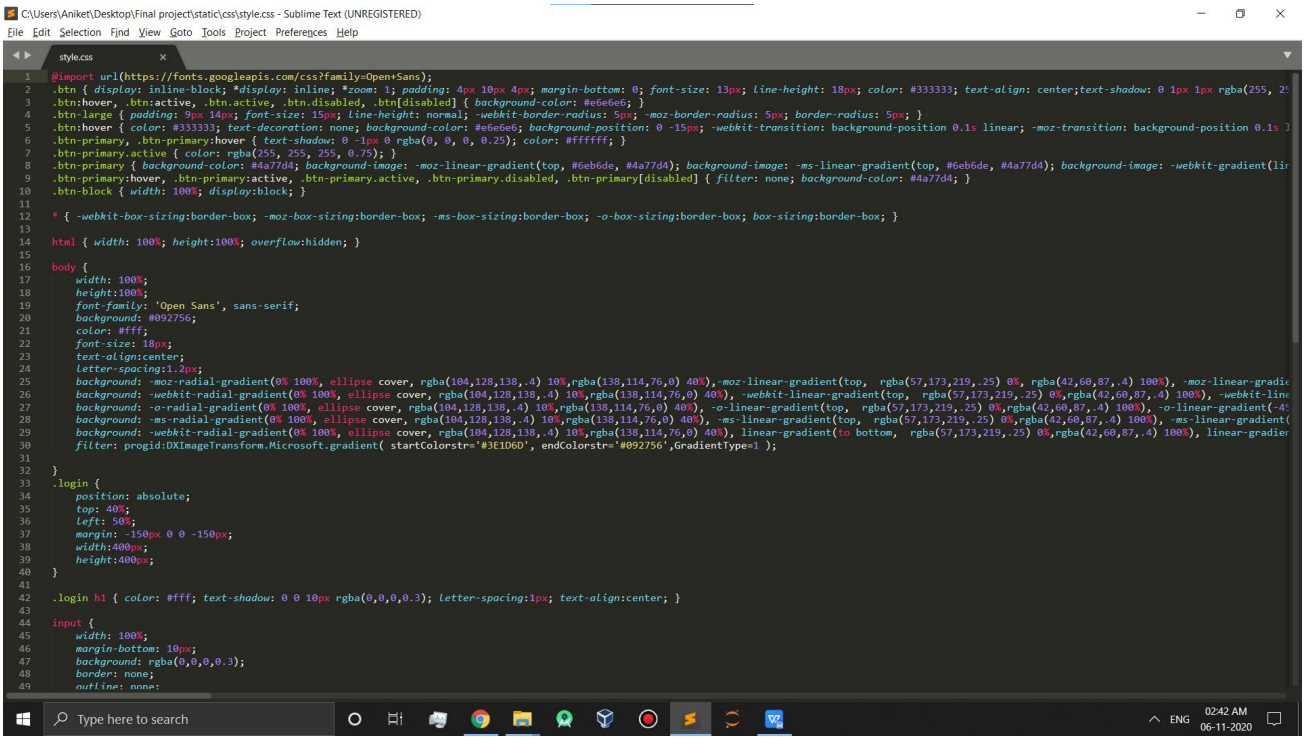
UI code:

Index.html

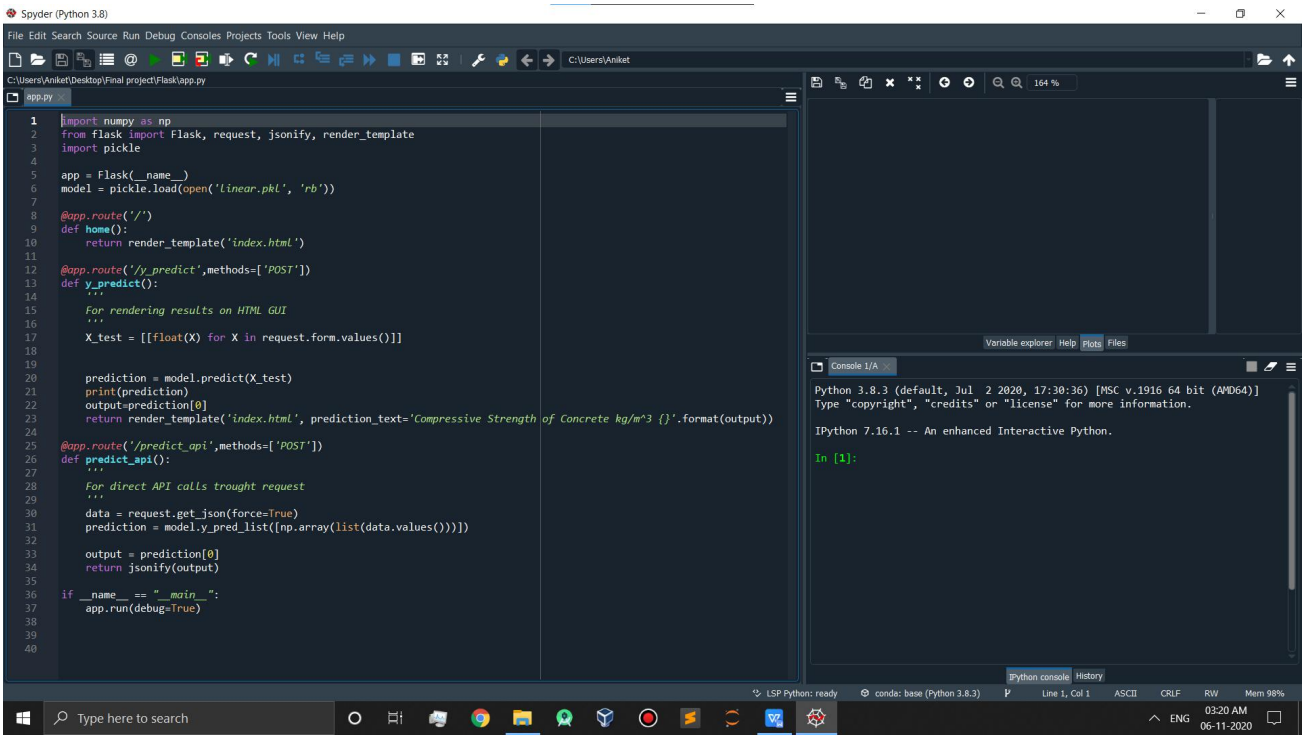
index.html

```
<!DOCTYPE html>
<html >
<!--From https://codepen.io/frytyler/pen/EGdtg-->
<head>
  <meta charset="UTF-8">
  <title>Machine Learning</title>
  <link href='https://fonts.googleapis.com/css?family=Pacifico' rel='stylesheet' type='text/css'>
<link href='https://fonts.googleapis.com/css?family=Arimo' rel='stylesheet' type='text/css'>
<link href='https://fonts.googleapis.com/css?family=Hind:300' rel='stylesheet' type='text/css'>
<link href='https://fonts.googleapis.com/css?family=Open+Sans+Condensed:300' rel='stylesheet' type='text/css'>
<link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">

<style>
.login{
top: 20%;
}
</style>
</head>

<body>
 <div class="login">
  <h1>Predicting Compressive Strength of Concrete</h1>

    <!-- Main Input For Receiving Query to our ML -->
    <form action="{{ url_for('y_predict')}}"method="post">
      <input type="text" name="cement" placeholder="Cement (kg in a m^3 mixture)" required="required" />
        <input type="text" name="blast_furnace_slag" placeholder="Blast Furnace Slag (kg in a m^3 mixture)" required="required" />
    <input type="text" name="fly_ash" placeholder="Fly Ash (kg in a m^3 mixture)" required="required" />
        <input type="text" name="water" placeholder="Water (kg in a m^3 mixture)" required="required" />
        <input type="text" name="superplasticizer" placeholder="Superplasticizer (kg in a m^3 mixture)" required="required" />
        <input type="text" name="coarse_aggregate" placeholder="Coarse Aggregate (kg in a m^3 mixture)" required="required" />
        <input type="text" name="fine_aggregate" placeholder="Fine Aggregate (kg in a m^3 mixture) " required="required" />
        <input type="text" name="age" placeholder="Age (day)" required="required" />
        <button type="submit" class="btn btn-primary btn-block btn-large">Find Out Strength! &#128170</button>

    </form>

    <br>
    <br>
    {{ prediction_text }}

</div>
</body>
</html>
```

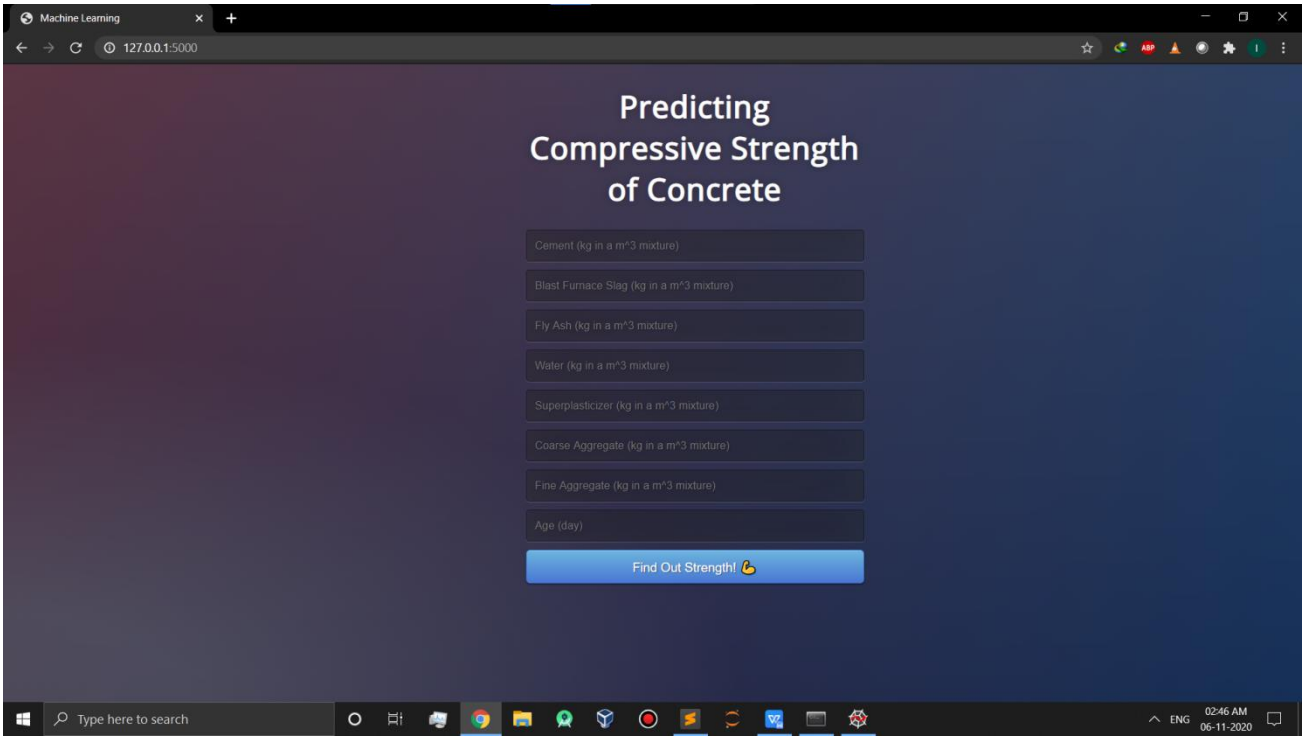
Style.css

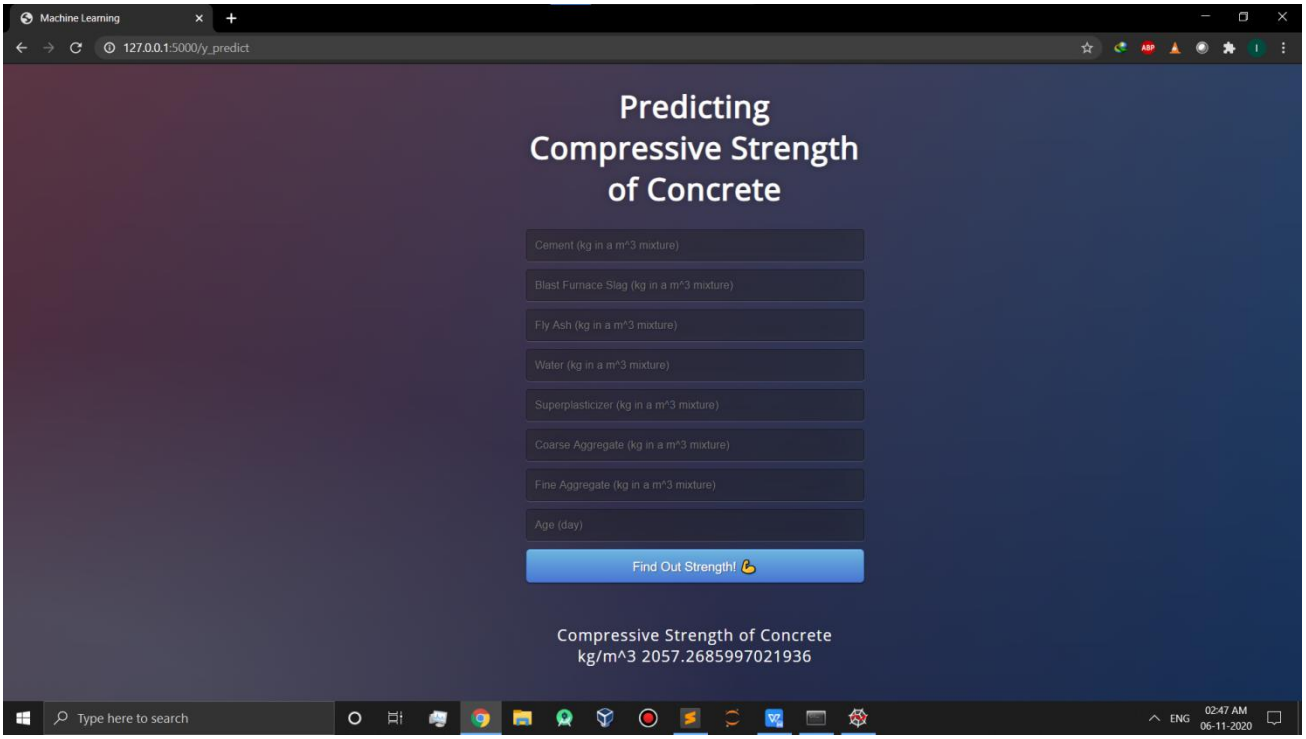


app.py



B.UI Output:


Machine Learning
127.0.0.1:5000
Predicting
Compressive Strength
of Concrete
Cement (kg in a m^3 mixture)
Blast Furnace Slag (kg in a m^3 mixture)
Fly Ash (kg in a m^3 mixture)
Water (kg in a m^3 mixture)
Superplasticizer (kg in a m^3 mixture)
Coarse Aggregate (kg in a m^3 mixture)
Fine Aggregate (kg in a m^3 mixture)
Age (day)
Find Out Strength!
Type here to search
ENG
02:46 AM
06-11-2020


Machine Learning
127.0.0.1:5000/y_predict
Predicting
Compressive Strength
of Concrete
Cement (kg in a m^3 mixture)
Blast Furnace Slag (kg in a m^3 mixture)
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Water (kg in a m^3 mixture)
Superplasticizer (kg in a m^3 mixture)
Coarse Aggregate (kg in a m^3 mixture)
Fine Aggregate (kg in a m^3 mixture)
Age (day)
Find Out Strength!
Compressive Strength of Concrete
kg/m^3 2057.2685997021936
Type here to search
ENG
02:47 AM
06-11-2020