Predicting Compressive Strength of Concrete using IBM Watson Auto AI Experiment

Team Number:RSIP Career Basic ML 020

Learning Track: Machine Learning

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Introduction

Overview

Concrete is a material used in construction that has great versatility and which is used across the globe. Concrete has several advantages, including good compression strength, durability, work ability, 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. This study proposed a comprehensive study using an advanced machine learning technique to predict the compression strength of concrete from early age test results.

Purpose

An ability to predict the compression strength of concrete early allows constructors to quickly understand the concrete's probable weaknesses and decide to manage a destruction process or continue with construction. Further, to the benefit of both user (and purchaser) and producer, reliably and rapidly predicting the results of a 28-day test would benefit all stakeholders as opposed to waiting the full, conventional, 28 days.

Literature Survey

Existing Problem

Determining accurate concrete strength is a major civil engineering problem. Concrete is the most important material in civil engineering. The concrete compression strength is a highly nonlinear function of age and ingredients. These ingredients include cement, blast furnace slag, fly ash, water, superplasticizer, coarse aggregate, and fine aggregate.

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, work ability, construction availability, and low cost.

Proposed Solution

We are building a Machine Learning model to predict the compressive strength of concrete using IBM Watson Auto AI Machine Learning Service. The model is deployed on IBM cloud to get scoring end point which can be used as API in mobile app or web app building. We are developing a web application which is built using node red service. We make use of the scoring end point to give user input values to the deployed model. The model prediction is then showcased on User Interface.

Theoretical Analysis

Block Diagram

Deploy the App

In the nodes write the codes, api key, payloads, headers etc.

Import the json file and add the dashboard nodes

Make Sure it' s Running and then visit URL

Create a Node Red App

Deploy the model created

Download Node Red Service

Run Auto AI And determine the best model

Create Machine Learning Instance

Upload dataset And Add Auto AI

Download Machine Learning Instance

Download IBM Watson Studio

Login IBM Cloud

IBM Cloud Registration

Software Designing

IBM Cloud Computing

It is a set of cloud computing services for business offered by the information technology company IBM. IBM Cloud includes infrastructure as a service (IaaS), software as a service (SaaS) and platform as a service (PaaS) offered through public, private and hybrid cloud delivery models, in addition to the components that make up those clouds.

IBM Watson Studio

IBM Watson Studio helps data scientists and analysts prepare data and build models at scale across any cloud. With its open, flexible multi cloud architecture, Watson Studio provides capabilities that empower businesses to simplify enterprise data science and AI, such as:

1. Automate AI lifecycle management with Auto AI
2. Visually prepare and build models with IBM SPSS Modeler
3. Build models using images with IBM Watson Visual Recognition and texts with IBM Watson Natural Language Classifier
4. Deploy and run models through one-click integration with IBM Watson Machine Learning
5. Manage and monitor models through integration with IBM Watson Open scale.

Node Red

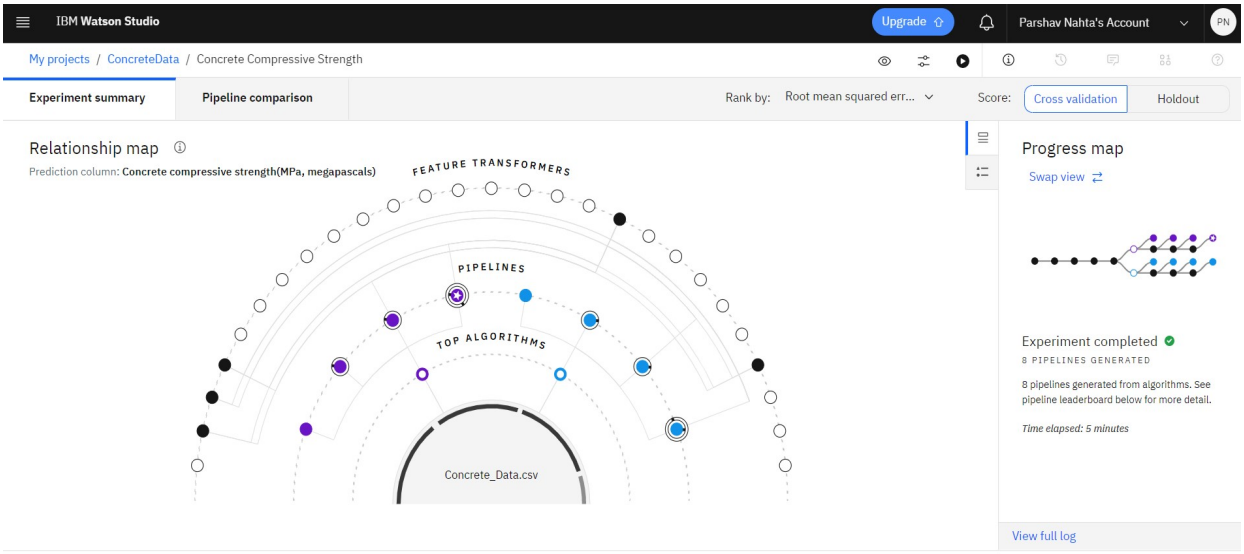
6. Node-RED is a flow-based development tool for visual

programming developed originally by IBM for wiring together hardware devices, APIs and online services as part of the Internet of Things.

7. Node-RED provides a web browser-based flow editor, which can be used to create JavaScript functions. Elements of applications can be saved or shared for re-use. The runtime is built on Node.js. The flows created in Node-RED are stored using JSON. Since version 0.14, MQTT nodes can make properly configured TLS connections.
8. In 2016, IBM contributed Node-RED as an open source JS Foundation project.

Pictorial Representataion

Step 1: Creating A Project add dataset to it and run auto ai



Step 2: Saving the Best Model

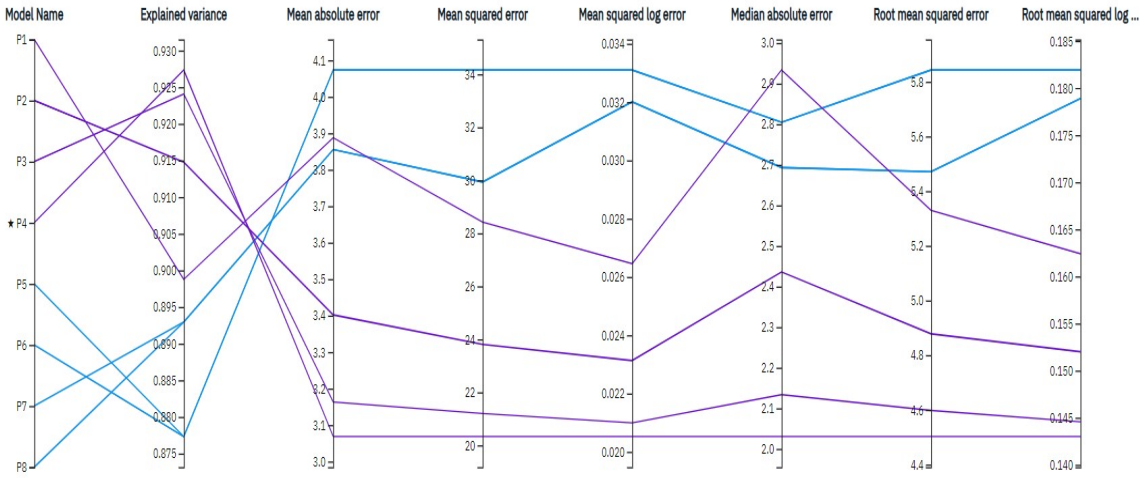
Pipeline leaderboard

	Rank	Name	Algorithm	RMSE (Optimized)	Enhancements	Build time
›	★ 1	Pipeline 4	Gradient Boosting Regressor	**4.502**	HPO-1 FE HPO-2	00:00:20
›	2	Pipeline 3	Gradient Boosting Regressor	**4.598**	HPO-1 FE	00:02:02
›	3	Pipeline 2	Gradient Boosting Regressor	**4.878**	HPO-1	00:00:11
›	4	Pipeline 1	Gradient Boosting Regressor	**5.330**	*None*	00:00:01
›	5	Pipeline 7	Random Forest Regressor	**5.471**	HPO-1 FE	00:00:45
›	6	Pipeline 8	Random Forest Regressor	**5.471**	HPO-1 FE HPO-2	00:00:35
›	7	Pipeline 5	Random Forest Regressor	**5.843**	*None*	00:00:01
›	8	Pipeline 6	Random Forest Regressor	**5.843**	HPO-1	00:00:09

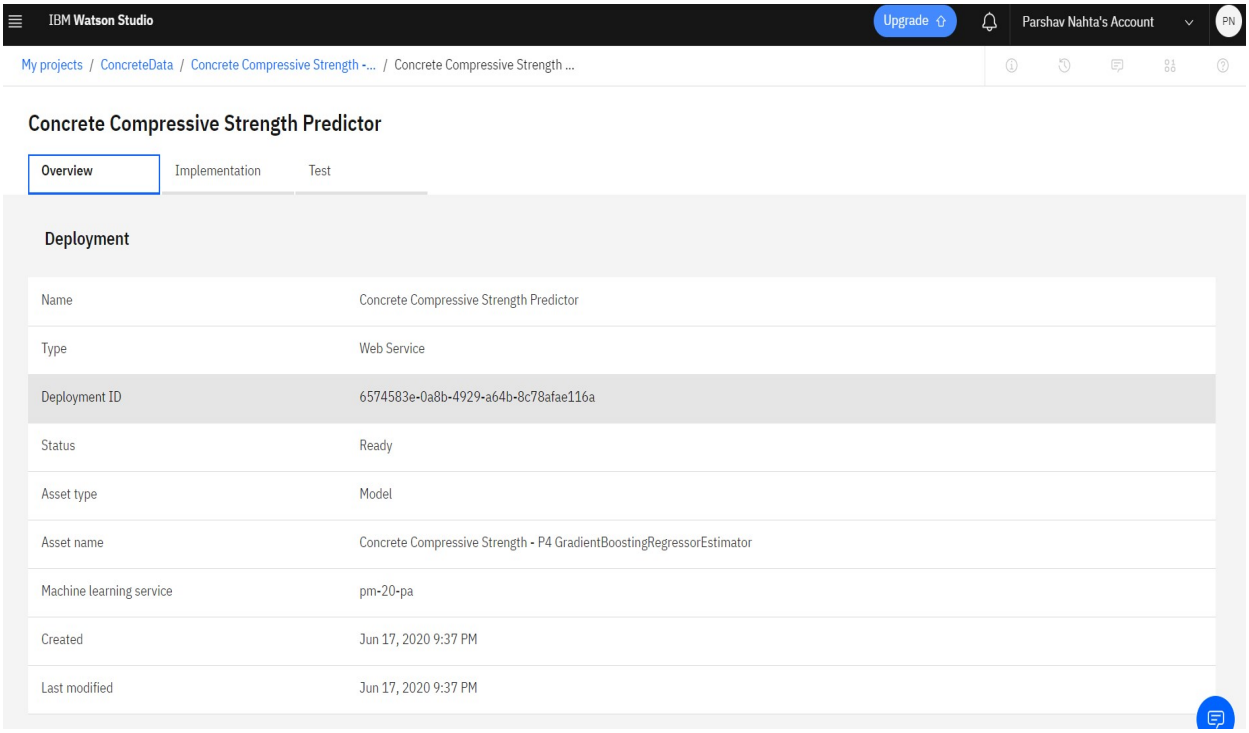
Step 3: Understanding the Metrics Chart

Metric chart

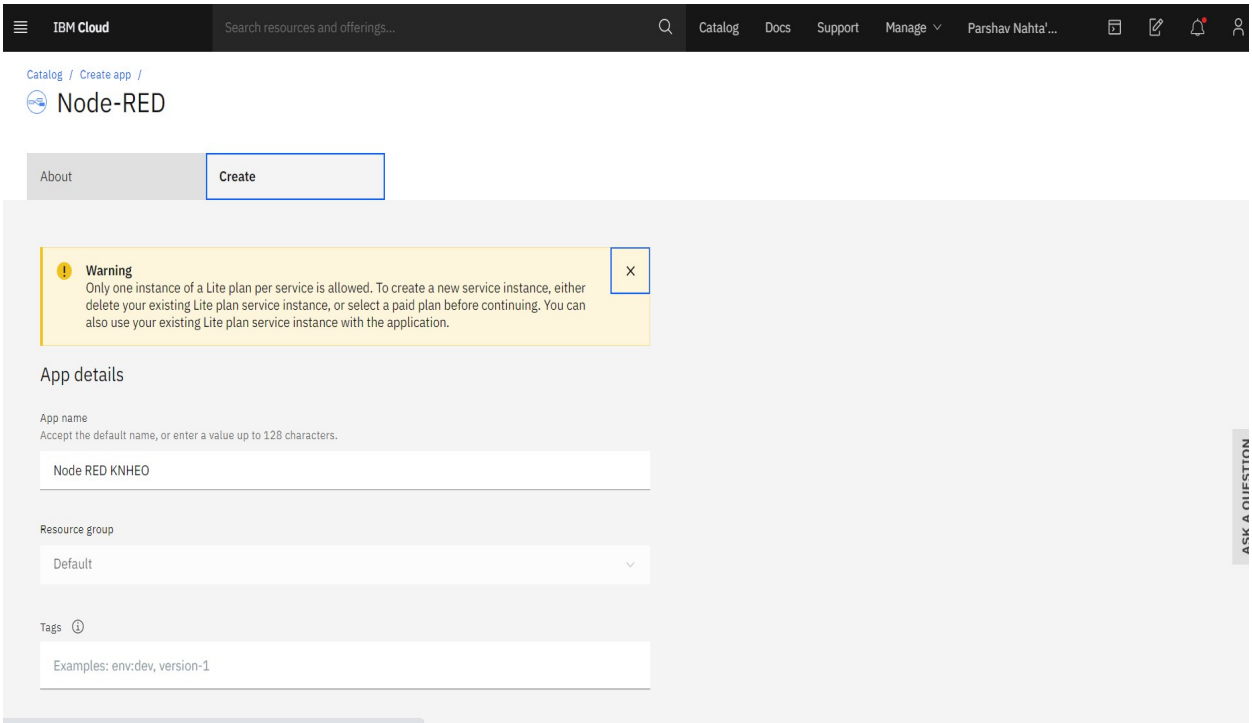
Prediction column: **Concrete compressive strength(MPa, megapascals)**



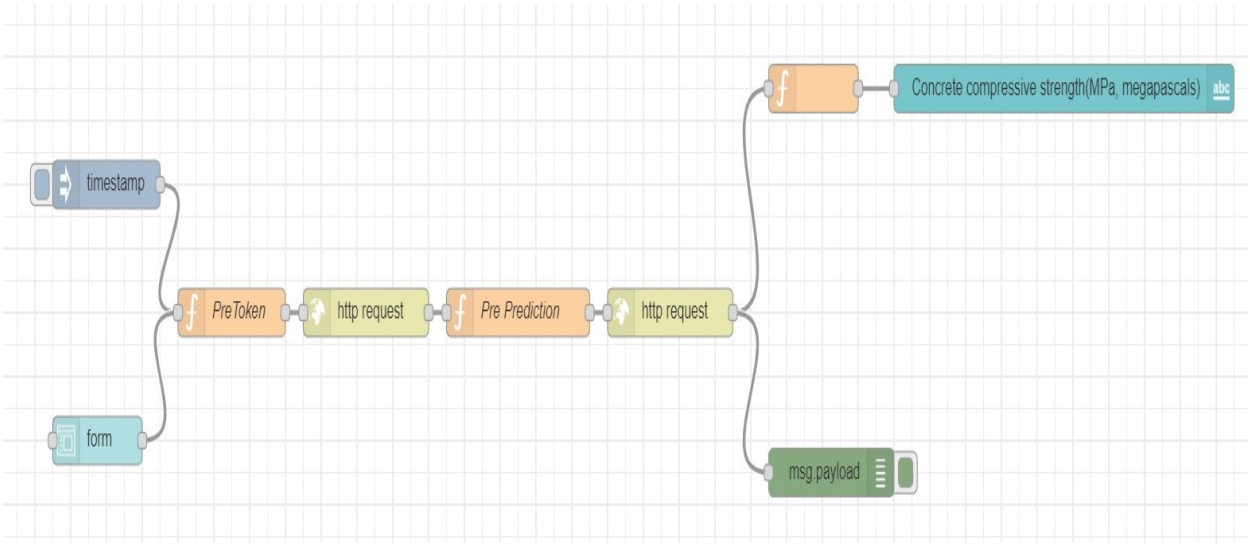
Step 4: Creating Deployment of the Model



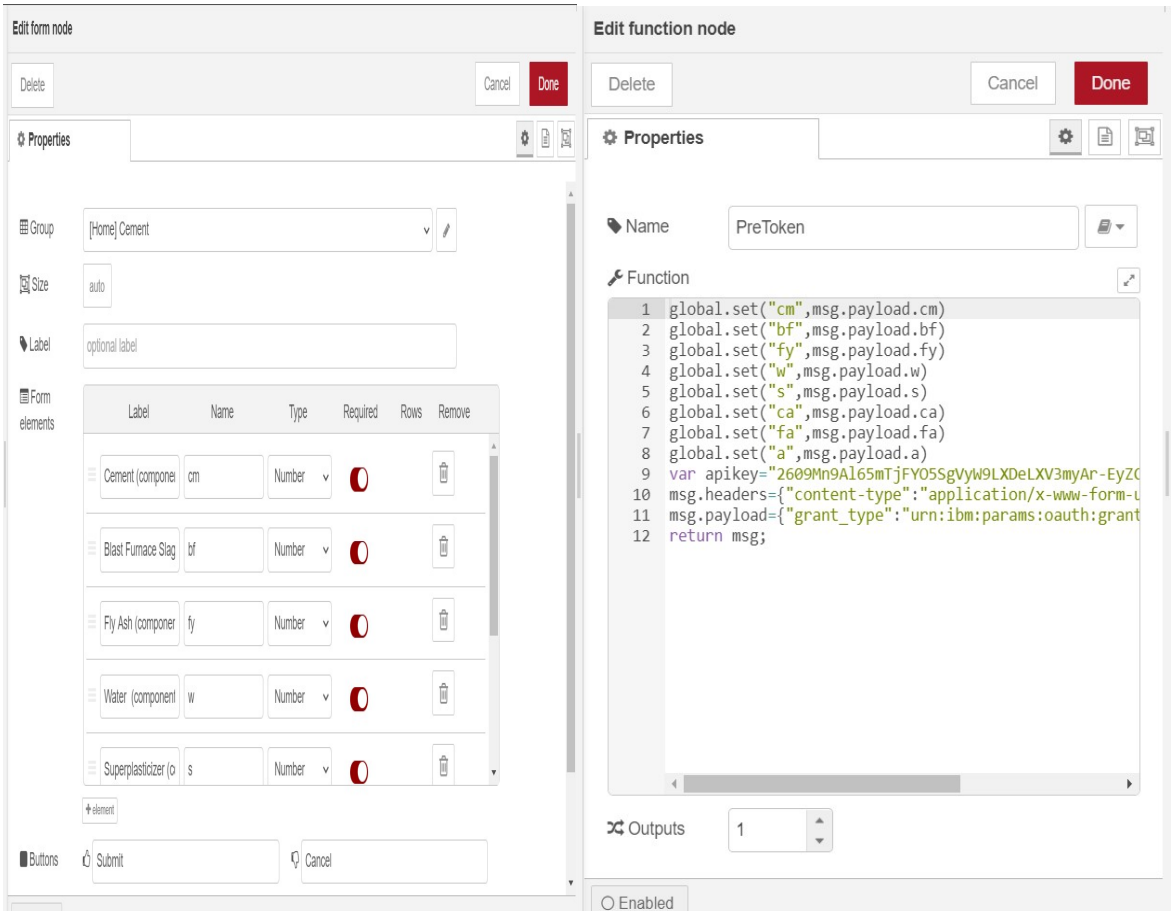
Step 5: Create Node Red App



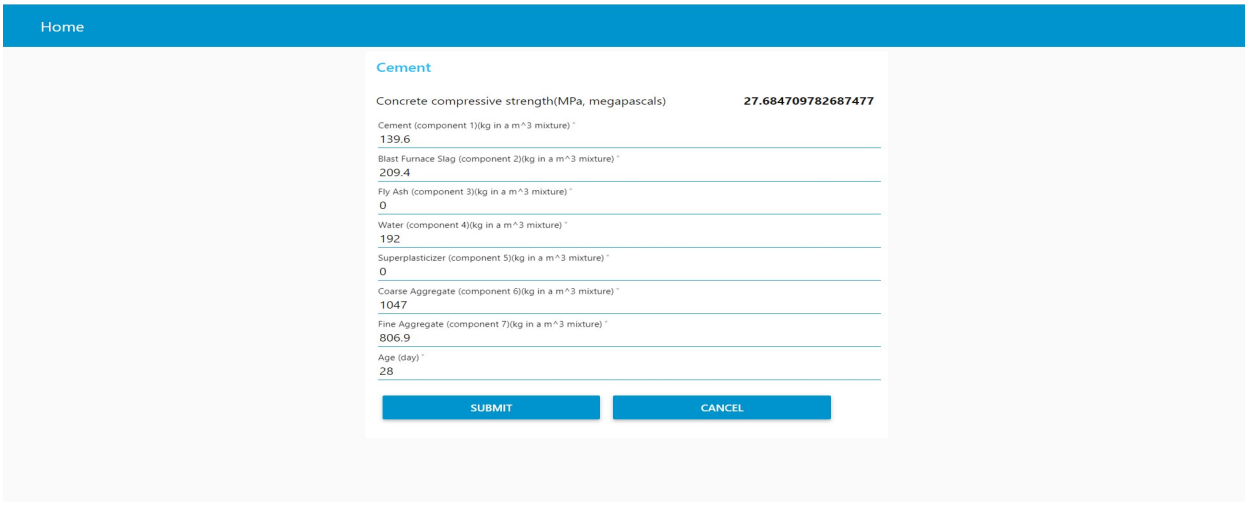
Step 6: After Successful Creation Visit My URL and add UI



Step 7: Edit the Form node, Set Global variables and other nodes

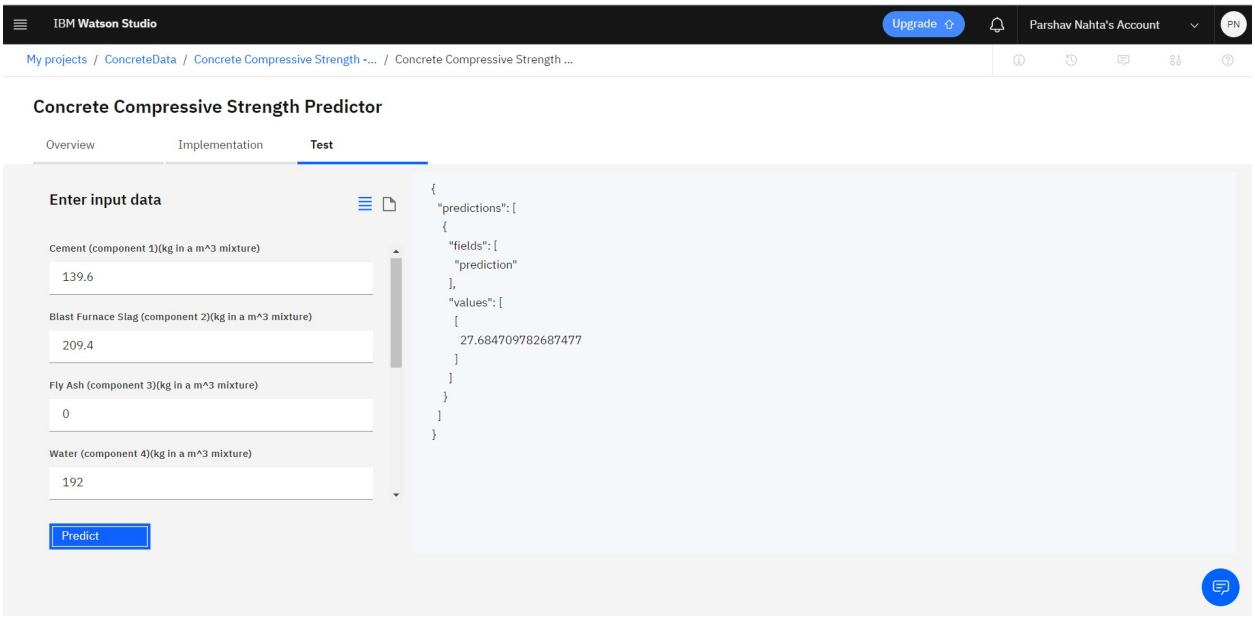


Step 7: Remove the Errors and Deploy the App



Experimental Investigation

While working on the implementation of your Machine Learning Project, IBM Cloud also provides very essential feature to test your implementation before you can deploy it, wherever you wanted to be. In context with "**Predicting Compressive Strength of Concrete using IBM Watson Auto AI Experiment**"and saving of the best fit algorithm based on minimum RMSE(Root Mean Squared Error), we test our Watson Auto AI model.Verify the Prediction Results of the Deployed App from the Model Deployments created in the IBM cloud to verify that the app is working fine.



Flow Chart

Create Watson Studio Service from the IBM Cloud catalogue section

Inside Watson Studio Service create new Auto AI project and create cloud object storage for storing datasets

Inside Project under Asset column upload your dataset and click to add this to your project. Also create Associate Service for your project and finally click on

Now, it's time to select what predictions you want from your dataset and click run the experiment. After the successful running of experiment save the best fi ed
model based on minimum RMSE value.

Before the deployment test your experiment by running the test section and providing suitable values to experimental analysis. Till now the project is successfully
created.

For creating UI (User Interface) for your algorithm. From Catalogue select software and then starter kit and here select Node Red App and click to create web app. For
the services to get successfully started.

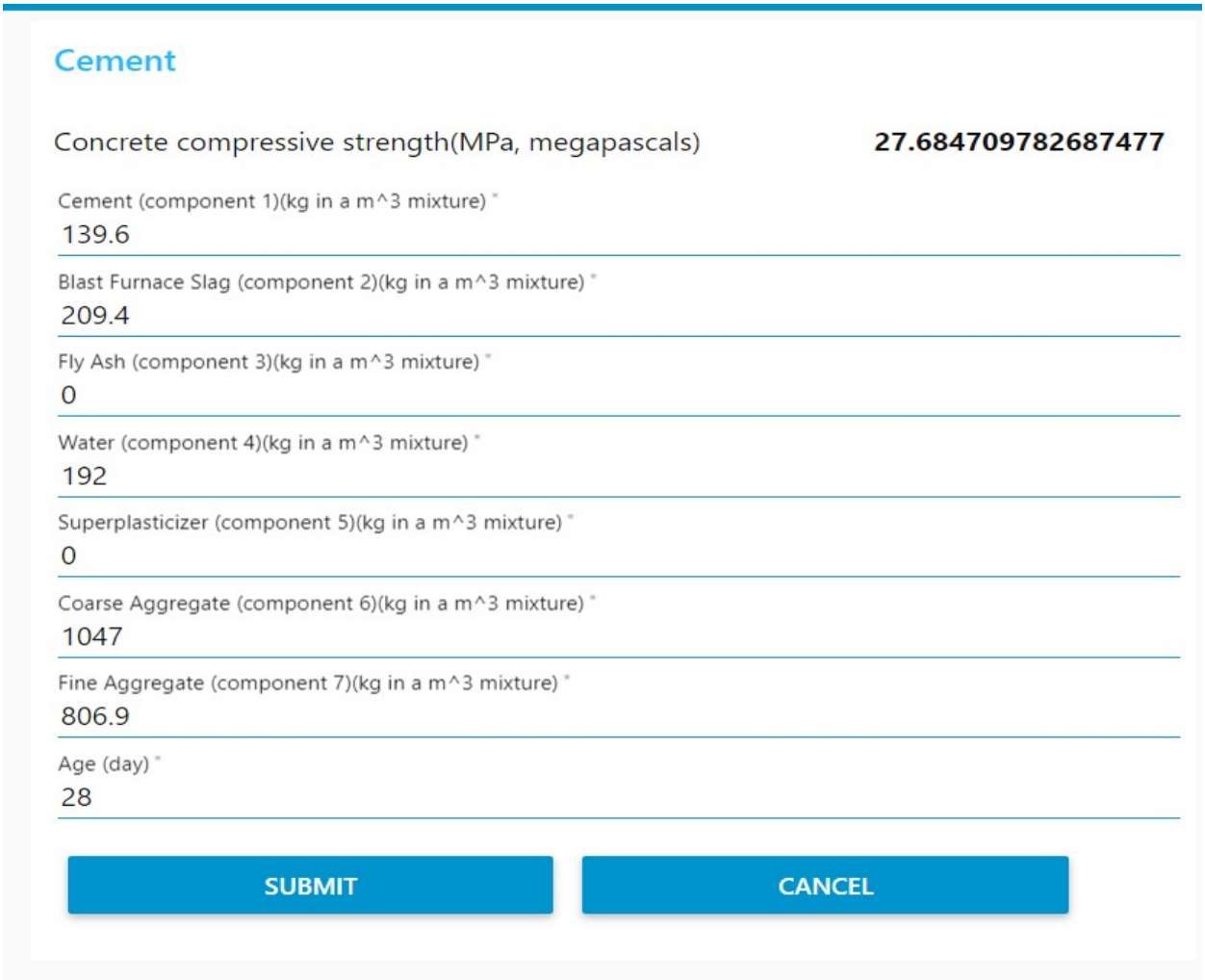
Now, making further progress, click to Node Red service, it will result in opening of Node Red Flows. Where you can easily drag and drop different sections to create your web apps.

Install Node-Red-Dashboard from pallets and also import a json (JavaScript Object Notation) file created in accordance with your choice for quickly completion of
your web app. Perform the changes, what you want then click on deploy.

After successfully deploy, copy the Node Red Flow link till .net and just paste in another browser tab with the addition of /ui and UI of Watson Auto AI experiment is ready

Result

This is how our final app looks



Advantages & Disadvantages

Advantages

1. Useful for Civil Engineers to predict the strength of Concrete
2. Decide which infrastructure can be made for strength concrete
3. Helps to reduce the cost invested in construction
4. Use the best quality cement based on their strength and ensure full safety.
5. Reduced errors and faults in construction
6. Access all the relevant data seamlessly and quickly.

7. Minimize acquisition costs and increases marketing efficiency.
8. Predicting cements overall capability to withstand pressure helps to take necessary decision to change the composition on the basis of the human and other traffic using the construction
9. Identifying potential network issues, competitive threats, and at-risk customers.

Disadvantages

10. Loss to the low-quality cement manufacturing companies
11. Loss of money, income, profits, to the middlemen
12. Reduced work, reduced labour, reduction in the source of income for labourers as the constructions made from perfect and the right quality cement will definitely last long

Applications

1. House, Society, Offices Constructions
2. Children Parks, Monuments, Sculptures Constructions
3. Bridges, Highways, Metro Pillars Construction
4. Theme parks, Resorts, Amusement Parks Constructions

Conclusions

We have successfully built a Machine Learning model to predict the compressive strength of concrete using IBM Watson Auto AI Machine

Learning Service.

The model is deployed on IBM cloud to get scoring end point which can be used as API in mobile app or web app building.

We have developed a web application which is built using node red service. We make use of the scoring end point to give user input values to the deployed model.

The model prediction is then showcased on User Interface with minimum RMSE (*root mean square* value metrics evaluation technique)

Future Scope

Predicting the concrete Strength will have a very positive and beneficial impact on the society thus causing the constructions to be more reliable and sustainable that can withstand the wear and tear more efficiently and in areas prone to natural disasters can be accurately built rom the most apt strength concrete that can withstand small blows of the earthquake reducing the loss to human life and the investment made in constructions. It will ensure that the public's life is at zero risk and construction like bridges , highways , metro pillars, buildings and other stuff can be made on the basis of their upcoming pressure holding

capacity so that accurate strength material can be chosen so that profits can be earned too and life safety is also ensured.

Bibliography

1. Dataset: Predicting Compressive Strength of the Concrete https://www.kaggle.com/pavanraj159/concrete-compressive-strength-data-set

2. Smart Bridge – Machine Learning Career Basic Course https://smartbridge.teachable.com/

Appendix

Source Code (Json File)

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