TEAM ID : PNT2022TMID18283

PROJECT TITLE : Efficient Water Quality Analysis & Prediction using Machine Learning

Project Report

1. INTRODUCTION

1.1 Project Overview

Water is considered as a vital resource that affects various aspects of human health and lives. The quality of water is a major concern for people living in urban areas. The quality of water serves as a powerful environmental determinant and a foundation for the prevention and control of waterborne diseases. However, predicting the urban water quality is a challenging task since the water quality varies in urban spaces non-linearly and depends on multiple factors, such as meteorology, water usage patterns, and land uses.

1.2 Purpose

This project aims at building a Machine Learning (ML) model to Predict Water Quality by considering all water quality standard indicators.Using ML techniques (Regression models) to predict the quality of water instead of using physical measurements or sensors to obtain the quality of water. ML techniques improves the accuracy of measurement over existing chemical and physical techniques as it is infeasible to obtain all the required features to predict the water quality.

2. LITERATURE SURVEY

2.1 Existing problem

The proposed system is intended to determine portability. It is divided into two phases, one for training and the other for testing. The following procedures are carried out in both sections. The data set was chosen as follows: The collection of essential parameters that affect water quality, identification of the number of data samples, and definition of the class labels for each data sample present in the data are all factors that go into selecting the water quality data set, which is a prerequisite to model construction. Ten indicator parameters make up the data sets used in this study. pH value and hardness are examples

of these factors. The proposed approach, however, is not constrained by the number of parameters or the selection of parameters. A k-fold cross-validation technique is employed to set the learning and testing framework in this study, corresponding to each data sample in the data set. Using this technique, the dataset is separated into k-disjoint sets of equal size, each with roughly the same class distribution. In turn, this division's subsets are utilized as the test set, with the remaining subsets serving as the training set. These are the Decision Tree (DT) and K-Nearest Neighbour (KNN) methods. Each strategy takes a different approach in terms of the underlying relational structure between the indicator parameters and the class label. As a result, each technique's performance for the same data set is likely to differ. Validating the performance of different classifiers on an unknown data set: Data mining provides several metrics for validating the performance of different classifiers on an unknown data set. A repeated cross-validation procedure in the Matlab caret package created the learning and testing environment. The following procedure was used to apply the classification algorithm:

1. The data set was split into training (80%) and testing (20%). (20 percent).
2. The training set was subjected to repeated cross-validation, with the number of iterations fixed to Classifiers being trained in this manner.
3. The model's optimal parameter configuration was selected, resulting in maximum accuracy.
4. The model was scrutinized.

2.2 References

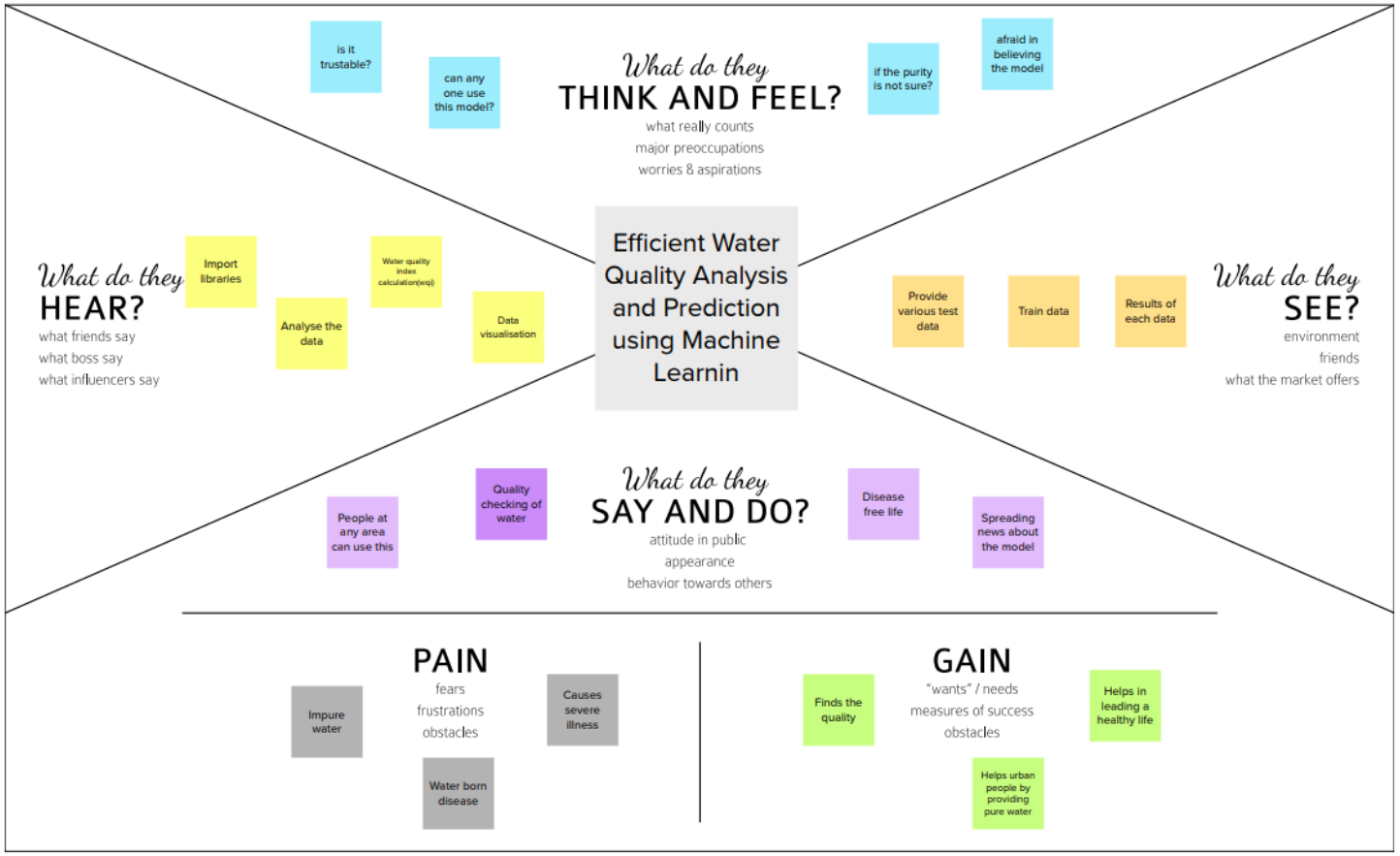
- PCRWR. National Water Quality Monitoring Programme, Fifth Monitoring Report (2005–2006); Pakistan Council of Research in Water Resources Islamabad: Islamabad, Pakistan, 2007.
- Ling, J.K.B. Water Quality Study and Its Relationship with High Tide and Low Tide at Kuantan River. Bachelor’s Thesis, Universiti Malaysia Pahang, Gambang, Malaysia, 2010.

2.3 Problem Statement Definition

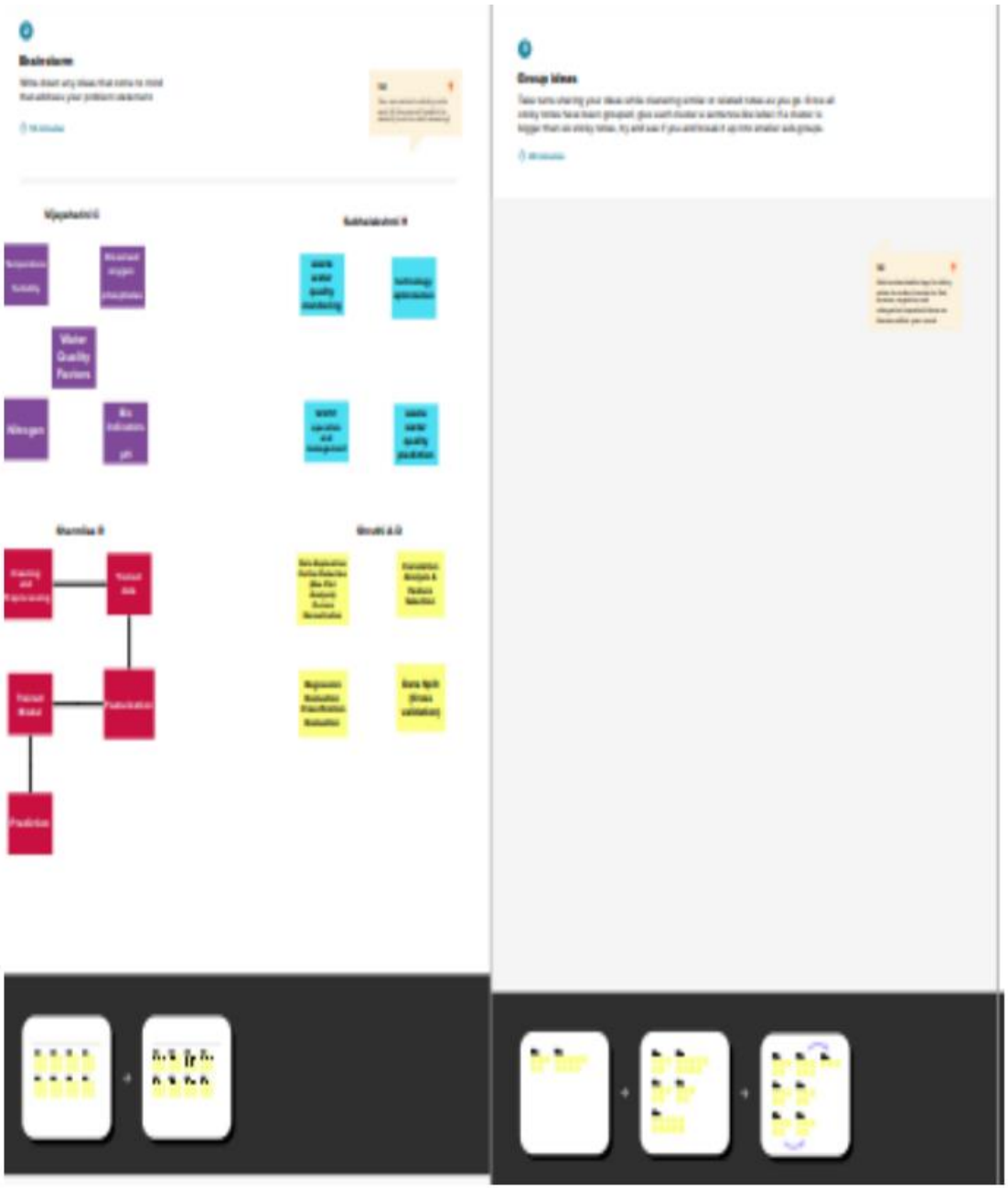
The main aim of the project is to predict the quality of the water. We are building a web app to predict the quality of the water. Project aims at building a Machine Learning (ML) model to Predict Water Quality by considering all water quality standard indicators. WQI is fundamentally calculated by initially multiplying the q value of each parameter by its corresponding weight, adding them all up and then dividing the result by the sum of weights of the employed parameters

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming



3.3 Proposed Solution

S.No	Parameter	Description
1.	Problem Statement	Water is considered as a vital resource that affects various aspects of human health and lives. The quality of water is a major concern for people living in urban areas. The quality of water serves as a powerful environmental determinant and a foundation for the prevention and control of waterborne diseases. However, predicting the urban water quality is a challenging task since the water quality varies in urban spaces non-linearly and depends on multiple factors, such as meteorology, water usage patterns, and land uses, so this project aims at building a Machine Learning (ML) model to Predict Water Quality by considering all water quality standard indicators.
2.	Idea / Solution description	The solution is derived from the data sets by comparing the accuracy rate with the previous data set and the current data set.
3.	Novelty / Uniqueness	Using ML techniques (Regression models) to predict the quality of water instead of using physical measurements or sensors to obtain the quality of water. ML techniques improves the accuracy of measurement over existing chemical and physical techniques as it is infeasible to obtain all the required features to predict the water quality. Physical and chemical measurements may lead to the usage of expensive instruments and also take a lot of time. ML techniques make the process easier, feasible and faster.

4.	Social Impact /Customer Satisfaction	Our intended audience consists of people who are concerned about the quality of water they drink. Water's health is more important which should be considered as many water-borne diseases are more widely known. The proposed solution will help in identifying water pollution and helps the customer to drink healthy water.
5.	Business Model (Revenue Model)	Industries that provide sanitation facilities and products (like water purifiers, quality testers etc.) can deploy this solution to provide more waste water treatment plants, better insights in health concerns and there may also be an increase in awareness and demand for better water quality testing and
		availability. People will start looking for treatments related to water-borne diseases as the awareness increases
6.	Scalability of the Solution	The solution proposed will be deployed as a web application. So, it is easily accessible by anyone who has internet services and has no specific software and hardware specifications

3.4 Problem Solution fit

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns.

Purpose:

- Customer needs to know about water's parameters such as pH, nitrate content so that it can be given to the ML model to predict the quality of water.
- User uses various experimental techniques like analyzing the quantity of chemical present and also analyzes physical properties of the water.
- Solve complex problems in a way that fits the state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior.
- Sharpen your communication and marketing strategy with the right triggers and messaging.

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Executive administration	Regulation of monitoring the water environment status and regulatory compliance like pollution event emergency management, and it includes two different functions: early warning/forecast monitoring.
FR-4	Data handling	File contains water quality metrics for different water Bodies.
FR-5	Quality analysis	Analyze with the acquired information of the water across various water quality indicator like (PH, Turbidity TDS Temperature) using different model.
FR-6	Model Prediction	Confirming based on water quality index and shows the machine learning prediction (Good, Partially Good, Poor) with the percentage of presence of various parameter.
FR-7	Remote Visualization	Visualization through charts based on present and past values of all the parameter for future forecast.
FR-8	Notification services	Confirming through notification of water status prediction with parameter presence along with timestamp.

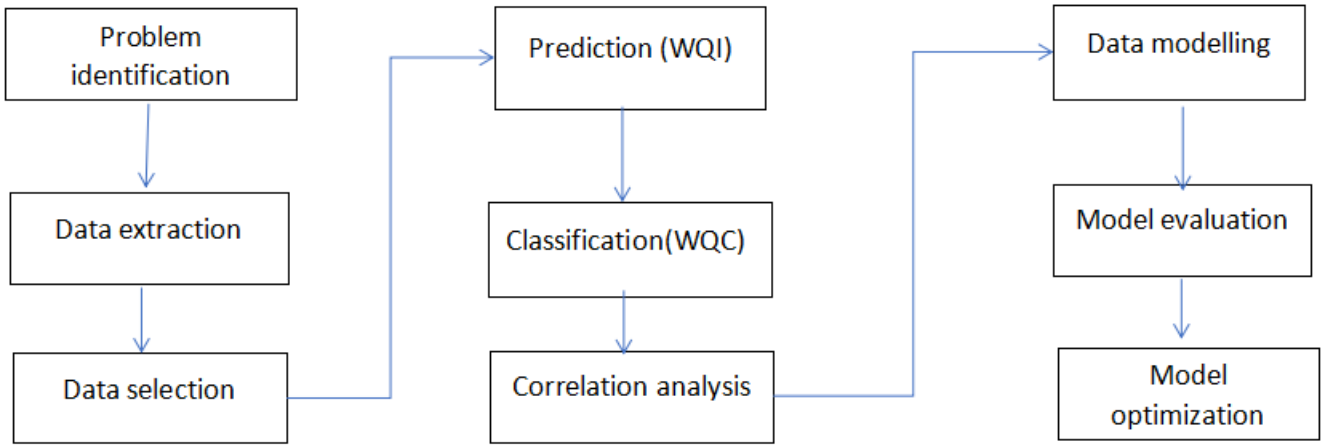
4.2 Non-Functional requirements

Following are the non-functional requirements of the proposed solution.

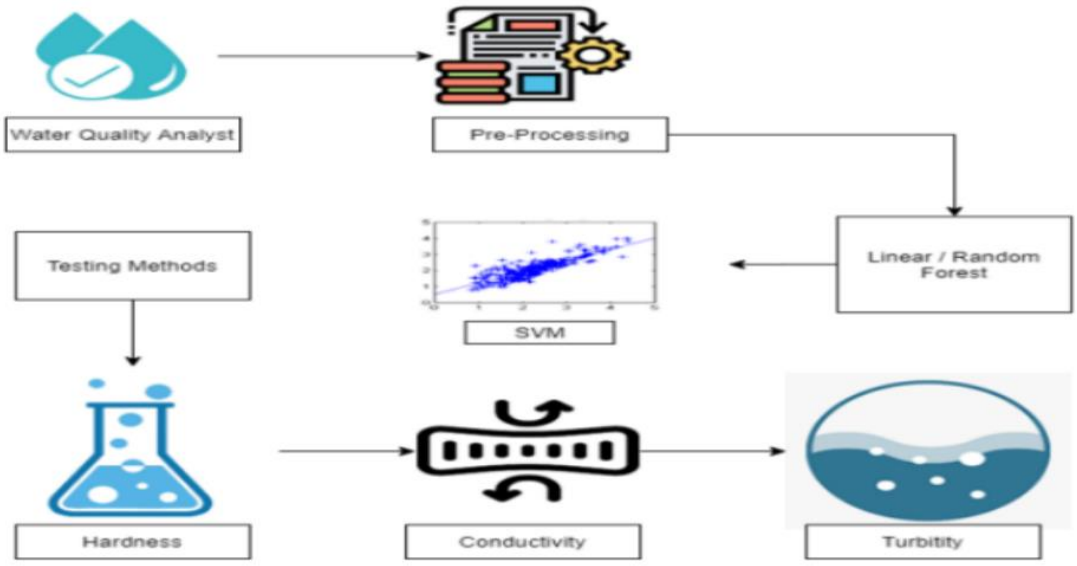
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The system provides a natural interaction with the users. Accurate water quality prediction with short time analysis and provide prediction safe to drink or not using some parameters and provide a great significance for water environment protection.
NFR-2	**Security**	The model enables with the high security system as the user's data will not be shared to the other sources. The system is protected with the user name and password throughout the process.
NFR-3	**Reliability**	The system is very reliable as it can last for long period of time when it is well maintained. The model can be extended in large scale by increasing the datasets.
NFR-4	**Performance**	Our system should run on 32 bit (x86) or 64 bit (x64) Dual-core 2.66-GHZ or faster processor. It should not exceed 2 GB RAM.
NFR-5	**Availability**	The system should be available for the duration of the user access the system until the user terminate the access. The system response to request of the user in less time and the recovery is done is less time.
NFR-6	**Scalability**	It provides an efficient outcome and has the ability to increase or decrease the performance of the system based on the datasets.

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



5.3 User Stories

Sprint	Functional Requirement (Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Members
Sprint-1	Data Preparation	USN-1	Collecting water dataset and pre-processing it	20	High	Vijayaharini Subhalakshmi
Sprint-2	Model Building	USN-2	Create an ML model to predict water quality	5	Medium	Sharmilaa
Sprint-2	Model Evaluation	USN-3	Calculate the performance,error rate, and complexity of the ML model and evaluate the dataset based on the parameter that the dataset consists of.	5	Medium	Sruthi
Sprint-2	Model Deployment	USN-4	As a user, I need to deploy the model and need to find the results.	10	Medium	
Sprint-3	Web page(Form)	USN-5	As a user , I can use the application by entering the water dataset to analyze or predict the results.	20	Medium	Vijayaharini Subhalakshmi
Sprint-4	Dashboard	USN-6	As a user, I can predict the water quality by clicking the submit button and the application will show whether the water is efficient for use or not	20	High	Sharmilaa Sruthi

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Members
Sprint-1	Data Preparation	USN-1	Collecting water dataset and pre-processing it	20	High	Vijayaharini Subhalakshmi
Sprint-2	Model Building	USN-2	Create an ML model to predict water quality	5	Medium	Sharmilaa
Sprint-2	Model Evaluation	USN-3	Calculate the performance,error rate, and complexity of the ML model and evaluate the dataset based on the parameter that the dataset consists of.	5	Medium	Sruthi
Sprint-2	Model Deployment	USN-4	As a user, I need to deploy the model and need to find the results.	10	Medium	
Sprint-3	Web page(Form)	USN-5	As a user , I can use the application by entering the water dataset to analyze or predict the results.	20	Medium	Vijayaharini Subhalakshmi
Sprint-4	Dashboard	USN-6	As a user, I can predict the water quality by clicking the submit button and the application will show whether the water is efficient for use or not	20	High	Sharmilaa Sruthi

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date	Story Points Completed	Sprint Release Date
Sprint-1	20	6 Days	23 Oct 2022	28 Oct 2022	20	29 Oct 2022
Sprint-2	20	7 Days	29 Oct 2022	04 Nov 2022	20	05 Nov 2022
Sprint-3	20	7 Days	05 Nov 2022	11 Nov 2022	20	12 Nov 2022
Sprint-4	20	8 Days	12 Nov 2022	19 Nov 2022	20	19 Nov 2022

7. CODING & SOLUTIONING

7.1 Feature 1

In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
```

Reading Dataset

In [ ]:

In [2]:
```
import os, types
import pandas as pd
from botocore.client import Config
import ibm_boto3

def __iter__(self): return 0

# @hidden_cell
# The following code accesses a file in your IBM Cloud Object Storage. It includes your credentials.
# You might want to remove those credentials before you share the notebook.
cos_client = ibm_boto3.client(service_name='s3',
    ibm_api_key_id='XASQkNEL212fp8ybFcqZgV8bG9ErwvLqzJFEzwDfuFa3',
    ibm_auth_endpoint="https://iam.cloud.ibm.com/oidc/token",
    config=Config(signature_version='oauth'),
    endpoint_url='https://s3.private.us.cloud-object-storage.appdomain.cloud')

bucket = 'datascience-donotdelete-pr-otpznaf0icrijh'
object_key = 'water_data1.txt'

streaming_body_1 = cos_client.get_object(Bucket=bucket, Key=object_key)['Body']

df=pd.read_csv(streaming_body_1)
df
```

Out[2]:

	STATION CODE	LOCATIONS	STATE	Temp	D.O. (mg/l)	PH	CONDUCTIVITY (µmhos/cm)	B.O.D. (mg/l)	NITRATENAN N+ NITRITENANN (mg/l)	FECAL COLIFORM (MPN/100ml)	TOTAL COLIFORM (MPN/100ml)Mean	year
0	1393	DAMANGANGA AT D/S OF MADHUBAN, DAMAN	DAMAN & DIU	30.6	6.7	7.5	203	NAN	0.1	11	27	2014
1	1399	ZUARI AT D/S OF PT. WHERE KUMBARJRIA CANAL JOI...	GOA	29.8	5.7	7.2	189	2	0.2	4953	8391	2014
2	1475	ZUARI AT PANCHAWADI	GOA	29.5	6.3	6.9	179	1.7	0.1	3243	5330	2014

Analyse the data

In [3]:
```
df.head()
```

Out[3]:

	STATION CODE	LOCATIONS	STATE	Temp	D.O. (mg/l)	PH	CONDUCTIVITY (µmhos/cm)	B.O.D. (mg/l)	NITRATENAN N+ NITRITENANN (mg/l)	FECAL COLIFORM (MPN/100ml)	TOTAL COLIFORM (MPN/100ml)Mean	year
0	1393	DAMANGANGA AT D/S OF MADHUBAN, DAMAN	DAMAN & DIU	30.6	6.7	7.5	203	NAN	0.1	11	27	2014
1	1399	ZUARI AT D/S OF PT. WHERE KUMBARJRIA CANAL JOI...	GOA	29.8	5.7	7.2	189	2	0.2	4953	8391	2014
2	1475	ZUARI AT PANCHAWADI	GOA	29.5	6.3	6.9	179	1.7	0.1	3243	5330	2014
3	3181	RIVER ZUARI AT BORIM BRIDGE	GOA	29.7	5.8	6.9	64	3.8	0.5	5382	8443	2014
4	3182	RIVER ZUARI AT MARCAIM JETTY	GOA	29.5	5.8	7.3	83	1.9	0.4	3428	5500	2014

In [4]:
```
df.describe()
```

Out[4]:

	year
count	1991.000000
mean	2010.038172
std	3.057333
min	2003.000000
25%	2008.000000
50%	2011.000000
75%	2013.000000
max	2014.000000

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1991 entries, 0 to 1990
Data columns (total 12 columns):
 #   Column                          Non-Null Count  Dtype
---  ------                          --------------  -----
 0   STATION CODE                    1991 non-null   object
 1   LOCATIONS                       1991 non-null   object
```

```
 0   STATION CODE                       1991 non-null   object
 1   LOCATIONS                          1991 non-null   object
 2   STATE                              1991 non-null   object
 3   Temp                               1991 non-null   object
 4   D.O. (mg/l)                        1991 non-null   object
 5   PH                                 1991 non-null   object
 6   CONDUCTIVITY (µmhos/cm)            1991 non-null   object
 7   B.O.D. (mg/l)                      1991 non-null   object
 8   NITRATENAN N+ NITRITENANN (mg/l)   1991 non-null   object
 9   FECAL COLIFORM (MPN/100ml)         1991 non-null   object
 10  TOTAL COLIFORM (MPN/100ml)Mean     1991 non-null   object
 11  year                               1991 non-null   int64
dtypes: int64(1), object(11)
memory usage: 186.8+ KB
```

In [6]:
```
df.shape
```

Out[6]:
```
(1991, 12)
```

Handling Missing Values

In [7]:
```
df.isnull().any()
```

Out[7]:
```
STATION CODE                       False
LOCATIONS                          False
STATE                              False
Temp                               False
D.O. (mg/l)                        False
PH                                 False
CONDUCTIVITY (µmhos/cm)            False
B.O.D. (mg/l)                      False
NITRATENAN N+ NITRITENANN (mg/l)   False
FECAL COLIFORM (MPN/100ml)         False
TOTAL COLIFORM (MPN/100ml)Mean     False
year                               False
dtype: bool
```

In [8]:
```
df.isnull().sum()
```

Out[8]:
```
STATION CODE                       0
LOCATIONS                          0
STATE                              0
Temp                               0
D.O. (mg/l)                        0
PH                                 0
CONDUCTIVITY (µmhos/cm)            0
B.O.D. (mg/l)                      0
NITRATENAN N+ NITRITENANN (mg/l)   0
FECAL COLIFORM (MPN/100ml)         0
TOTAL COLIFORM (MPN/100ml)Mean     0
year                               0
dtype: int64
```

In [9]:
```
df.dtypes
```

Out[9]:
```
STATION CODE                       object
LOCATIONS                          object
STATE                              object
Temp                               object
D.O. (mg/l)                        object
PH                                 object
CONDUCTIVITY (µmhos/cm)            object
B.O.D. (mg/l)                      object
NITRATENAN N+ NITRITENANN (mg/l)   object
FECAL COLIFORM (MPN/100ml)         object
TOTAL COLIFORM (MPN/100ml)Mean     object
year                                int64
dtype: object
```

In [10]:
```
df['Temp']=pd.to_numeric(df['Temp'],errors='coerce')
df['D.O. (mg/l)']=pd.to_numeric(df['D.O. (mg/l)'],errors='coerce')
df['PH']=pd.to_numeric(df['PH'],errors='coerce')
df['B.O.D. (mg/l)']=pd.to_numeric(df['B.O.D. (mg/l)'],errors='coerce')
df['CONDUCTIVITY (µmhos/cm)']=pd.to_numeric(df['CONDUCTIVITY (µmhos/cm)'],errors='coerce')
df['NITRATENAN N+ NITRITENANN (mg/l)']=pd.to_numeric(df['NITRATENAN N+ NITRITENANN (mg/l)'],errors='coerce')
df['TOTAL COLIFORM (MPN/100ml)Mean']=pd.to_numeric(df['TOTAL COLIFORM (MPN/100ml)Mean'],errors='coerce')
df.dtypes
```

Out[10]:
```
STATION CODE                        object
LOCATIONS                           object
STATE                               object
Temp                               float64
D.O. (mg/l)                        float64
PH                                 float64
CONDUCTIVITY (µmhos/cm)            float64
B.O.D. (mg/l)                      float64
NITRATENAN N+ NITRITENANN (mg/l)   float64
FECAL COLIFORM (MPN/100ml)          object
TOTAL COLIFORM (MPN/100ml)Mean     float64
year                                 int64
```

In [11]:
```
df.isnull().sum()
```

Out[11]:
```
STATION CODE                          0
LOCATIONS                             0
STATE                                 0
Temp                                 92
D.O. (mg/l)                          31
PH                                    8
CONDUCTIVITY (µmhos/cm)              25
B.O.D. (mg/l)                        43
NITRATENAN N+ NITRITENANN (mg/l)    225
FECAL COLIFORM (MPN/100ml)            0
TOTAL COLIFORM (MPN/100ml)Mean      132
year                                  0
dtype: int64
```

In [12]:
```
df['Temp'].fillna(df['Temp'].mean(),inplace=True)
df['D.O. (mg/l)'].fillna(df['D.O. (mg/l)'].mean(),inplace=True)
df['PH'].fillna(df['PH'].mean(),inplace=True)
df['CONDUCTIVITY (µmhos/cm)'].fillna(df['CONDUCTIVITY (µmhos/cm)'].mean(),inplace=True)
df['B.O.D. (mg/l)'].fillna(df['B.O.D. (mg/l)'].mean(),inplace=True)
df['NITRATENAN N+ NITRITENANN (mg/l)'].fillna(df['NITRATENAN N+ NITRITENANN (mg/l)'].mean(),inplace=True)
df['TOTAL COLIFORM (MPN/100ml)Mean'].fillna(df['TOTAL COLIFORM (MPN/100ml)Mean'].mean(),inplace=True)
```

In [13]:
```
df.drop(["FECAL COLIFORM (MPN/100ml)"],axis=1,inplace=True)
```

In [14]:
```
df=df.rename(columns = {'D.O. (mg/l)': 'do'})
df=df.rename(columns = {'CONDUCTIVITY (µmhos/cm)': 'co'})
df=df.rename(columns = {'B.O.D. (mg/l)': 'bod'})
df=df.rename(columns = {'NITRATENAN N+ NITRITENANN (mg/l)': 'na'})
df=df.rename(columns = {'TOTAL COLIFORM (MPN/100ml)Mean': 'tc'})
df=df.rename(columns = {'STATION CODE': 'station'})
df=df.rename(columns = {'LOCATIONS': 'location'})
df=df.rename(columns = {'STATE': 'state'})
df=df.rename(columns = {'PH': 'ph'})
```

Water Quality Index (WQI) Calculation

In [15]:
```
#calculation of pH
df['npH']=df.ph.apply(lambda x: (100 if(8.5>=x>=7)
                                 else(80 if(8.6>=x>=8.5) or (6.9>=x>=6.8)
                                   else (60 if(8.8>=x>=8.6) or (6.8>=x>=6.7)
                                       else(40 if(9>=x>=8.8) or (6.7>=x>=6.5)
                                           else 0)))))
```

In [16]:
```
#calculation of dissolved oxygen
df['ndo']=df.do.apply(lambda x: (100 if(x>=6)
                                 else(80 if(6>=x>=5.1)
                                   else (60 if(5>=x>=4.1)
                                       else(40 if(4>=x>=3)
                                           else 0)))))
```

In [17]:
```
#calculation of total coliform
df['nco']=df.tc.apply(lambda x: (100 if(5>=x>=0)
                                 else(80 if(50>=x>=5)
                                   else (60 if(500>=x>=50)
                                       else(40 if(10000>=x>=500)
                                           else 0)))))
```

In [18]:
```
#calculation of B.D.O
df['nbdo']=df.bod.apply(lambda x:(100 if(3>=x>=0)
                                 else(80 if(6>=x>=3)
                                   else (60 if(80>=x>=6)
                                       else(40 if(125>=x>=80)
                                           else 0)))))
```

In [19]:
```
#calculation of electric conductivity
df['nec']=df.co.apply(lambda x:(100 if(75>=x>=0)
                                 else(80 if(150>=x>=75)
                                   else (60 if(225>=x>=150)
                                       else(40 if(300>=x>=225)
                                           else 0)))))
```

In [20]:
```
#calculation of nitrate
df['nna']=df.na.apply(lambda x:(100 if(20>=x>=0)
                                 else(80 if(50>=x>=20)
                                   else (60 if(100>=x>=50)
                                       else(40 if(200>=x>=100)
                                           else 0)))))
```

In [20]:
```
#calculation of nitrate
df['nna']=df.na.apply(lambda x:(100 if(20>=x>=0)
                                else(80 if(50>=x>=20)
                                  else (60 if(100>=x>=50)
                                      else(40 if(200>=x>=100)
                                          else 0)))))
```

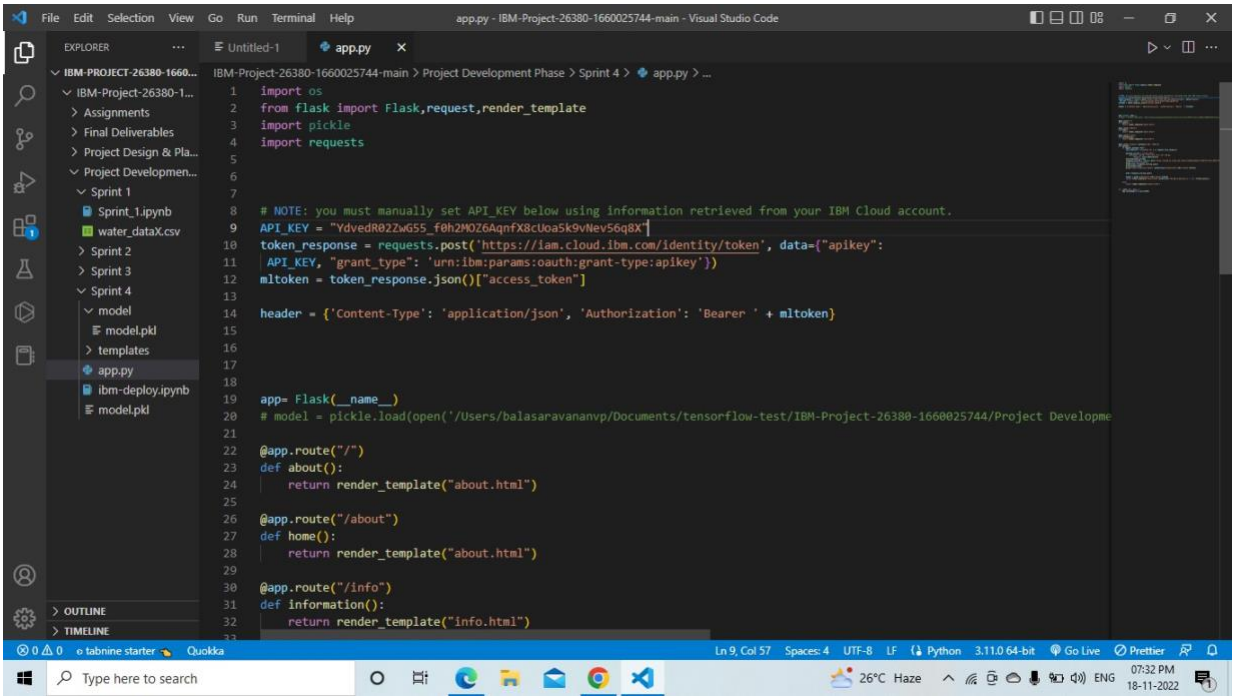
In [21]:
```
#Calculation of Water Quality Index WQI
df['wph']=df.npH*0.165
df['wdo']=df.ndo*0.281
df['wbdo']=df.nbdo*0.234
df['wec']=df.nec*0.009
df['wna']=df.nna*0.028
df['wco']=df.nco*0.281
df['wqi']=df.wph+df.wdo+df.wbdo+df.wec+df.wna+df.wco
df
```

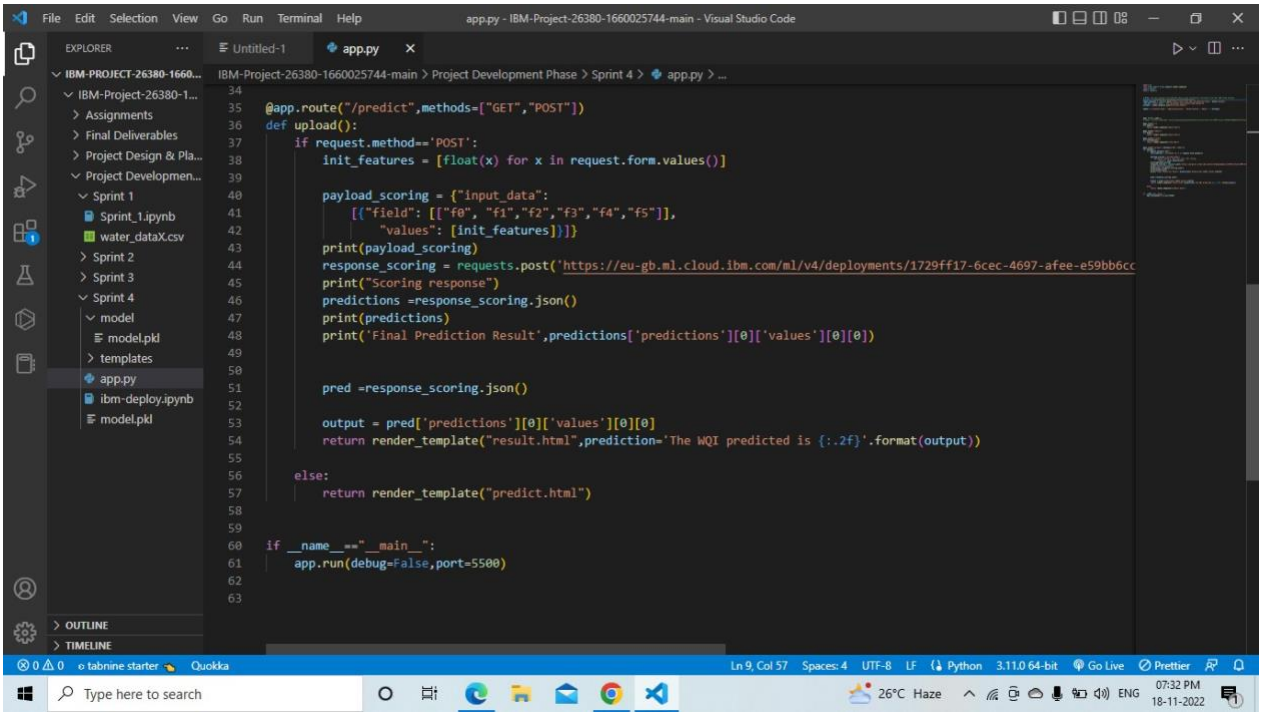
Out[21]:

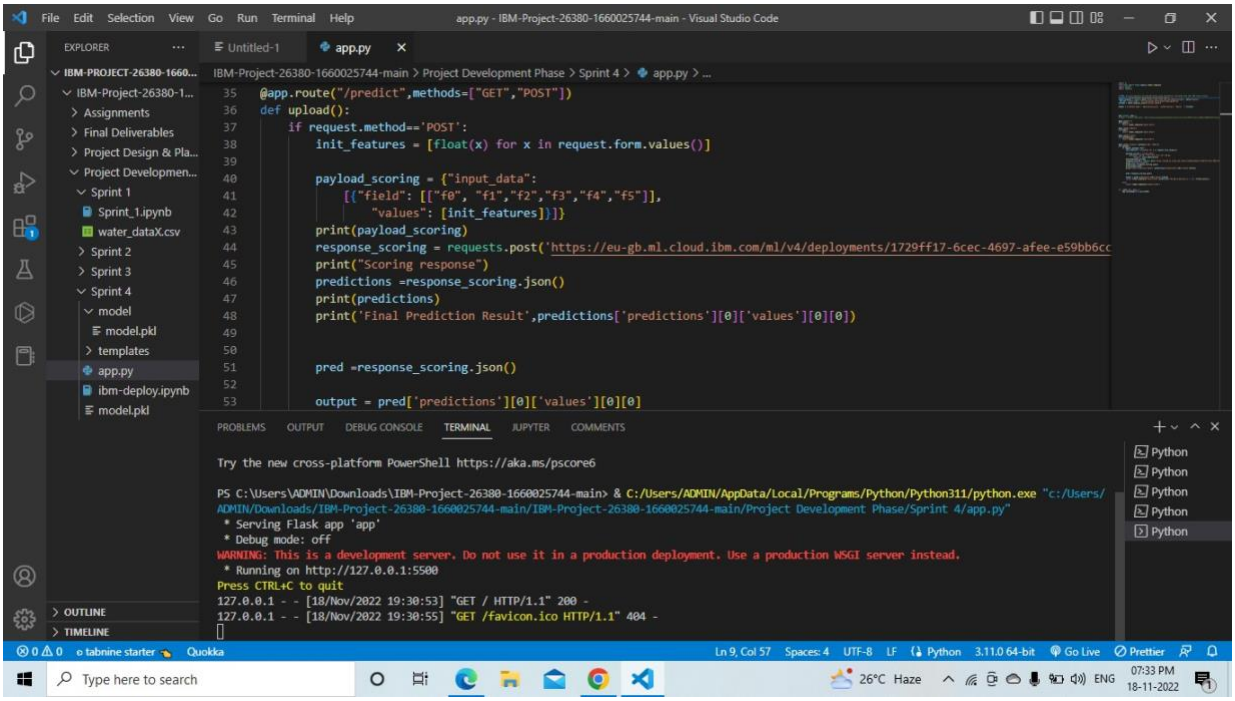
	station	location	state	Temp	do	ph	co	bod	na	tc	...	nbdo	nec	nna	wph	wdo	wbdo	wec	wna	wco	wqi
0	1393	DAMANGANGA AT D/S OF MADHUBAN, DAMAN	DAMAN & DIU	30.600000	6.7	7.5	203.0	6.940049	0.100000	27.0	...	60	60	100	16.5	28.10	14.04	0.54	2.8	22.48	84.46
1	1399	ZUARI AT D/S OF PT. WHERE KUMBARJRIA CANAL JOI...	GOA	29.800000	5.7	7.2	189.0	2.000000	0.200000	8391.0	...	100	60	100	16.5	22.48	23.40	0.54	2.8	11.24	76.96
2	1475	ZUARI AT PANCHAWADI	GOA	29.500000	6.3	6.9	179.0	1.700000	0.100000	5330.0	...	100	60	100	13.2	28.10	23.40	0.54	2.8	11.24	79.28
3	3181	RIVER ZUARI AT BORIM BRIDGE	GOA	29.700000	5.8	6.9	64.0	3.800000	0.500000	8443.0	...	80	100	100	13.2	22.48	18.72	0.90	2.8	11.24	69.34
4	3182	RIVER ZUARI AT MARCAIM JETTY	GOA	29.500000	5.8	7.3	83.0	1.900000	0.400000	5500.0	...	100	80	100	16.5	22.48	23.40	0.72	2.8	11.24	77.14
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1986	1330	TAMBIRAPARANI AT ARUMUGANERI, TAMILNADU	NAN	26.209814	7.9	738.0	7.2	2.700000	0.518000	202.0	...	100	100	100	0.0	28.10	23.40	0.90	2.8	16.86	72.06
1987	1450	PALAR AT VANIYAMBADI WATER SUPPLY HEAD WORK, T...	NAN	29.000000	7.5	585.0	6.3	2.600000	0.155000	315.0	...	100	100	100	0.0	28.10	23.40	0.90	2.8	16.86	72.06
1988	1403	GUMTI AT U/S SOUTH TRIPURA,TRIPURA	NAN	28.000000	7.6	98.0	6.2	1.200000	1.623079	570.0	...	100	100	100	0.0	28.10	23.40	0.90	2.8	11.24	66.44
1989	1404	GUMTI AT D/S SOUTH TRIPURA, TRIPURA	NAN	28.000000	7.7	91.0	6.5	1.300000	1.623079	562.0	...	100	100	100	0.0	28.10	23.40	0.90	2.8	11.24	66.44
1990	1726	CHANDRAPUR, AGARTALA D/S OF HAORA RIVER, TRIPURA	NAN	29.000000	7.6	110.0	5.7	1.100000	1.623079	546.0	...	100	100	100	0.0	28.10	23.40	0.90	2.8	11.24	66.44

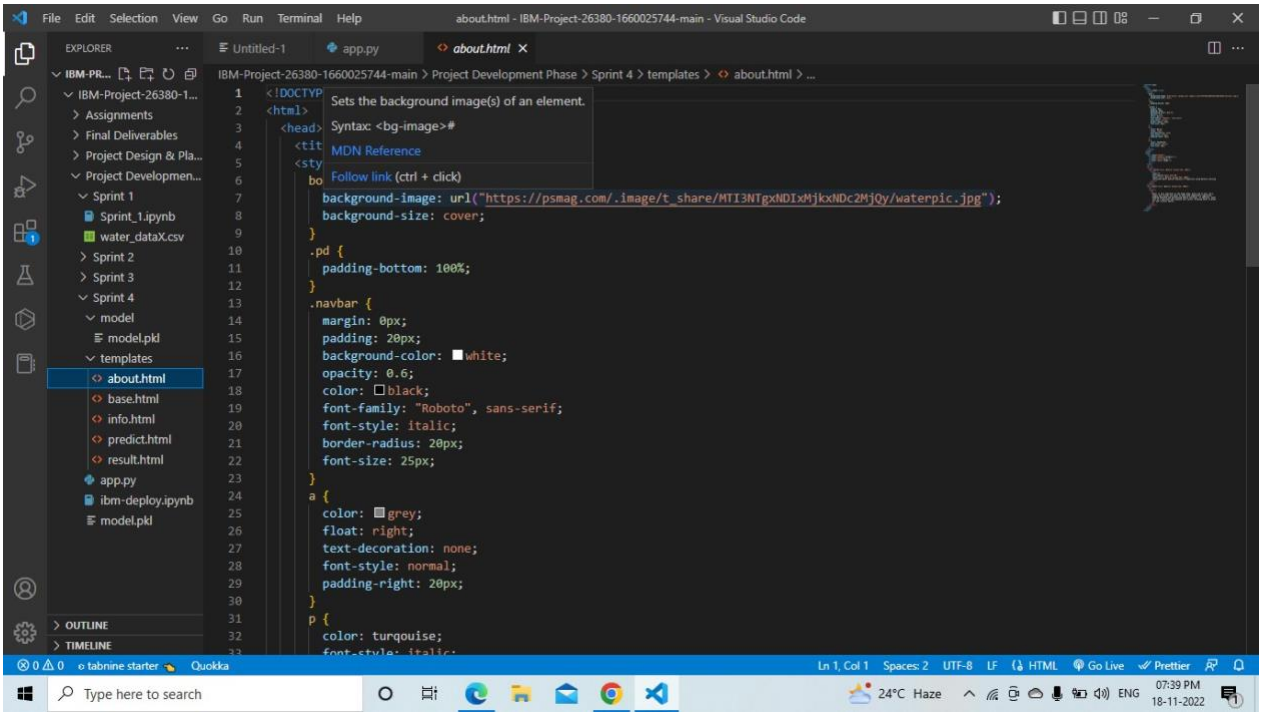
1991 rows × 24 columns

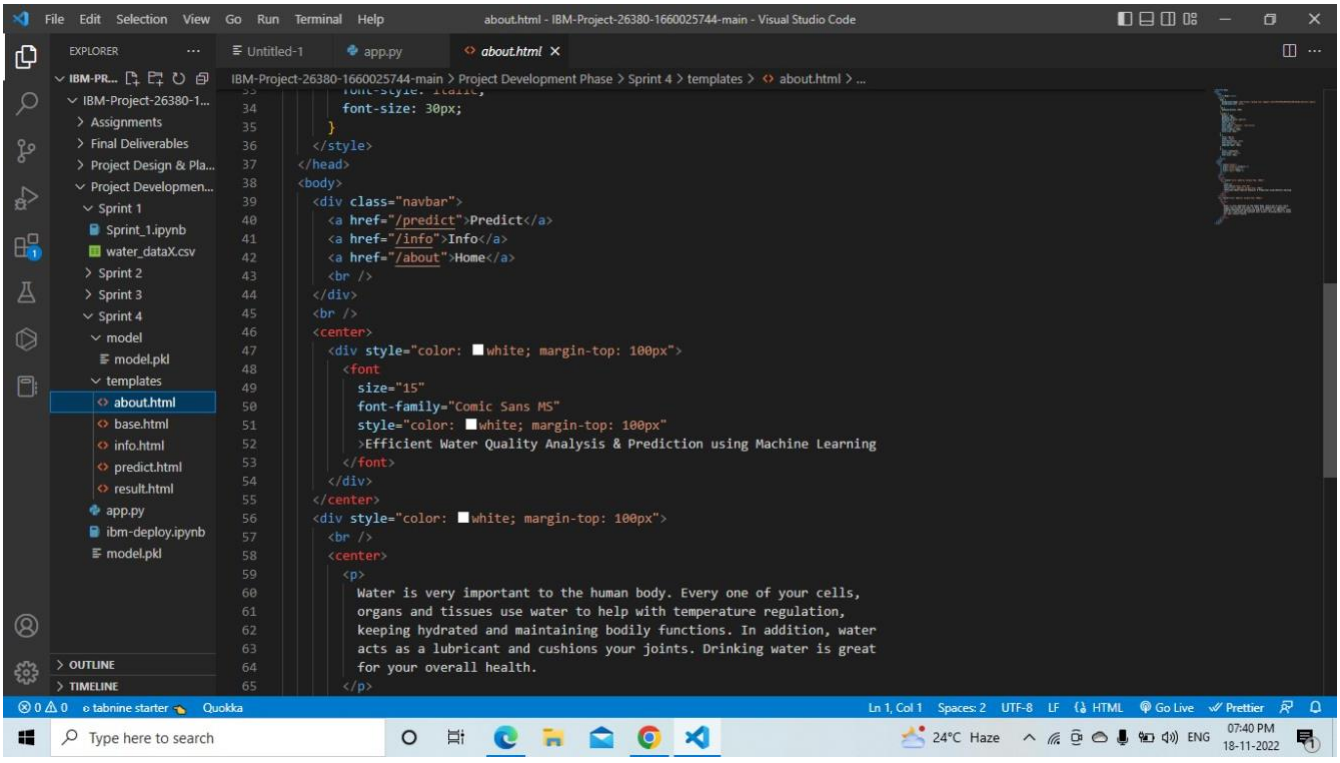
7.2 Feature 2




File Edit Selection View Go Run Terminal Help
app.py - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > app.py > ...
IBM-PROJECT-26380-1660...
IBM-Project-26380-1...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
app.py
ibm-deploy.ipynb
model.pkl
OUTLINE
TIMELINE
@app.route("/predict",methods=["GET","POST"])
def upload():
if request.method=='POST':
init_features = [float(x) for x in request.form.values()]
payload_scoring = {"input_data":
[{"field": [["f0", "f1","f2","f3","f4","f5"]],
"values": [init_features]}]}
print(payload_scoring)
response_scoring = requests.post('https://eu-gb.ml.cloud.ibm.com/ml/v4/deployments/1729ff17-6cec-4697-afee-e59bb6cc
print("Scoring response")
predictions =response_scoring.json()
print(predictions)
print('Final Prediction Result',predictions['predictions'][0]['values'][0][0])
pred =response_scoring.json()
output = pred['predictions'][0]['values'][0][0]
return render_template("result.html",prediction='The WQI predicted is {:.2f}'.format(output))
else:
return render_template("predict.html")
if __name__=="__main__":
app.run(debug=False,port=5500)
Ln 9, Col 57 Spaces: 4 UTF-8 LF Python 3.11.0 64-bit Go Live Prettier
Type here to search
26°C Haze
ENG
07:32 PM
18-11-2022


File Edit Selection View Go Run Terminal Help
app.py - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > app.py > ...
IBM-PROJECT-26380-1660...
IBM-Project-26380-1...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
app.py
ibm-deploy.ipynb
model.pkl
@app.route("/predict",methods=["GET","POST"])
def upload():
if request.method=='POST':
init_features = [float(x) for x in request.form.values()]
payload_scoring = {"input_data":
[{"field": [["f0", "f1","f2","f3","f4","f5"]],
"values": [init_features]}]}
print(payload_scoring)
response_scoring = requests.post('https://eu-gb.ml.cloud.ibm.com/ml/v4/deployments/1729ff17-6cec-4697-afee-e59bb6cc
print("Scoring response")
predictions =response_scoring.json()
print(predictions)
print('Final Prediction Result',predictions['predictions'][0]['values'][0][0])
pred =response_scoring.json()
output = pred['predictions'][0]['values'][0][0]
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL JUPYTER COMMENTS
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS C:\Users\ADMIN\Downloads\IBM-Project-26380-1660025744-main> & C:/Users/ADMIN/AppData/Local/Programs/Python/Python311/python.exe "c:/Users/
ADMIN/Downloads/IBM-Project-26380-1660025744-main/IBM-Project-26380-1660025744-main/Project Development Phase/Sprint 4/app.py"
* Serving Flask app 'app'
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on http://127.0.0.1:5500
Press CTRL+C to quit
127.0.0.1 - - [18/Nov/2022 19:30:53] "GET / HTTP/1.1" 200 -
127.0.0.1 - - [18/Nov/2022 19:30:55] "GET /favicon.ico HTTP/1.1" 404 -
Python
Python
Python
Python
Python
Ln 9, Col 57 Spaces: 4 UTF-8 LF Python 3.11.0 64-bit Go Live Prettier
Type here to search
26°C Haze
ENG
07:33 PM
18-11-2022


File Edit Selection View Go Run Terminal Help
about.html - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
about.html
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > templates > about.html > ...
Sets the background image(s) of an element.
Syntax: <bg-image>#
MDN Reference
Follow link (ctrl + click)
background-image: url("https://psmag.com/.image/t_share/MTI3NTgxNDIxMjkxNDc2MjQy/waterpic.jpg");
background-size: cover;
.pd {
padding-bottom: 100%;
.navbar {
margin: 0px;
padding: 20px;
background-color: white;
opacity: 0.6;
color: black;
font-family: "Roboto", sans-serif;
font-style: italic;
border-radius: 20px;
font-size: 25px;
a {
color: grey;
float: right;
text-decoration: none;
font-style: normal;
padding-right: 20px;
p {
color: turqouise;
IBM-PR...
IBM-Project-26380-1...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
about.html
base.html
info.html
predict.html
result.html
app.py
ibm-deploy.ipynb
model.pkl
OUTLINE
TIMELINE
Ln 1, Col 1 Spaces: 2 UTF-8 LF HTML Go Live Prettier
tabnine starter Quokka
Type here to search
24°C Haze
ENG
07:39 PM
18-11-2022

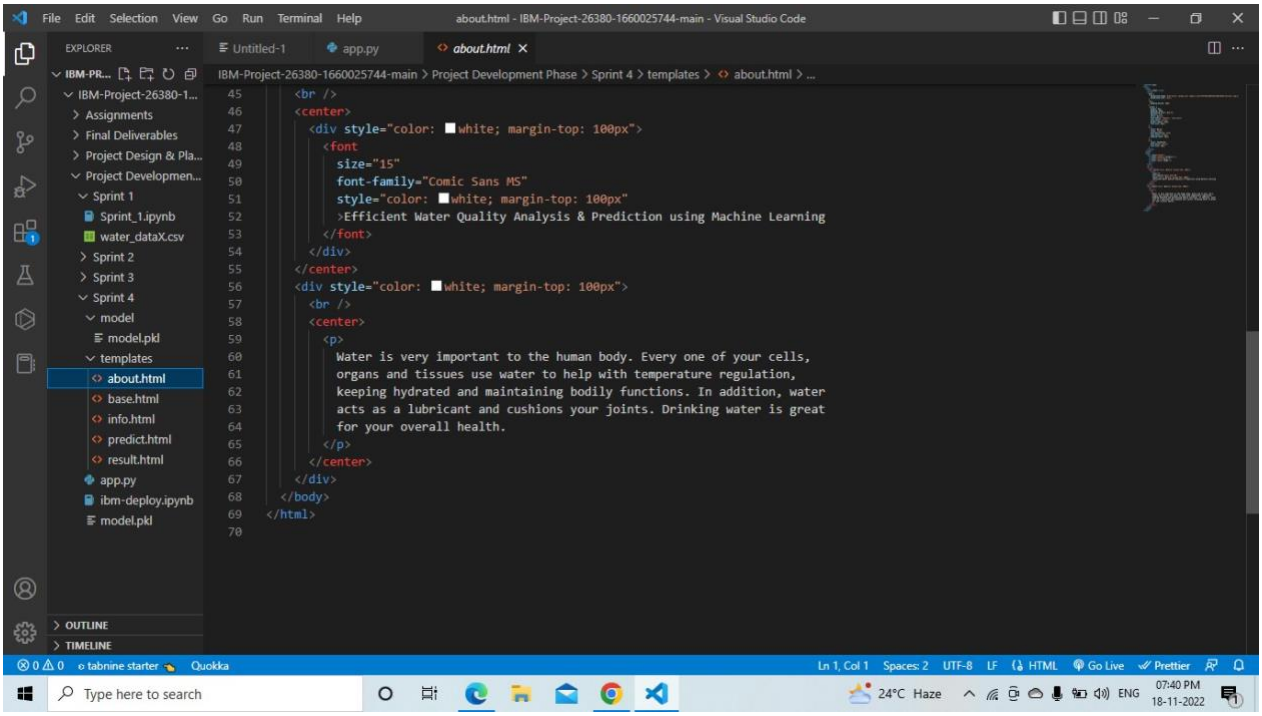

File Edit Selection View Go Run Terminal Help
about.html - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
about.html
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > templates > about.html > ...
font-size: 30px;
</style>
</head>
<body>

Predict
Info
Home

<font
size="15"
font-family="Comic Sans MS"
style="color: white; margin-top: 100px"
>Efficient Water Quality Analysis & Prediction using Machine Learning

Water is very important to the human body. Every one of your cells,
organs and tissues use water to help with temperature regulation,
keeping hydrated and maintaining bodily functions. In addition, water
acts as a lubricant and cushions your joints. Drinking water is great
for your overall health.

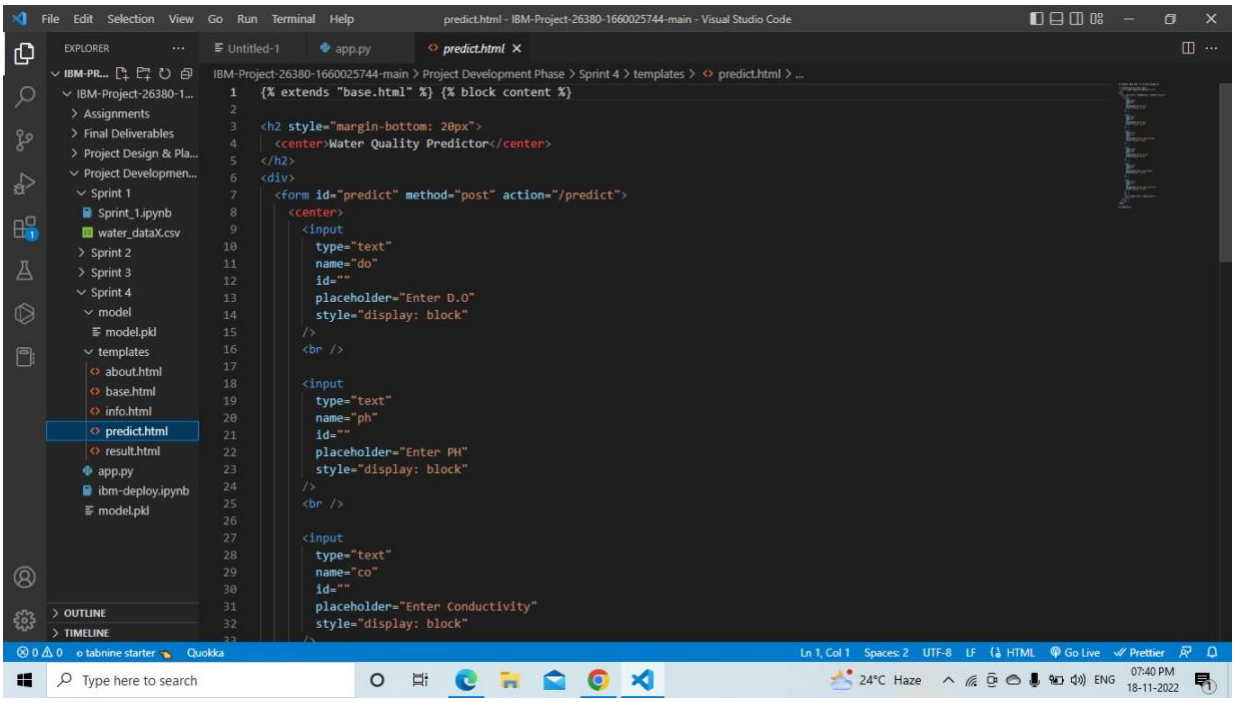
IBM-PR...
IBM-Project-26380-1...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
about.html
base.html
info.html
predict.html
result.html
app.py
ibm-deploy.ipynb
model.pkl
OUTLINE
TIMELINE
Ln 1, Col 1 Spaces: 2 UTF-8 LF HTML Go Live Prettier
tabnine starter Quokka
Type here to search
24°C Haze
ENG
07:40 PM
18-11-2022


about.html - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
about.html
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > templates > about.html > ...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
about.html
base.html
info.html
predict.html
result.html
app.py
ibm-deploy.ipynb
model.pkl

<font
size="15"
font-family="Comic Sans MS"
style="color: white; margin-top: 100px"
>Efficient Water Quality Analysis & Prediction using Machine Learning

Water is very important to the human body. Every one of your cells,
organs and tissues use water to help with temperature regulation,
keeping hydrated and maintaining bodily functions. In addition, water
acts as a lubricant and cushions your joints. Drinking water is great
for your overall health.

</body>
</html>
OUTLINE
TIMELINE
Ln 1, Col 1
Spaces: 2
UTF-8
LF
HTML
Go Live
Prettier
Type here to search
24°C Haze
ENG
07:40 PM
18-11-2022

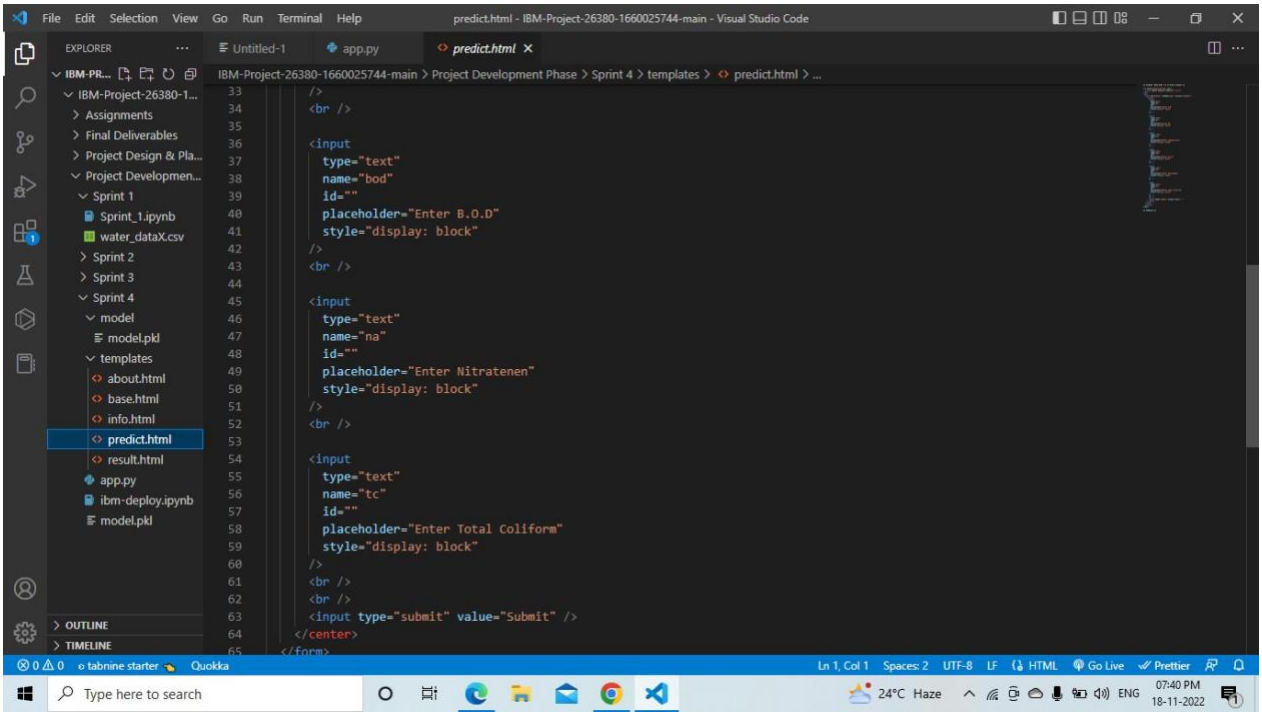

predict.html - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
predict.html
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > templates > predict.html > ...
{% extends "base.html" %} {% block content %}
<h2 style="margin-bottom: 20px">
Water Quality Predictor
</h2>

<form id="predict" method="post" action="/predict">

<input
type="text"
name="do"
id=""
placeholder="Enter D.O"
style="display: block"
/>

<input
type="text"
name="ph"
id=""
placeholder="Enter PH"
style="display: block"
/>

<input
type="text"
name="co"
id=""
placeholder="Enter Conductivity"
style="display: block"
/>
OUTLINE
TIMELINE
Ln 1, Col 1
Spaces: 2
UTF-8
LF
HTML
Go Live
Prettier
Type here to search
24°C Haze
ENG
07:40 PM
18-11-2022


File Edit Selection View Go Run Terminal Help
predict.html - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
predict.html
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > templates > predict.html > ...
IBM-PR...
IBM-Project-26380-1...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
about.html
base.html
info.html
predict.html
result.html
app.py
ibm-deploy.ipynb
model.pkl
OUTLINE
TIMELINE
/>

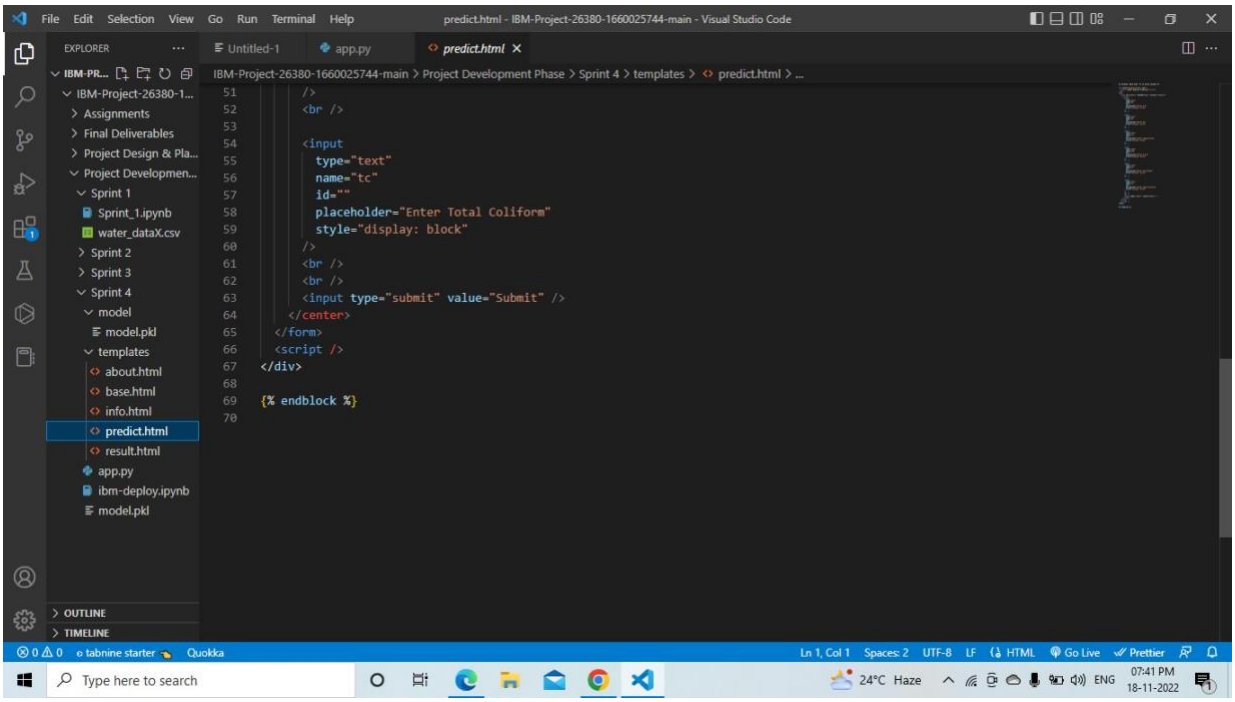
<input
type="text"
name="bod"
id=""
placeholder="Enter B.O.D"
style="display: block"
/>

<input
type="text"
name="na"
id=""
placeholder="Enter Nitratenen"
style="display: block"
/>

<input
type="text"
name="tc"
id=""
placeholder="Enter Total Coliform"
style="display: block"
/>

<input type="submit" value="Submit" />

</form>
tabnine starter
Quokka
Ln 1, Col 1
Spaces: 2
UTF-8
LF
HTML
Go Live
Prettier
Type here to search
24°C Haze
ENG
07:40 PM
18-11-2022

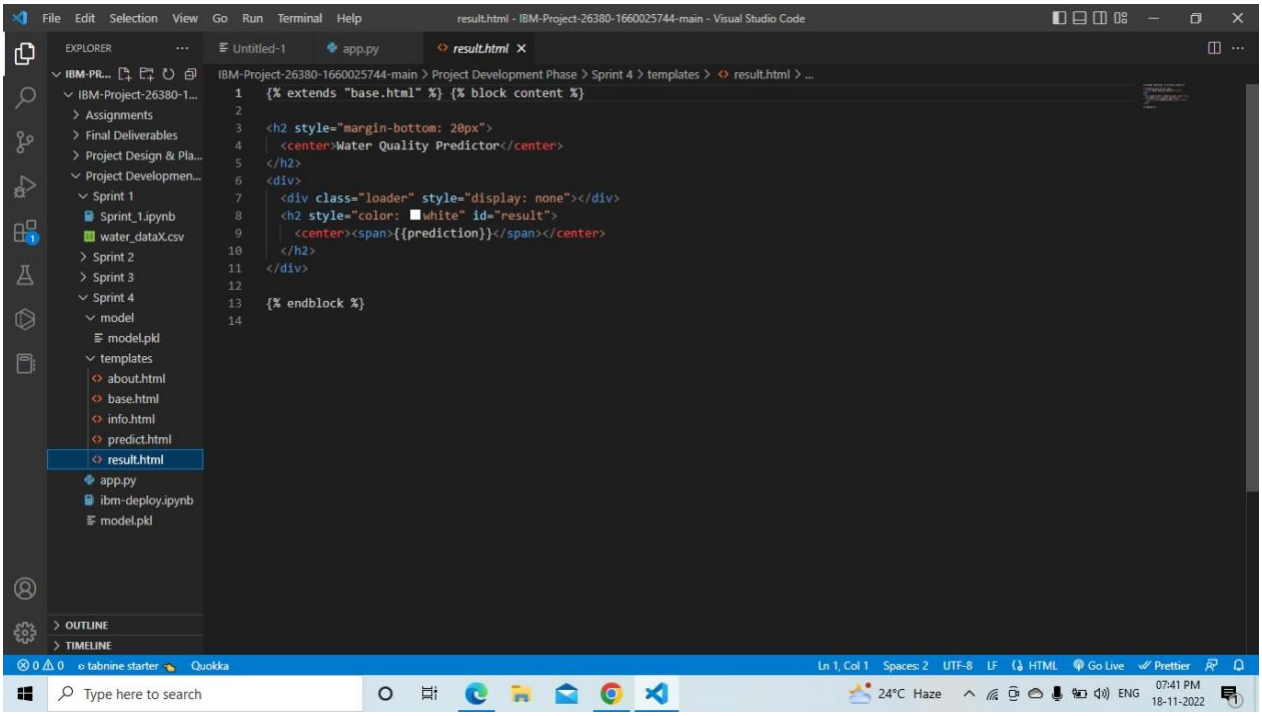

File Edit Selection View Go Run Terminal Help
predict.html - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
predict.html
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > templates > predict.html > ...
IBM-PR...
IBM-Project-26380-1...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
about.html
base.html
info.html
predict.html
result.html
app.py
ibm-deploy.ipynb
model.pkl
OUTLINE
TIMELINE
/>

<input
type="text"
name="tc"
id=""
placeholder="Enter Total Coliform"
style="display: block"
/>

<input type="submit" value="Submit" />

</form>
<script />

{% endblock %}
tabnine starter
Quokka
Ln 1, Col 1
Spaces: 2
UTF-8
LF
HTML
Go Live
Prettier
Type here to search
24°C Haze
ENG
07:41 PM
18-11-2022


File Edit Selection View Go Run Terminal Help
result.html - IBM-Project-26380-1660025744-main - Visual Studio Code
EXPLORER
Untitled-1
app.py
result.html
IBM-Project-26380-1660025744-main > Project Development Phase > Sprint 4 > templates > result.html > ...
{% extends "base.html" %} {% block content %}
<h2 style="margin-bottom: 20px">
Water Quality Predictor
</h2>

<h2 style="color: white" id="result">
{{prediction}}
</h2>

{% endblock %}
IBM-PR...
IBM-Project-26380-1...
Assignments
Final Deliverables
Project Design & Pla...
Project Developmen...
Sprint 1
Sprint_1.ipynb
water_dataX.csv
Sprint 2
Sprint 3
Sprint 4
model
model.pkl
templates
about.html
base.html
info.html
predict.html
result.html
app.py
ibm-deploy.ipynb
model.pkl
OUTLINE
TIMELINE
tabnine starter
Quokka
Ln 1, Col 1
Spaces: 2
UTF-8
LF
HTML
Go Live
Prettier
Type here to search
24°C Haze
ENG
07:41 PM
18-11-2022

8.TESTING

8.1.Test Cases

Test case ID	Feature Type	Component	Test scenario	Steps to execute	Test Data	Expected Result	Actual Result	Status	Comments	TC for Automation(Y/N)	BUG ID	Executed By
IndexPage_TC_001	UI	Index Page	Verify the UI elements in Index	1.Enter the local host url and click go.	127.0.0.1.50 00	Application should show below UI elements:1.Title of the project 2.Description of the project	Working as expected	PASS	Successfuk	Y		C.Vijayahari ni
IndexPage_TC_002	UI	Index Page	Verify user is able to navigate into the predict page	1.Enter the localhost url and click predict.	127.0.0.1.50 00	User should navigate to predict page	Working as expeced	PASS	Successful	Y		H.Subhalaks hmi
Predict Page_TC_003	UI	Predit Page	Verify the UI elements in Predict Page	1.Enter the localhost url and click go. 2.Click on want to predict button	127.0.0.1.50 00	Application should show below UI elements:1.Enter the data input. 2.Check the predict button	Working as expected	PASS	Successful	Y		R.D.Sharmil a
Predict Page_TC_004	Functional	Predit Page	Verify user is able to give input in the form	1.Enter the localhost url and click go. 2.Click on predict. 3.Enter the values	127.0.0.1.5 00	User should able to give input textbook	Working as expected	PASS	successful	Y		A.D.Shruthi

Predict Page_TC_005	UI	Predict Page	Verify users are able to see the result text when clicking on the predict button.	1. Enter the localhost url and click go.2.Click predict button. 2. Enter input data. 4.Click on the predict button.	127.0.0.1.5000	Users should be able to predict the quality predicted value in XX WQI text.	Working as expected	PASS	Successful	Y		C.Vijayaharini

8.2 User Acceptance Testing

Purpose of User Acceptance Testing

The purpose of this document is to briefly explain the test coverage and open issues of the [Efficient Water Quality Analysis & Prediction using Machine Learning] project at the time of the release to User Acceptance Testing (UAT).

Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Severity 5	Subtotal
By Design	1	1	1	0	0	3
Duplicate	1	0	1	0	0	2
External	1	0	0	1	0	2
Fixed	2	1	0	0	0	3
Not Reproduced	0	0	0	0	0	0
Skipped	0	0	0	0	0	0

Test Case Analysis

Shows the number of test cases that have passed, failed, and untested

Section	Total cases	Not Tested	Fail	Pass
Index Page	2	0	0	2
Predict Page	8	0	0	8

9.RESULTS

9.1 Performance Metrics

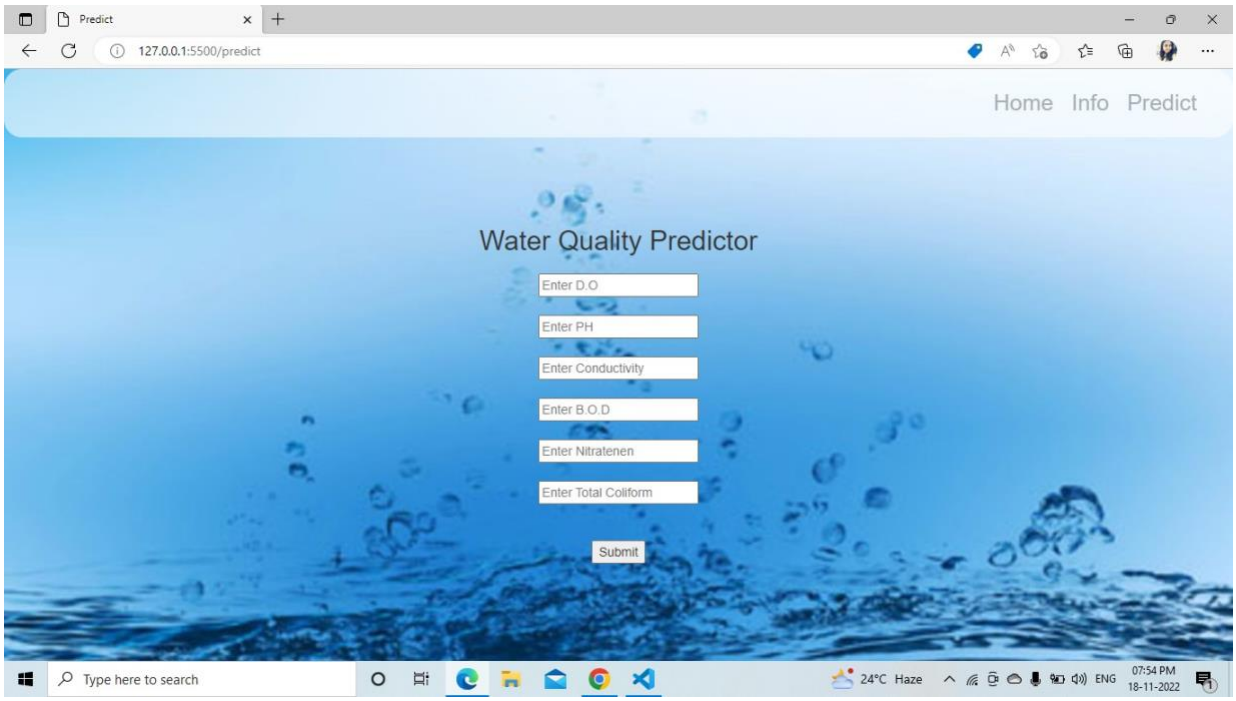
S.No.	Parameter	Values	Screenshot

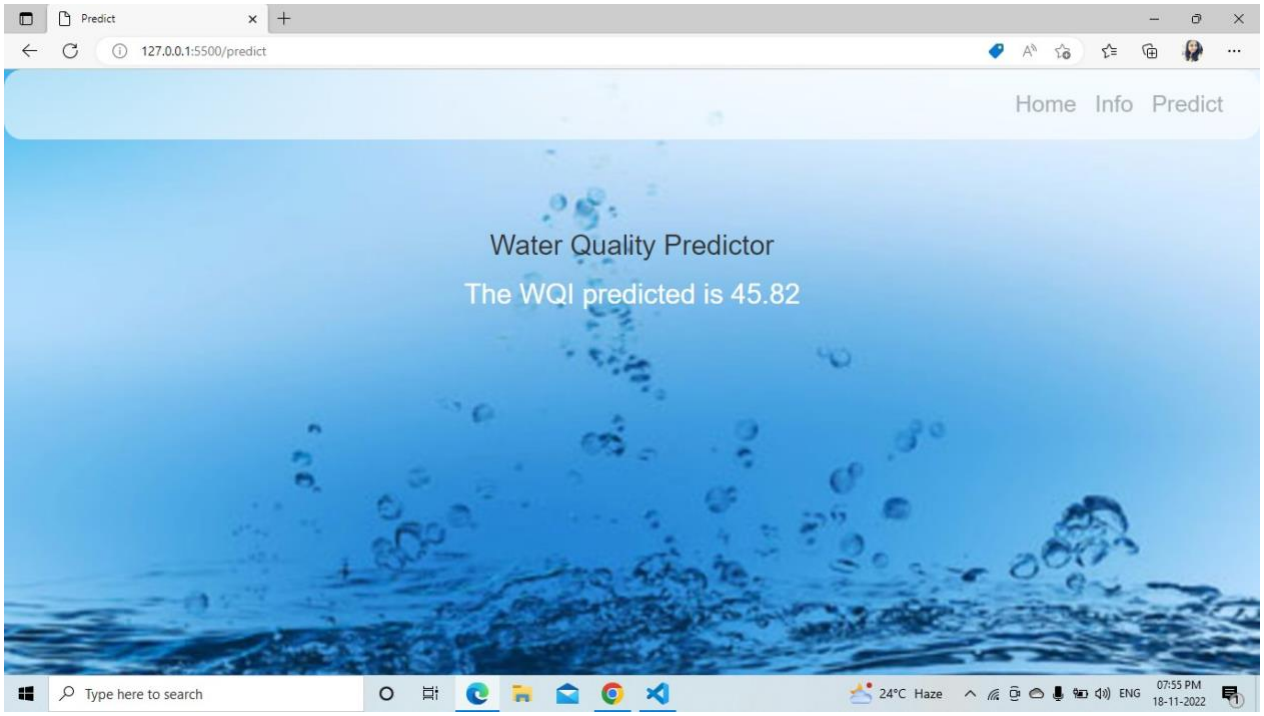
1.	Metrics	**Regression Model:**
		MAE : 0.987
		MSE : 5.55
		RMSE : 2.35
		R2 score: 0.96
			In [47]:
			`from sklearn import metrics`
			`print('MAE:',metrics.mean_absolute_error(y_test,y_pred))`
			`print('MSE:',metrics.mean_squared_error(y_test,y_pred))`
			`print('RMSE:',np.sqrt(metrics.mean_squared_error(y_test,y_pred)))`
			MAE: 0.9872080200501312
			MSE: 5.555095879699248
			RMSE: 2.3569250899634566
			In [48]:
			`metrics.r2_score(y_test, y_pred)`
			Out[48]:
			0.96971918125809

2.	Tune the Model	Hyperparameter Tuning –
		n_estimators = 10,
			`from sklearn.ensemble import RandomForestRegressor`
			`regressor = RandomForestRegressor(n_estimators = 10, random_state = 0)`
			`regressor.fit(x_train, y_train)`
			`y_pred = regressor.predict(x_test)`

7.3 Output


Home
127.0.0.1:5500
Home Info Predict
Efficient Water Quality Analysis & Prediction using Machine Learning
Water is very important to the human body. Every one of your cells, organs and tissues use water to help with temperature regulation, keeping hydrated and maintaining bodily functions. In addition, water acts as a lubricant and cushions your joints. Drinking water is great for your overall health.
Type here to search
24°C Haze
ENG
07:54 PM
18-11-2022


Predict
127.0.0.1:5500/predict
Home Info Predict
Water Quality Predictor
Enter D.O
Enter PH
Enter Conductivity
Enter B.O.D
Enter Nitratenen
Enter Total Coliform
Submit
Type here to search
24°C Haze
ENG
07:54 PM
18-11-2022



8. ADVANTAGES & DISADVANTAGES

ADVANTAGES

- Water quality standards protect human health and avoid the costs related to medical care, productivity loss, and even loss of life
- Help researchers predict and learn from natural processes in the environment and determine human impacts on an ecosystem
- Water quality modeling helps people understand the eminence of water quality issues and models provide evidence for policy makers to make decisions in order to properly mitigate water.
- Water quality standards also protect iconic, locally grown products such as wild rice and walleye.

DISADVANTAGES

- The android mobile user will not be able to insert or view details if the server goes down.

- Thus there is a disadvantage of single point failure.

9. CONCLUSION

By the end of this project we will

· gain a broad understanding of water quality

· know how to build a web application using the Flask framework.

· know how to pre-process data and

· know how to clean the data using different data preprocessing techniques

10. FUTURE SCOPE

- The need for data science experts is thriving in every job space and is not limited to only technology. Since this is a highly in-demand career choice and guaranteed high-paying salaries, an advanced education coupled with excellent skills is mandatory.
- Data scientists are highly educated and boast of intelligence and a certain skill set relevant to the field .
- There is a distinct space and need for professionals who have insight into how a business can flourish with data driven solutions and implementation.
- The data science trend will not be taking a backseat anytime soon.

13.APPENDIX

Source Code :

```
import os
import numpy as np
from flask import Flask,request,render_template
import pickle
import requests
```

```
# NOTE: you must manually set API_KEY below using information retrieved from your IBM Cloud account.
API_KEY = "YdvedR02ZwG55_f0h2MOZ6AqnfX8cUoa5k9vNev56q8X"
token_response = requests.post('https://iam.cloud.ibm.com/identity/token', data={"apikey":
 API_KEY, "grant_type": 'urn:ibm:params:oauth:grant-type:apikey'})
mltoken = token_response.json()["access_token"]

header = {'Content-Type': 'application/json', 'Authorization': 'Bearer ' + mltoken}




app= Flask(__name__)
# model = pickle.load(open('/Users/balasaravananvp/Documents/tensorflow-test/IBM-Project-26380-1660025744/Project Development Phase/Sprint 4/gow.pkl', 'rb')) # loading the trained model

@app.route("/")
def about():
    return render_template("about.html")

@app.route("/about")
def home():
    return render_template("about.html")

@app.route("/info")
def information():
    return render_template("info.html")



@app.route("/predict",methods=["GET","POST"])
```

```
def upload():
    if request.method=='POST':
        init_features = [float(x) for x in request.form.values()]


        payload_scoring = {"input_data":
                           [{"field": [["f0", "f1","f2","f3","f4","f5"]],
                "values": [init_features]}]}
        print(payload_scoring)
        response_scoring = requests.post('https://eu-gb.ml.cloud.ibm.com/ml/v4/deployments/1729ff17-6cec-4697-afee-e59bb6cc3c9c/predictions?version=2022-11-13', json=payload_scoring, headers={'Authorization': 'Bearer ' + mltoken})
        print("Scoring response")
        predictions =response_scoring.json()
        print(predictions)
        print('Final Prediction Result',predictions['predictions'][0]['values'][0][0])



        pred =response_scoring.json()


        output = pred['predictions'][0]['values'][0][0]
        return render_template("result.html",prediction='The WQI predicted is {:.2f}'.format(output))


    else:
        return render_template("predict.html")



if __name__=="__main__":
    app.run(debug=False,port=5500)
```

GitHub Link:
https://github.com/IBM-EPBL/IBM-Project-39097-1660394670

Project Demo Link :

https://drive.google.com/file/d/1pJ0IB_0hLXBCfwmVJryxu_QcC9MNzKVC/view?usp=sharing