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Shedding Light on Effect of Atmospheric Phenomenaon Air Quality Prediction by Employing Deep Learning

Geetaanjali GNS
Dept. of Data Science and Business Systems
SRM Institute of Science and Technology
Chennai, India
gg2119@srmist.edu.in

Sushanth Teegela
Dept. of Data Science and Business Systems
SRM Institute of Science and Technology
Chennai, India
ts7099@srmist.edu.in

Radha R
Dept. of Data Science and Business Systems
SRM Institute of Science and Technology
Chennai, India radhar@srmist.edu.in

***Abstract*— Weather patterns can be utilized to foresee air quality since they fundamentally affect it. But since deep learning is a "discovery," it is difficult to construct dependable deep learning models that consider meteorological circumstances while foreseeing air quality. In this review, we utilize reasonable deep learning out how to show the effect of meteorological elements on air quality estimates to determine the previously mentioned issue.1) The source data from air poison data sets, as PM2.5, PM10, and SO2 hourly obsessions, as well as meteorological condition data sets ssessing temperature, suddenness, and pneumatic stress, are gotten in this paper; (2) To foresee air quality under four circumstances, the Long Short Term Memory (LSTM) and Gated Recurrent Unit(GRU)models are laid out;(3)The air quality's reasonableness is analyzed utilizing the Shapley Additive ExPlanation (SHAP)technique. We find that basically considering atmospheric conditions doesn't work on estimate precision. In any case, gauge precision is better when meteorological circumstances and other air contaminations are joined than when just other air toxins are incorporated. Additionally, the mainconsider anticipating air quality is climatic strain, trailed by temperature and stickiness. The cooperation of climatic factors and other air impurities might be the reason for the uniqueness in gaurge precision. The after effects of this study could assist with working on the exactness of air quality estimates and make them more solid.**

Keywords—LSTM,GRU,SHAP.

I. INTRODUCTION

Natural issues have emerged because of the continuous speed increase of worldwide urbanization and industrialization. The deterioration of air quality brought on by industrialization and urbanization is one of the most significant issues affecting the environment [1, 2]. Energy creation and utilization tasks, for example, power plants, ventures, and auto fumes emanations, have at last added to the nonstop deteriorating of worldwide air quality [3]. Air contamination represent sacritical danger to individuals' lives and wellbeings inceit can prompt various respiratory circumstances and even malignant growth[4]. AirtoxinslikeSO2, PM10, and PM2.5 are the most pervasive. A small molecule with a breadthunder 2.5 micronsis known as PM2.5. Since PM2.5 particles are more dynamic than bigger particulate poisons,they canrapidly and handily spread,persevere in the air for quite a while, and transport intensifies that are hurtful to human wellbeing and the climate. PM2.5[2] is one of the main supporters of air contamination. Asthma, bronchitis, and cardio vascular infection might be welcomed on by its capacity to effortlessly enter the humanthroat and nasal pit because of its little molecule size [5]. Air pollution is bad for people's health[4,6]. A number of respiratory conditions and even impairments in cardiopulmonary function can result from prolonged exposure to high levels of air pollution. Numerous diseases will spread rapidly, putting people's health at risk, affecting their quality of life and happiness scores, and raising mortality rates [7]. As well as influencing the climate, air contamination additionally hurts the environment by decreasing its assortment and solidness[1].

Not in the least regular occasions of air contamination represent a danger to human wellbeing, yet they likewise cause huge monetary misfortunes and a plenty of cultural issues[8]. In like manner, advantageous legitimate assessment, careful guess of air quality, and useful security and treatment considering air pollution measures could help critical divisions and related relationship in taking impediment actions early, as well as more appropriately coordinating outings. Disease outbreaks could be avoided and people's health could be preserved[9].

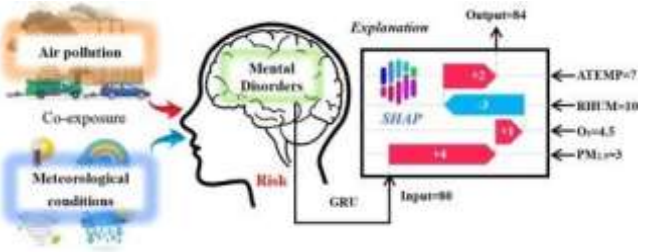

Fig.1.

As a result,forecasts of air quality may provide useful data for controlling and preventing air pollution.Accurate assessment and forecasting of changes in air quality may assist in the management and prevention of air pollution, thereby safeguarding the environment and humanhealth[10].This is made possible by having a better understanding of the underlying variables and shifting patterns of air pollutants.

Air quality expectation likewise assists pertinent divisions with fat homing the state of air quality, thus a critical hypothetical establishment might be provided for it. As a result, programs to reduce and prevent air pollution can be tailored to specific circumstances. It likewise gives valuable contemplations and thoughts for future chiefs to seek after

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additional savvy and proficient activities to improve air quality[11]. Some examples of relevant research efforts are listed below. For example, Kumar and Goyal [12] conjecture the everyday Air Quality Index(AQI) for each seas on utilizing three measurable models: principal component regression (PCR), the auto-regressive integrated moving average(ARIMA), and a mix of the two. In view of back-direction focuses and nonlinear regression(NLR), Cobourn[13] proposed PM2.5expectation model with lower mean outright blunders. The most common way of utilizing physical and compound estimations to anticipate air quality is more troublesome. Rajput and co. 14] recommended a method for utilizing an AQI to assess and address quality status. This could assist with better determining of air quality measurements. In spite of this, the model is a period recurrence expectation model that performs best throughout more limited time periods.

This paper's findings can be summed up in the following format:

1. Long Short-Term Memory and Gated Recurrent Unit Were Deployed and tested against multiple circumstances and have fetched favorable outcomes.
2. The way the atmospheric phenomena exerts impact on quality of air, has been brought to light using Shapley Additive ExPlanation, this will be valuable in order to enhance the precision in future findings.
3. Built an application to apply the prediction in realtime.

II. Literature Survey

A. *The emergence of affordable sensing for regulating urban air pollution*

Air pollution and expanded street traffic are connected to the steadily expanding populace of urban communities. It has been exhibited that metropolitan tenants face a huge danger from raised degrees of air contamination by and large. Not withstanding, the impacts of incredibly high contamination yet restricted openness over the long haul and space stay obscure. Organizations of static and inadequate estimation locales support conventional air quality estimation strategies.Unfortunately, they are excessively costly to catch rhythm spatial fluctuation and recognize contamination areas of interest, which are fundamental for the improvement of compelling ongoing openness control techniques.The customary way to deal with permitting continuous data to be put away in a slim structure has been generally modified by late headways in the improvement of minimal expense miniature size detecting advances.Be that as it may, whether or not the less exact information they produce is helpful continues.This article clears up the significant hindrances for their fruitful application and the elements that have prompted an expansion in the utilization of reasonable sensors for city air pollution control.

B. *Air Pollution and Ncds Diseases: A Study by the Environmental Committee of the Federation of GlobalRespiratorySocieties,Volume01:TheHarmfulConsequencesofAirPollution:*

Air pollution is a significant danger to human wellbeing in the climate. Openness to outside fine particulate matter(particulate matter with a streamlined measurement of 2.5meters) is the fifth driving reason for death around the world, representing 4.2 million passings and in excess of 103 million handicap changed life years lost,as per the Worldwide Weight of Sickness Report. Indoor air tainting is at risk for an extra 3.8 million passings, according to the World Prosperity Affiliation. Air pollution can be unsafe on a transient premise,as proven by side effects in the respiratory or heart frameworks, as well as over the longhaul, potentially influencing each organ in the body. It very well may be there as on for, convolute,or fuel various negative medical problems. Since small and ultrafine particles can get in to organs, contamination poisonousness can cause tissue harm either straightforwardly or by implication through foundational incendiary cycles. Innate and epigenetic factors both impact powerlessness.Despite the fact that individuals of any age, areas, and financial classes are impacted via air contamination, the people who are most often uncovered are bound to turn out to be sick. At the point when individuals are sick or need social help, they are particularly delicate to air pollution. Indeed, even at portions that were recently remembered to be inside satisfactory air quality principles ,unfriendly impacts persevere.

C. *Particulate Matter 2.5's influence on the respiratory system in humans:*

As of late ,various school astics have zeroed in on the association between air pollution and issues of the respiratory framework. As of late, exhaust cloud level shave expanded in China, bringing down air quality and raising worries across the globe. Particles with a diameter of less than 2.5 micrometers (PM2.5) can possibly enter the lungs, making the alveolar wall become bothered and disintegrated, compromising lung capability. Thusly, it is fundamental to research the impacts of PM2.5 on the respiratory framework and afterward help China in resolving its recent concerns with air pollution. In light of epidemiological, exploratory, and component studies, the impacts of PM 2.5 on the human respiratory framework will be analyzed in this survey.At last,we ask specialists to make a contamination related wellbeing record and encourage the general population to restrict their openness to air pollution.

D. *Analysis of data and mining of climatic variations and air quality co-relations: A study in China:*

PM2.5,PM10,andO3contamination represent a developing danger to human wellbeing, especially in China's megacities. Air pollutants' dissemination and focus are impacted by meteorological circumstances, which altogether affect their weakening and dispersion.We examined the associations between Beijing's meteorological circumstances and air contamination fixations from January 2017 to January 2018. That's what we find: 1)A solitary meteorological component meaningfully affects the centralization of contaminations; (2) There is major areas of strength for a between the blend of temperature and wind speed, moistness and wind speed, and strain and temperature, showing that various meteorological elements

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cooperate to influence the convergence of poisons; (3) Poison fixation is impacted distinctively by different meteorological variables.Our discoveries canpossibly further develop metropolitan administration execution while additionally aiding climate-based figures of air quality.

E. Based on cognitive calculation, a novel technique forpredictingairqualityhasbeendeveloped:

The recognizable proof and treatment of developing aircontamination welcomed on by mechanical progressions isquitepossiblyofthemaintestconfrontingthispresentreality.Contaminationlevelshavewithoutadoubtrisenemphaticallylately. Utilizing profound learning methods and an recurrentneural network (RNN), the current work expects to foster awise figure for air contamination fixations over the course ofthefollowingtwodays.Theidealdesignforitsactivityisthenfoundutilizingaparticleswarmoptimization(PSO)strategy.The smart air quality prediction model (SAQPM) is a cleverindicatorinlightofcannyprocessingthatutilizesstreamlingandunaidedlearning,otherwisecalledlongshorttermmemory (LSTM). The essential goal is to estimate six kindsofcentralizationsofaircontamination:Nitrogendioxide(NO2),carbonmonoxide(CO),ozone(O3),andsulfurdioxide (SO2) are instances of PM2.5 and PM10 particles.SAQPM comprises of fourstages. Gatheringinformationfrom many stations — 35 in this occurrence — is the initialstep.Settinguptheinformationincorporates(a)isolatingeachstation with its own concentration, (b) tending to missingqualities,and(c)normalizingthedatasetwiththeMinMaxScalar strategy to a scope of (0, 1) Utilizing theutilitarian PSO calculation, the third step includes fosteringtheLSTMindicatorbydecidingtheidealorganizationdesignandboundaryvalues(weight,predisposition,numberofstowedawaylayers,numberofhubsineachsecretlayer,andenactmentcapability).Thetencross-approvalthoughtisthenused to separate the dataset into preparing and testing parts.Thepreparationdatasetisthenusedtoconstructtheindicator.Each station's evaluation results are determined in the fourthstepbytakingreadingsofthegroupingofeverypoisonconsistently for a limit of 30 days and computing the normalof the symmetric mean absolute percentage error (SMAPE)northof25days.

III. METHODOLOGY

In any case, in spite of the way that a deep learning models utilize meteorological circumstances to foresee air quality, meteorological factors are just utilized as info information, and there is no exploration on what meteorological circumstances mean for air quality expectation. In this specific case, it is obscure the way that meteorological factors impact air quality expectation in profound learning models.

This is on the grounds that the profound learning model is by and large a "black box," meaning it can't be made sense of. In any case, the profound learning model's extraordinary fitting benefit for complex information associations can be utilized to consolidate meteorological condition information with air quality information to gauge air quality.

Evaluating the effect of meteorological circumstances on air quality conjectures their connections actually faces various obstructions.

A. Drawbacks

1. However, considering that deep learning is a "black-box" technology, incorporating meteorologicalconditionsintoairqualitypredictioncanbechallenging.
2. Itisobscurewhatmeteorologicalcircumstancesmean for air quality prediction in profound learningmodels,includinghowtheyimpactairqualityforecast.

We utilize logical deep learning out how to uncover theimpact of meteorological factors on air quality expectationandfittinglymakesenseofwhatmeteorologicalcircumstances mean forairqualityforecast to defeat thepreviouslymentionedissues.Byshowingtheeffectofmeteorologicalelementsonthefigureof airquality,theprecisionisadditionallymovedalong.Itisfeasibletoproduceairqualitypredictionmodelsutilizingprofoundlearningwithmore prominent accuracy and constancy. Therefore, it couldwork better practically speaking. This could make it morestraightforwardforindividualstomakesensibletravelarrangementsandgototherightprecautionlengthstosafeguardtheirwellbeingontime.Workedoncomprehensionoftheconditionoftheairqualityisutilizedtoexecutepertinentsafeguardandcontrolestimatestoaccomplishopportuneandeffectivenaturaladministration.

B.Benefits:

1. It is possible to create deep learning models for airqualitypredictionthataremorereliableandaccurate.
2. Thiscouldmakeitmorestraightforwardforindividualstomakesensibletravelarrangementsandgo to the right deterrent lengths to safeguard theirwellbeingimmediately.

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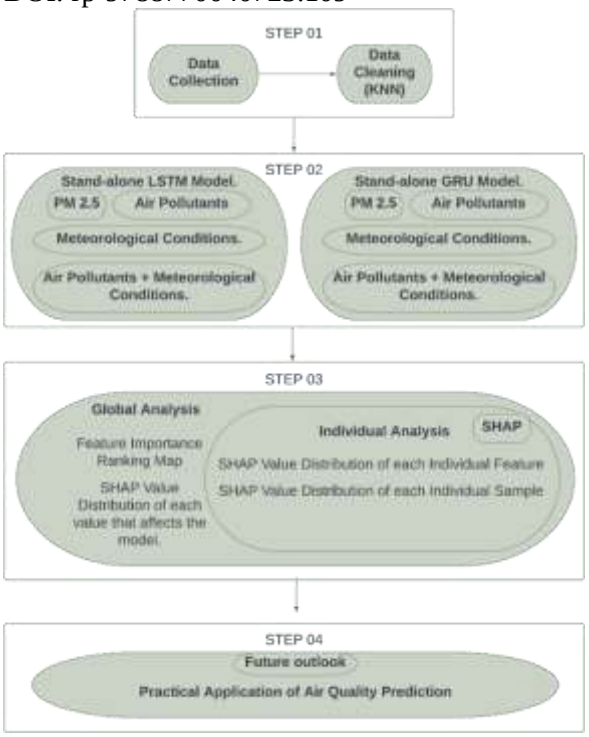

Fig.2.(Architecture).

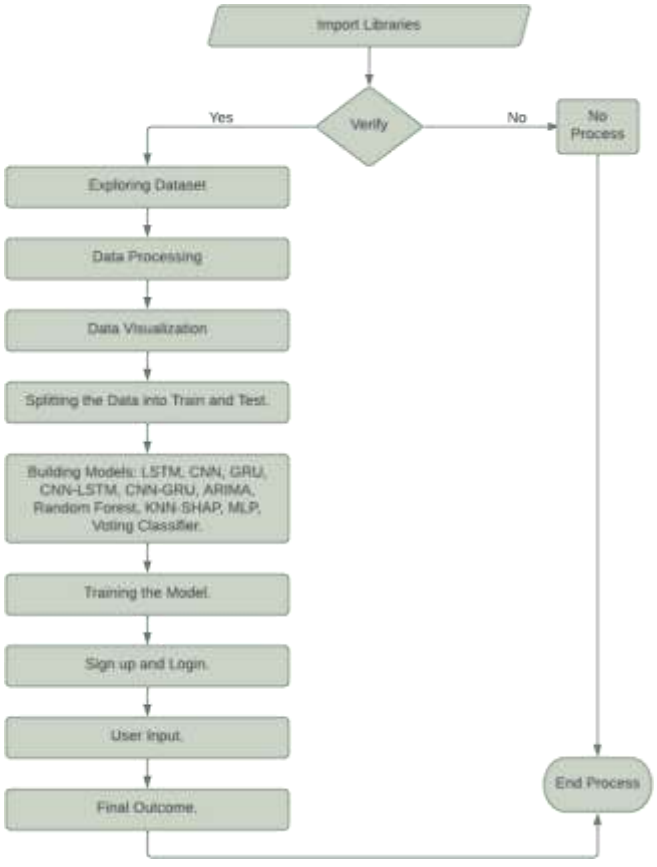

Fig. 3.Data Flow Diagram.

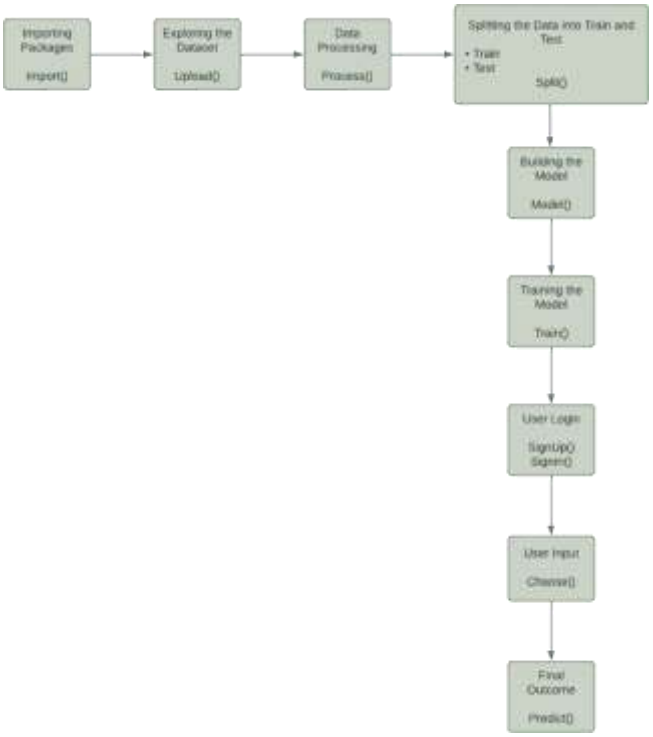

Fig. 4Class Diagram

IV. MODULES

1. Explorationofdata:Thismodulewillbeusedtoenterdataintothesystem.
2. Processing:Usingthismodule,wewillreaddataforprocessing.
3. Splittingthedataintotrainandtest:Datawillbedividedintotrainandtestwiththismodul
4. Constructing a model: LSTM, RNN, GRU,CNN+LSTM, CNN+GRU, ARIMA, RANDOMFOREST,KNN-SHAP,MLP,andavotingclassifieraresomeofthemethods. Accuracyofthecalculatedalgorithm
5. Userregistrationandlogin:Byusingthismodule,youcanregisterandlogin.
6. Userinput:Usingthismodulewillprovidepredictioninput.
7. Prediction: Itwillbeshownwhatthefinalpredictedvalue is.

V. IMPLEMENTATION

A. Algorithms

LSTM: Long short-term memory associations (LSTM)are utilized in the domain of Deep Learning. Variousrecurrentneuralnetworks(RNNs)mightbeutilizedtolearnlong haul conditions, especially in grouping expectationissues.

RNN: The most current strategy for successiveinformation,recurrentneuralnetworks(RNN),isutilizedbySiri on Apple and Google's voice search. It is the

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principalcalculation to review its contribution because of its innermemory, making it ideal for successive information basedMLchallenges.

GRU: In 2014, Kyunghyun Cho et al. proposed gatedrecurrent units (GRUs) as a repetitive brain network gatinginstrument.TheGRUworksinbasicallythesamemannert oaLSTMwithaneglectentryway,howeveritcomesupshortonyi elddoorandconsequentlyhaslessboundaries.

CNN+LSTM: Long Short-Term Memory (LSTM) andConvolutionalNeuralNetwork(CNN).LSTMcanremoven earbytexthighlightsfromexpandedtextgroupingswhileproduct ivelysavingthecharacteristicsofverifiabledatabyutilizingthe designofCNN.

CNN+GRU: CNN is used for include extraction,whileGRU is utilized as a completely connected layer.
SinceCoronavirusisanotherailment,thereisdeficientaccessible information for tests. The informational collection used inthisexaminationcamefromtwofreesources.

ARIMA: ARIMA models are frequently alluded to asARIMA (p,d,q), where p indicates the request for theautoregressive model, d characterizes the level ofuniqueness, and q means the request for the moving-normalmodel.ARIMAmodelsutilizedifferencingtochangeove ranon-fixed time series into a fixed one, and afterward utilizepastinformationtogaugefuturequalities.

RANDOMFOREST:AnRandomForestCalculationisano table directed ML method utilized in ML to settle orderandrelapseissues.Werealizethatatimberlandcontainsma nytrees,andthemoretreesthereare,themoregroundedthewoodl andwillbe.

KNN-SHAP: SHAP is a numerical method tounderstandingtheexpectationsofMLmodels.Itdependsonga me hypothesis and might be utilized to evaluate eachelement's commitment to the forecast to make sense of theexpectationsofanyMLmodel.

MLP:Thetruncation"MLPClassifier"alludestoamulti-layer perceptron classifier that, as the name infers, isconnected to a brain organization. As opposed to othergrouping strategies, for example, Support Vectors or NaiveBayes Classifier, MLPClassifier utilizes a basic brainorganizationtosortinformation.

Voting Classifier: After training several base models, avotingclassifierisamachinelearningestimatorthatpredictsbyi ntegratingtheoutcomesofnumerousbaseestimators.Asthe aggregating criterion, voting for each estimator outputmaybeaggregated.

Application: A simple web-application was deployed topredictairqualitytoauser,usingapicklefilethatwassavedduri ngexecutionofthepredictionsystem.

TABLE I. SPECIFICATIONS OF SOFTWARE USED

Software	Specifications
OperatingSystem	Windows
CodingLanguage	Python3.7

TABLE II.SPECIFICATIONS OF SOFTWARE USED

Hardware	Specifications
Processor	Intel(R)Core(TM)i5-7200UCPU
RAM	8 GB
Freaquency	@2.50GHz2.70GHz
SystemType	64-bitoperatingsystem, x64-basedprocessor

VI. EXPERIMENTAL RESULTS

A. *Algorithms*

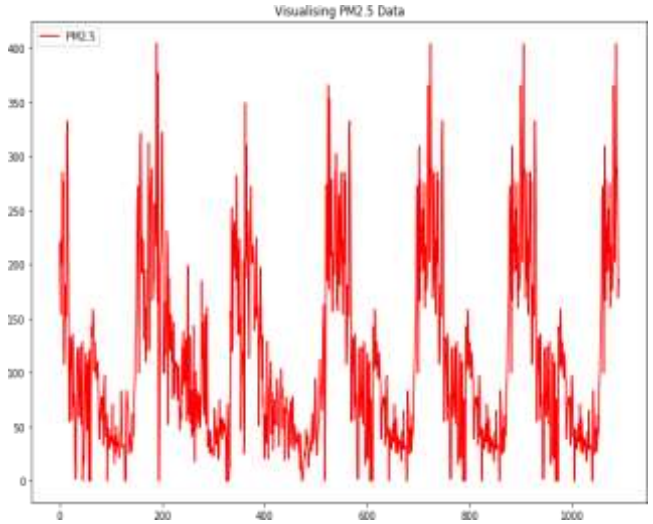

Fig. 5.(PM2.5, before removal of null and duplicate values).

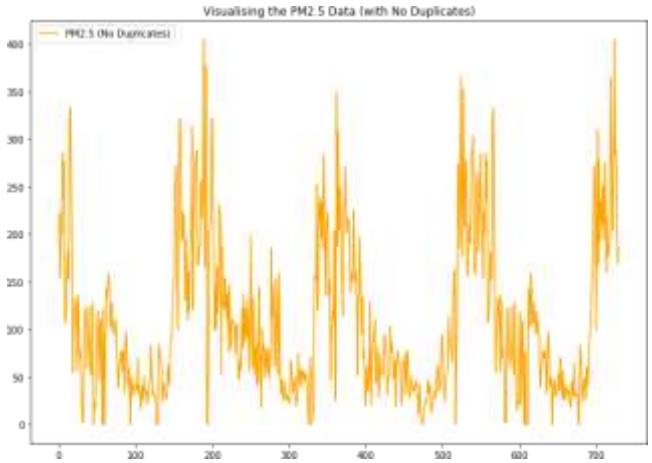

Fig. 6.(PM2.5, After Removal of duplicate values).

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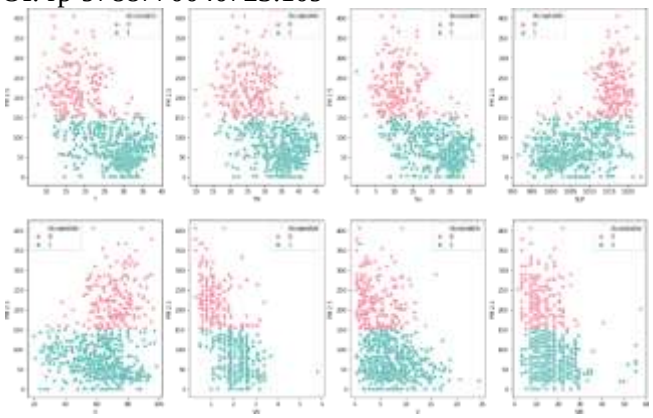

Fig. 7. (Scatterplots depicting acceptable and harmful ratios of Pm2.5 values)

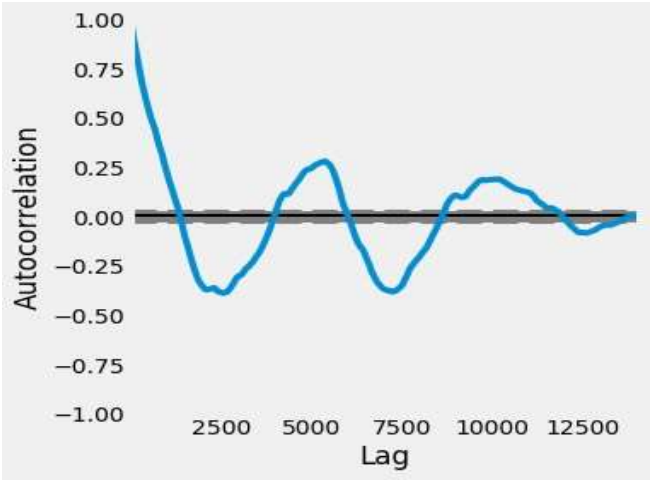

Fig. 10.

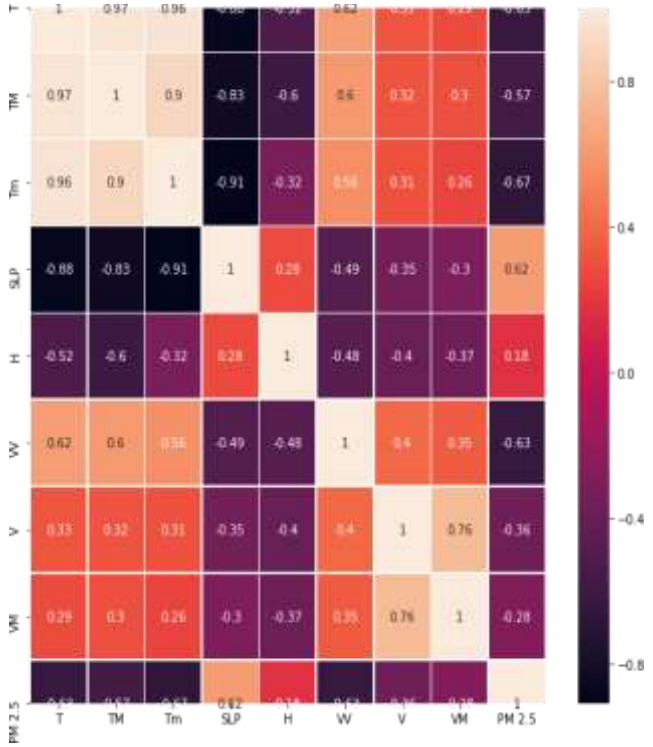

Fig. 8. (Heatmap of all parameters in a correlation with each other)

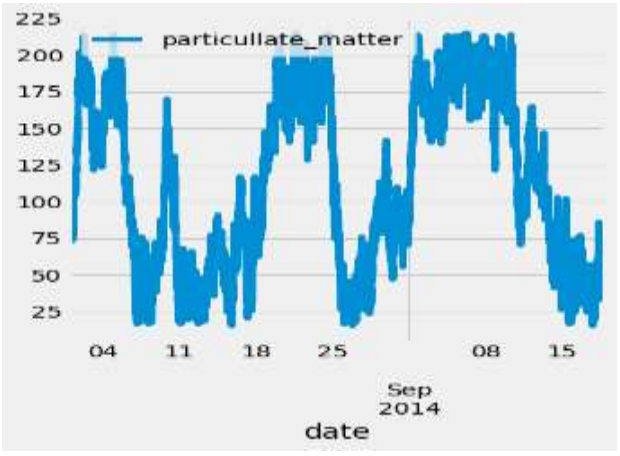

Fig. 9.

B. *Application*

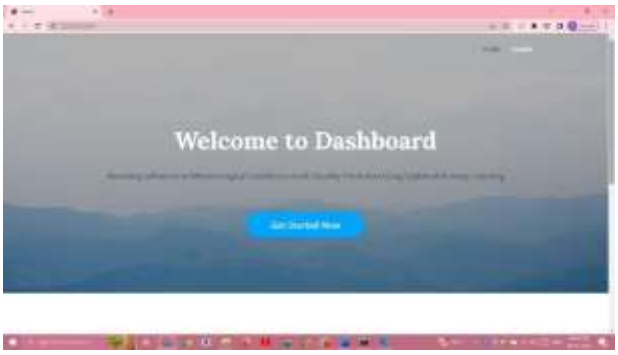

Fig. 11. Home Page

Fig. 12.SignUp page

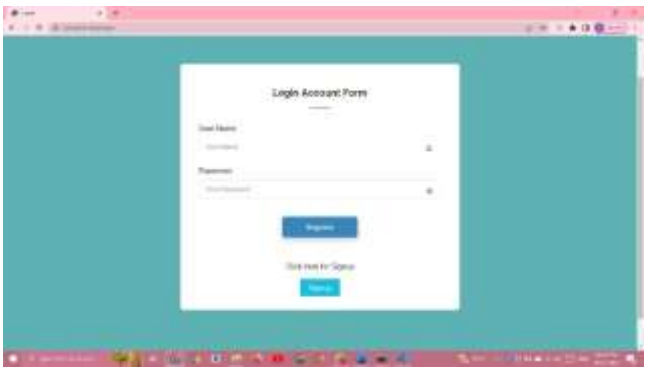

Fig.13.(SignInPage)

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Fig.14.(EnterValuesofrequiredparameterstopredictAirQuality)

Fig.15.(PredictedValueisObtained)

VII. Conclusion

To research the impact of meteorological circumstances onairqualityexpectation,weutilizetheSHapleyAdditiveExPlanationsexplainabledeeplearningtechniqueinthisreview.Using theSHAPtranslationwaytodealwithdecipher the current LSTM and GRU air quality expectationmodelsandresearchtheeffectofmeteorologicalcircumstances on air quality forecast is the focal thought. (1)TheoutcomesshowthattheLSTMandGRUmodels'expectationexactnessisn'timprovedbyessentiallyconsolidating meteorological elements. Notwithstanding, theconjecture precision improves when extra air poisons areadded, and the forecast exactness works on much furtherwhen meteorological circumstances are joined with extra airtoxins.2)TheLSTMandGRUmodelsallspotmeteorological circumstancesinthemainthreeasfarastheircommitment to air quality expectation, whether or not theyjustconsidermeteorologicalcircumstancesorjointhemwithother air poisons forPM2.5 forecast.Themain consideranticipatingairqualityisbarometricalstrain,trailedbytemperatureandstickiness.SO2greatestlyaffectstheforecastofairqualitywhenjustaircontaminationsareconsidered.3)Byandby,whensimplymeteorologicalconditions are utilized to gauge air quality, the significantcommitment of meteorological circumstances to the forecastslows down the discoveries and makes them more incorrect.The significant contribution of meteorological variables toforecast simplifies and enhances air quality prediction whenevaluated alongside other air contaminants. 4) The SHAPworthmightdifferrelyinguponthesituation,suggestingthatthe commitment to the expectation result fluctuates, whichmight represent the shifted last forecast exactnesses. This isbroughtaboutbythecollaborationofotherairpollutantsandclimaticcircumstances.Toresearchhowmeteorologicalelements impact air quality forecast, this work utilizes theSHAPstrategy,areasonabledeeplearningapproach,asopposed to past investigations. This works on the constancyofdeeplearningmodelsforairqualityexpectationandsupports inside and out study and appreciation. We plan tofoster more solid and precise deep learning models for airqualityexpectationlateronthatcanbeappliedtogenuineairqualityprediction.

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