i **ii**

**iiiCLIMATEiCHANGEiPREDICTIONiUSINGiMACHINEiLEARNING**

iiiiiiiiiii(foritheipartialifulfillment*i*ofiMastersiinicomputeriapplication)

I iiiiiiiiiiiiiiiiiii*Submittediby*

**iiiiMANJEETiSINGH**

**iiiiiiiiiiiiiiiiiiIiiiiiUnderitheiguidance**

**iiiiiiiiiiiofii**

*ii iiiii***iiMr.iAtikaiGupta**



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# DEPARTMENTiOFiCOMPUTERiSCIENCEiANDiENGINEERINGi

**iiiiiiiiiGRAPHICiERAiHILLiUNVERSITY,iDEHRADUN**

**CERTIFICATE**

ThisiisitoiconfirmithatiManjeetiSingh'sithesis,i"iweatheriitemperatureichangeiprediction,"iwhichiwasisubmitteditoiGraphiciEraiHilliUniversityiforiconsiderationiofitheiMasteriofiComputeriScienceidegree,iisianiaccurateiaccountiofitheistudyithatiwasicarriedioutiunderiouridirection.iNoiotheriInstituteioriUniversityihasireceivedithisiproject'simaterialsiinifullioriinipartiforitheipurposeiofiawardingiaidegreeioricertificate.

**PROJECTiINCHARGE**

**Mr.iAtikaiGupta**

**(Assistantiprofessor,iGEHU)**

### **ACKNOWLEDGEMENT**

Weiwouldilikeitoithanki**Ms.iAtikaiGupta**iforiheripatience,iencouragement,iandisupportiasiweiworkeditoifinishithisiprojectiandiforibelievingiinime.iAdditionally,iweithankiallitheieducatorsiwhoiprovidediusiwithiinsightfulirecommendationsiforitheiproject.iWeiareigratefuliforiouriparents'iongoingihelpiandiinspiration.iWeialsoiwantitoiexpressiourigratitudeitoithemiforigivingiusitheichanceitoigetithusifariiniouriacademicipursuits.iWeiwouldilikeitoithankiouriprojecticoordinatoriandiprojectiguideiiniparticular.iLastly,ibuticertainlyinotileast.iAlliotheripeopleiwhoiassistediusithroughoutithisiendeavour,iwhetheridirectlyiori

indirectly,iiareihighlyiowed.

Mr.iManjeetiSingh (RolliNo.-i2101110)

**ABSTRACTi**

**i**

Long term weather temperature change prediction has major importance in various sectors like climate related studies, agricultural, energy, medical and many more. This paper evaluates the performance of several Machine Learning algorithm Linear Regression, in problem of annual weather temperature change prediction, from previous measured values. The first challenge dwells on creating a reliable, efficient statistical reliable data model on large data set and accurately capture relationship between average annual temperature and potential factors. The data is predicted and forecasted by linear regression because it is obtaining the highest accuracy for greenhouse gases and temperature among all the technologies which can be used. The weather temperature change can help the whole world because not only human but also different animals are suffering from the global temperature.

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**TABLEiOFiCONTENTSi**

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| **CERTIFICATE** | **Iiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiii2** |
| **ACKNOWLEDGEMENT** | **3** |
| **ABSTRACT** | **4** |
| **CHAPTERi1** | **6** |
| INTRODUCTION | **6** |
| **CHAPTERi2** | **7** |
| REQUIREMENTiANALYSIS | **7-8** |
| **CHAPTERi3** | **9-10** |
| SOFTWRAEi/iPROJECTiDESIGN | **9** |
| DATAiCOLLECTION  DATAiPRE-PROCESSING  PREDICTION  VISUALIZATION | **10** |
| **CHAPTERi4** | **11-17** |
| WORKFLOW | **12-14** |
| LIBRARIESiANDiMODULES | **15-17** |
| **CHAPTERi5** | **18-21** |
| CODEiSNAPSHOT | **18-21** |
| **CHAPTERi6** | **22-25** |
| CONCLUSIONiANDiFUTUREiSCOPE | **22-23** |
| RESULT  REFERENCES | **24-25** |

**CHAPTERi–i1**

**INTRODUCTION**

**i**

Usingimoreithaniaicentury'siworthiofihistoricalimeteorologicalidata,iweiwilliattemptitoisolveitheiproblemiofiestimatingitheiaverageiworldwideilandiandioceanitemperature.iWe'reigoingitoipretendithatiweidon'tihaveiaccessitoianyiforecastsiforitheiweather.iWeidoihaveiaccessitoihistoricaliworlditemperatureiaveragesiforitheipasti100iyears,iincludingiglobalimaximumiandiminimumitemperaturesiasiwelliasiglobalilandiandioceanitemperatures.iWithialliofithis,iweimayiconcludeithatitheiproblemiisioneirequiringisupervised,iregressionimachineilearning.

Theitargetimakesithisiairegressionijobibecauseiitiisicontinuous,ianditheifactithatiweihaveibothitheifeaturesianditheitargetithatiweiwantitoiforecastimakesiitisupervised.iMultipleiregressionimodelsiwillireceiveibothitheifeaturesianditheitargetsiduringitraining,ianditheyimustifigureioutihowitoitranslateitheidataiintoiaiprediction.iAdditionally,ibecauseitheitargetivalueiisicontinuous,ithisiisiairegressionitaski(asiopposeditoidiscreteiclassesiiniclassification).

**LineariRegression:**

Ailinkibetweeniaidependentivariableioriscalarivariableiandianiindependentivariableioriexplanatoryivariableicanibeideterminediusingitheilineariregressioniapproach.iInithisiapproach,ilinearipredictorifunctioniisiuseditoirepresentitheirelationships.iHere,ithisitechniqueiisiuseditoitrainitheidata.iMakingianiobjectioutiofithatifunctioniandiusingiitiforipredictionirequiresitheiuseiofiailinearipredictorifunction.iTheidataiisiprojectediforitheifutureiafteritheiformationiofitheithing.

Theiwidelyiutilisedimethodiforiforecastingiinifieldsilikeiclimateipredictioniandiotheridomainsiisiregression.iSimilaritoihowitheiweathericanichangeidramaticallyidayibyiday,itheiclimateicanibeidefinediasitheiaverageistateiofitheiatmosphereioveriailongeriperiodiofitime.

**CHAPTER-2**

## iiiiiiiiiiREQUIREMENTiANALYSIS

**i**

### **1.1iMatplotlibi**

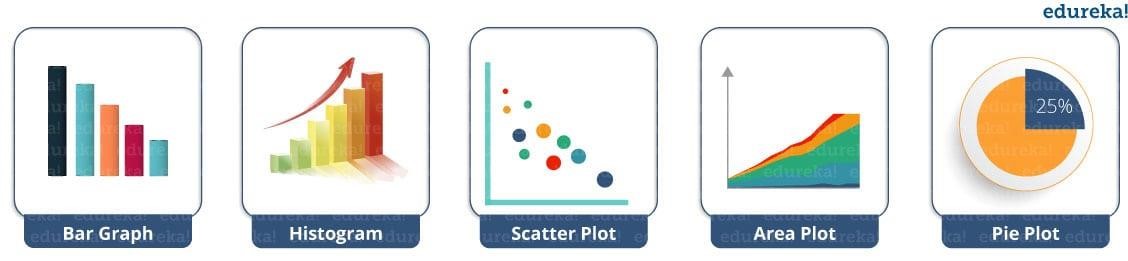
Fori2Didisplaysiofiarrays,iMatplotlibiisiaifantasticiPythonivisualisationilibrary.iAimulti-platformidataivisualisationipackageicallediMatplotlibiwasicreateditoidealiwithitheilargeriSciPyistackiandiisibasedioniNumPyiarrays.

Oneiofivisualization'sibiggestiadvantagesiisithatiitigivesiusivisualiaccessitoivastivolumesiofidataiiniformsithatiareisimpleitoiunderstand.iThereiareinumerousiplotsiiniMatplotlib,iincludingiline,ibar,iscatter,ihistogram,ietc..i

**1.2iBasiciplotsiiniMatplotlib:i**

ThereiareinumerousiplotitypesiavailableiiniMatplotlib.iPlotsiaidiinirecognisingitrends,ipatterns,iandirelationships.iTheyiareifrequentlyitoolsiforireasoningiaboutiquantitativeidata.i

i



Figurei2.1iVariousigraphiinimatplotlibi

##### **2.1iJUPYTERiNOTEBOOKi**

Toicreateiandishareidocumentsiwithiliveicode,iequations,ivisualisations,ianditext,iyouicaniuseitheifreeiandiopen-sourceiJupyteriNotebookiwebitool.

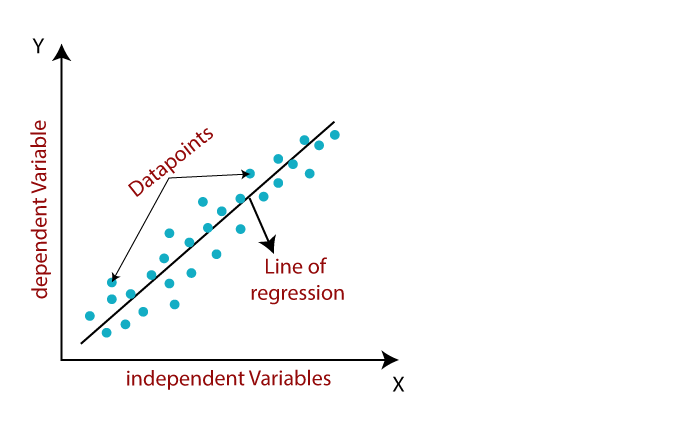
TheiIPythoniproject,iwhichiformerlyihadianiIPythoniNotebookiprojectiofiitsiown,igaveiriseitoiJupyteriNotebooks.iTheiprimaryiprogrammingilanguagesiitisupportsiareiJulia,iPython,iandiR,ihenceitheinameiJupyter.iPythoniprogrammingiisisupportedibyitheiIPythonikernelithaticomesiwithiJupyter.

**2.2iBenefitsiofijupyterinotebook**i:-ii

* LanguageiofiChoiceiii
* ShareiNotebooksii
* InteractiveiOutputii
* BigiDataiIntegrationi

**3.iLineariRegressioni-**iOneiofitheisimplestiandimostiwidelyiusediMachineiLearningitechniquesiisilineariregression.iItiisiaistatisticalitechniqueiforiperformingipredictiveianalysis.iTheilineariregressionialgorithm,iofteniknowniasilineariregression,idemonstratesiailinearirelationshipibetweeniaidependenti(y)iandioneiorimoreiindependenti(X)ivariables.iGivenithatilineariregressionidemonstratesiailinearirelationship,iitimayibeiuseditoidetermineihowitheidependentivariable'sivalueichangesiasiaifunctioniofitheiindependentivariable'sivalue.

Theilinkibetweenitheivariablesiisirepresentedibyiaislopingistraightilineiinitheilineariregressionimodel.iThinkionitheiphotoibelow:

****

**Figurei1:iLineariRegression**

**CHAPTERi–i3**

**SOFTWRAEi/iPROJECTiDESIGN**

|  |  |  |
| --- | --- | --- |
| **SR.iiNOii** | **SOFTWAREiREQUIREMENTSi** | |
| **1.i** | **OperatingiSystem:ii** | **Windows-7,8,10.** |
| **2.i** | **ProgrammingiEnvironments:ii** | **JupyteriNotebooki** |
| **3.i** | **LanguagesiUsed:ii** | **Pythoni** |

**i**

## 3.1iDataiCollectioni

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Inithisimoduleitheirawiisicollectedidataifromidifferentidataiset.iThenitheidataisetiisichangediasiperineed.iThisirawidataicannotibeipredictedidirectly.iSo,iitiisineededitoicleaniandipre-process.ii

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## 3.2iDataiPre-processingii

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i

* 1. **DataiPredictioniandiforecasting:i**i

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Inithisistep,itheipre-processedidataiisitakeniforitheiprediction.iThisipredictionicanibeidoneiinianyiprocessiwhichiareimentionediabove.iButitheiLineariRegressionialgorithmiscoresimoreipredictioniaccuracyithanitheiotherialgorithm.iSo,iinithisiprojectitheilineariregressionimethodiisiusediforitheiprediction.iForithat,itheipre-processedidataiisisplittediforitheitrainianditestipurpose.iTheniaipredictiveiobjectiisicreateditoipredictitheitestivalueiwhichiisitrainedibyitheitrainedivalue.iThenitheiobjectiisiuseditoiforecastidataiforinextifewiyears.ii

i

**3.4iVisualization:i**i

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i

i

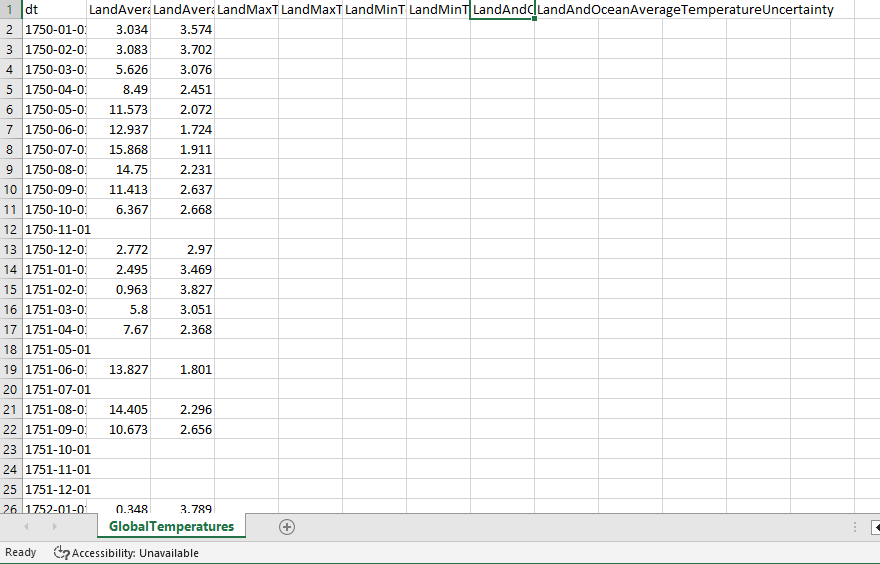
**i**

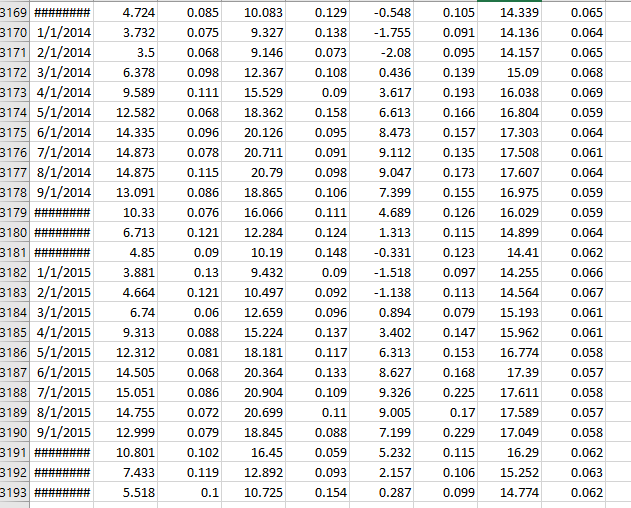
I iiiiiiii**CHAPTERi-5**

**DATASET**

**i**

**Datasetiwithidate,iLandAverageTemperatureiLandAverageTemperatureUncertainty,i**i**LandMaxTemperature,iLandMinTemperature,iLandAndOceanAverageTemperature.**

i

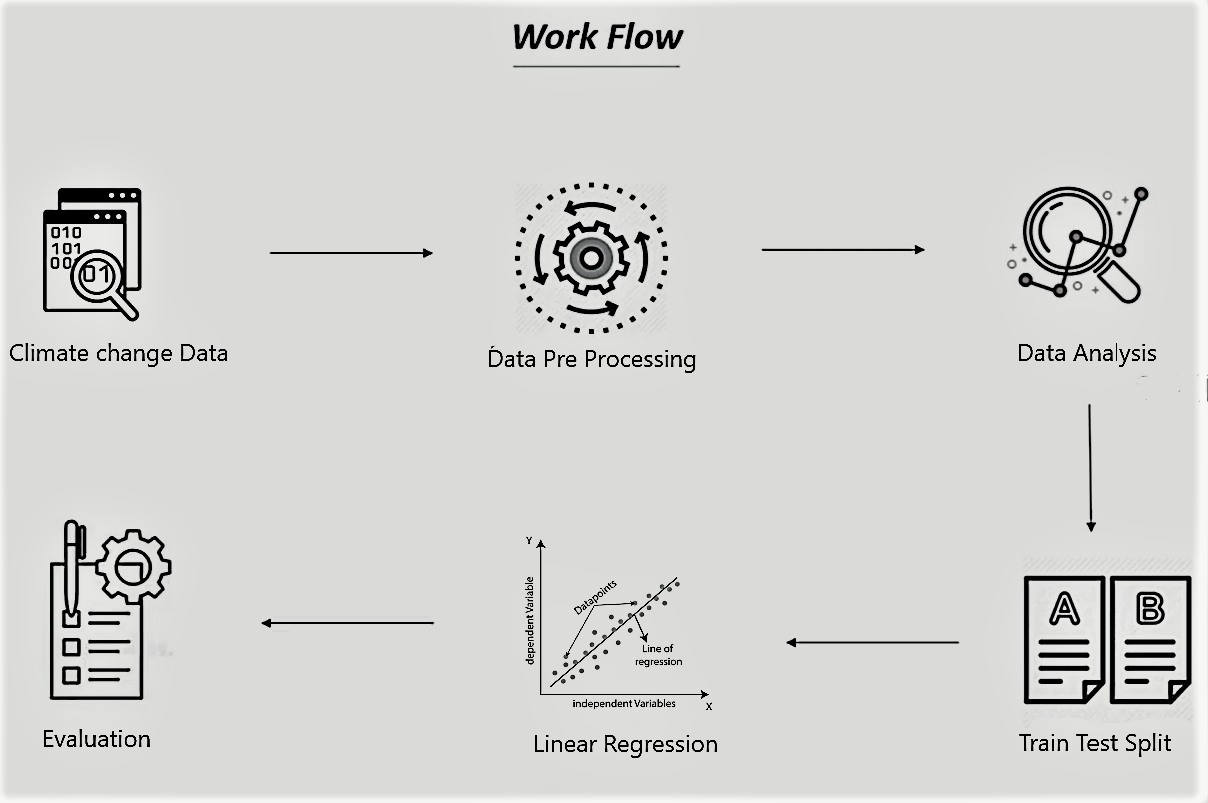
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**Alliidataiisicollectedifromii1750itoi2000iiandithereiiisi3193irowsiandii9icolumninitheientireidataset.iiii**

iiiiiiiiiiiiiiiiiiiii**WORKFLOW**

# Let'silookiatiaiprocessitoibetterigraspiwhatiwe'reigoingitoidoiinithisiprojectisoithatiyouicanicomprehendiouristrategy.i

Knowingiwhatiliesiahead,iweiwillistartiwithitheiveryibasiciandimosticrucialicomponentiofimachineilearning—aidataset—iniorderitoicompleteithisiassignment.



**iiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiFigurei2:iworkflowi**

**Aboutitheidataset:i**Asitheinameiimplies,iaidatasetiisiaicollectioniofidata.iProjectsiusingimachineilearningiusuallyirequireiaidataset.iFirst,iiniorderitoitrainiourimodeliandiaidiiniprediction,iweirequireitheitrainingidataset.iThen,iweiforecastiandievaluateitheiaccuracyiofiourimodeliusingitestingidatasets.iI'veiutiliseditheiKaggleidatasetiforimyiproject.iThereiareiseveralisuchiwebsitesiavailableiforidownloading.i(Takeinoteithatitheimodeliwillirequireimoreitimeitoitrainitheigreateritheidataset.iI'lliadviseiyouitoistartiwithiaimediumsizedidatasetithatidoesn'tihaveitooimanyivaluesiiniorderitoibetterigraspihowiitiworksiasiaibeginning.)iHowever,iyouishouldibeiawareithatiwhileitheimoreidataiyouiinputitheimodeliforitrainingiallowsiusitoitrainiitimoreithoroughlyiandiproduceimoreiaccurateiresults,iitialsoilengthensitheicompilationiprocess.

**Requiredidependencies:i**Importingitheiessentialidependenciesithatiweiwilliuseiinitheifollowingisectioniofitheiprogrammeiisitheifirstithingithatiweineeditoiaccomplish.iWeiwillibeiutilisingiNumpy,iPandas,iMatplotlib,iandiSklearniinithisiproject.Youiwillilearnihowieachiofitheseicomponentsiisiusediasiouriprojectiprogresses..

### **ReadingiTheiDataifromitheiDataset**:iiTheidownloadedidatasetimustibeiinsertediintoiouriprogramisoithatiouricodeicanireadiitiandiuseiititoicarryioutitheirequiredioperations.

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### Usingitheicommandivariableiname.head(),iweicaniviewitheifirstifiveirowsiofitheitableiandiexamineihowitheidataiwasisavediinitheivariable.

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### SplittingiXiandiYiintoitrainingianditestingivariables:iTheidataiwillibeidividediintoifourvariables:iXitrain,iYitrain,iXitest,iandiYitest.i

### Xitrain:iConsistsiofiairandomiassortmentiofivaluesiforitheivariablei"X"

### Theioutputi(AverageTemprature)iofitheimatchingivalueiofiXitrainiisicontainediinitheiYi

### train.

### Xitest:idoesinotiincludeivaluesifromiXitrainiandicontainsiairandomiselectioniofivaluesi

### fromivariablei"X"i(iasitheyiareialreadyitaken).

Theioutputi(AveragePredictiveTemprature)iofitheirelevantiXitestivalueiisicontainediintheiYitrain.

### ModeliTraining:iLineariRegression:iHere,iweireferitoiourimodeliasiai"Reg."i

Reg.fit(xi,iy)

Let'sitrainitheimodeliusingitheivariablesi(Xitrain,iYitrain)ifromitheitrainingidataset.

regressor.fit(X\_train,Y\_train)

"WhenitheivaluesiofiXiareithese,ithenitheivalueiofiYiisithis,"iisihowitheimodeliinstructsiitsiusers.

### ModeliEvaluation:iLet'siuseitheipredict()ifunctionitoiforecastitheivaluesiofitheiXitestidatasetinow.

### DataiPredictioni=iReg.Predict(Xitest).

# iLIBRARIESiANDiMODULES

# NUMPY

# iTheiPythonipackageiNumPyiisiuseditoimanipulateiarrays.iAdditionally,iiticontainsimatrices,ifourieritransform,iandifunctionsiforiworkingiinitheiareaiofilinearialgebra.

# TravisiOliphantidevelopediNumPy.iYouicaniuseiitiforifreeibecauseiitiisianiopenisourceiproject.iNumericaliPythoniisireferreditoiasiNumPy.

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# AlthoughisomeiofitheiPythonilibraryiNumPyiisiwritteniiniPython,itheimajorityiofitheiportionsithaticalliforiquickicomputationiareiimplementediiniCioriC++.

# PANDAS

# iPython'siPandasipackageiisiuseditoimanipulateidataicollections.iItioffersitoolsiforidataiexploration,icleaning,ianalysis,iandimanipulation.iWesiMcKinneyicameiupiwithitheimonikeri"Pandas"iini2008,iandiitirefersitoibothi"PaneliData"iandi"PythoniDataiAnalysis."

# WithitheiaidiofiPandas,iweicaniexamineilargeidataisetsiandidrawiconclusionsibasedionistatisticaliprinciples.iPandasicaniorganize,idisorganized,idataisets,imakingithemiunderstandableiandiuseful.iInidataiscience,irelevantidataiisicrucial.

# Rowsithatiareiirrelevantioricontainiincorrectidata,isuchiasiemptyioriNULLivalues,icanialsoibeideletedibyiPandas.iThisiprocessiisiknowniasidataicleansing.

# MATPLOTLIB

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# Theiplottingifunctionsiareidirecteditoitheicurrentiaxes,iandidifferentistatesiareiretainediinimatplotlib.pyplotibetweenifunctionicallsitoikeepitrackiofithingsilikeitheicurrentifigureiandiplottingiareai(pleaseinoteithati"axes"ihereiandiinimostiplacesiinitheidocumentationirefersitoitheiaxesipartiofiaifigureiandinotitheistrictimathematicalitermiforimoreithanioneiaxis).

# SEABORNi

# AimatplotlibbasediPythonidataivisualisationipackageiisicallediSeaborn.iItioffersiaisophisticatedidrawingitooliforicreatingieye-catchingiandieducationalistatisticsivisuals.

# Youicanireaditheiintroductoryinotesioritheipaperiforiaiquickioverviewiofitheiconceptsiunderlyingitheilibrary.iToilearnihowitoidownloadiandiuseitheipackage,igoitoitheiinstallationipage.iSeeisomeiofitheithingsiyouicaniaccomplishiwithiSeabornibyibrowsingitheisampleigallery,iandithenilearnihowibyilookingiatitheitutorialsioriAPIidocumentation.iPlotsiareimostlyiuseditoishowihowidifferentivariablesirelateitoioneianother.iTheseivariablesimayibeientirelyinumericaliorimayirepresentiaicategory,isuchiasiaigroup,iclass,ioridivision.

# Seabornicategorisesitheiplotiintoitheifollowingigroups.i–

# RelationalinarrativesiToicomprehenditheirelationshipibetweenitwoivariables,iutiliseithisifigure.

# Categoricaliplots:iThisigraphicidiscussesicategoricalivariablesianditheivisualisationiofithem.

# Plotsiuseditoiexamineiunivariateiandibivariateidistributionsiincludeidistributioniplots.

# Regressioniplots:iTheimainipurposeiofitheiregressioniplotsiiniSeaborniisitoiprovideiaivisualiaidithatihighlightsitrendsiiniaidatasetiduringiexploratoryidataianalysis.

# Aniarrayiofiscatterplotsimakesiupiaimatrixiplot.iMultipleiinstancesiofitheisameiploticanibeidrawnionivariousidatasetisubsets,iwhichiisiaihandyistrategyiforimulti-plotigrids.

# SKLEARNiSELECTION

# iItiisiaiPythonipackageithatiprovidesiairangeiofidataiprocessingifeaturesithatimayibeiusediforimodelichoice,iclustering,iandiclassification.iModeliselectioniisiaitechniqueiforicreatingianianalysisiplaniandiutilisingiititoigaugeifreshidata.iWhenicreatingiaiforecast,ichoosingitheiappropriateimodelienablesiyouitoiprovideipreciseiresults.Youimustiuseiaicertainidatasetitoitrainiyourimodeliiniorderitoidoithat.iAfterithat,iyouicompareitheimodelitoiaidifferentidataset.

# Youimustifirstidivideiyouridataset,iifiyouionlyihaveione,iusingitheiSklearnitrainitestisplitifunction.

# TheiSklearnimodeliselectionifunctionitrainitestisplitidividesidataiarraysiintoitrainingidataianditestingidataisubsets.iThisifunctionieliminatesitheirequirementiforimanualidatasetidivision.

# Usingidefault,itheitwoisubsetsiwillibeirandomlyipartitionedibyiSklearnitrainitestisplit.iHowever,iyouimayialsoigiveitheioperationiairandomistate.

# X,iy.iTheidatasetiyouichooseitoiutiliseiisitheifirstiparameter.

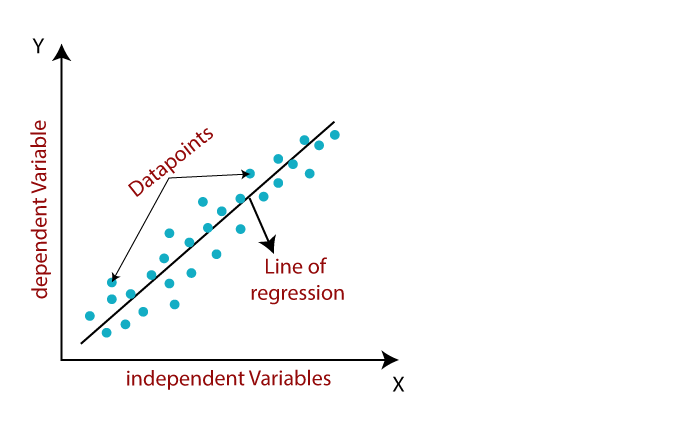
# Trainisize:Theitrainingidataset'sisizeiisisetibyithisioption.iThreeichoicesiareiavailable:iThreeioptionsiareiavailable:iNonei(theidefault),iInti(whichiasksiforitheipreciseiamountiofisamples),iandifloati(whichihasiairangeiofi0.1itoi1.0).

# Testisize:iTheitestingidataset'sisizeiisispecifiedibyithisioption.iTheitrainingisizeiisisuitableiforitheidefaultistate.iIfitheitrainingisizeiisileftiatidefault,iitiwillibeisetitoi0.25.

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# LINEARiREGRESSOR:i

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Lineariregressionioffersiaiwideirangeiofiapplications.iTheimajorityiofiapplicationsifalliintoitwoimainigroups:

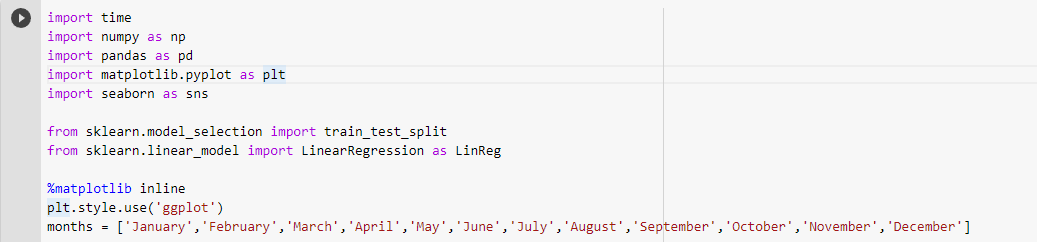
* Ifipredictingiforecast,iorireducedierrorsiareitheigoals;ilineariregressionicanibeiuseditoiadaptiaistatisticalimodelitoianiacquiredigivenidatasetiofiresponderiandiexogenousivariablesidata.iIfinewivaluesiofitheiindependentivariableiareiobtainediwithoutianiassociatediexpectedivalueiaftericreatingiairatheristructure,itheicontrollerimoduleimayibeiuseditoiassessitheieffects.
* Ifitheipurposeiisitoiexamineidifferencesiinitheidependentivariablesidueitoichangeiinitheicausalivariables,ilineariregressionianalysisimayibeiuseditoiassessitheistrengthiofitheirelationshipsiamongitheireactionianditheiinformativeifactors.iEvaluateiifianyiexplanatoryifactorsihaveinoilinearilinkiwithitheiansweriatiall,iorifindiwhicheverisubgroupsiofiindependentivariablesiincludeiredundantidataiaboutitheianswer.

# iiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiii

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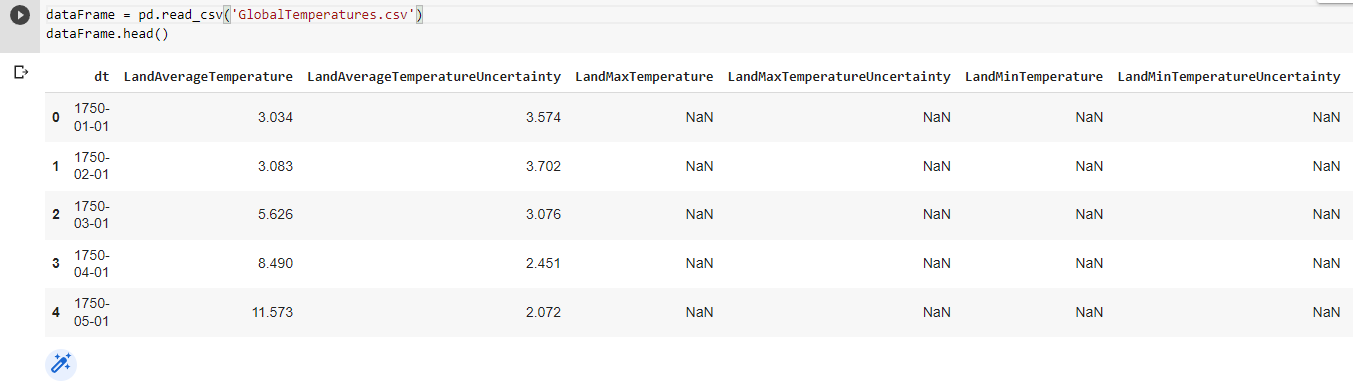
# ii

**CHAPTERi-i6**

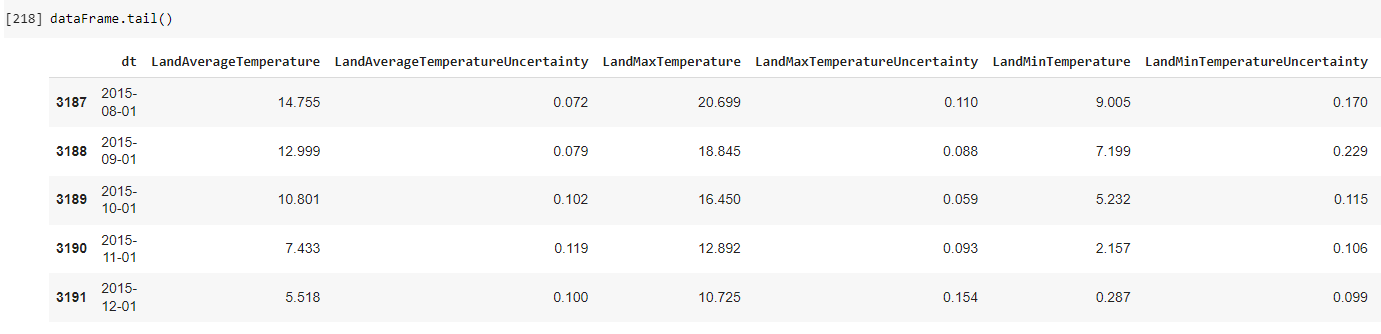


**Figurei3:iimportedilibraries**

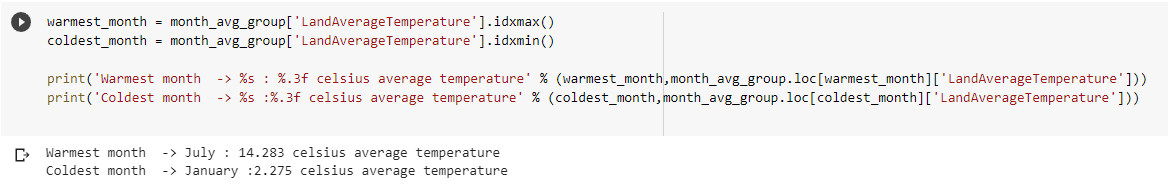
2.



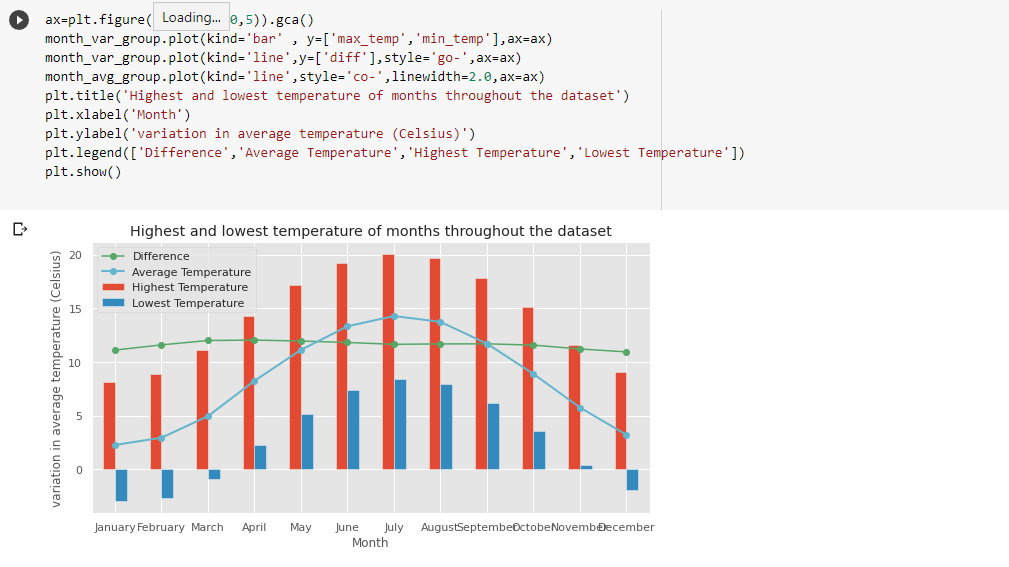
**Figurei4:iHeadiofidataset**



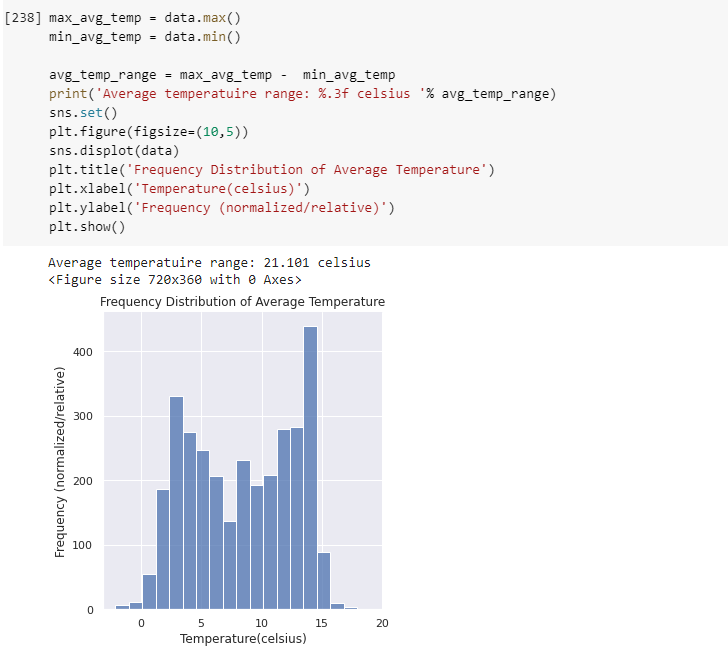
**Figurei5:iTailiofidataset**



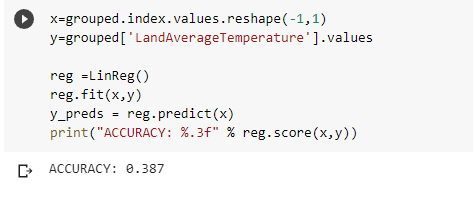
**Figurei6:iWarmestiandiColdestiMonthiData**



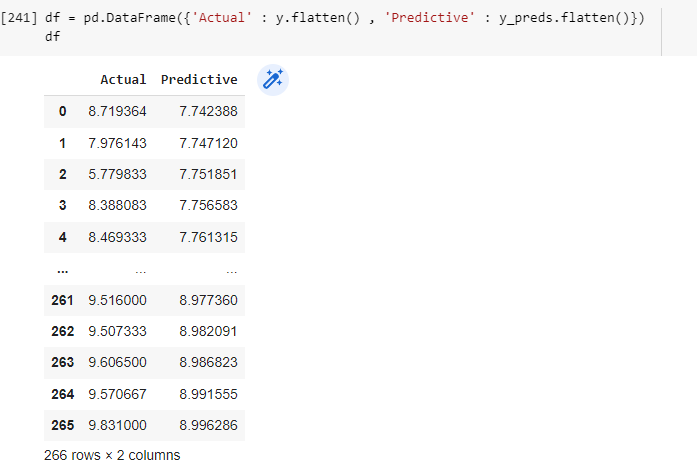
**Figurei7:**i**Highestiandilowestitemperatureiofimonthsithroughoutitheidataset**



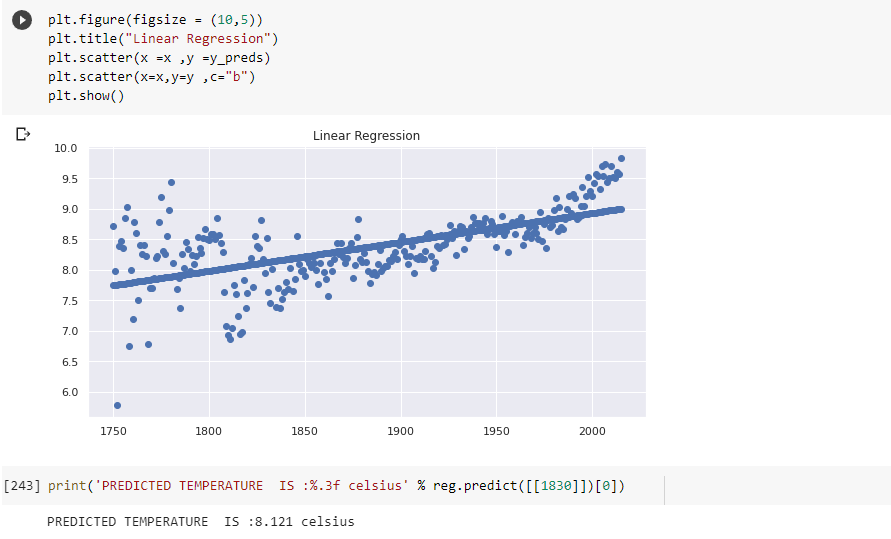
**Figurei8:iFrequencyiDistributioniofiAverageiTemperature**



**Figurei9:iAccuracyiofiSet**



**Figurei10:iActualiandipredictiveitemperature**



**Figurei11:iPredictediTemperature**

# iiiiii

# iiiiiiiiCHAPTERi-i7

# iiiiiiiCONCLUSION

# Accordingitoitheiscenarios,ithisiprojectiwillihelpiusidetermineitheiidealimomentiandiInithisipaper,itheidatai(temperature)iofi100-150iyearsiisianalyzed.iLineariRegressioniandiLinearimodeliareiuseditoipredictiandiforecastitheitemperatureiandigreenhouseigasesiforitheinexti10iyearsiiniaverage.iTheimatplotlibilibraryiisiuseditoiplotitheipredictedianditheiforecastedidata.iSo,iatilastitheifollowingiconclusionicanibeidrawni–iAimodeliforiforecastingidataiforinexti10iyearsiisitrainedianditestediwithidifferentiinputivariablesilikeitemperature,iSomeigraphsiareiplottediasiaigraphicaliinterfaceiforitheipredictediandiforecastedidataiforiallitheiinputsiwithitheihelpiofimatplotlibilibrary.

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## iiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiRESULT

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Theipredictedivalueishowniinitheigraphilieimostlyionitheioriginalivalue.

UsingithisimodeliweicanigetioripredictitheiTempratureifluctuationiwhichidependsionivariousifactorsilikeiLandiTemprature,iOceaniTempratureietc.

**i**

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