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1 INTRODUCTION:

1.1 OVERVIEW:

In Combined Cycle Power Plant analysis with the given dataset we have sensor data for Temperature (T), Ambient Pressure (AP), Relative Humidity (RH) and Exhaust Vacuum (V) of the power plant which produces the net hourly electrical energy output (EP) of the plant. Use Data Science Techniques to find out patterns from the available data to check which features impact the label most.
A combined cycle power plant (CCPP) is composed of gas turbines (GT), steam turbines (ST) and heat recovery steam generators. In a CCPP, the electricity is generated by gas and steam turbines, which are combined in one cycle, and is transferred from one turbine to another. While the Vacuum is collected from and has the effect on the Steam Turbine, the other three of the ambient variables affect the GT performance.

1.2 Purpose:

The will use as they how much powers where used as the such that for main parameters which is used as ambient temperature, atmospheric pressure, relative humidity and exhaust steam pressure this will how affecting we can consulate our machine by easily we can predict the how much parameters affected by electrical output Combined cycle power plants are frequently used for power production. These days prediction of power plant output based on operating parameters is a major concern.

Predicting full load electrical power output of a base load power plant is important in order to maximize the profit from the available megawatt hour.

2 LITERATURESURVEY

2.1 Existing Problem:

The combined cycle power plant is a non-linear, closed loop system, which consists of high-pressure (HP) superheated, HP evaporator, HP economizer, low-pressure (LP) evaporator, HP drum, HP deaerator, condenser, HP and LP steam turbine and gas turbine. The two types of turbines in the plant for example the gas turbine and the HP and LP steam turbines operate concurrently to generate power to the plant. The exhaust gas which originate from the combustion chamber drives the gas turbine, after which it flows into the heat recovery steam generator (HRSG) to generate superheated steam to be used in driving the HP and LP steam turbines. In this thesis, the combined cycle power plant is modelled at component level using the

physical method. Assuming that there is delay in transport, except for the gas turbine system, the mass and heat balances are applied on the components of the plant to derive the governing equations of the components.

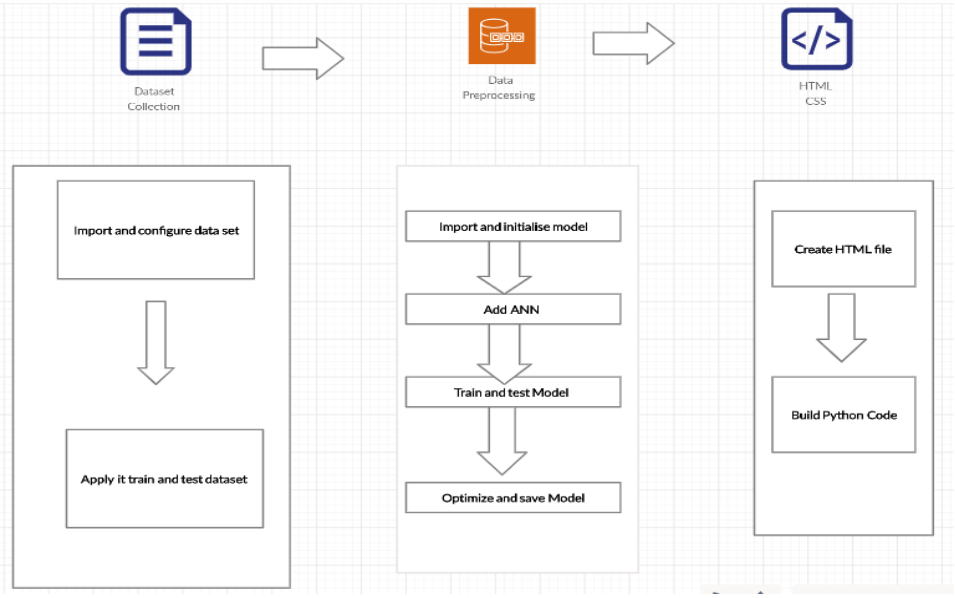
2.2 Proposed solution:

This Project examines and compares machine learning regression methods to develop a predictive model, which can predict hourly full load electrical power output of a combined cycle power plant. The base load operation of a power plant is influenced by four main parameters, which are used as input variables in the dataset.

Such as ambient temperature, atmospheric pressure, relative humidity, and exhaust steam pressure. These parameters affect electrical power output, which is considered as the target variable. For this we are building web application to enter the inputs and view the result.

3 THEORITICAL ANALYSIS

3.1 Block diagram



3.2 Hardware/Software designing

- Strategy: Using ANN based neural networks Algorithm to predict the CCPP electrical power output prediction
- Dataset Creation :Data Collection
- Data Preprocessing:
  - Importing Data Set
  - Evaluating Any Null Values

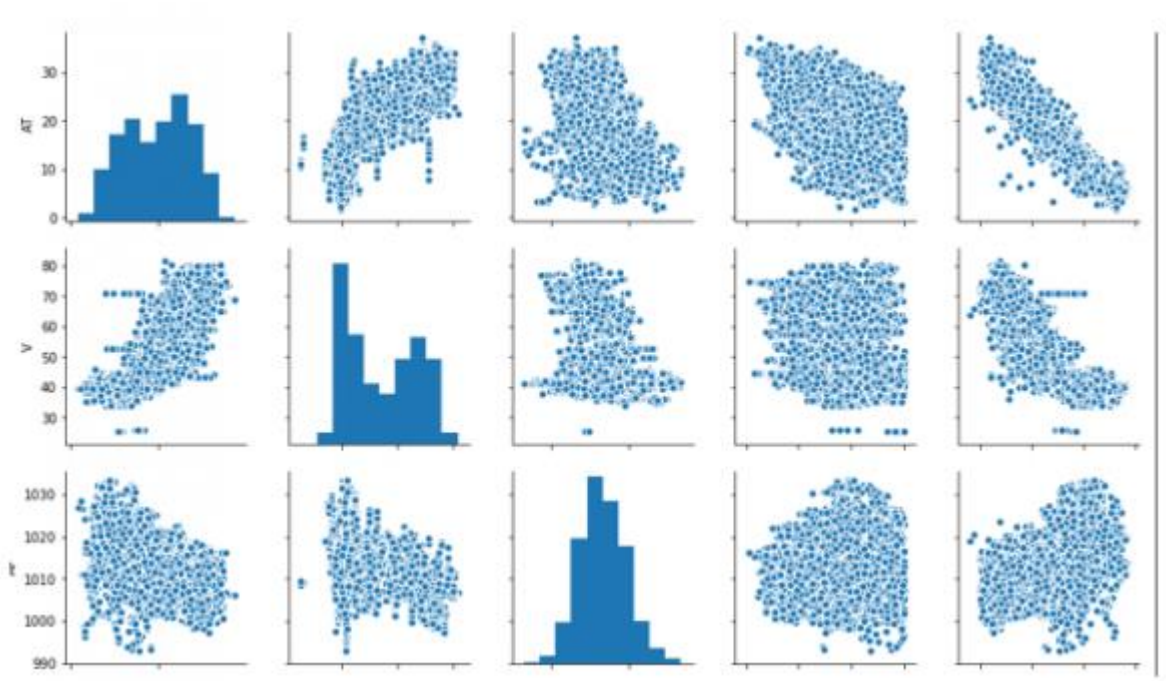
- Training and Testing Dataset by applying Multi linear regression method.
- Model Building :
    - Import Model Building Libraries
    - Initializing the model
    - Loading Preprocessing Data
    - Adding ANN and Dense layer
    - Configure Learning Process
    - Train and Test Model
    - Optimize and save the Model
- Application Building
    - Create HTML file
    - Build Python Code

4 EXPERIMENTAL INVESTIGATIONS

The label for the data set is PE which is a continuous variable.
Data Visualization is one of the powerful parts of Data Science to infer logic form data and find some patterns.
The factors affecting PE are also continuous. So, in order to analyse the dataset using graphs we use the plots like pairplot , heatmap, lmplot etc.

We can analysis through pairplot

```
import seaborn as sns
import matplotlib.pyplot as plt
sns.pairplot(data)
plt.show()
```



While executing the above lines of code we get the pairplot of all the parameters in the data set.
By analysing the above graph we get to understand that AT and V may have a negative correlation with PE, as their values increases there may be a decrease in the energy PE released from the combined cycle power plant.
Relative humidity RH also has similar graph compared to AP vs PE but is somewhat more uniform which implies PE may have less effect due to RH, that to0 there may be an increase in PE with an increase in RH.

next we can analysis through heatmap

```
import matplotlib.pyplot as plt
import seaborn as sns
sns.heatmap(a.corr(),annot = True)
```

Heatmap is the plot of values of correlation between the variables in data set. The correlation values are plotted using heatmap.

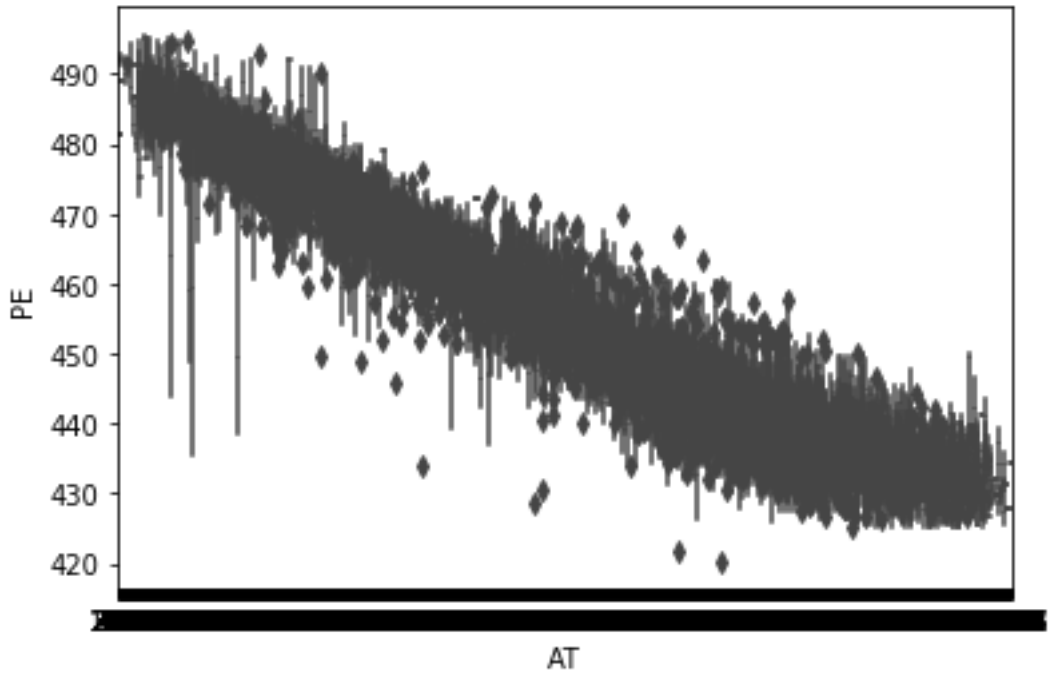
AT has a negative correlation of -0.95 with PE, which is very much close to -1. Thus AT may have an inverse relation with PE. Thus the value of PE may decrease linearly with increase in the value of AT, which supports previous analysis.

V has a negative correlation of -0.87 with PE, which is close to -1. Thus V may also have an inverse relation with PE. Thus the value of PE may also decrease linearly with an increase in V.

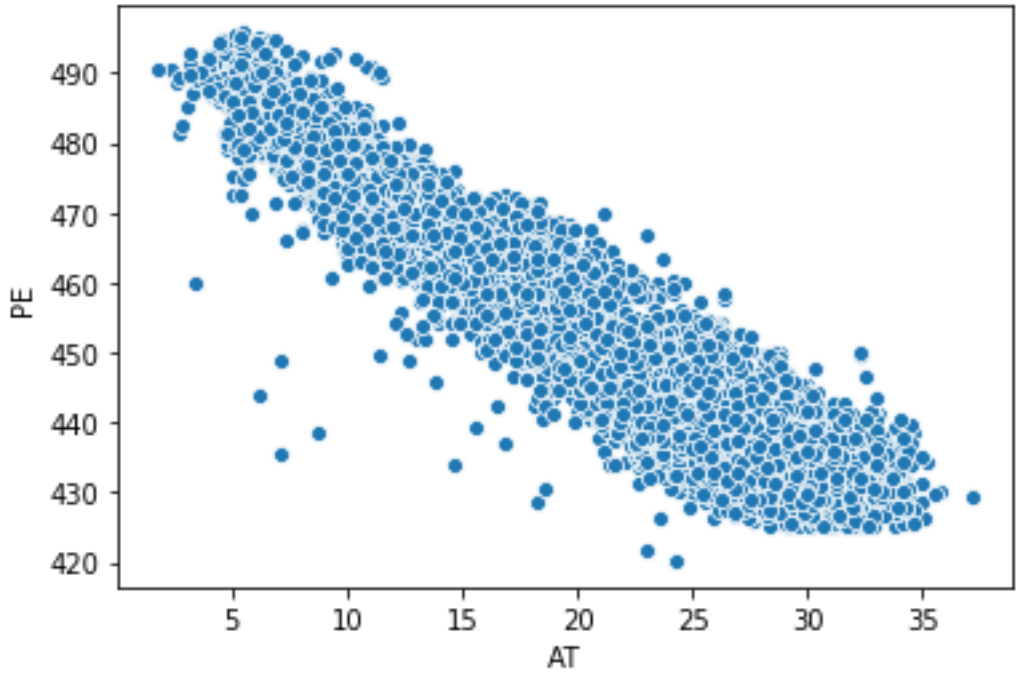
AP has a correlation of 0.52, this indicates that there may be an increase in the value of PE with an increase in AP.

RH has a correlation of 0.39, this indicates that there may be a slight increase in the value of PE with an increase in AP.

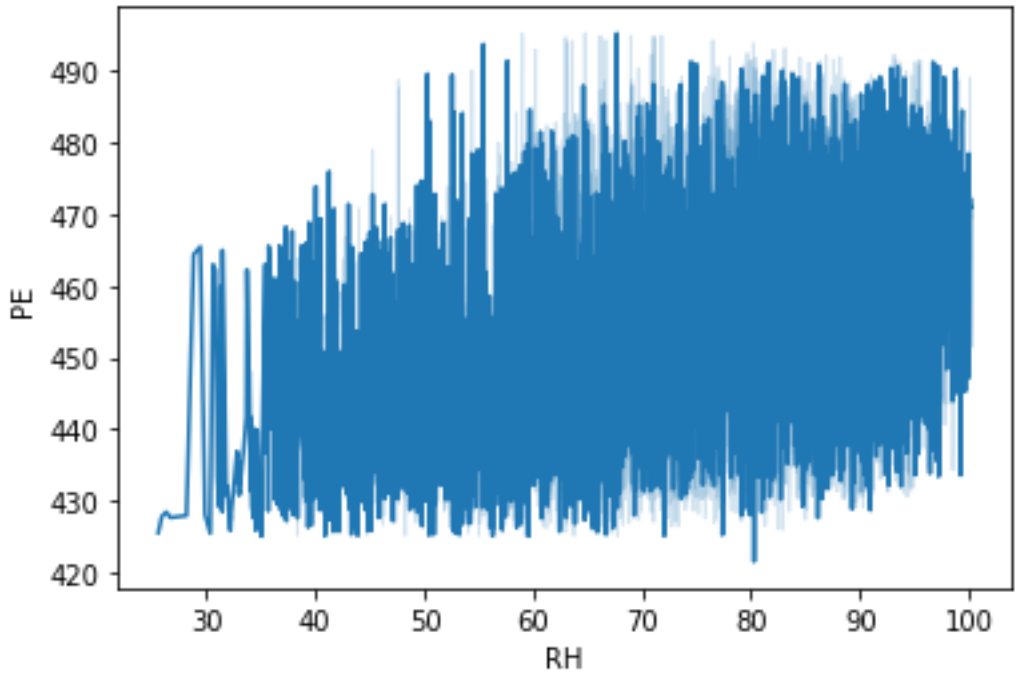
```
sns.boxplot(x = "AT",y = "PE" ,data = ds)
```



next we can go through scatterplot
sns.scatterplot(x=”AT”,y=”PE”,data=ds)



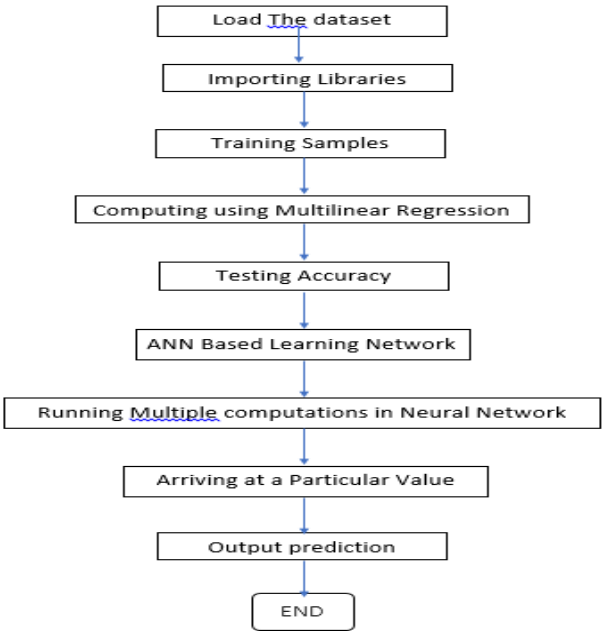
RHvs PE
Sns.lineplot(x=”RH”,y=”PE”,data=ds)



As we compare the above graphs the scatterplot of PE and AT makes it the mostly the correlation is Negative relationship between them.

Sns.implot(x=”AP”,y=”PE”,data=ds)

5 FLOWCHART



6 RESULT

Therefore By analysing the given data, we can say that PE is increasing with AT and V. While PE is decreasing with the increment of AP.
So, in order to increase energy production of power plant (PE), we need to operate the combined cycle power plant at low AT, low V, high RH, and high AP.
There can be some more Data Science Techniques which can be applied to find some more patterns form the given dataset.

7 ADVANTAGES

- There are two advantages to analysis data using multiple regression model has ability to determine the relative influence of one or more predictor variables to criterion the value
- It has the ability to identify the outliers or anomalies.
- Each independent variable model has its own slope relative to independent variable for the given set of independent variables

DISADVANTAGES:

- The disadvantages of using multiple regression usually the outcomes are come downs to the dataset the data being used.

8 APPLICATIONS

- The model develops to predict the electrical power output in the easy way for the peoples.
- The involvement of this peoples will clearly predicts the every month of the how much power was used they can easily see in this electrical power output (CCPP).

9 CONCLUSION

This project presents a technical application of the recent progress of ANN based processing. It will predicting full load electrical power output of a base load power plant is important in order to maximize the profit from the available megawatt hour. Furthermore, the finding from the model building to the pros and cons of the model are also specified .In addition, applications, future focus, and solutions are provided. At present, the design and use of this ANN-based Machine learning .our ultimate goal is to using Machine Learning through algorithm of ANN tools to predicting the profit of the power base.

10 Future Scope

- The interpretation of the learned ANN features with mathematical formalization and clear explanation, is quite poor. One way to tackle this issue is from qualitative understanding based on visualization.
- The scope of Machine Learning is not limited to the investment sector. Rather, it is expanding across all fields such as banking and finance, information technology, media & entertainment, gaming, and the automotive industry.
- Machine learning is merely based on predictions made based on experience. It enables machines to make data-driven decisions, which is more efficient than explicitly programming to carry out certain tasks.

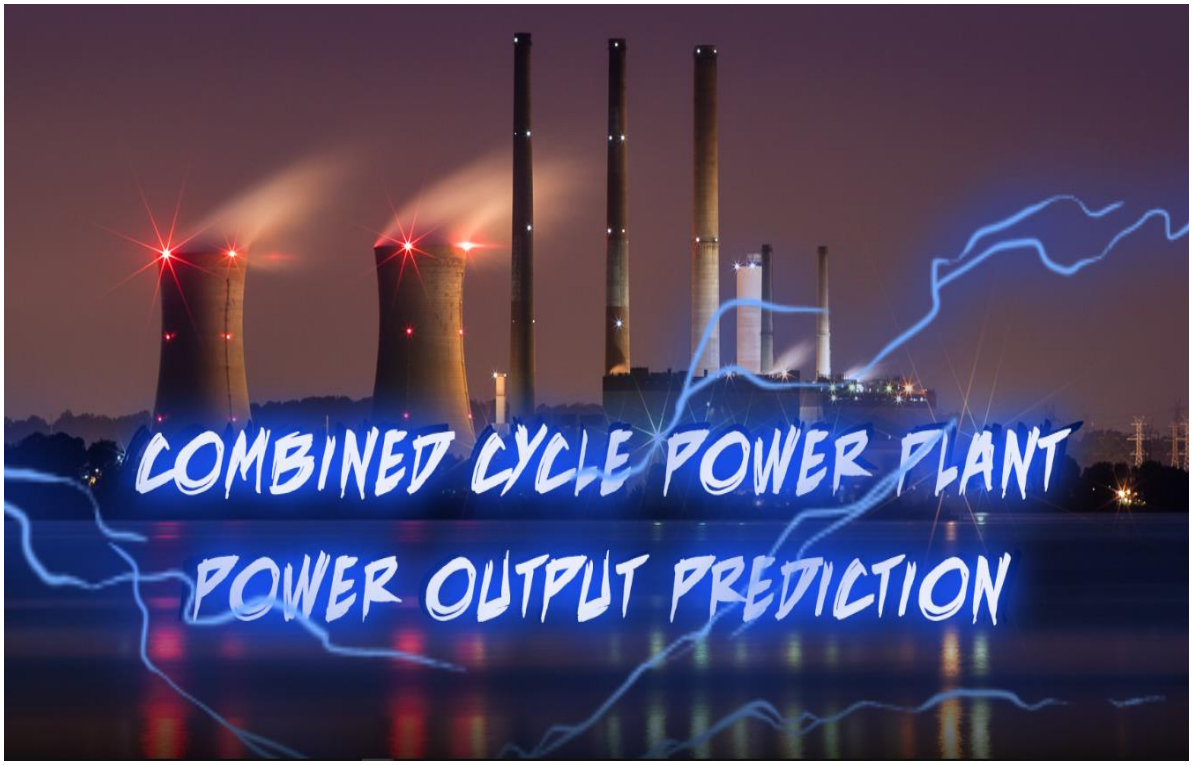
11 BIBLIOGRAPHY AND APPENDIX

Model Building

- Dataset
- Jupiter Notebook

Application Building

- HTML file
- CSS file
- Flask
- Spyder



PREDICTION OF ELECTRICAL POWER OUTPUT

Enter The Values In Their Corresponding Spaces

Ambient Temperature:

Exhaust Vacuum:

Ambient Pressure:

Relative Humidity:

Predict

A. Source code

HTML CODE

```
<!DOCTYPE html>
<html>
<head>
<title>CCPP power output prediction</title>
<link
href="https://cdn.bootcss.com/bootstrap/4.0.0/css/bootstrap.min.css"
rel="stylesheet">
    <script
src="https://cdn.bootcss.com/popper.js/1.12.9/umd/popper.min.js"></scri
pt>
    <script
src="https://cdn.bootcss.com/jquery/3.3.1/jquery.min.js"></script>
    <script
src="https://cdn.bootcss.com/bootstrap/4.0.0/js/bootstrap.min.js"></scr
ipt>
    <link rel="stylesheet" href="{{ url_for('static',
filename='css/style.css') }}" type= "text/css" >

</head>
<body>

    <section class="zoom">
    <img src="{{url_for('static', filename='elec-left.png')}}"
id="layer2"/>
    <img src="{{url_for('static', filename='elec-right.png')}}"
id="layer1"/>
    <img src="{{url_for('static', filename='new_text.png')}}"
hspace="850" id="text"/>
    </section>
    <section class="maincontent">
    <p><strong>ABOUT:</strong></p>
    <p><strong>A Combined Cycle Power Plant (CCPP) is composed of gas
turbines (GT), steam turbines (ST) and heat recovery steam
generators.<br> In a CCPP, the electricity is generated by gas and
steam turbines, which are combined in one cycle, and is transferred
from one turbine to another. While the Vacuum is collected from and has
effect on the Steam Turbine, the other three of the ambient variables
effect the GT performance.<br>When it comes to industrial work, the
electric power output becomes essential. This model consists of hourly
average ambient variables like Temperature (T), Ambient Pressure (AP),
Relative Humidity (RH) and Exhaust Vacuum (V) to predict the net hourly
electrical energy output (EP) of the plant.</strong></p>
    </section>
    <div class="container">
              <img src="{{url_for('static', filename='heatmap.png')}}">
              <div class="content">
              <h3>CORRELATION HEATMAP</h3>
              <p>From the analysis of correlation heatmap we can infer
that the power output(PE) has a strong negative correlation with
ambient temperature(AT) and exhaust vacuum(V) which implies that lesser
the value of AT and V more will be PE. Ambient pressure(AP) has a
decent increasing relationship with PE where has RH is un-correlated
hence value of relative humidity(RH) wont have much affect on PE.</p>
              </div>
```

```
        </div>

    <section class="predcontent">
    <header><h1>PREDICTION OF ELECTRICAL POWER OUTPUT</h1></header>
            <h3><br>Enter The Values In Their Corresponding
Spaces<br><br></h3>
            <form action = "/login" method = "post">
            <p><strong>Ambient Temperature:</strong></p>
            <p><input type = "text" name = "at"/></p>
            <p><strong>Exhaust Vacuum:</strong></p>
            <p><input type = "text" name = "v"/></p>
            <p><strong>Ambient Pressure:</strong></p>
            <p><input type = "text" name = "ap"/></p>
            <p><strong>Relative Humidity:</strong></p>
            <p><input type = "text" name = "rh"/></p>
            <p><input type = "submit" value = "Predict"/></p>
            </form>
            <p><b>{{label}}</b></p>
    </section>
    <script type="text/javascript">
        var layer1 = document.getElementById('layer1')
        scroll = window.pageYOffset;
        document.addEventListener('scroll',
          function (e){
          var offset = window.pageYOffset;
          scroll = offset;
          layer1.style.width = (100 + scroll) + '%'
          });

          var layer2 = document.getElementById('layer2')
        scroll = window.pageYOffset;
        document.addEventListener('scroll',
          function (e){
          var offset = window.pageYOffset;
          scroll = offset;
          layer2.style.width = (100 + scroll/5) + '%';
          layer2.style.left = scroll/50 + '%';
          });
    </script>
</body>
</html>
```

CSS CODE

```
body{
        background: #0d122a;

}
.zoom
{
    width: 100%;
    height: 1000px;
    position: relative;
    overflow: hidden;
    background: url(659526.jpg);
    background-size:cover;
}
.zoom:before
{
    content: '';
    position: absolute;
    bottom: 0;
    width: 100%;
    height: 200px;
    z-index: 1000;
    background: linear-gradient(transparent, #000);
}
.zoom #layer1
{
    position: absolute;
    left: 40%;
    width: 100%;
    transform: translateX(-50%);
    z-index: 10;

}
.zoom #layer2
{
    position: absolute;
    right: 0;
    width: 100%;
    z-index: 9;

}
.zoom #text
{
    position: absolute;
    margin-top: 300px;
    right: 0;
    width: 87%;
    transform: translateX(50%);
}
.maincontent
{
    padding: 100px;
    box-sizing: border-box;

}
```

```
.maincontent p
{
    color: #ffff;
    font-size: 1.3em;
}

.container{
       width: 500px;
       margin: 100px auto;
       margin-right: 500px;
       /*border: 2px solid black;*/
       font-family: arial;
       position: relative;
       overflow: hidden;
}
.container img{
       width: 100%;
       height: auto;
       transition: all .5s;
}
.container:hover img{
       transform: scale(1.09);
}
.container .content{
       background: rgba(0,0,0,.7);
       position: absolute;
       top: -100%;
       left: 0;
       text-align: justify;
       height: 100%;
       color: white;
       box-sizing: border-box;
       transition: all .5s;
}
.content h3{
       text-align: center;
       font-size: 25px;
       margin-top:20px;
       border-bottom: 1px solid #808080;
       padding: 0 10px 20px 10px;
}
.content p{
       padding: 0px 20px 15px 20px;
       border-bottom: 1px solid #808080;
       font-size:17px;
}

.container:hover .content{
       top: 0;
}

.predcontent
{
   padding: 100px;
   box-sizing: border-box;
   text-align:center;
}
```

```
.predcontent p
{
    color:lightgrey;
    font-size:1.4em;
}
.predcontent h1
{
    color:orange;
}
.predcontent h3
{
    color:#ffff;
}
.predcontent b
{
    color: #ffff;
    font-size:1.8em;
    color:turquoise;
}

input[type=text] {
    background-color: white;
    border: 2px solid #4CAF50;
    border-radius: 4px;
    transition: width 0.4s ease-in-out;
}

input[type=text]:focus {
  background-color: #4CAF50;
}

input[type=button], input[type=submit], input[type=reset] {
  background-color: #4CAF50;
  border: none;
  color: white;
  padding: 16px 32px;
  text-decoration: none;
  margin: 4px 2px;
  cursor: pointer;
  transition: .5s;
}

input[type="submit"]:hover {
    background-color: #0d122a;
    border: 1px solid #999;
    color: #4CAF50;
}
```

PYTHON CODE:

```
 from flask import Flask , render_template ,request
import numpy as np
import tensorflow as tf
from keras.models import load_model
global model,graph
graph = tf.get_default_graph()
app  = Flask(__name__)
model = load_model("electric.h5")
@app.route('/')
def hello_world():
    return render_template('base.html')
@app.route('/login', methods = ['GET','POST'])
def login():
    at = request.form["at"]
    v = request.form["v"]
    ap = request.form["ap"]
    rh = request.form["rh"]
    total= [[int(at),int(v),int(ap),int(rh)]]
    print(total)
    with graph.as_default():
        y_pred=model.predict(np.array(total))
    return render_template('base.html',label = "The Electric Power
Output is = "+str(y_pred[0][0]))
if __name__=='__main__':
    app.run(debug = True)
```