SMARTBRIDGE INTERNSHIP PROGRAM

MLDL - APRIL 15 - TEAM 9

Project

On

Predicting the Energy Output of Wind Power Mill

Based on the Weather Conditions

Using

Machine Learning Algorithms

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1. Introduction:

1.1. Overview & Purpose :

Wind energy plays an increasing role in the supply of energy worldwide. The energy output of a wind farm is highly dependent on the weather conditions present at its site.

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. **Machine learning focuses on the development of computer programs** that can access data use it learn for themselves.

The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide**. The primary aim is to allow the computers learn automatically** without human intervention or assistance and adjust actions accordingly.

Some Machine Learning Methods:

- Supervised machine learning algorithms
- Unsupervised machine learning algorithms
- Semi – Supervised machine learning algorithms
- Reinforcement machine learning algorithms

Machine learning enables analysis of massive quantities of data. While it generally delivers faster, more accurate results in order to identify profitable opportunities or dangerous risks, it may also require additional time and resources to train it properly. Combining machine learning with AI and cognitive technologies can make it even more effective in **processing large volumes of information.** And these ML methods have become popular as they allow researchers to improve the prediction accuracy.

The Main aim of our Project is to predict (or) estimate the Theoretical Energy Output of the Wind Power Mill Based on the Weather Conditions for proper monitoring or constructing the Wind Power Mill at chosen site. And also If the output can be predicted more accurately, energy suppliers can coordinate the collaborative production of different energy sources more efficiently to avoid costly overproduction.

2. Literature Survey:

2.1. Existing Problem:

Here, reliability and failure prediction models can enable operators to apply preventive O&M strategies rather than corrective actions. In order to develop these models, the failure rates and downtimes of wind turbine (WT) components have to be understood profoundly.

This paper is focused on tackling three of the main issues related to WT failure analyses. These are, the non-uniform data treatment, the scarcity of available failure analyses, and the lack of investigation on alternative data sources.

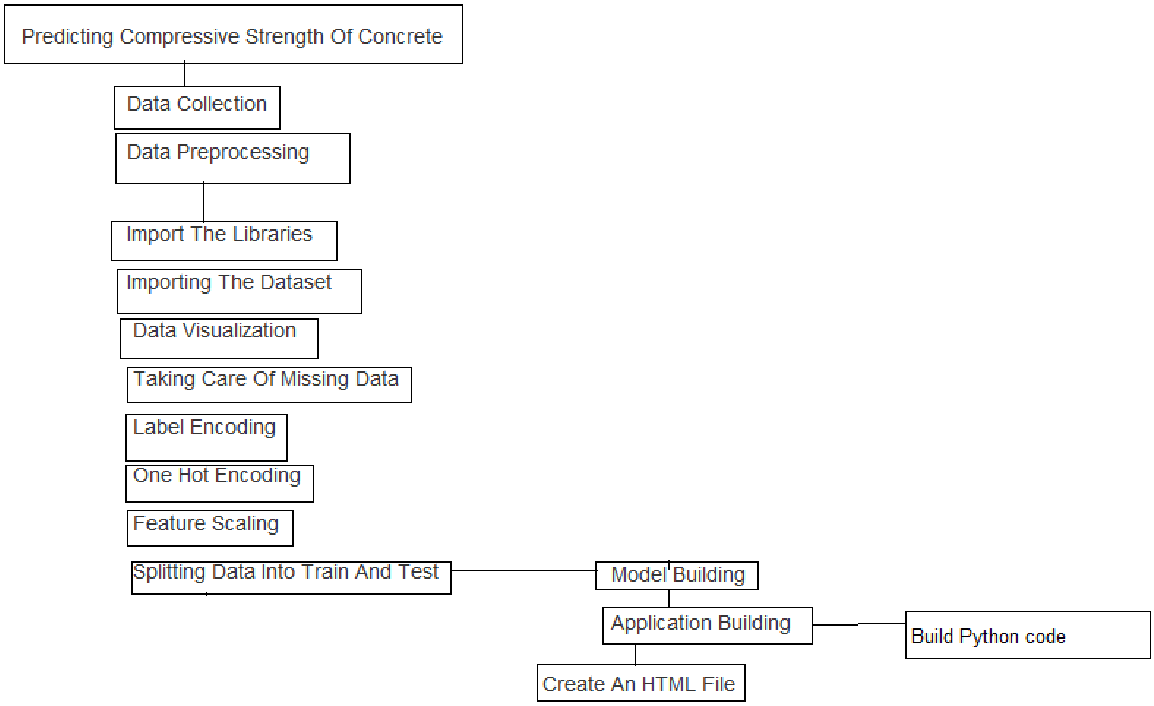
2.2. Proposed Solution:

The Main aim of our Project is to predict (or) estimate the Theoretical Energy Output of the Wind Power Mill Based on the Weather Conditions for proper monitoring or constructing the Wind Power Mill at chosen site.

And also If the output can be predicted more accurately, energy suppliers can coordinate the collaborative production of different energy sources more efficiently to avoid costly overproduction. It can produce very predictions with an accuracy about 93%.

3. Theoretical Analysis:

3.1. Block Diagram:



3.2. Hardware/Software Designing:

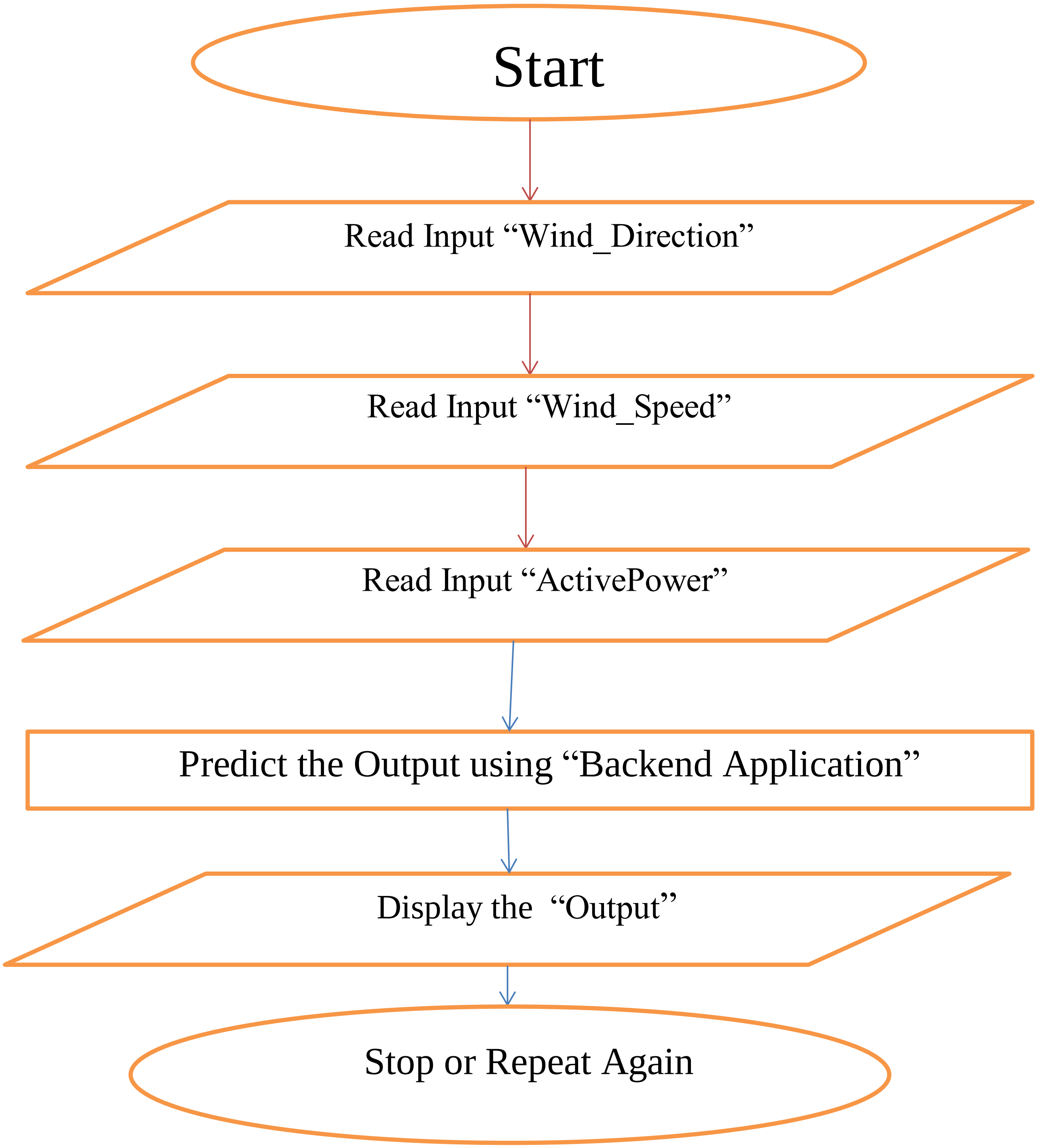
- Model Building using python
- Create Frontend HTML code file
- Create Backend file using python
- Build Flask Web Application

4. Experimental Investigation:

To train the model we need a dataset containing practical results of existing Wind Power Mills as values in the columns “Wind Direction, Wind Speed, Active Power, Theoretical Power”, with records of several months which were updated

at uniform intervals. For this project this data used is a file named ‘T1.csv’ which contains above mentioned data.

5. Flowchart for WebApplication:



6. Result:

We build the Linear Regression model to predict the Energy output of wind turbine using python language and got accuracy about ‘92.3’. And finally, implemented a Web Application to make use of the model.

7. Advantages & Disadvantages:

7.1. Advantages:

- Wind power has a remarkably small impact upon the carbon footprint.
- There are zero carbon emissions associated with the operation of wind turbines.
- The only emissions emitted from wind turbines arise from their manufacture, construction and maintenance.
- Wind energy has one of the lowest water consumption footprints, unlike fossil fuels and nuclear powerplants.
- Wind turbines reduce a nation's demand for imported fuel sources.
- Wind power production meant that Europe managed to avoid fuel costs amounting to €5.7 billion.
- Wind turbines are a great resource to help generate energy in remote locations such as mountain communities or the countryside.
- Wind power can be combined with Solar Energy in order to generate a sustainable energy source in developing countries.

7.2. Disadvantages:

- Wind turbines depend on a suitable wind speed in order to generate electricity.
- If wind speed is below a certain threshold, turbines depend on other forms of electricity generation in order to operate.
- Planning permission can be hard to get hold of for onshore wind farms due to the visual impact of the turbines.
- The complexity of manufacturing offshore wind farms makes it a much more costly method than onshore wind farms.
- Wind turbines generate a lot less power than the average fossil fuelled power station, requiring multiple wind turbines to be built in order to make an impact.

8. Applications:

- Wind turbine occupies less space than a limited sized power station.
- Wind mills occupies a few square meter for the base. So the land around the turbine can to be used for agriculture.
- With the development of advanced technologies. The efficiency of exploitation of wind energy is increased to considerable amount.
- Since the wind is available free of cost. Wind energy can be extracted as free source of energy.
- Wind turbine are a great resource to generate energy in remote areas, such as mountain communication and deserts. where the installation of wind turbine is easy.
- The Wind turbine can be developed in different sizes and capacity, in order to meet out the need of various population.
- Wind energy is environment friendly to surrounding. Since no fossil fuels (no liberation of greenhouse gases are brunt to generate electricity from wind energy.
- If wind energy developed in combination with solar energy then this energy source is great for developed. Developing countries to provide a steady, reliable supply of electricity.

9. Conclusion:

By using the Web Application we built one can determine whether a chosen site is suitable for the construction of the Wind power mill or not. And it helps energy suppliers can coordinate the collaborative production of different energy sources more efficiently to avoid costly overproduction.

10. Appendix:

- ## Main Model Code:

```
# -*- coding: utf-8 -*-
"""finalandfixed(3).ipynb
Automatically generated by Colaboratory.
Original file is located at
   https://colab.research.google.com/drive/1kQrDVGw9-aAUsU-IrvOYNzRnU9GLzDdL
"""
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
data_set= pd.read_csv("/content/T1.csv")
data_set.info()
data_set.isnull().any()
data_1=data_set.copy()
#Giving proper names to columns
data_1.rename(columns={'LV ActivePower (kW)':'ActivePower(kW)',"Wind Speed
(m/s)":"WindSpeed(m/s)","Wind Direction (°)":"Wind_Direction"},
              inplace=True)
data_1.drop(columns=['Date/Time'],axis = 1,inplace = True)
data_1.head()
#deleting False Data
data_2 = data_1[((data_1['WindSpeed(m/s)']>=3.3) & (data_1['ActivePower(kW)']>0)) |
((data_1['WindSpeed(m/s)']>3.3) & (data_1['Theoretical_Power_Curve (KWh)']>0))]
data_2.head()
Wind_data=data_2['Wind_Direction'].copy()
Theri=data_2['Theoretical_Power_Curve (KWh)'].copy()
data_2.drop(columns = ['Wind_Direction'],inplace = True)
data_2.head()
data_2['Theoretical_Power_Curve (KWh)'] = Theri
data_2.rename(columns= {
   'Theoretical_Power_Curve (KWh)' : 'Theoretical_Power'
})
data_2.insert(0,'Wind_Direction',Wind_data)
data_2.head()
AP= data_2['ActivePower(kW)']
data_2.drop('ActivePower(kW)',inplace = True,axis = 1)
data_2.insert(2,'Active Power',AP)
```

```
dic = dict()
for i in range(len(data_2)):
  s = str(i)
  dic[s] = i
len(dic)
li=list(dic.values())
data_2['index'] = li
data_2.set_index('index',inplace = True)
data_2.head()
x = data_2.iloc[:,0:3].values
y = data_2.iloc[:,3:4].values
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size = 0.33,random_state = 0)
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(x_train,y_train)
y_pred = regressor.predict(x_test)
import pickle
pickle.dump(regressor,open('Power.pkl','wb'))
from sklearn.metrics import r2_score
r2_score(y_test,y_pred)
sol = regressor.predict([[270,10.27,4000],[80.502724,11.404030,1780]])
sol
```

- App.py Code:

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

model = pickle.load(open('Power.pkl','rb'))
app = Flask(__name__)

@app.route('/')
def home():
    return render_template("index.html")
@app.route('/login',methods = ['post','get'])
def login():
    get_WD = float(request.form['Wind_Direction'])
    get_WS = float(request.form['Wind_Speed'])
    get_AP = float(request.form['Active_Power'])
```

```
    final_data = [[get_WD,get_WS,get_AP]]
    y_pred = model.predict(np.array(final_data))
    result = str(y_pred[0][0])
    return render_template("index.html",show = str(result)+" KWh")


if __name__== '__main__':
    app.run(debug = True)
```

- HTML page Code:

```
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <meta http-equiv="X-UA-Compatible" content="ie=edge">
    <title>Predicting Power output of Wind Turbine Based on Weather Conditions</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"></script>
    <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"></script>
    <link href="{{ url_for('static', filename='css/main.css') }}" rel="stylesheet">
     <style>
     .bg-dark {
            background-color:     #4B92BB!important;
     }
     #result {
            color: #0a1c4ed1;
     }
     </style>
</head>

<body>
    <nav class="navbar navbar-dark bg-dark">
        <div class="container">
            <a class="navbar-brand" href="#">To Predict Power Output of Wind Turbine</a>
        </div>
    </nav>
    <div class="container">
        <div id="content" style="margin-top:2em">
```

```
<div class="container">
  <div class="row">
        <div class="col-sm-6 bd" >
          <h3>Wind Power Prediction : </h3>
          <br>
          <p>Wind energy is a significant and eligible source that has the potential
for producing energy in a continuous and sustainable
            manner among renewable energy sources. However, wind energy has
several challenges, such as initial investment costs, the
                stationary property of wind plants, and the difficulty in finding
wind-efficient energy areas. In this study, long-term wind
                power forecasting was performed based on daily wind speed data
using five machine learning algorithms. We proposed a method
                based on machine learning algorithms to forecast wind power
values efficiently. We conducted several case studies to reveal
                performances of machine learning algorithms. The results showed
that machine learning algorithms could be used for
                forecasting long-term wind power values with respect to historical
wind speed data. Furthermore, the results showed
                that machine learning-based models could be applied to a location
different from model-trained locations. This study
                demonstrated that machine learning algorithms could be
successfully used before the establishment of wind plants in
                an unknown geographical location whether it is logical by using
the model of a base location.</p>
                <img src="https://etimg.etb2bimg.com/photo/73073004.cms"
style="height:350px"class="img-rounded" alt="Gesture">
                <p> The following figure depicts the Depenency of wind power on
wind speed.</p>
                <img src="http://www.wind-
works.org/cms/uploads/RTEmagicC_Figure-6-7-Power-Curve.jpg.jpg"
style="height:350px"class="img-rounded" alt="Gesture">
        </div>
        <div class="col-sm-6">
                <div>
                        <h4>Enter the details to predict:</h4>
        <form action = "http://localhost:5000/login" id="upload-file"
method="post","get" enctype="multipart/form-data">
                <p> Enter Wind Direction: </p>
                <p> <input type = "text" name = "Wind_Direction"/></p>
```

```
                        <p> Enter Wind Speed: </p>
                        <p> <input type = "text" name = "Wind_Speed"/></p>
                        <p> Enter ActivePower: </p>
                        <p> <input type = "text" name = "Active_Power"/></p>
                        <p> <input type = "submit" value = "Predict!"/></p>
                </form>
                <b>{{show}}</b>
                </div>

                <h3>
                        <span id="result"> </span>
                </h3>

        </div>
                </div>

         </div>
        </div>
        </div>
   </div>
</body>

<footer>
   <script src="{{ url_for('static', filename='js/main.js') }}" type="text/javascript"></script>
</footer>

</html>
```