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INTRODUCTION

a. Overview :

Windpowergenerationisincreasingrapidlyandtheavailabilityofwindenergy dependsonwind speed,whichisarandomvariable.Thishighlydepends on the weather conditions at that place.

Inourproject,wepropose anintelligenttechniqueforforecastingwind speed and power outputofa wind turbine from several hoursup to 72 hours ahead.

Wewillcarryoutthisproblemonpubliclyavailableweatherandenergy data sets correlating and considering different features in our project.

b. Purpose :

Predictingwindenergyoutputwill enableustocutdownonproduction costs and collaborate on different energy sources more efficiently.

LITERATURE SURVEY

a. Existing problem :

Wind power generation is rapidly picking up in many countries. With the ever-increasing demand for electricity which powers our industries, technology and our homes, it is of utmost importance to consider using it in a responsible way.

That is where the concept of non-conventional energy sources like wind energy comes in. The one disadvantage with this form of generating power is the uncertainty in the wind direction, speed, and other climatic changes in the concerned area.

b. Proposed solution

In an attempt to overcome this challenge, we have come up with a model that would be able to give a solution to our queries for our python questions. We will be using IBM Cloudservices for variousthings that we need to achieve. The main services that we would be using are as follows:

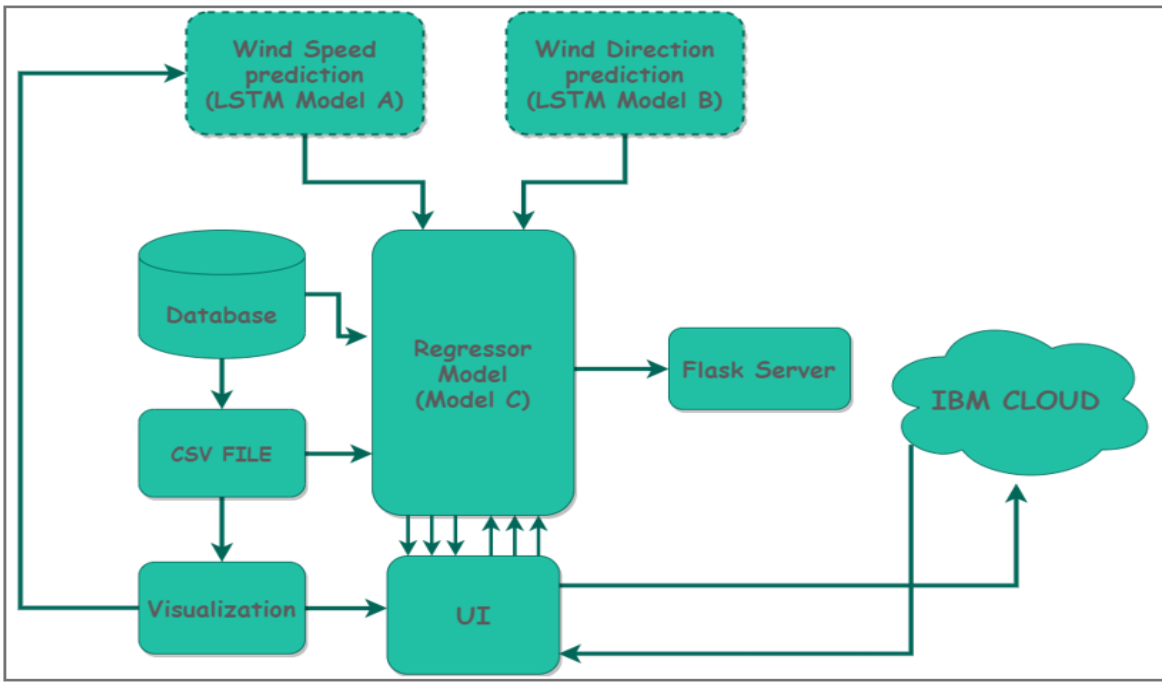
1. IBM MLServices
2. Cloud Functions
3. IBM Cloud
4. Dash
5. MD Bootstrap
6. UserInterface
7. Flask

The above-mentioned serviceswould be used for variousthings and in the end, wewould be creatinga UI dashboard.

In the UI dashboard, we will be displaying the graphs and plots that allow the user to make an estimate of the future wind conditions allowing him to make a wise decision based on the future predictions of the wind features.

THEORETICAL ANALYSIS

a. Block diagram



b. Hardware / Software designing

What is the IBM Cloud platform?

The IBM® cloud platform combines a platform as a service (PaaS) with infrastructure as a service (IaaS) to provide an integrated experience.

The platform scales and supports both small development teams and organizations, and large enterprise businesses.

Globally deployed across data centers around the world, the solution you build on IBM Cloud™ spins up fast and performs reliably in a tested and supported environment you can trust.

https://cloud.ibm.com/docs/overview?topic=overview-whatis-platform

Dash :

Dash is a productive Python framework for building web applications.Written on top of Flask, Plotly.js, and React.js, Dashis ideal for building data visualization apps with highly custom user interfaces in pure Python. It's particularly suited for anyonewho works with data in Python.

Through a couple of simple patterns,Dash abstracts away all of the technologies and protocols that are required to build an interactive web-based application.Dashis simple enoughthat you canbind a user interface aroundyour Python code in an afternoon.

Bootstrap :

“Themost popular HTML,CSS, and JS framework for developing responsive, mobile-first projects on the web.”

In layman’s terms: Bootstrap is a giant collection of handy, reusable bits of code written in HTML, CSS, and JavaScript. It’s also a front-end development framework that enablesdevelopers & designers to quickly build fully responsive websites.

IBM Cloud Functions :

IBM Cloud Functions is a distributed computing service that executes application logic in response to requests from the web or mobile apps. You can set up specific actions to occur based on HTTP-based API requests from web apps or mobile apps, and from event-based requests from services like Cloudant.

ML/ DL Models:

ARIMA MODEL:

Using the ARIMA model, you can forecast a time series using the series past values.In this post,we build an optimal ARIMAmodel from scratchand extend it to Seasonal ARIMA(SARIMA) and SARIMAXmodels. You willalso see how to build auto Arima models in python

LSTM MODEL:

LSTM Networks. Long Short Term Memory networks– usually just called“LSTMs” – are a special kind of RNN, capable of learning long-term dependencies. They were introduced by Hochreiter & Schmidhuber (1997), and were refined and popularized by many people in following work

Regressor MODEL:

IT uses random forest,linear regression, xg boost models.And we have combined them using VotingRegressor which takesthe mean outputof all the above models and improves the accuracyto a great extent

EXPERIMENTAL INVESTIGATIONS

1. Create IBM Cloud services

2. Clean the Dataset

1. Remove any NULL values if present
2. Remove any and all negatives

3. Feature Engineering

1. Preparing the proper input dataset, compatible with the machine learning algorithm requirements.
2. Improving the performance of machine learning models.

4. Testing with various models

1. ARIMA Model
2. RNN
3. LSTM
4. XGBoost
5. Regressor model(random forest, linear regression, xg boost)

5. Creating the UI.

The UI is basically a dashboard that will graphically present different factors affecting the power output and how they are changing and updating. As a main part of the UI, the power output prediction will also be visualized as line or scatter plot.

A. Designing the dashboard type UI
   i. Cloning the project repo
   ii. Understanding the working of Dash web server
   iii. Making a Django project and designing of the application structure
B. Add visualizations for the independent factors of prediction
   i. Loading the data into the database
   ii. Connecting the database with the web application
   iii. Designing the graphs and pushing them on the dashboard
   iv. Testing it out (unit testing)
C. Add plots for the prediction as dependent on different factors
   i. Predictions are saved in the database and regularly updating
   ii. Make scatter plot/line plot for the predictions against different factors

iii. UI testing

D. Running application on localhost

6. Deploying to the IBM Cloud/Heroku

The application is deployed to the IBM Cloud/Heroku.
Web app hosting - IBM Cloud Bluemix
Database for the web app - IBM Cloudant

A. Connecting the application with IBM Cloudant database
B. Deploy the application to IBM CloudBluemix
C. Test it working on assigned URL eg.*myUrl.mybluemix.net*

Pros

1. Accurate wind power forecasts are also important in reducing the occurrence or length of curtailments (which translate to cost savings), improved worker safety, and mitigating the physical impacts of extreme weather on wind power systems
2. Wind speed forecasting naturally has greater value where balancing markets are part of a competitive trading system for electricity, because the balancing market provides financial incentives to the generators and retailers for accurate output predictions.

Cons

3. The challenges to face when wind generation is injected in a power system depend on the share of that renewable energy.
4. For Denmark, which is a country with one of the highest shares of wind power in the electricity mix, the average wind power penetration over the years is of 16–20% (meaning that 16–20% of the electricity consumption is met wind energy), while the instantaneous penetration (that is, the instantaneous wind power production compared to the consumption to be met at a given time) may be above 100%.

APPLICATIONS OF WIND PREDICTION

1. Better Power Output

Windpowerforecastsareimportantinefficientlyusingwindturbinesfor generating power output.

2. Efficient

Predicting features like wind speed and wind direction can greatly help one to makedecisions on when to switchon the windturbine and whento switch it off(when it is assumed to not get the suitable conditions for generating power)

3. Environment friendly

If we are able to achievepredicting the wind power output,then it will open up more avenues for efficient power production in this field. This will lower the dependence on conventional sourcesof energy likecoal which can cause harm to our environment.

Project Team:

Our team consists of fourmembers:

1. M.V.SHREYA - 1919102147
2. R.VENKATAKRISHNA - 1919102178
3. D.R.VIJAYASRI - 1919102185
4. R.VIJAYAVARSHINI - 1919102186

RESULT

The results that we derive from our application can be used to predict the wind power output with great visualizations with the help of graphs and plots, alerts, appealing UI, and a user-friendly interface powered by Regressor and deep learning models like lstm all coupled and deployed together in a powerful and reliable IBM cloud.

CONCLUSION

In this project, we have established the application to predict future wind power output values based on the regressorand deep learningmodels.

The UI provides a great deal of information to anyone who would like to know about the future power output presented in the form of visualizations.

Deploying it to the cloud makes it more scalable.

FUTURE SCOPE

Our attempt would be to further improve the predictions using the ARIMA model and other models that are powerful.

Imparting more features (like location, due level, humidity, etc) to our training set will enhance the predictions and will open up a new perspective on every front of wind prediction.