Predicting the Energy Output of Wind Turbine Based on Weather Conditions using Watson Auto AI

INTRODUCTION

OVERVIEW

This work focuses on how to deploy an application that will utilize multiple Watson AI Services including Cloud function, Waton Machine Learning and Node-RED/other web frame-work services to predict the energy output of wind turbine based on weather conditions. During the course of this project, we combined Watson services,and built customer satisfaction interactive portals for prediction on current conditions.

PROBLEM STATEMENT

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

LITERATURE SURVEY

EXISTING PROBLEM:

If we examine the problem statement we could easily identify that the problem statement talks about how that wind energy plays an important role in supply of energy,but yet the harnessing of energy is not upto mark. Due to irregularities or vagaries in the atmospheric conditions and the wind available there is a substantial loss of the energy that could be utilised more efficiently.

PROPOSED SOLUTION:

Accurately predicting the wind energy output will help in collaborative production of energy more efficiently .We are building a Machine Learning model to predict the energy output of wind turbine using IBM Watson AutoAI Machine Learning Service. The model is deployed on IBM cloud to get scoring end point which can be used as API in mobile app or web app building. We are developing a web application which is built using node red service. We make use of the scoring end point to give user input values to the deployed model.

HARDWARE/SOFTWARE DESIGN:

- Python
- Python For Data Analysis
- Python For Data Visualization
- Machine Learning
- IBM Cloud
- IBM Watson

EXPERIMENTAL PROCEDURE

Create the following services:

- Create IBM Cloud Account
- Watson Machine Learning Service
- IBM Cloudant
- Node Red

ADVANTAGES AND DISADVANTAGES

ADVANTAGES

The advantages are as follows:

- The Web Dashboard responds to weather conditions analysis that are not manually answered.
- We can improve results by training data to our choice of parameters.

● No need to search weather analysis in different sites.
● Easy to use and has a friendly user interface to work with.
● Companies can deploy to improve their energy harnessing efficiency.
● Reduces man power
● Can be used even in areas of less connectivity.
● Cost efficient
● The database maintained can allow companies,to easily monitor the access/users.
● Promotes Alternative resources of energy and drives a motto to use Clean & Green Fuel.

DISADVANTAGES

The disadvantages are as follows:
● Requires all services that handles requests and renders responses.
● Requires some complex integration of services.

APPLICATIONS

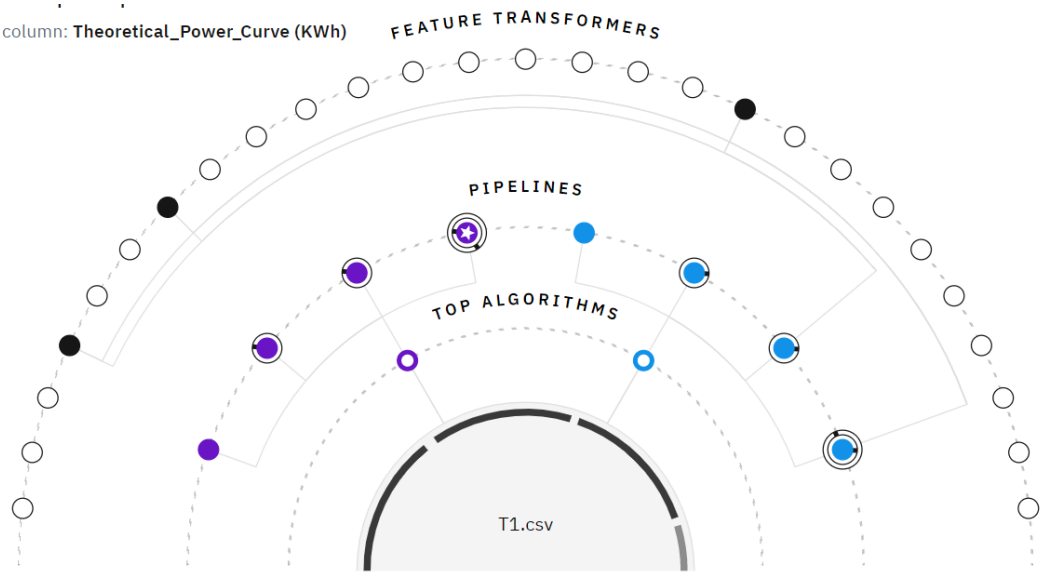
● Several companies can use the service and deploy it,on their own servers.
● This would save time and money as no three to four applications are needed.
● The service can be provided to users in application along with other features.
● Could be helpful even in areas with less connectivity.
● As the application is quite robust and resilient in its architecture,it allows one to easily navigate through different sections.

APPENDIX

Deploying the ML Model:

Here we took the Theoretical_Power as the parameter for training the ML model. After the experiment you need to select the best pipeline (out of 8).

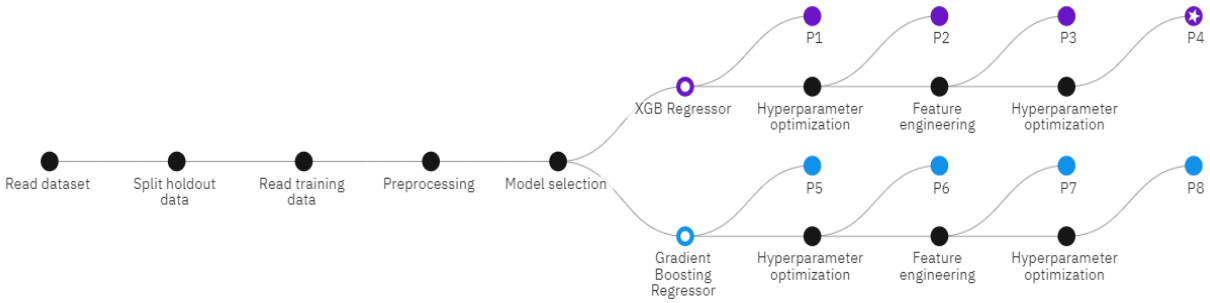
Prediction column: **Theoretical_Power_Curve (KWh)**



Pipeline leaderboard

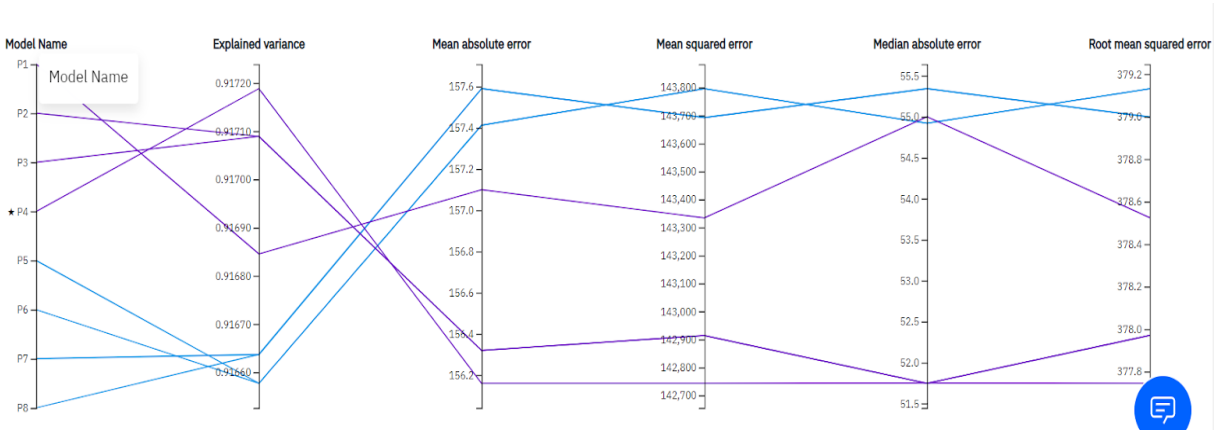
	Rank	Name	Algorithm	RMSE (Optimized)	Enhancements	Build time
>	★ 1	Pipeline 4	XGB Regressor	**377.745**	HPO-1 FE HPO-2	00:43:56
>	2	Pipeline 2	XGB Regressor	**377.971**	HPO-1	00:14:47
>	3	Pipeline 3	XGB Regressor	**377.971**	HPO-1 FE	00:48:27
>	4	Pipeline 1	XGB Regressor	**378.525**	*None*	00:00:04
>	5	Pipeline 7	Gradient Boosting Regressor	**378.998**	HPO-1 FE	00:07:09
>	6	Pipeline 8	Gradient Boosting Regressor	**378.998**	HPO-1 FE HPO-2	00:01:29
>	7	Pipeline 5	Gradient Boosting Regressor	**379.132**	*None*	00:00:07
>	8	Pipeline 6	Gradient Boosting Regressor	**379.132**	HPO-1	00:00:38

Save the best pipeline as a M.L. model for your Jupyter notebook.



Metric chart

Prediction column: Theoretical_Power_Curve (KWh)

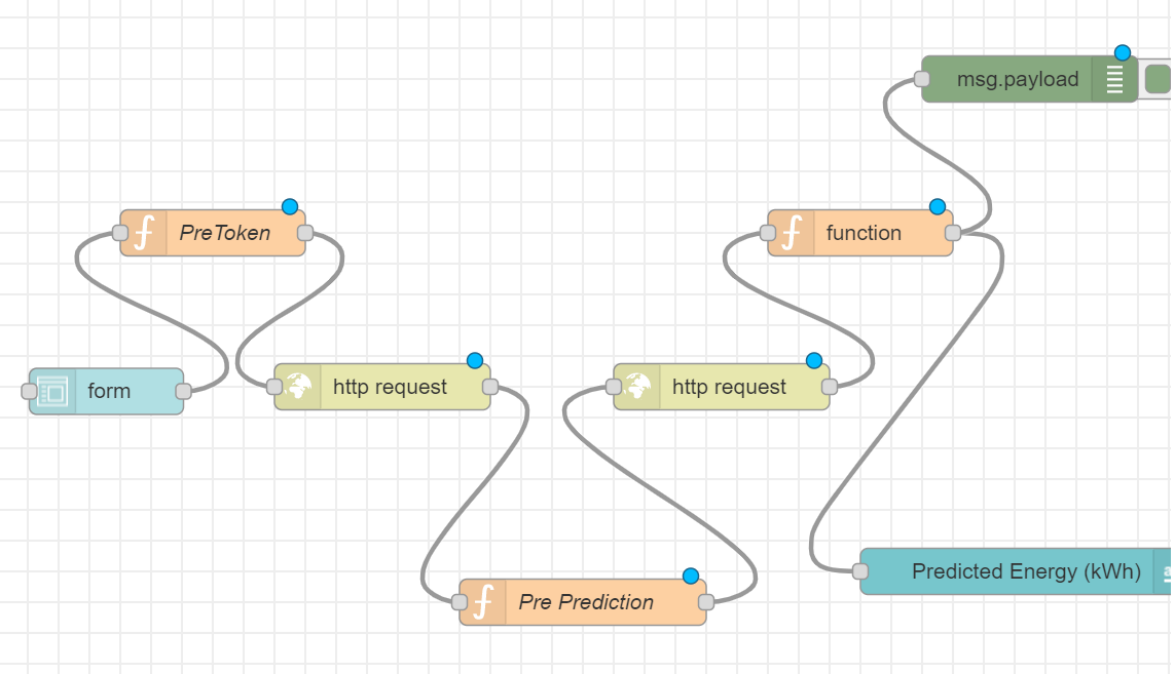


Setting Up The Scoring Endpoint:

Set up the scoring endpoint for your model,from the deployments section which will assist in linking the M.L. model to the front end and the back end. Also,API Key and Instance Id are taken from Watson Machine Learning Credentials.

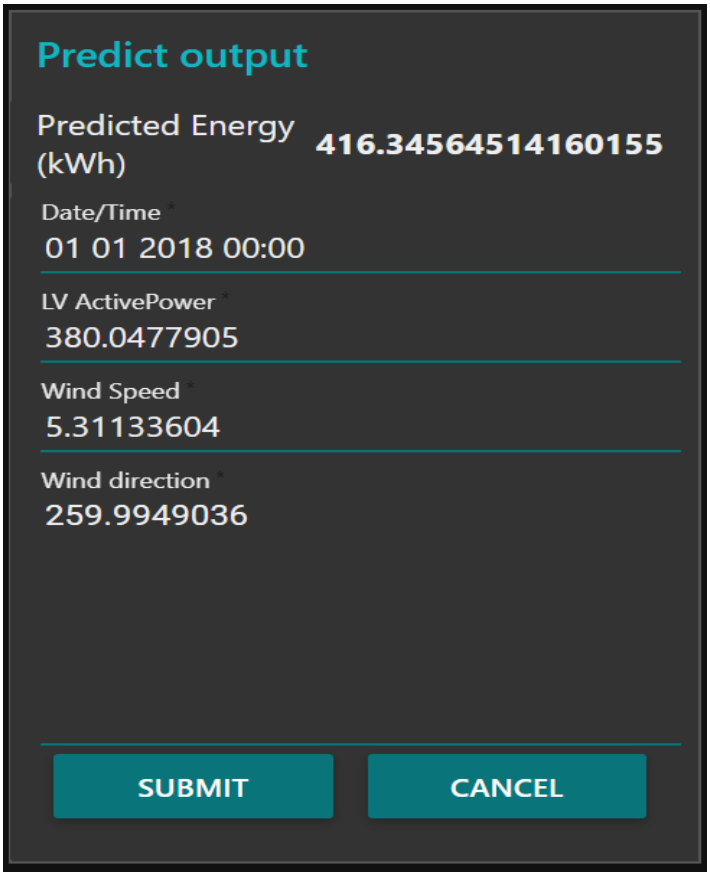
Designing the Node-RED Flow:

We have designed the following Node-RED flow for the application:



Deploying the Node-RED Flow :

The final deployed flow looks like this:



CONCLUSION

By doing the above project,we successfully created an interactive energy prediction dashboard using Watson studio,Watson Machine Learning ,Node-RED and Weather Data.
The experimental investigations showed the integration of different IBM cloud services. The results show that the responses from the Application were relevant and helpful. Although, the Web- Application demands complex integration of services it can be deployed easily to leverage the energy prediction and improve the energy production,effectively.

FUTURE SCOPE

We can include watson studio text to speech and speech to text services to access the application handsfree. This is one of the future scope of this project.For future research can be guided to improve relevant results and response time. Simplification of integration of services can be achieved by normalizing the architecture. Also,a user feedback system can be incorporated to render the user queries and needs, but still we have given contact us portion for that part.

More attractive user-interface design can implemented with help of node-red dashboard.There can be storage of responses so that every time it should not search for same answers to already asked questions. More features of Watson Studio can be implemented in Node-red so that there can be direct change to Node-RED flow.

BIBLIOGRAPHY

A. M. Foley, P. G. Leahy, A. Marvuglia, and E. J. McKeogh. Current methods and advances in forecasting of wind power generation. Renewable Energy, 37:1–8, 2012.

R. Jursa and K. Rohrig. Short-term wind power forecasting using evolutionary algorithms for the automated specification of artificial intelligence models. International Journal of Forecasting, 24:694–709, 2008.

I. S´anchez. Short-term prediction of wind energy production. International Journal of Forecasting, 22(1):43 – 56, 2006.