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Evaluation of XGBoost vs. other Machine Learning models for wind parameters identification

B. García-Puente1, A. Rodríguez-Hurtado1, M. Santos2 and J.E. Sierra-García3
1 Faculty of Computer Sciences, Complutense University, beleng11@ucm.es, antrod03@ucm.es
2 Institute of Knowledge Technology, Complutense University, msantos@ucm.es
3 Electromechanical Engineering Department, University of Burgos, jesierra@ubu.es

Abstract

In this project, we test a recent and powerful intelligent technique, extreme gradient boosting (XGBoost), for wind prediction. The forecasting models of some wind features (Active Power, Wind Speed and Wind Direction) with XGBoost are compared with Support Vector Regression (SVR), Gaussian Process Regression (GPR) and Neural Networks (NN) models. Specifically, the three

Materials and Evaluation Methods

The datased used has been obtained from the SCADA system of a wind turbine which is generating power in Turkey.

In this project, the inputs and outputs of the algorithms must follow some guidelines defined as:

$$input = \{x_t, x_{t-1}, x_{t-2}, \dots, x_{t-M}\};$$
$$output = x_{t+\Delta}$$

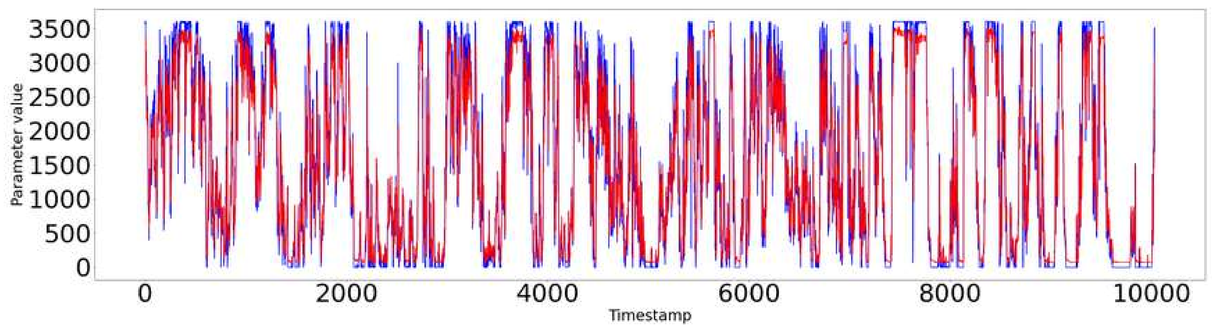
It is important to carefully select M (the number of past values to use as input) and Δ (time at when we want to obtain the predicted value). To obtain the best combination of those parameters for each algorithm, different values have been tested and compared.

The metrics used to evaluate wich algorithm is the best for forecasting each wind feature are the following:

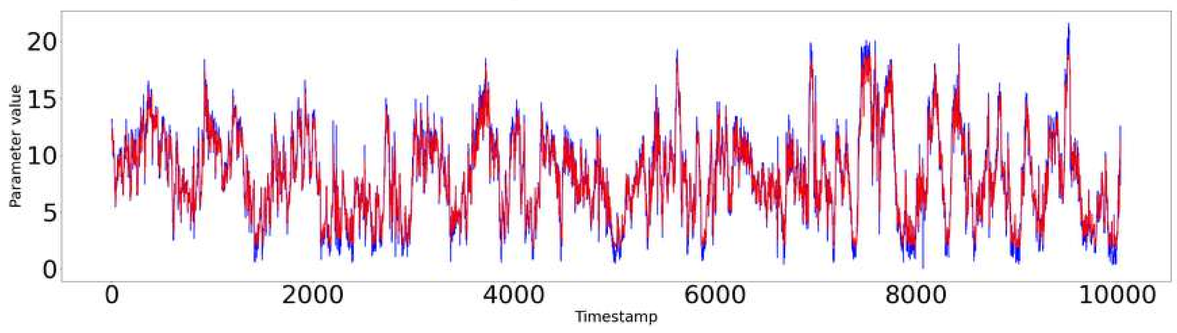
$$RMSE = [\sum \frac{(\hat{x}_i - x_i)^2}{N}]^{1/2} \quad MAE = \frac{1}{n}\sum|x_i - x| \quad R^2 = \frac{SSR}{SST} = \frac{\sum(\hat{x}_i - \bar{x})^2}{\sum(x_i - \bar{x})^2}$$

Results

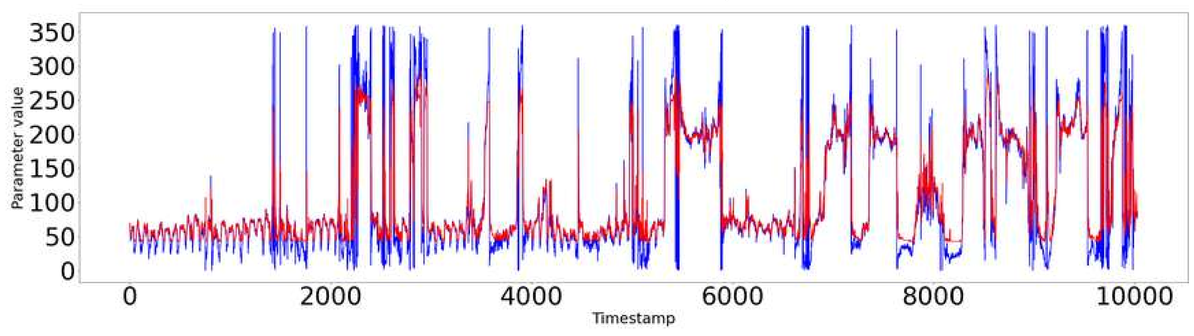
Active Power: M=72,Δ=3



Wind Speed: M=72,Δ=3



Wind Direction: M=72,Δ=3



Difference Between Models

Active Power

Algorithm	M	Δ	Best RMSE	MAE	R2
XGBoost	72	3	**482.4018**	335.0285	**0.8646**
GPR	72	3	487.8276	338.8071	0.8616
SVR	72	3	497.8148	**330.3092**	0.8558
MLP	72	3	529.3002	371.6042	0.837

Wind Speed

Algorithm	M	Δ	Best RMSE	MAE	R2
XGBoost	72	3	**1.4363**	1.0736	**0.8655**
GPR	72	3	1.4402	**1.0705**	0.8648
SVR	72	3	1.4907	1.1035	0.8551
MLP	72	3	1.6242	1.228	0.8281

Wind Direction

Algorithm	M	Δ	Best RMSE	MAE	R2
XGBoost	72	3	**44.3778**	20.5795	**0.7266**
GPR	72	3	45.8228	21.0369	0.7085
SVR	72	3	46.9885	**19.9221**	0.6935
MLP	72	3	46.9521	22.1195	0.6939

Conclusions

- XGBoost is capable of providing good short-term predictions.
- An increase in M does not imply an improvement in prediction results due to the random nature of the wind.
- Increasing the size of the dataset helps to improve the results of the models.

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