IDEATION PHASE – LITERATURE SURVEY

Date	**04 October 2022**
Team ID	**PNT2022TMID45553**
Project Name	**Predicting the energy output of wind turbine based on weather condition**
Maximum Marks	**4 Marks**

Paper 1 : M. Schmidt and H. Lipson. Age-fitness Pareto optimization. In Genetic Programming Theory and Practice VIII, Genetic and Evolutionary Computation, chapter 8, pages 129–146. Springer, 2010.

We propose a multi-objective method, inspired by the Age Layered Population Structure algorithm, for avoiding premature convergence in evolutionary algorithms, and demonstrate a three-fold performance improvement over comparable methods. Previous research has shown that partitioning an evolving population into age groups can greatly improve the ability to identify global optima and avoid converging to local optima. Here, we propose that treating age as an explicit optimization criterion can increase performance even further, with fewer algorithm implementation parameters. The proposed method evolves a population on the two-dimensional Pareto front comprising (a) how long the genotype has been in the population (age); and (b) its performance (fitness). We compare this approach with previous approaches on the Symbolic Regression problem, sweeping the problem difficulty over a range of solution complexities and number of variables. Our results indicate that the multi-objective approach identifies the exact target solution more often than the age-layered population and standard population methods. The multi-objective method also performs better on higher complexity problems and higher dimensional datasets - finding global optima with less computational effort.

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Paper 2 : A.Kusiak, H. Zheng, and Z. Song. Short-term prediction of wind farm power: A data mining approach. IEEE Transactions on Energy Conversion, 24(1):125 – 136, 2009.

This paper examines time series models for predicting the power of a wind farm at different time scales, i.e., 10-min and hour-long intervals. The time series models are built with data mining algorithms. Five different data mining algorithms have been tested on various wind farm datasets. Two of the five algorithms performed particularly well. The support vector machine regression algorithm provides accurate predictions of wind power and wind speed at 10-min intervals up to 1 h into the future, while the multilayer perceptron algorithm is accurate in predicting power over hour-long intervals up to 4 h ahead. Wind speed can be predicted fairly accurately based on its historical values; however, the power cannot be accurately determined given a power curve model and the predicted wind speed. Test computational results of all time series models and data mining algorithms are discussed. The tests were performed on data generated at a wind farm of 100 turbines. Suggestions for future research are provided.

Paper 3 : O. Kramer and F. Gieseke. Short-term wind energy forecasting using support vector regression. In International Conference on Soft Computing Models in Industrial and Environmental Applications, pages 271–280. Springer, 2011.

Wind energy prediction has an important part to play in a smart energy grid for load balancing and capacity planning. In this paper we explore, if wind measurements based on the existing infrastructure of windmills in neighbored wind parks can be learned with a soft computing approach for wind energy prediction in the ten-minute to six-hour range. For this sake we employ Support Vector Regression (SVR) for time series forecasting, and run experimental analyses on real-world wind data from the NREL western wind resource dataset. In the experimental part of the paper we concentrate on loss function parameterization of SVR. We try to answer how far ahead a reliable wind forecast is possible, and how much information from the past is

necessary. We demonstrate the capabilities of SVR-based wind energy forecast on the micro-scale level of one wind grid point, and on the larger scale of a whole wind park.

Paper 4 : O. Kramer and F. Gieseke. Analysis of wind energy time series with kernel methods and neural networks. In Seventh International Conference on Natural Computation (ICNC), pages 2381–2385, 2011.

Wind energy has an important part to play as renewable energy resource in a sustainable world. For a reliable integration of wind energy the volatile nature of wind has to be understood. This article shows how kernel methods and neural networks can serve as modeling, forecasting and monitoring techniques, and, how they contribute to a successful integration of wind into smart energy grids. First, we will employ kernel density estimation for modeling of wind data. Kernel density estimation allows a statistically sound modeling of time series data. The corresponding experiments are based on real data of wind energy time series from the NREL western wind resource dataset. Second, we will show how prediction of wind energy can be accomplished with the help of support vector regression. Last, we will use self-organizing feature maps to map high-dimensional wind time series to colored sequences that can be used for error detection.

Paper 5 : 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.

Wind power generation differs from conventional thermal generation due to the stochastic nature of wind. Thus wind power forecasting plays a key role in dealing with the challenges of balancing supply and demand in any electricity system, given the uncertainty associated with the wind farm power output. Accurate wind power forecasting reduces the need for additional balancing energy and reserve power to integrate wind power. Wind power forecasting tools enable better dispatch, scheduling and unit commitment of thermal generators, hydro plant and energy storage plant and more competitive

market trading as wind power ramps up and down on the grid. This paper presents an in-depth review of the current methods and advances in wind power forecasting and prediction. Firstly, numerical wind prediction methods from global to local scales, ensemble forecasting, upscaling and downscaling processes are discussed. Next the statistical and machine learning approach methods are detailed. Then the techniques used for benchmarking and uncertainty analysis of forecasts are overviewed, and the performance of various approaches over different forecast time horizons is examined. Finally, current research activities, challenges and potential future developments are appraised.

Paper 6 : 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.

Wind energy is having an increasing influence on the energy supply in many countries, but in contrast to conventional power plants, it is a fluctuating energy source. For its integration into the electricity supply structure, it is necessary to predict the wind power hours or days ahead. There are models based on physical, statistical and artificial intelligence approaches for the prediction of wind power. This paper introduces a new short-term prediction method based on the application of evolutionary optimization algorithms for the automated specification of two well-known time series prediction models, i.e., neural networks and the nearest neighbour search. Two optimization algorithms are applied and compared, namely particle swarm optimization and differential evolution. To predict the power output of a certain wind farm, this method uses predicted weather data and historic power data of that wind farm, as well as historic power data of other wind farms far from the location of the wind farm considered. Using these optimization algorithms, we get a reduction of the prediction error compared to the model based on neural networks with standard manually selected variables. An additional reduction in error can be obtained by using the mean model output of the neural network model and of the nearest neighbour search based prediction approach.

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Paper 7 : 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.

Wind power generation differs from conventional thermal generation due to the stochastic nature of wind. Thus wind power forecasting plays a key role in dealing with the challenges of balancing supply and demand in any electricity system, given the uncertainty associated with the wind farm power output. Accurate wind power forecasting reduces the need for additional balancing energy and reserve power to integrate wind power. Wind power forecasting tools enable better dispatch, scheduling and unit commitment of thermal generators, hydro plant and energy storage plant and more competitive market trading as wind power ramps up and down on the grid. This paper presents an in-depth review of the current methods and advances in wind power forecasting and prediction. Firstly, numerical wind prediction methods from global to local scales, ensemble forecasting, upscaling and downscaling processes are discussed. Next the statistical and machine learning approach methods are detailed. Then the techniques used for benchmarking and uncertainty analysis of forecasts are overviewed, and the performance of various approaches over different forecast time horizons is examined. Finally, current research activities, challenges and potential future developments are appraised.