Adaptive robust polynomial regression for power curve modeling with application to wind power forecasting

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Wind farm power curve modeling, which characterizes the relationship between meteorological variables and power production, is a crucial procedure for wind power forecasting. In many cases, power curve modeling is more impacted by the limited quality of input data rather than the stochastic nature of the energy conversion process. Such nature may be due to the varying wind conditions, aging and state of the turbines, etc. And, an equivalent steady-state power curve, estimated under normal operating conditions with the intention to filter abnormal data, is not sufficient to solve the problem because of the lack of time adaptivity. In this paper, a refined local polynomial regression algorithm is proposed to yield an adaptive robust model of the time-varying scattered power curve for forecasting applications. The time adaptivity of the algorithm is considered with a new data-driven bandwidth selection method, which is a combination of pilot estimation based on blockwise least-squares parabolic fitting and the probability integral transform. The regression model is then extended to a more robust one, in which a new dynamic forgetting factor is defined to make the estimator forget the out-of-date data swiftly and also achieve a better trade-off between robustness against noisy data and time adaptivity. A case study based on a real-world dataset validates the properties of the proposed regression method. Results show that the new method could flexibly respond to abnormal data at different lead times and has better performance than common benchmarks for short-term forecasting.

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