

Robust modelling framework for short-term forecasting of global horizontal irradiance

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Abstract

The increasing demand for electricity and the need for clean energy sources have increased solar energy use. Accurate forecasts of solar energy are required for easy management of the grid. This paper compares the accuracy of two Gaussian Process Regression (GPR) models combined with Additive Quantile Regression (AQR) and Bayesian Structural Time Series (BSTS) models in the 2-day ahead forecasting of global horizontal irradiance using data from the University of Pretoria from July 2020 to August 2021. Four methods were adopted for variable selection, Lasso, ElasticNet, Boruta, and GBR (Gradient Boosting Regression). The variables selected using GBR were used because they produced the lowest MAE (Minimum Absolute Errors) value. A comparison of seven models GPR (Gaussian Process Regression), Two-layer DGPR (Two-layer Deep Gaussian Process Regression), bstslong (Bayesian Structural Time Series long), AQRA (Additive Quantile Regression Averaging), QRNN(Quantile Regression Neural Network), PLAQR(Partial Linear additive Quantile Regression), and Opera(Online Prediction by ExpRt Aggregation) was made. The evaluation metrics used to select the best model were the MAE (Mean Absolute Error) and RMSE (Root Mean Square Error). Further evaluations were done using proper scoring rules and Murphy diagrams. The best individual model was found to be the GPR. The best forecast combination was AQRA ((AQR Averaging) based on MAE. However, based on RMSE, GPNN was the best forecast combination method. Companies such as Eskom could use the methods adopted in this study to control and manage the power grid. The results will promote economic development and sustainability of energy resources.

Keywords: Additive quantile regression; Bayesian structural time series; Forecast combination; Gaussian processes; Solar irradiance.