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Day-ahead solar radiation forecasting using GFS and artificial neural networks

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More and more photovoltaic (PV) energy is injected into grids. However, its inherent variability threatens the fundamental equilibrium between energy production and consumption. PV forecasting is thus seen as the most efficient way to leverage PV insertion into grids. By anticipating PV production fluctuations, the grid managers can adapt their other means of production, therefore ensuring grid stability. Day-ahead PV production forecasting specifically serves this purpose: it enables daily means of production planning so that the best (greenest, cheapest) can be selected to complete renewable energy production.
Day-ahead forecasting often relies on Numerical Weather Prediction (NWP). This approach is based on deterministic atmospheric process modelling which cannot take into account the stochastic variability of cloud cover. It also requires both a complex workflow management and site-specific calibration. Alternatively, time series modelling has been proven efficient for solar radiation forecasting. The common approach consists in modelling the coupling between historical measurements and future values.
In this article, we present a model in which we exploit GFS (Global Forecasting System) forecasts as an input. We build an artificial neural network (ANN) which takes as inputs historical solar radiation and GFS data (notably DSWRF) to output solar radiation at a one-hour time step. We experiment our model on the BSRN Carpentras (France) station, using 2012 and 2013 measurements. Our ANN is trained on one year (ratio between training and validation is 70%/30%) and results are evaluated on the other year. Using GFS as an input of the ANN leads to an improvement of the nRMSE (from 35% to 30%) compared to an ANN using only historical measurements.
Coupling both historical solar radiation measurements and GFS forecasts has proved useful for enhancing solar radiation forecasting with artificial neural networks. Using global, open data, this model can easily be world-widely deployed, provided historical measurements are available.