Solar Radiation Forecasting Using Artificial Neural Network for Local Power Reserve

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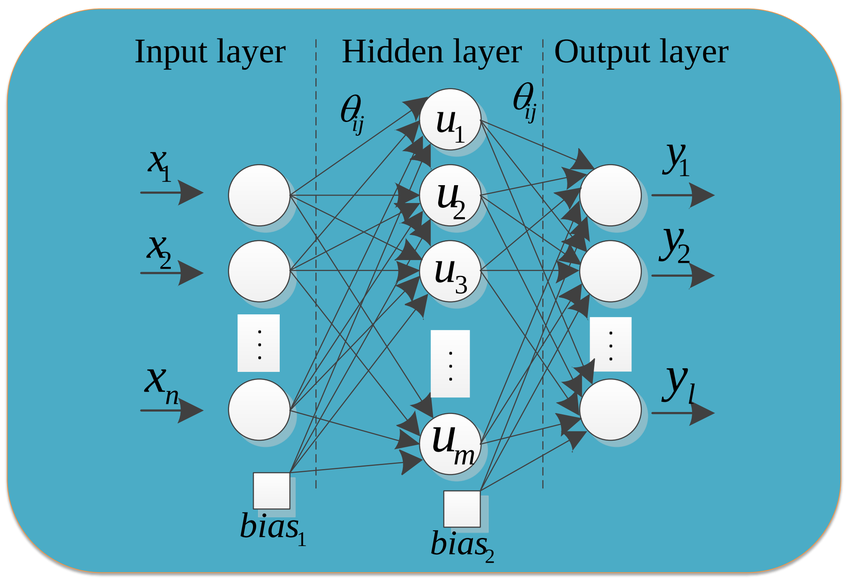
ABSTRACT

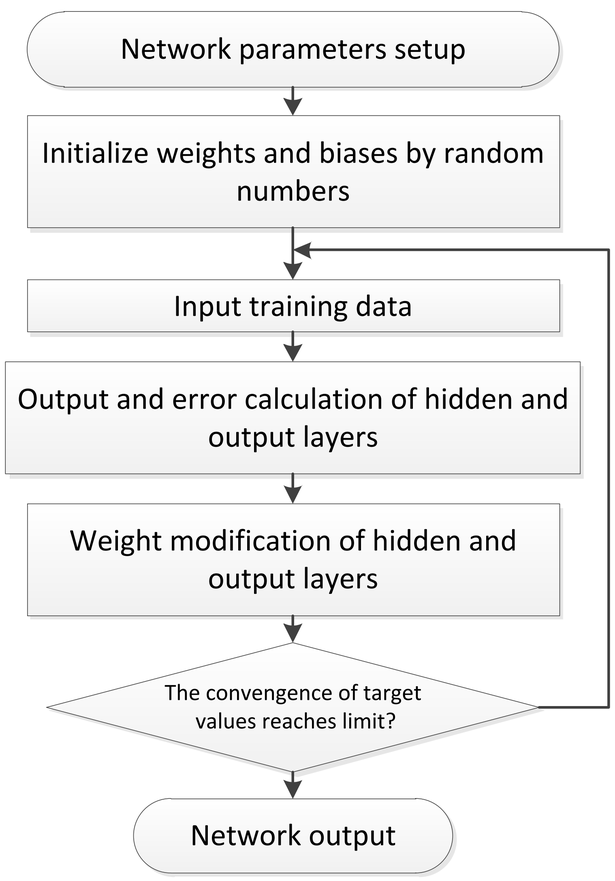
Renewable energy sources have a variable nature and are depending on weather conditions. To satisfy the instantaneous balancing between electrical production and consumption, the operation of electrical networks requires a power reserve to compensate unforeseen imbalances. This one must be minimized in order to reduce the system cost while ensuring a satisfying security level. A back propagation Artificial Neural Network (ANN) is proposed to predict the Global Solar Radiations (GSR). Predictions have been analyzed according to weather classification with some error indexes, which are also used to evaluate performances. These forecasting results can be used for power reserve quantification by analysis of forecasting uncertainty errors of both generation and load.

METHOD: BACK-PROPAGATION ANN

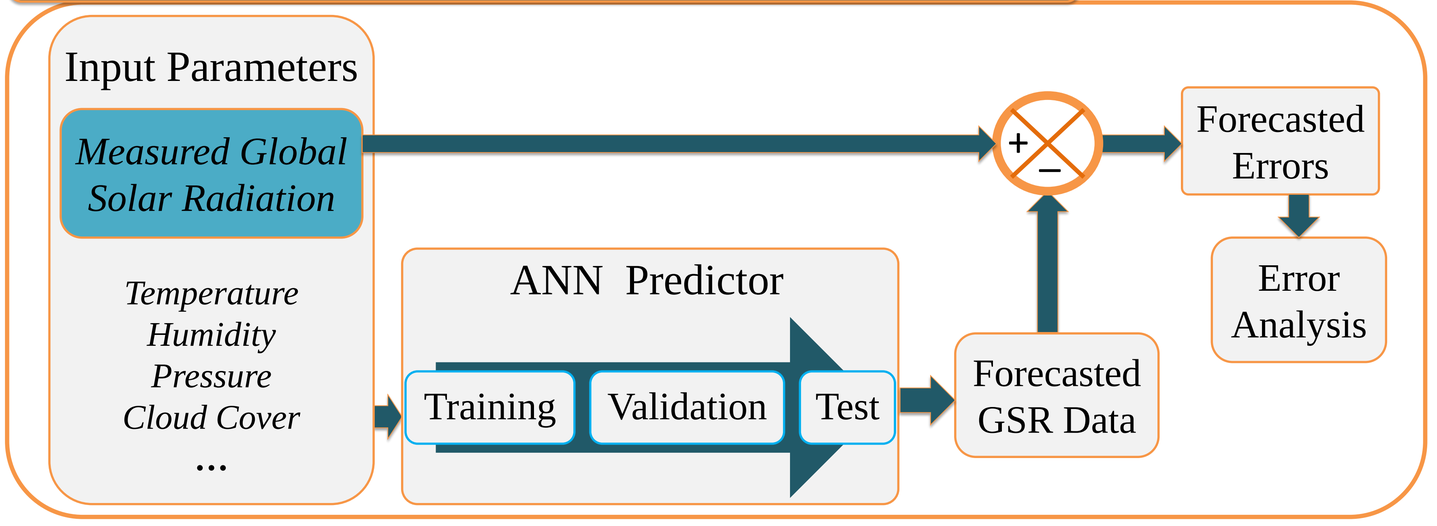
➢ *Topology of a Three-layer BP ANN*



➢ *Training Procedure of a BP ANN*

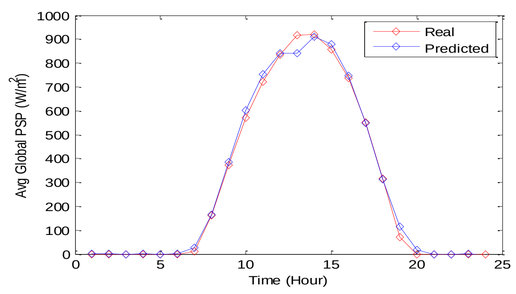


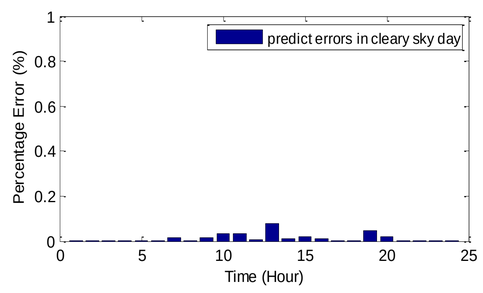
PREDICTION FLOW PROCESS: A Case Study



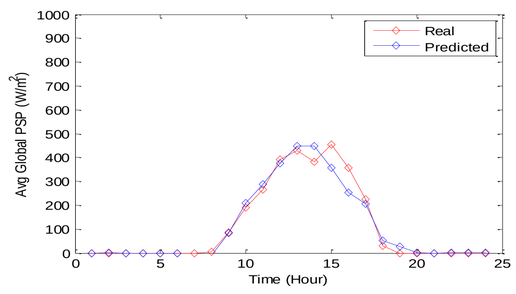
RESULTS (1): GSR Forecasting

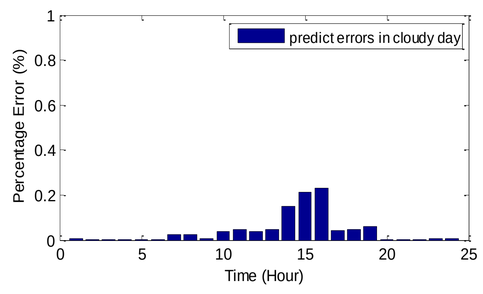
➢ *Clear Sky Day*



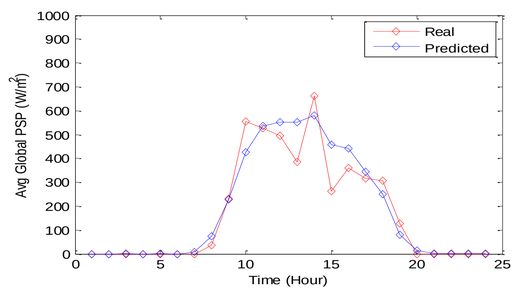


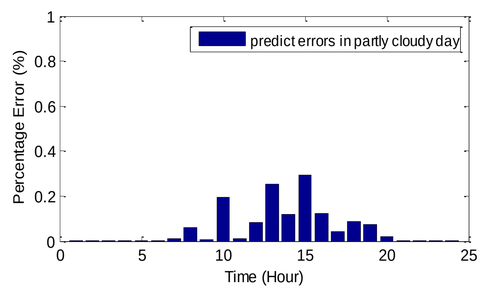
➢ *Cloudy Day*





➢ *Partly Cloudy Day*





	Clear Day	Cloudy Day	Partly Cloudy Day
Real daily GSR (Wh/m2)	7045.3	2814.2	4266.0
Predicted GSR (Wh/m2)	7142.6	2729.5	4546.5
Absolute Error (Wh/m2)	97.3	84.7	280.5
$e_{\%,MAPE}$ (%)	1.4	3.0	6.6
Standard Deviation (std)	0.019	0.064	0.084

RESULTS (2): RMSE and MAE of Prediction Network

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y - y_{pred})^2}$$

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|y - y_{pred}|$$

	RMSE[%]	MAE[%]
Training set	9.359	4.964
Validation set	11.849	6.714
Test set	9.811	5.057

CONCLUSION

- **A BP NN is presented for the day-ahead GSR forecasting by using some meteorological data.**
- **Errors between prediction and real measurements for three different weather conditions are discussed.**
- **In future studies, uncertainty analysis will be performed with normal probability density functions in order to calculate the probability and possibilities of error distribution. Then, the power reserve will be sized by taking into account a reliability risk index. Figure in the right shows the necessary future steps to be taken.**