RET Project: A Hybrid Regression Algorithm for Solar Power Forecasting

Research Experience for Teachers (RET) Summer 2020

Kathy Turner, Ed D, Mentors: Graduate Student Kristen Jaskie, Dr. Jean Larson, Dr. Andreas Spanias
SenSIP Center, School of ECEE, Arizona State University.

RESEARCH BACKGROUND/DESCRIPTION

- This RET program focus is on applications of ML methods and IoT used in solar energy prediction.
- Data collected from one residential property was used to learn, validate, and test the ML algorithms.
- My background is Applied Math and CS.

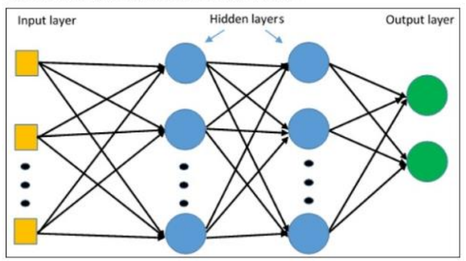
RESEARCH OBJECTIVES/PLAN

- Develop the use of ML algorithms in energy
- Predict future solar energy production
- Integrate what I have learned into the classroom

Neural Network (Multi-layer Preceptrons) Forecasting

Multi-layer Preceptrons are shallow neural networks (as opposed to deep learning networks). This means that they usually only have a couple of hidden layers.

These networks generally have the following structure:



RESEARCH RESULTS/REMARKS

- Residential property: learning, validation and testing.
- The linear predictions were somewhat lower than the real numbers.
- The NN polynomial faired better with a less than one Kw difference.
- Further research with increased data bank should result in more reliability.

Linear regression MSE

Daily MSE for Test Set = 0.011805533359688493

	Real	Predictions
0	5.2	2.135746
1	4.4	2.135949
2	3.7	2.136152
3	4.3	2.136355
4	5.2	2.136559
...	...	...
475	5.5	2.232214
476	5.6	2.232417
477	5.8	2.232620
478	6.0	2.232823
479	6.0	2.233026

480 rows × 2 columns

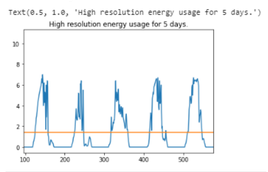
NNF Polynomial MSE

Final test MSE 0.033942436435379864

	Predictions	Real
0	5.2	4.758029
1	4.4	4.759663
2	3.7	4.761297
3	4.3	4.762931
4	5.2	4.764564
...	...	...
475	5.5	5.534110
476	5.6	5.535744
477	5.8	5.537378
478	6.0	5.539012
479	6.0	5.540645

480 rows × 2 columns

5-Day visualization



REFERENCES

[1] U. Shanthamallu, A. Spanias, C. Tepedelenlioglu, M. Stanley, "A Brief Survey of Machine Learning Methods and their Sensor and IoT Applications," *Proc. 8th IISA 201),* Larnaca, August 2017. [2] K. Jaskie and A. Spanias, "Positive and Unlabeled Learning Algorithms and Applications: A Survey," *Proc. IEEE IISA 2019,* Patras, July 2019. [3] Assouline, D., Mohajeri, N., & Scartezzini, J. L. (2017). Quantifying rooftop photovoltaic solar energy potential: A machine learning approach. *Solar Energy*, *141*, 278-296. [4] Lonij, V. P., Jayadevan, V. T., Brooks, A. E., Rodriguez, J. J., Koch, K., Leuthold, M., & Cronin, A. D. (2012, June). Forecasts of PV power output using power measurements of 80 residential PV installs. In *2012 38th IEEE Photovoltaic Specialists Conference* (pp. 003300-003305). [5] A. Tuohy et al., "Solar Forecasting: Methods, Challenges, and Performance," in IEEE Power and Energy Magazine, vol. 13, no. 6, pp. 50-59, Nov.-Dec. 2015, [6] Fumo, N. and Rafe Biswas, M., 2015. Regression analysis for prediction of residential energy consumption. *Renewable and Sustainable Energy Reviews*, 47, pp.332-343. [7] H. Yang, C. Huang, Y. Huang and Y. Pai, "A Weather-Based Hybrid Method for 1-Day Ahead Hourly Forecasting of PV Power Output," in IEEE Transactions on Sustainable Energy, vol. 5, no. 3, pp. 917-926, July 2014, [8] J. Huang, Y. Liang, H. Bian and X. Wang, "Using Cluster Analysis and Least Square Support Vector Machine to Predicting Power Demand for the Next-Day," in IEEE Access, vol. 7, pp. 82681-82692, 2019.

LESSON PLAN OBJECTIVES

- Students will be able to catalog their research
- Students will be able to communicate their findings
- Students will be able to predict what type of algorithm may have been used, given different types of algorithms used in Machine Learning (ML) and analyze its design and structure.
- Students develop a hypothesis of how the innovation could be used in the future or used in an alternative way.

LESSON IMPLEMENTATION/OUTCOMES

- Students will be online researching their chosen topic and taking notes for the next 45 minutes. Students have a resource page and requirement page to help keep them focused.
- Closure is performed during the last 5 minutes of class. Circulate and scan every checklist, making sure it is stamped with the date stamp.

EXPLORE CHECKLIST

Ira A. Fulton Schools of Engineering
ARIZONA STATE UNIVERSITY
Sensor Signal and Information Processing Center
https://sensip.asu.edu
This work is funded in part by SenSIP center and NSF Award 1953745