Can we predict the parameter to optimize solar and wind energy production and help reduce the consumption on renewable sources?

Building the prediction model of average solar radiation using 2-layered Artificial Neural Network (ANN)

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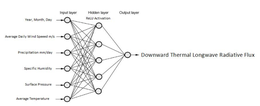
INTRO:

In Arlington, people are depended upon non-renewable sources as their main energy source while clean energy source is still feasible. Using the neural network model in the weather data collected from NASA, we figured out that the average solar radiation and wind speed here is favorable for solar and wind energy production. So, we proposed the plan to make a hybrid power plant to produce electricity using solar panels and wind turbines combined. Using this, the residents of Arlington and UTA community can produce their own electricity and be independent of the current nonrenewable sources.

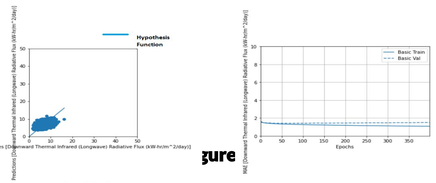
Application of neural network in predicting average solar radiation and wind pattern to build the hybrid solar panel and windmill to generate electricity.

METHODS



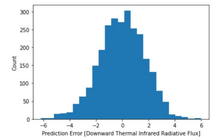
1. From NASA site we have collected the metrological and solar irradiance and related parameters of last twenty years of Arlington as our main data to both train and test the neural network model.
2. After collecting the data, we first mean normalized it and then built a neural network architecture called Artificial Neural Network (ANN) with 7 input features that included the weather data; dense layer with ReLU activation function; and Mean Average Error (MAE) and Mean Squared Error (MSE) as our cost function using TensorFlow.

RESULTS



gure
Function

GitHub source code and data repository to our project



curve of Error Distribution

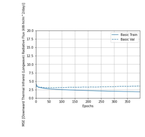


Figure: Mean Squared Error Cost Function

When we use the two-layered neural network with Mean Average Error (MAE) rather than Mean Squared Error (MSE) as the cost function, we had a better performance with the testing data set. Also with 300 epochs of iterations, we were able to predict the average solar output with 16.667% error and the error distribution curve also matches the Gaussian Curve.

With this model, we can predict the average solar radiation per day and can estimate the average energy that solar panel and wind turbine can produce.

Applications:

From the above result, we, thus, propose a hybrid model which will be comprised of smart solar flower panel and wind turbine to generate electricity. The solar flower will be of 8 solar plates, basically piled together to form a shape like a sunflower.

The major advantage over traditional solar plates is that it would cover more surface area over small space increasing efficiency. And, as the average wind speed in Arlington is around 15 mph which will be best suited for running the wind turbine along with that the long day hours and summer heat can be utilized in developing electricity out of solar power. Our proposed hybrid plan is economical and feasible as with approximately $1200 installation fee we can produce enough energy to light up a complete home with the use of 2kWh Wind turbine and 800 Wh solar flower producing energy continuously.

Acknowledgements:

Research on average solar radiation on planet

Estimated price of wind turbine

Monthly electricity expenditure

UNIVERSITY OF TEXAS ARLINGTON