Surface Albedo Prediction using Artificial Neural Networks

SenSIP Algorithms and Devices REU

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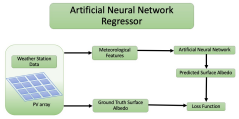
ABSTRACT

- Surface albedo describes the fraction of sunlight reflected by a surface using a value from zero to one.
- Surface albedo can fluctuate due to environmental conditions.
- This project explores the leveraging of artificial neural networks to predict surface albedo.

MOTIVATION

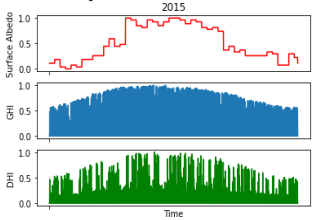
- Weather changes cause power fluctuations in PV arrays.
- Prediction of these changes can make PV arrays more efficient.
- Surface albedo is strongly correlated with irradiance and power.



Overview of surface albedo prediction process.

PROBLEM STATEMENT

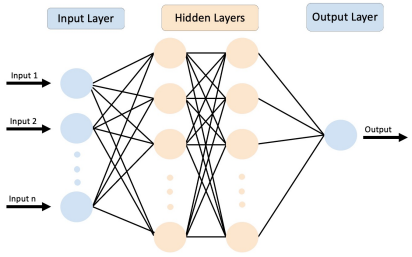
- Use data from NSRDB dataset to predict surface albedo and determine which features correlate most strongly to surface albedo prediction.



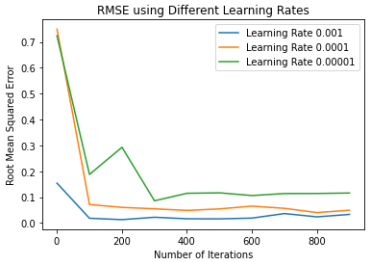
Average DHI, GHI, and Surface Albedo values for the year 2015.

EXPERIMENTAL METHODS

- Pre-process NSRDB data (standardization, one-hot encoding, train/test split).
- Determine how many layers and nodes are optimal for neural network.
- Train MLPRegressor to perform surface albedo prediction.
- Use RMSE as a metric to calculate the distance between ground truth and predicted surface albedo.
- Evaluate RMSE with varying learning rates, activation functions, solvers, and batch sizes.



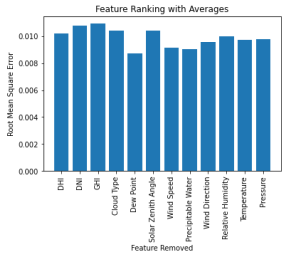
Overview of neural network architecture.



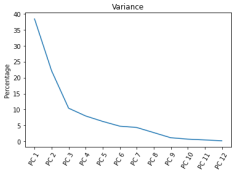
RMSE values with three different learning rates.

EXPERIMENTAL RESULTS

- The four features most strongly correlated to surface albedo were GHI, DNI, Solar Zenith Angle, and Cloud Type.
- The first three components contribute to 71% of the total variance.
- Future work could explore how the features are related to each other and compare dimensionality reduction using an auto-encoder to PCA.



RMSE value averages removing one feature at a time.



Graph depicting the variance of the dataset.

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