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Fault Classification in Photovoltaic Arrays Using Dropout and Pruned Neural Networks

Faults in utility-scale solar arrays often lead to increased maintenance costs and reduced efficiency. Since photovoltaic (PV) arrays are generally installed in remote locations, maintenance and annual repairs due to faults incur large costs and delays. To automatically detect faults, PV arrays can be equipped with smart electronics that provide data for analytics. Smart monitoring devices (SMDs) that have remote monitoring and control capability have been proposed to provide data for each panel and enable detection of faults and shading.

However, even with the use of SMDs, fault detection and classification remain a challenge. Current methods to identify faulty conditions in PV arrays include the support vector machine (SVM), decision tree-based approach, and a minimum covariance determinant (MCD)-based distance metric. Although these approaches and others provide encouraging results, they are based on aggregated data and generally cannot localize and distinguish between electrical faults and shading. Neural networks (NNs) have also been used for fault detection and classification tasks, and research focus remains on optimizing NN hyperparameters and architecture.

Researchers at Arizona State University have developed fully connected neural networks (NNs) and dropout NNs trained specifically for fault classification in PV arrays. Network pruning is performed to find sparse NNs, at a cost of a 3% decrease in accuracy for a 2x compression. Along with custom hardware which enables monitoring of voltage, current, temperature, and irradiance at the module level, a custom NN with reduced parameters will be beneficial for the development of compact and specialized hardware for fault classification in PV arrays.

Potential Applications:

- Monitoring of utility-scale solar arrays
- PV fault classification