

ECE Distinguished Seminar Series

Signal Processing and Machine Learning Applied to Model Selection and Bad Data Detection for the Electrical Grid

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Showcase Room

Abstract

This talk focuses on using signal processing and machine learning applied to renewable energy and the smart grid. We start off by giving an introduction to the Hawai'i energy landscape and the University of Hawai'i.

We discuss modeling distributed solar PV energy sources. With higher penetrations of distributed solar PV energy sources new methods are needed to effectively model these distributed energy sources. These generally involve using more distributed state estimation methods modeling energy sources and loads using graphical approaches. Here we look at approximations of the distributed energy sources using tree structures. We look at existing algorithms such as the Chow-Liu tree approximation algorithm using the Kullback Leibler (KL) Divergence and discuss the quality of approximation algorithms by formulating the problem as a detection problem and considering Receiver Operating Curves (ROC)s and the Area Under the Curve (AUC). We find theoretical lower and upper bounds for the AUC and conduct simulations on real and simulated data showing the quality of the tree approximations.

We then discuss detecting bad data for the electrical grid. We use a machine learning approach by formulating an online sparse one-class least squares support vector machine (OC)-(LS)-(SVM). The online OC-LS-SVM achieves sparsity by using information based criteria and detects outliers by classifying data using a threshold test. We then test our algorithm on IEEE bus simulation data. We inject bad data at critical locations, inject multiple bad data, and use false data injection attacks. The online OC-LS-SVM performs better on all tests than traditional state estimation methods using the largest residual test method.

Bio

Anthony Kuh received his B.S. in Electrical Engineering and Computer Science at the University of California, Berkeley in 1979, an M.S. in Electrical Engineering from Stanford University in 1980, and a Ph.D. in Electrical Engineering from Princeton University in 1987. Dr. Kuh previously worked at AT&T Bell Laboratories and has been on the faculty in Electrical Engineering at the University of Hawai'i since 1986. He is currently a Professor in the Department, serving as director of the interdisciplinary renewable energy and island sustainability (REIS) group. Previously, he served as Department Chair of Electrical Engineering. Dr. Kuh's research is in the area of neural networks and machine learning, adaptive signal processing, sensor networks, and renewable energy and smart grid applications. In January, 2017 he started service as a program director for NSF. He is in the Electrical, Communications, and Cyber Systems (ECCS) division working in the Energy, Power, Control, and Network (EPCN) group.

Dr. Kuh won a National Science Foundation Presidential Young Investigator Award and is an IEEE Fellow. He was also a recipient of the Boeing A. D. Welliver Fellowship and received a Distinguished Fulbright Scholar's Award working at Imperial College in London. Dr. Kuh was an Associate Editor for the IEEE Transactions on Circuits and Systems, served on the IEEE Neural Networks Administrative Committee, served on the IEEE Neural Networks for Signal Processing Committee, and was a Distinguished Lecturer for the IEEE Circuits and Systems Society. Dr. Kuh served as the technical co-chair for the 2007 IEEE ICASSP held in Honolulu. He served as the IEEE Signal Processing Society Regions 1-6 Director at Large and was a senior editor of the IEEE Journal of Selected Topics in Signal Processing. He currently serves on the Board of Governors of the Asia Pacific Signal and Information Processing Association as Vice President of Technical Activities.