Robust and Nonparametric Methods for Topology Error Identification and Voltage Calibration in Power Systems Engineering

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(ABSTRACT)

There is a growing interest in robust and nonparametric methods with engineering applications, due to the nature of the data. Here, we study two power systems engineering applications that employ or recommend robust and nonparametric methods; topology error identification and voltage calibration.

Topology errors are a well-known, well-documented problem for utility companies. A topology error occurs when a line's status in a power network, whether active or deactive, is misclassified. This will lead to an incorrect Jacobian matrix used to estimate the unknown parameters of a network in a nonlinear regression model. We propose a solution using nonlinear regression techniques to identify the correct status of every line in the network by deriving a statistical model of the power flows and injections while employing Kirchhoff's Current Law. Simulation results on the IEEE-118 bus system showed that the methodology was able to detect where topology errors occurred as well as identify gross measurement errors.

The Friedman Two-Way Analysis of Variance by Ranks test is advocated to calibrate voltage measurements at a bus in a power network. However, it was found that the Friedman test was only slightly more robust or *resistant* in the presence of discordant measurements than the classical F-test. The resistance of a statistical test is defined as the fraction of bad data necessary to switch a statistical conclusion. We mathematically derive the maximum resistance to rejection and to acceptance of the Friedman test, as well as the Brown-Mood test, and show that the Brown-Mood test has a higher maximum resistance to rejection and to acceptance than the Friedman test. In addition, we simulate the expected resistance to rejection and to acceptance of both tests and show that on average the Brown-Mood test is slightly more robust to rejection while on average the Friedman test is more robust to acceptance.