Experiments in Advanced Fault Detection in the Jansky Very Large Array

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As the Next-Generation Very Large Array (ngVLA) and other instruments with an order of magnitude more antennas and associated equipment are designed and commissioned, the need for advanced monitoring algorithms and simple presentation tools is only becoming more intense.

Tens of thousands of data points are used to monitor the health of the the Jansky Very Large Array. Thresholding is currently used to filter high-priority data, but is incapable of bringing to human attention low-order systemic problems or sub-par values indicative of incipient failures or subtle failure modes. The sheer volume of raw data precludes easy human viewing and deep analysis.

More advanced monitoring algorithms are needed to monitor the health of the system by integrating all relevant data, identifying failures both underway and incipient, and pinpointing underlying causes in a way easily assimilated by operators and engineers. The results of the analyses must be presented to operators and engineers such that the size of the presentation scales only with the magnitude of the faults, not with that of the systems being monitored.

We present the results of initial experiments with advanced monitoring algorithms, including Boolean monitors, expert systems, and statistical evaluators. The tools that implement these algorithms use data from a variety of sources, including real-time monitor data from the array, archival data from databases, and post-correlation data. Even in the early stages of experimentation, these analysis tools have demonstrated great value, allowing us to discover low-level and developing problems with systems ranging from the front end to the correlator.

We discuss how these tools might be applied to other instruments, and how they will impact the design of the ngVLA. We also discuss directions of future experiments that include fault tree analysis, deep-learning networks, and self-repair.