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Machine Learning for Real-Time Transient Detection

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The Square Kilometer Array (SKA) poses complex new challenges for high time resolution observations. The traditional operational approach of archiving and analyzing the data offline will not be possible given the unprecedented data rates that will be generated by the SKA. We are developing machine learning methods that exploit learned statistical properties of the data stream to enable large-scale signal analysis and anomaly detection in real-time. One application is the detection of fast transient pulses with millisecond (or less) duration. Data surrounding anomalous transient events can be saved, if they can be detected quickly enough (before the data buffer is overwritten with new data). In contrast to existing dedispersion searches that evaluate the signal at the same series of dispersion measures (DMs) for all data, our approach uses an adaptive strategy that selects likely DMs based on the particular signal being analyzed. This adaptive approach is able to dramatically reduce the required computational cost and shows great promise in keeping up with the anticipated SKA data rates. We have evaluated the adaptive and traditional approaches in a variety of computational cost regimes, motivated by the performance characteristics of different hardware components. We have also identified other areas in which machine learning methods can contribute to SKA data analysis, such as RFI excision and source type classification, and we plan to explore how these methods can be extended to other domains such as optical astronomy.

Primary author: Dr WAGSTAFF, Kiri (Jet Propulsion Laboratory, California Institute of Technology)

Co-authors: Dr THOMPSON, David (Jet Propulsion Laboratory, California Institute of Technology); Dr JONES, Dayton (Jet Propulsion Laboratory, California Institute of Technology); Dr MAJID, Walid (Jet Propulsion Laboratory, California Institute of Technology)

Presenter: Dr WAGSTAFF, Kiri (Jet Propulsion Laboratory, California Institute of Technology)

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