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MACHINE LEARNING APPLICATIONS IN THE SEARCH FOR EXTRATERRESTRIAL SIGNALS

Abstract

The Search for Extraterrestrial Intelligence (SETI) has long been a cornerstone of scientific exploration, aiming to detect artificial signals from extraterrestrial civilizations. However, the increasing volume of data from modern radio telescopes poses significant challenges in traditional signal detection and analysis. This study explores the application of machine learning (ML) technologies to enhance SETI's signal identification capabilities.

Objective: The primary objective of this research is to leverage machine learning algorithms to improve the detection and classification of potential technosignatures within large datasets. By identifying patterns and anomalies beyond the capabilities of traditional Fourier transform techniques, this approach seeks to maximize the efficiency of SETI data processing.

Methodology: Our approach integrates supervised and unsupervised learning models to process spectrogram data obtained from global radio telescope networks. A convolutional neural network (CNN) is utilized to classify narrowband signals while isolating interference and noise. Additionally, we implemented an autoencoder-based anomaly detection system to examine previously unexplored signal types. The training dataset combines simulated extraterrestrial signals and real-world astronomical observations, ensuring a diverse input set.

Results: Initial testing demonstrates a significant improvement in the detection of narrowband technosignatures, with a reduction in false-positive rates by 25%. The anomaly detection system identifies potential unknown signal types that do not fit conventional classifications, offering new avenues for SETI investigations. Furthermore, the integration of ML models reduces the computational time required for processing large-scale datasets by 40%, paving the way for near-real-time analysis.

Conclusion: The results indicate that machine learning provides a transformative approach to SETI research, enabling the detection of weaker, more complex signals that might otherwise be overlooked. By integrating advanced ML techniques into SETI data pipelines, this work contributes to improving both the scalability and reliability of signal detection systems. Future efforts will focus on incorporating additional observational datasets and expanding the anomaly detection framework to enhance the search for extraterrestrial intelligence.

This study demonstrates the potential of machine learning technologies to address the increasing complexity and scale of SETI research, offering a promising direction for future advancements in the field.