Machine Learning Prediction of Successful Rocket Launches at NASA Kennedy Using Lightning Data

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Abstract

Rocket launches are among the most technically demanding operations in aerospace, where even minor environmental fluctuations can trigger costly delays or catastrophic failures. At NASA's Kennedy Space Center (KSC), lightning remains the most disruptive and least predictable weather variable, posing risks to crew safety, onboard electronics, and mission timelines. This study presents a decision support system based on machine learning that predicts launch viability by analyzing historical weather data, with a focus on electric field measurements collected from KSC's field mill sensors.

The research involved a comparative analysis of rainfall, wind shear, and lightning data, using scatter plots to assess their predictive reliability. While rainfall and wind shear showed no consistent correlation with launch outcomes, electric field strength emerged as a robust indicator, revealing a clear threshold between successful and postponed launches. To address severe class imbalance (135 successful vs. 10 postponed launches), the study applied the Synthetic Minority Oversampling Technique (SMOTE) and feature scaling prior to training a Support Vector Machine (SVM) classifier. The resulting model generates probability-based predictions and determines a decision threshold of 915 V/m, aligning with observed launch behavior and expert meteorological guidance.

This work demonstrates how environmental sensor data, when paired with AI, can help transform launch protocols using data-driven strategies. It offers a framework for integrating predictive modeling into aerospace operations, reducing unnecessary delays while preserving safety. More broadly, the work illustrates how machine learning can uncover actionable patterns in noisy environmental data, enabling informed decisions in areas where uncertainty and operational risk intersect, from aerospace to disaster response.

Full paper available at: https://thanikap.github.io/launchpredictresearch.pdf