Hurricane Forecasting Using Comprehensive Multivariable Machine Learning Modeling With Atmospheric Temperatures, Polar Motion, and Sunspot Numbers

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Nine of NOAA's top 10 costliest natural disasters were major hurricanes, highlighting the logically clear need to protect the 40% of the global population living near coastal areas. Despite improvements, current prediction mechanisms struggle to forecast hurricanes beyond 5 days. Furthermore, most hurricane watches provide communities just 48 hours to prepare for storm impact. This study aimed to utilize the unique correlations with hurricanes of a novel predictor variable set (atmospheric temperatures, polar motion, and sunspot numbers) to develop a comprehensive multivariable machine learning model to forecast hurricanes using a unique time series approach. Artificial Neural Networks and AutoRegressive Integrated Moving Average models were individually trained and tested on each predictor variable, with the superior model for each dataset chosen using Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) metrics. The multivariable neural network was trained on a dataframe containing hurricane occurrence lags (KZ filtered for differentiability) along with the predictor variables. The multivariable model achieved a normalized MAE of 0.005510 and RMSE of 0.014245 during testing and was able to produce efficient, reliable forecasts of hurricane occurrence chances for one year. To model changes in geographic locations corresponding to the hurricane occurrence chance forecasts over time, the hurricane latitude and longitude datasets were individually forecasted a year into the future with the same approach used for the predictor variables. The success of these predictor variables and model combination provides promise for more extensive hurricane forecasts, improved alert times, and billions of dollars saved per hurricane.

Awards Won:
Fourth Award of $600
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