Environmental Radioactivity and Meteorological Variables: Statistical Relationships and Machine Learning Regression

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Whilst doing background radioactivity measurements I noticed that it changes significantly throughout the months. Thus, I asked myself if environmental radioactivity was influenced by the meteorological variables: temperature, pressure and air humidity, and if it was possible to predict environmental radioactivity based on those variables through a regression procedure, implemented by a machine learning (ML) model. To answer this question, I first designed and built three identical measuring devices, all capable of automatically measuring radioactivity, temperature, pressure and air humidity, six times a day, each time averaging the data over a one-hour interval. I used statistical and signal processing techniques to analyze the data gathered from the measuring instruments. Downstream of appropriate low-pass filtering, I found out that there is a very strong correlation between the radioactivity signal and those of all the meteorological variables. However, these correlations are highly variable over months, both in magnitude and sign: a behavior already observed in some quite recent scientific papers. Then I went further: I tried to train ML models to compute the radioactivity values based on meteorological variables. After experimenting with various ML regression techniques and working schemes, I achieved good results using a pipeline I called sliding prediction, combined with the Gaussian process regressor (GPR). I demonstrated that a model trained with the last 20 days of data can accurately predict the radioactivity (fed by the meteorological variables) for a few days ahead. This is a really important result, as this possibility has never been proven before.

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