WHEN MACHINE LEARNING DOES NOT HELP: CLASSIFICATION OF RADIATION COUNTING DATA

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ABSTRACT

Radiation measurements obtained with simple detectors are well described by Poisson counting statistics, where the mean count rate carries most of the relevant physical information. Here, we examine whether standard machine learning (ML) methods can improve the classification of radiation measurement scenarios beyond what can be achieved using basic statistical descriptors. Measurements were performed with a Geiger counter for seven distinct configurations, involving two radioactive sources of different strengths, varying source–detector distances, and shielding conditions. For each configuration, multiple samples were collected as short sequences of repeated count measurements. Several approaches were compared, including a nearest-mean classifier, Random Forests, and other standard classifiers (including distance-based and linear models). The results show that the simple nearest-mean approach consistently matches or outperforms the tested ML methods. Using the full sequence of counts or additional derived features did not lead to improved performance. This is consistent with the underlying Poisson statistics, for which the sample mean acts as a sufficient statistic for the count rate. These results illustrate a practical limitation of ML in settings where the data-generating process is well understood and dominated by simple statistical structure.

Keywords: radiation detection, machine learning, Poisson process, classification, Geiger counter.