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Machine Learning update for compliance verification of the Comprehensive nuclear-Test-Ban Treaty.

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Abstract A possible method of explosion detection for the Comprehensive nuclear-Test-Ban-Treaty (CTBT) consists of monitoring the amount of radioxenon in the atmosphere by measuring and sampling the activity concentration of Xe-131m, Xe-133, Xe-133m, and Xe-135. Several samples were simulated under different circumstances of nuclear detonation, and are used as training datasets to establish an optimal classification model employing state-of-the-art technologies in machine learning (ML). We conducted a preliminary study involving ML algorithms including Naïve Bayes, Neural Networks, Decision Trees, k-Nearest Neighbours, and Support Vector Machines. In addition to confirming that ML technology is appropriate for this problem, the study suggested that it can help guide our quest for more accurate simulated data sets, which benefit the entire CTBT community. By using these algorithms, we discovered undesirable artifacts of our initial synthetic explosion data set that needed to be rectified. Our preliminary ML study compelled us to improve the dataset by using a more realistic set of fission yields and by including atmospheric dispersion effects. The fission yields were corrected for amount of time in the explosion cavity and we assume a 10% release rate each 24 hours. The radioxenon from the explosion site was atmospherically transported (through simulations) to CTBT stations to determine an amount of radioxenon that would be measured by the stations. This was done for real atmospheric data. This new synthetic data set and the results of the machine learning algorithm obtained on it will be discussed.

Keywords: Machine Learning, CTBT, radioxenon monitoring, atmospheric transport.