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Title: Using Machine Learning Techniques to Identify Irradiated Fuel Attributes

Abstract
Separated plutonium poses a threat to nuclear nonproliferation efforts should it fall into the wrong hands. A deterrent to this scenario is the ability to attribute separated plutonium, enabling the global community to impose penalties on plutonium smuggling efforts. A previous nuclear forensics methodology developed at Texas A&M University was able to find separated plutonium's reactor of origin, burnup, and the time since irradiation (TSI). The methodology compared a set of ten intra-element isotopic ratios with a library of isotopic ratio values produced for various reactors using MCNP burnup simulations, and then calculating what reactor of origin, burnup, and TSI has an isotope ratio set that is the most probable match. An issue with this approach was that it is incapable of correctly attributing spoofed plutonium where plutonium sourced from two different reactors are mixed. To add this capability, a new approach is under development that builds upon the simulated reactor data available, but uses models trained by machine learning rather than the previous maximum likelihood method to perform attribution. The new methodology utilizes a support vector machine classifier with a set of seven isotopic ratios to find the reactor of origin and a set of regression models trained using gaussian process regression to predict the burnup with a different set of seven isotopes. TSI is calculated analytically using decay equations. One advantage of this approach is that each parameter of interest is resolved individually and only by using relevant isotopic ratios, as opposed to the original methodology which used all of the isotopes to resolve all parameters together. Thus far, the new methodology is capable of attributing pure plutonium samples and has been validated using experimental data. The next step will to be augment the classifier training data set with spoofed plutonium data.