Using Machine Learning to Improve Gamma-Neutron Discrimination in P-terphenyl and ^{6}Li Glass Detectors

Developing reliable neutron-gamma pulse shape discrimination (PSD) methods for scintillator detectors is important for fundamental science and modern security applications. Traditional PSD approaches are inadequate for low energy particles. We developed and optimized machine learning methods to overcome these energy limitations and to improve neutron-gamma separation. We sought to classify these particles using an artificial neural network (ANN) and visualize neutron-gamma separation using dimensionality reduction methods. To create training and testing data sets, p-terphenyl crystal and ^{6}Li glass detectors were used to detect isolated gammas, fast neutrons (p-terphenyl) and thermal neutrons (^{6}Li glass). The data was then used to optimize the ANN, which consisted of a non-sequential model for binary classification. Dimensionality reduction techniques were used to visually separate neutrons and gammas. We discuss the accuracy of the ANN in identifying neutrons and gammas over the incident energy spectrum and present the dimensionality reduction methods which yielded distinct neutron-gamma separation.