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Supervised learning of Photo-Electron counting in scintillator-based dark matter experiments

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Many scintillator based detectors employ a set of photomultiplier tubes (PMT) to observe the scintillation light from potential signal and background events. It is important to be able to count the number of photo-electrons (PE) in the pulses observed in the PMTs, because the position and energy reconstruction of the events is directly related to how well the spatial distribution of the PEs in the PMTs as well as their total number might be measured. This task is challenging for fast scintillators, since the PEs often overlap each other in time. Standard Bayesian statistics methods are often used and this has been the method employed in analyzing the data from liquid argon experiments such as MiniCLEAN and DEAP. In this work, we show that for the MiniCLEAN detector it is possible to use a multi-layer perceptron to learn the number of PEs using only raw pulse features with better accuracy and precision than existing methods. This can even help to perform position reconstruction with better accuracy and precision, at least in some generic cases.

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