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Coincidence classification in the large field-of view J-PET scanners with machine learning methods

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In PET medical imaging, the reconstruction of the spatial distribution of the radiotracer in patient's body is based on the photon pairs grouped into time coincidences. Due to the limited resolution the selected coincidences contain a fraction of events with a photon scattered in the patient or detector material and photons accidentally registered in a coincidence. Scatters and accidentals deteriorate the final image quality.
For a total-body scanner, the background level becomes a challenge. First, the accidentals statistics increase roughly quadratic with the scanner axial length. Second, the multiply scattered photons fraction is more pronounced. Morover in J-PET scanner the signal registration is based on the Compton scattering process, which makes the inter-detector scatters harder to discriminate.

We apply supervised learning models to estimate the background contribution. In particular, boosted decision trees and deep learning neural networks are considered. The training and test samples are based on GATE Monte Carlo simulations. Selection of optimal feature set and feature transformations is performed. Performances of XGBoost, AdaBoost and selected NN classifiers are compared with cut-based selection criteria. Considered models are compared based on efficiency metrics. Finally, preliminary comparison of reconstructed image quality is provided.

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