Gaussian Mixture Model Estimation in 2D Pet Image Reconstruction

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In positron emission tomography (PET), the radiotracer located in the object of interest emits pairs of gamma rays in opposite directions, forming a line. These events are captured by the scanner, meaning that the obtained image is a set of lines. Traditional methods of reconstructing the original location of the tracer are based on estimating the intensity in pixels or voxels on a predetermined grid, and are sensitive to noise or limited by high computational complexity. In this work, we investigate a novel method of PET image reconstruction based on the assumption that the underlying originals follow the Gaussian mixture model (GMM). One-dimensional projections of the model can be obtained directly from the measurements, giving us an overdetermined system of equations for the parameters. By using recursive reduction of dimensionality we are able to quickly find the minimal L1 solution for a single component, and the full model is estimated by an iterative procedure that resembles the expectation-maximization algorithm. We propose several variations of this procedure, depending on choices of weights and metric. As proof of concept, experiments are performed on artificial data and the proposed reconstruction methods are compared to each other and to existing, traditional methods. Given that the model is parametric and sparse, the encouraging results give hope that when adapted to real data, this approach will allow for accurate reconstruction from fewer measurements, meaning less exposure to radiation.

Acknowledgements: This research has been supported by the Croatian Science Foundation under the project IP-2019-04-6703.