Evaluation of penalizing functions in compressed Sensing to recover undersampled data in PET Imaging

Algorithm to reconstruct the image:

\[
\hat{x} = \min_x \left[ \Phi(x) + \tau \text{Pen}(x) \right] \quad \text{such that} \quad x \geq 0
\]

\[
\Phi(x) = \sum_j (G_x)_j y_j \log(G_x)_j \quad \text{Poisson loglikelihood function}
\]

Where

- \( y \): Partially sampled sinogram
- \( x \): recovered Image
- \( G \): system Matrix
- \( y_j \): \( j \)-th element of the undersampled sinogram

\[
\text{Pen}(x) = \|x\|_{TV}, \lambda_1 \|MU^T x\|_1 + \lambda_2 \|x\|_v, rdp
\]

\( \tau \): regularization constant

\( x \): estimated image that we want to recover

Four different sparse models (penalizing functions) were evaluated while using a fixed poisson noise model: a) a TV penalty term which assumes the image has a sparse representation in the finite difference domain.; b) a linear combination of a wavelet and TV (WT) penalty term; c) a recursive dyadic partitions (RDP) penalty term which is a model based estimate for the structure of an image; and d) a variant of RDP that utilizes a cycle-spun translation invariant version referred to RDPTI.