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Variational analysis of a dynamic PET reconstruction model with optimal transport regularization

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We consider the dynamic Positron Emission Tomography (PET) reconstruction method proposed by Schmitzer et al. [1] that particularly aims to reconstruct the temporal evolution of single or small numbers of cells by leveraging optimal transport. Using a MAP estimate the cells' evolution is reconstructed by minimizing a functional $\mathcal{E}_n$ - composed of a Kulback-Leibler-type data fidelity term and the Benamour-Brenier functional - over the space of positive Radon measures. This choice of the regularization ensures temporal consistency between different time points.

The PET measurements in our forward model are described by Poisson point processes with a given intensity q_n. In the talk we show Γ-convergence of the stochastic functionals $\mathcal{E}_n$ to a deterministic limit functional for $q_n \to \infty$. This helps understanding the properties of the considered reconstruction method for an increasing SNR. To compute the Γ-limit we show convergence of Poisson point processes for intensities growing to infinity as well as convergence of the optimal transport regularization. The latter requires the approximation of arbitrary Radon measures by ones satisfying the continuity equation while controlling the Benamou-Brenier energy.

Reference:

[1] B. Schmitzer, K. P. Schäfers, and B. Wirth. Dynamic Cell Imaging in PET with
Optimal Transport Regularization. IEEE Transactions on Medical Imaging,
2019.

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