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Stochastic Optimisation Framework using the Core Imaging Library and Synergistic Image Reconstruction Framework for PET Reconstruction

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This study introduces a flexible, plug-and-play style stochastic optimization framework into the Core Imaging Library (CIL), facilitating the development and evaluation of diverse stochastic algorithms for image reconstruction tasks.

By plugging stochastic gradient estimators into base algorithms (including gradient descent and ISTA), we can produce a range of stochastic algorithms, including stochastic gradient descent (SGD), stochastic average gradient (SAG), and stochastic variance reduced gradient (SVRG), among other techniques.

We demonstrate the stochastic framework on positron emission tomography (PET) reconstruction, thanks to the combined use of the Synergistic Image Reconstruction Framework (SIRF).

We assess the performance of the algorithms with respect to the number of 'data passes,' i.e., how many times the algorithm has processed all the data in expectation. Results demonstrate that the stochastic algorithms achieve the optimal solution in fewer data passes than their deterministic counterparts. The plug-and-play nature of the software also allows for an easy comparison between different stochastic methods.

Future research endeavours will concentrate on expanding and testing the framework on other imaging modalities and data, and expanding the portfolio of implemented algorithms. We also aim to integrate further step-size rules and preconditioning options for further performance enhancement.

Field

Software and quantification

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