Non-linear compressed sensing and its application to beam hardening correction in x-ray tomography

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Traditionally, compressed sensing assumes a *linear*, ill-posed or non-invertible forward model, which is inverted with the help of non-convex constraints. Recently these ideas have been extended to non-linear forward models. It could be shown that, under certain conditions, strong performance guarantees available for traditional compressed sensing also hold in the non-linear case.

In this talk I will present some initial results that explore these ideas empirically on an x-ray tomographic reconstruction problem. Using a non-linear x-ray transmission model which accounts for energy dependent absorption, it is demonstrated that non-linear compressed sensing methods can lead to superior tomographic reconstruction. However, it is also observed empirically that compressed sensing reconstruction not always finds the global optimum of the non-linear compressed sensing cost function, indicating that in some cases, the theoretical requirements are not always met.

Our results are based on an iterative reconstruction method that extends recently introduced conjugate gradient hard thresholding algorithms to the non-linear setting. Using an efficient line search procedure, the efficient computational method only requires the specification of the global, unconstrained cost function, its gradient and a non-linear compressed sensing projection operator, which, in the simplest case, boils down to the standard sparse projection operator used often in traditional compressed sensing. For x-ray tomographic reconstruction, wee show that it is advantages to adapt this operator to enforce more appropriate constraints.