Title: Fixed-point Algorithms for Emission Computed Tomography Reconstruction

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Abstract

Emission computed tomography (ECT) is a noninvasive molecular imaging method that finds wide clinical applications. It provides estimates of the radiotracer distribution inside a patient’s body through tomographic reconstruction from the detected emission events. In this talk, we propose a fixed-point algorithm - preconditioned alternating projection algorithm (PAPA) for solving the maximum a posteriori (MAP) ECT reconstruction problem. Specifically, we formulate the reconstruction problem as a constrained convex optimization problem with the total variation (TV) regularization via the Bayes law. We then characterize the solution of the optimization problem and show that it satisfies a system of fixed-point equations defined in terms of two proximity operators of the convex functions that define the TV-norm and the constraint involved in the problem. This characterization naturally leads to an alternating projection algorithm (APA) for finding the solution. For efficient numerical computation, we introduce to the APA a preconditioning matrix (the EM-preconditioner) for the large-scale and dense system matrix. We prove theoretically convergence of the PAPA. In numerical experiments, performance of our algorithms, with an appropriately selected preconditioning matrix, is compared with performance of the conventional expectation-maximization (EM) algorithm with TV regularization (EM-TV) and that of the recently developed nested EM-TV algorithm for ECT reconstruction. Based on the numerical experiments performed in our work, we observe that the APA with the EM-preconditioner outperforms significantly the conventional EM-TV in all aspects including the convergence speed and the reconstruction quality. It also outperforms the nested EM-TV in the convergence speed while providing comparable reconstruction quality.

Speaker

Professor Yuesheng Xu is currently the Guohua Chair Professor of Sun Yat-sen under the “One Thousand Talent Schemes” of China in 2011. He has been a professor in Syracuse University, USA, and the Eberly Chair Professor of Applied Mathematics in West Virginia University, USA. He was awarded the 100 Outstanding Young Chinese Scientists, Chinese Academy of Sciences in 1999, and Changjiang Guest Professorship in 2005.

He was the managing editor of the international journal: Advances in Computational Mathematics. His research interest resides in approximation theory, wavelets, integral equations, fast algorithms, signal and image processing.

Host: Associate Professor Wang Li-Lian, School of Physical and Mathematical Sciences