THE UNIVERSITY OF CHICAGO

COMPUTATIONAL AND APPLIED MATHEMATICS COLLOQUIUM

FATMA TERZIOGLU

CCAM William H. Kruskal Instructor

Uniqueness and Stability of Reconstruction in Multi-Energy Computed Tomography

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via ZOOM

ABSTRACT

Multi-Energy Computed Tomography (ME-CT) is a medical imaging modality aiming to reconstruct the spatial density of materials by using energy-dependent attenuation properties of probing x-rays. While conventional single-energy CT can only reveal the morphology of scanned objects, and hence is qualitative, ME-CT can provide absolute and quantitative information on the scanned object, e.g., its chemical composition.

ME-CT measurements are mathematically modeled by a nonlinear function that maps line integrals of the unknown densities of a finite number of materials (typically bone, water and contrast agents) to their energy-weighted integrals obtained using several x-ray source energy spectra. Image reconstruction in ME-CT may thus be achieved in two steps: first the reconstruction of line integrals of the material densities from their energy-weighted integrals, and then the reconstruction of material densities from their line integrals. The second step is the standard linear x-ray CT problem whose invertibility is well-known. The first step is however a nonlinear map, with no known analytical inverse.

Although developing numerical material reconstruction algorithms in ME-CT has attracted significant interest in the last decade, the uniqueness and stability of the inversion has rarely been addressed. In this talk, I present sufficient criteria that guarantee global uniqueness and stability of ME-CT reconstructions. The results of a reconstruction algorithm whose convergence is ensured by these criteria will also be provided.

For further information and inquiries, please email Zellencia Harris at zellenciah@uchicago.edu. If you wish to subscribe to our listserv, please visit the following website: https://lists.uchicago.edu/web/subscribe/cam_colloquium."