# Universal Statistical Model for Image Reconstruction

Eugene Demidenko
Dartmouth College

Thursday, May 25, 2000
102 Bradley Hall, 4:00 pm
(Tea 3:30 pm Math Lounge)

**Abstract**

Due to recent technological advances in data acquisition, researchers are able to obtain images. In many instances images are reconstructed by solving the inverse problem. For instance, in computed tomography applying x-rays through the body we can reconstruct the image by measuring the intensity of attenuated outcome on the periphery. To reconstruct the image two components must be provided: the forward problem (e.g. how x-ray intensity drops when it goes through a body of certain thickness) and the method for reconstruction.

Mainly three methods apply to reconstruct the image: fitting by least or penalized least squares or finding the posterior image using Bayesian approach. Each of these methods has its own shortcoming: Least squares may produce bad image because image restoration is an ill-posed inverse problem. Penalized least squares makes the initial ill-posed problem well-posed but the regularization parameter is unknown. Bayesian approach requires full specification of the prior image which makes statistical inference somewhat subjective. We suggest to apply a recently emerged mixed effects modeling technique which accommodates the existing approaches in one universal model. Importantly, a statistical model for image reconstruction leads to a self-evaluated precision of the reconstructed image that creates a foundation for solutions of important questions such as how many sources and detectors to use, optimal mesh, image comparison, etc.

It is shown how the universal statistical model based on mixed effects approach is applied to computed tomography (spectroscopy), photon emission tomography, magnetic resonance imaging (MRI), functional MRI (fMRI), and general inverse problem.

This talk should be accessible to undergraduates.