The Center for Statistics

GK 1023: Identification in Mathematical Models

Lecture series on

Statistical Inverse Problems

by Prof. B.Mair, University of Florida (USA)

from June 20th to 6th of July, 2005

1st Week			
Monday,	**20th June**	**11:15 - 13:00**	**Transmission Tomography** – Model (Radon transform), mathematical properties – Filtered back projection algorithm (FBP)
Tuesday,	**21st June**	**14:15 - 16:00**	**Emission tomography (ET)** – Medical uses, physics of the process, engineering of scanners – Probabilistic model (involves Poisson thinning) – Properties of maximum likelihood (ML) estimators
Wednesday,	**22nd June**	**14:15 - 16:00**	**Algorithms for computing ML estimators in ET** – FBP,ART, EM
2nd Week			
Monday,	**27th June**	**11:15 - 13:00**	**Statistical errors in ET data** – Description of errors (Randoms, scatter, attenuation) – Error-correcting methods
Tuesday,	**28th June**	**14:15 - 16:00**	**Algorithms for error-correction** – Penalized ML, or maximum aposteriori (MAP) methods and algo. – Wavelet denoising of Poisson data
Wednesday,	**29th June**	**14:15 - 16:00**	**Generalization of EM-ML algorithm** – Generalizes EM-ML algorithm to reconstruction of infinite dimensional functions – applications to other areas – general EM algorithm
3rd Week			
Monday,	**4th July**	**11:15 - 13:00**	**Accelerated EMML algorithm** – Ordered subsets (OSEM) – Re-scaled block iterative (RBIEM) – Convergence will be investigated
Tuesday,	**5th July**	**14:15 - 16:00**	**List-mode ET**
Wednesday,	**6th July**	**14:15 - 16:00**	**New technologies, challenges** – Fusion of modalities – PET/CT scanners – organ/patient motion

Abstract:
Emission tomography is an important method for functional, molecular imaging of living tissue. It can be used to detect abnormalities in cellular activity before there is any observable anatomical change. It is used to identify many forms of cancer, a damaged heart, and many brain disorders. It is based on the metabolism of various naturally occurring chemicals which are tagged with a radio-isotope. As the isotope decays, the emitted photons are detected and numerical algorithms produce an image of the amount of radiotracer at each location. The direct (non-iterative) filtered back projection algorithm has been the mainstay for reconstructing tomographic images since its inception in the seventies. However, due to the variety of applications requiring relatively short imaging times, and the need for accurate quantitative information, modern scanners now incorporate iterative algorithms based on statistical models and methods. The most common iterative algorithms are modifications of the standard expectation maximization algorithm. As a result, we will pay special attention to this method. We will discuss some of the physics motivating the statistical models, convergence characteristics of the algorithms, and indicate interesting open problems in the area.

Location: Seminar room of the IMS, **Maschmühlenweg 8 - 10**

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