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香港浸會大學
HONG KONG BAPTIST UNIVERSITY

Institute for Computational Mathematics

Lecture Series

Numerical Multilinear Algebra

Speaker : Dr. Lim Lek-Heng
University of California
USA

Venue : FSC1217, Fong Shu Chuen Library
Ho Sin Hang Campus
Hong Kong Baptist University

	Title	**Date**	**Time**
Lecture 1	Tensors as Hypermatrices	5 January 2009 (Monday)	10:00 a.m. - 12:00 noon
Lecture 2	Multilinear Decompositions	6 January 2009 (Tuesday)	10:00 a.m. - 12:00 noon
Lecture 3	Computations and Applications	7 January 2009 (Wednesday)	10:00 a.m. - 12:00 noon

– All interested are welcome –

For further information, please visit **http://www.math.hkbu.edu.hk/ICM/lectures**, or call 34115056.

Lecture 1 : Tensors as Hypermatrices

Abstract : We will discuss the various meanings ascribed to the term "tensor" in algebra, analysis, and geometry, as well as in engineering, physics, statistics, and technometrics. Just as linear operators, bilinear forms, and dyads may all be represented by the same matrices, we will see that different types of higher-order tensors may be represented by hypermatrices if we ignore covariance and contravariance. Basic concepts like norms, rank, determinants for matrices do not however have well-known generalizations to hypermatrices --- not unless we look beyond a single field. In fact, the study of tensor norms came from functional analysis, tensor ranks started in computational complexity, and hyperdeterminants originated from algebraic geometry. We will discuss these and other hypermatrix generalizations of matrix mathematics.

Lecture 2 : Multilinear Decompositions

Abstract : We will examine two classes of decompositions and their corresponding approximation problems. We will first discuss "secant decompositions," which one may view as r-term decompositions over a dictionary that is a continuously varying manifold or variety. Examples include resolving a tensor into a sum of decomposable tensors, an operator into a sum of Kronecker products, a homogeneous polynomial into a sum of powers of linear forms, a joint probability distribution into a sum of conditional probability distributions, a multivariate function into a sum of separable functions. For each of these, we will discuss its closely related cousin that takes the form of a "subspace decomposition". We will look at some known results and problems in studies of such decompositions.

Lecture 3 : Computations and Applications

Abstract : We will be interested in applications of these techniques to data analysis, machine learning, neuroscience, and signal processing. We will present the methods as different ways of generalizing principal components analysis (PCA) using multilinear algebra and the two classes of decompositions. In particular, we will examine a new technique called Principal Cumulant Components Analysis (PCCA) that relies on subspace approximations of cumulants, which are symmetric tensor generalizations of the covariance matrix. We will compute principal cumulant components using a limited memory BFGS algorithm on Grassmannians. This part of the lectures will feature new joint work with Jason Morton of Stanford (PCCA) and Berkant Savas of UT Austin (Grassmannian L-BFGS).