TEXAS TECH UNIVERSITY
Department *of* Computer Science

Prolate Spheroidal Wave Functions, Quadratures and Their Utilities in Data Science

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Abstract: As machine learning solutions become ubiquitous, a frequently encountered problem when dealing with real-world data is lack of sufficient data. Many approaches exist in combating this inadequacy: model complexity reduction, transfer learning, data augmentation, and data synthesis. Alternatively, data can be transformed so that hidden patterns can be modelled with fewer parameters. One such potential approach is to transform using bandlimited functions, which are functions whose Fourier transforms have compact support. Indeed, classical Fourier analysis is an indispensable tool in many scientific and engineering disciplines (e.g. mathematics, statistics, signal processing, image processing, communications, optics, electromagnetics, quantum mechanics, etc.), and more recently in machine learning. More than 40 years ago, Slepian et al discovered that Prolate Spheroidal Wave Functions (PSWFs) are the optimal approach for the analysis of band-limited functions on the interval. Surprisingly, their usage as a standard computational tool is still largely unexplored. The principal reason appears to be the lack of necessary evaluation schemes.

This talk will present recent developments in the theory of band-limited functions. We will show that the evaluation of PSWFs presents no serious difficulties in the modern computational environment. We provide numerical schemes as well as asymptotic formulae for this evaluation, including for high frequencies. Analogues of some of the classical numerical techniques for band-limited functions are available; we illustrate their utilities in data science with examples.

Bio: Dr. Xiao received a B.E. degree in Computer Science and Technology from Tsinghua University in Beijing, China, and a Ph.D. degree in Computer Science from Yale University in New Haven, CT. Before going into industry, she taught at the University of California, Davis in the Mathematics Department. Dr. Xiao has received multiple National Science Foundation (NSF) grants as a Principal Investigator (PI), and other extramural and internal funds as a PI or a collaborator. She has also been contracted to work on a variety of other grants and government projects. For the past ten years, Dr. Xiao has held positions in industry as a scientist, software engineer, Director of Engineering, and, most recently, Head of R&D at Clostra, Inc. She has published two books, numerous journal articles, and many conference papers. Her research interests span Artificial Intelligence, Numerical Computation, Band-Limited Functions, Video and Image Processing, Signal processing, Wireless Communications, and Machine Learning. Her current research interest is in the development of scalable, high-efficiency solutions for data science problems.